NASDAQ Futures (NFX) Combination & Implied Orders

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Table of Contents

1. Combination Strategies

The Trading System supports the trading of Strategies also referred to as Combination Orders, which will trade in a separate Order Book. The Exchange may list Combination Orders comprised of either Futures or Options, but not both Futures and Options, and users may create their own tailor made combinations (TMC) for Futures or Options combinations not already defined in the Trading System. Combination Orders consisting solely of Call or Put Options of the same underlying and Expiry but with different strikes must include at least one buy and one sell leg. Market participants may submit Combination Orders that, if matched, will simultaneously trade the referenced single leg Instruments according to the specified strategy without execution risk. Combination Orders will first execute against respective legs of Orders before executing against other Combination Orders within the Combination Order Book. Once implemented, a TMC Order Book is visible to the entire market and lives throughout its defined lifetime from one to ten days (or less, if a single leg expires). Orders are permitted in Combination Order Books.

Instruments	A TMC Order may be comprised of a minimum of two, but not exceed four Instruments within the same or from different underlying Instruments. It is possible to have a relative ratio of up to 4:1 between the included Instruments. Inter-Commodity Spreads may be formed with a minimum of two Instruments but may not exceed four Instruments.
No Execution	Strategies that are TMC or pre-defined Combination Orders all Instruments will be simultaneously executed at a net price without execution risk, for each Instrument respectively including underlying legs.
Price	The price for an Order shall be stated as a common net price, i.e. the premium times the ratio for the Instrument to be bought minus the premium times the ratio for the Instrument to be sold.
Combination Order Book	When the TMC Order is created, it will appear in a Combination Order Book which is visible to the entire market.
Easy to Use	Users create the TMC Order by defining the Instruments, Expiry and Contract. A User would then identify the ratio between the Instruments as well as the number of contracts and the net price.
Implied-In Orders	Implied-in Order prices are automatically calculated by the Trading System but are not published. When a TMC Order is entered, the Order will be matched in the Order Book utilizing Implied-In Order prices from the respective leg Order Book.
Implied-Out Orders	Implied-out Orders are automatically generated by the Trading System, except for Tailor Made Combination Orders.

1.1 Introduction to Combination Strategies

Representative types of Combination Orders accepted by the Trading System, which may be comprised of a minimum of two, but not exceed four, legs are as follows:

- **Call (Put) Spreads** – Buy and sell two call (put) Options of the same underlying and expiration but with different strikes.
- **Calendar (Horizontal) Spreads** – Buy and sell two call (put) Options of the same underlying and strike, but with different expirations.
- **Straddles** – Buy a call Option and a put Option of the same underlying, expiration and strike.
- **Strangles** – Buy a call Option and a put Option of the same underlying and expiration, but with different strikes.
- **Butterfly Spread** – A Contract strategy consisting of three legs either for Futures or Options. Butterfly Option Spreads consist of three put and/or call Contracts. Butterfly Futures Spreads consist of three Contracts.
- **Condor and Iron Condor Spreads** – A Contract strategy consisting of four legs. Condor Options Spreads consist of four Options Contracts (all put or all callContracts). Condor Futures Spreads consist of four Futures Contracts. Iron Condor Options Spreads consist of four Options Contracts (two put and two call Contracts).
- **Intra-Commodity (Time) Spread** – Combinations may be formed by buying and selling two Futures of the same underlying, but with different expirations. Combinations may be formed by two different Future Expiries (NFX WTI Crude Oil Penultimate Financial Futures, March versus June contract).
  - The price ratio for the underlying legs will be configured to an integer of one. There will be no change to the trading tick size.
- **Inter-Commodity Spread** – Combinations may be formed of two or three different underlying Futures Contracts (NFX WTI Crude Oil Penultimate Financial Futures versus NFX RBOB Gasoline Financial Futures versus NFX Heating Oil Penultimate Financial Futures "Crack Spread").
  - The price ratio for the underlying legs will be configured to an integer of less than one, but rounded to four decimal places to the right from an initial calculation of fourteen places. Accordingly, the minimum price interval for a respective leg price is one hundredth of a cent ($0.0001) versus its outright leg trading tick which may be 0.01.

An example of a Time Spread NFX WTI Crude Oil Financial Future:

- Buy 1 NFX WTI Crude Oil Financial Future April 2017 contract

- Sell 1 NFX WTI Crude Oil Financial Future March 2017contract

Combination Orders are traded in a Combination Order Book. It is possible that the Combination Order can execute against another Combination Order, or (if configured) can execute against Orders in the single Order Book legs.

If not executable on entry, Combination Orders are stored in the Combination Order Book until such time as they are executable.

In addition, the Trading System is configured to generate automatic "Implied" Orders in the Order Books specified within the Combination (i.e. the legs) that are automatically re-calculated when prices change. Such Combination Order Books are generated by the Trading System, or, alternatively, may be defined by the Futures Participants themselves within the rules of the Exchange.

1.2 Combination Orders

Combination Orders require that a Combination Order Book be pre-defined in the Trading System by the Exchange. An example of a Combination Order within the Combination Order Book could be:

Combination Order Book Time Spread NFX WTI Crude Oil Financial Future:

- Buy 1 NFX WTI Crude Oil Financial Future April 2017 contract

- Sell 1 NFX WTI Crude Oil Financial Future March 2017 contract

Combination Orders are stored in the Combination Order Book until they are executed, either in the Order Book legs or directly in the Combination Order Book itself (i.e. a Combination to Combination match). It is configurable if integration with single Order Books (legs) by Contract should occur.

Combination Orders specify a quantity and whether they are buying or selling the Combination. Combination Order Books are priced using a net price method describedbelow..

If integration with single Order Books should occur, Implied Orders are available for trading. Implied Orders (also known herein as Derived Orders) are Orders automatically generated by the Trading System for the purpose of trading Combinations. Orders, which are Implied, are calculated and posted in single respective leg Order Books. Implied Orders display the liquidity available in the marketplace derived from available Combination Orders. Implied Orders are generated only during the continuous matching in the Open Session.

1.2.1 Defining Combination Order Books

Combination Order Books can be either Exchange-defined ("Standard") or participant-defined ("Tailor-Made") Combination Order Books. The Exchange-defined Combination Order Books, described herein, may be created by NFX Market Operations, or otherwise automatically generated by the Trading System for the more popular Combinations (based on underlying prices and time), Futures Participants may create their own Combination Order Books for Combinations they want to trade subject to the rules of the Exchange. Once a user defined Combination Order Book has been defined, trading will be subject the same rules as trading any other Combination Order. A Combination Order Book is made up of multiple respective single Order Book leg(s). For each leg, a side (whether to buy or sell) and ratio must be specified (how much to buy or sell of the leg per unit of the Combination) when entering the Order into the Trading System.

A Combination Order Book may specify both buys and sells of its single Order Book legs (e.g. buying the Combination equals buy leg A and sell leg B). For each leg, selling the Combination will always mean the opposite to buying the Combination. The convention of "buying and selling" the Combination as such makes trading in Combinations more comparable to trading in single Order Books.

For example:

Buying Combination Order Book Time Spread NFX WTI Crude Oil Financial Future (Order Book C):

- Buy 1 NFX WTI Crude Oil Financial Future April 2017 contract

- Sell 1 NFX WTI Crude Oil Financial Future March 2017 contract

A buyer of Order Book C would be buying NFX WTI Crude Oil Financial Future April 2017 Future and selling the March 2017 Future.

A seller of Order Book C would be selling NFX WTI Crude Oil Financial Future April 2017 Future and buying the March 2017 Future

1.2.1.1 Ratios 928

A ratio is defined for each leg of the Combination Order. Ratios define the quantity of the leg relative to the quantity of the Combination Order and are reflected in a given net price of the Combination Order (see also Pricing Combinations).

For example:

Buy Combination Order Book C:

Buy 1 unit of Order Book leg A (current BBO is 14-15)

Sell 2 units of Order Book leg B (current BBO is 5-6)

where 1 and 2 are the ratios for the legs

A buyer of Order Book C would pay a net price of 5 per unit ((1 * 15) - (2 * 5)).

A seller of Order Book C (i.e. Sell 1 unit leg A and Buy 2 units of leg B) would receive a net price of 2 per unit (-(1 * 14) + (2 * 6))

The ratio for the legs should always be given with the smallest common denominator. A Combination Order to buy 10 contracts of Order Book leg A, and sell 20 contracts of Order Book leg B, is instead set up to buy 1 of A, sell 2 of B, and then the lot size for the Combination Book is set to 10 contracts.

1.2.1.2 Order Book Handling

1.2.1.2.1 Combination to Single Leg

When Combination Orders are traded against single Orders, the rules of the single Order Book are followed.

The calculated quantity of each leg (e.g. Combination Order Quantity * Leg Ratio) must be valid in regards to the lot type of the single Order Book leg.

1.2.2 Pricing Combinations 934

The Trading System supports the net price "Net Price" method for pricing Combination Orders:

Net Price is the sum of the Price * Ratio for all legs.

If buying the Combination Order, the price of a bought leg is added and the price of a sold leg is subtracted:

$$B_{uy} \, N_{et} \, P_{rice} = B_{uy} - S_{ell}$$

For example:

A Combination Order Book, C is defined as

- Buy 2 units of Order Book leg A (current BBO is 7-8)

- Sell 1 unit of Order Book leg B (current BBO is 11-12)

for each bought contract of the Combination Order:

where 1 and 2 are the ratios for the legs

A buyer of Order Book C would pay a net price of 5 per unit , ((2*8) - (1*11))

If selling the Combination Order, the reverse is true:

$$S_{ell} \, N_{et} \, P_{rice} = S_{ell} - B_{uy}$$

A seller of Order Book C (i.e. Sell 2 unit leg A and Buy 1 units of leg B) would *receive* a net price of 2 per unit ((2*7) - (1 * 12))

If buying the Combination Order, the price of a bought leg (which is a buy-leg in the Combination Order definition) is added, and the price of a sold leg is subtracted. The result of this is that theprice for a Combination Order is:
- a positive value, when
  - The participant is buying the Combination Order and is willing to pay, or
  - The participant is selling the Combination Order and wants to be paid
- a negative value, when
  - The participant is buying the Combination Order and wants to be paid, or

> o   The participant is selling the Combination Order and is willing to pay

When using Net Price, legs could have a pricing unit ("Pricing Unit") of Price or Percent of Nominal, but all legs should have the same Pricing Unit, to get a relevant result. All legs, as well as the Combination Orders must have ascending price ranking. Note that the positive and negative value behavior described above do not always hold true when a Combination Order is made up of legs with different contract sizes.

1.2.3 Matching - Combination-to-Combination 948

If Combination Orders are matched against other Combination Orders, the matching follows the defined ranking and matching rules (see Ranking & Matching) for the Combination Order Book itself.

Note that trades to clearinghouses (The Options Clearing Corporation or OCC) are reported in the single Order Books. For Combination-to-Combination matches, the Trading System calculates the prices and quantities in the legs needed for the downstream Trading Systems and processes.

The split of Combination to Combination strategies "aka deals" is made by a downstream process. One effect of that, is that such a trade will never update the last match price in the single Order Books, and can therefore not cause triggering of Orders dependent of that price.

Another effect of that, is that such a trade will never update the last match price in the single Order Books, and can not update the price limits for last price.

Following is an example of a Combination-to-Combination Order match.

Given the following Combination Order traded in net price:

Buy Instrument A ratio = 1, Sell Instrument B ratio = 1

Combination Order Book			
100	$8.50	$9.10	110
50	$8.45	$9.20	100

A Combination Order comes in to sell 120 @ 8.40

Order matches both buy Orders.

1.2.3.1.1 Try to find two-way leg prices 961

If any of the legs do not have two-way prices, try to find prices, by using a reference price as guided in the next section, and applying a theoretical spread.

1.2.3.1.1.1 Reference Price Definition 962

One of the following prices, as prioritized below, will be the Reference Price:

- Current BBO;

- Historic BBO;
- Last paid price;
- Closing price;
- Reference Price received from external source via the FIX API;
- Manually entered by NFX Market Operations; or

- Last auction price.

If several Reference Prices are available, then the last updated Reference Price will be selected by the Trading System. For example, if an auction has been completed, this Reference Price will be used instead of the Closing Price. A subsequent manual update by NFX Market Operations will supersede the last auction price, and so on.

1.2.3.1.1.2 Calculate a theoretical spread 963

Find bid and ask prices for all legs, to use in coming price validations

Theoretical Spread in Number of Ticks = ThSpTicks. This will be set equal to the largest existing spread for any of the legs + 1 tick, always rounded to an even number of ticks, or if none of the legs has a current BBO, to 20 ticks.

For each leg:

- if Bid exists, but not Ask, set

  o Ask = Bid increased with ThSpTicks number of ticks

- if Ask exists, but not Bid, set

  o Bid = Ask decreased with ThSpTicks number of ticks

- if neither Bid nor Ask exist set, but Bid did exist as last previous Order, set

  o Ask = Last previous Bid increased with ThSpTicks number of ticks

- if neither Bid nor Ask exist set, but Ask did exist as last previous Order, set

  o Bid = Last previous Ask decreased with ThSpTicks number of ticks

- if neither Bid nor Ask exist, and no previous Bid or Ask did exist, set

  o Bid = Reference decreased with (ThSpTicks/2) number of ticks

  o Ask = Reference increased with (ThSpTicks/2) number of ticks

  o If no reference price exists and the configuration parameter Leg Prices Outside BBO allowed is set to YES, Bid = Lowest Tick and Ask = \$100.00

1.2.3.2 Break Combination Matches into Single Legs

When Combination-to-Combination Orders deals should be split into deals in single legs, an algorithm for finding prices and quantities for the single legs is applied. The algorithm chooses prices for the legs, so that they are within the current spread to the largest possible point. The algorithm allows for multiple matches in one single Order Book, if this is necessary to find appropriate prices which are at tick.

1.2.3.2.1 Leg-Price Algorithm

1.2.3.2.1.1 General assumptions

The algorithm for calculating leg prices for Combination-Combination Order matches is based on a few preconditions and assumptions on acceptable leg prices. The algorithm will provide a solution in a fixed number of steps given that the preconditions are fulfilled.

- Prices are available for all legs in all cases. This means that if current bid and ask figures are missing, a Reference Price will be used to calculate a spread and if no Reference Price exists and the configuration parameter Leg Prices Outside BBO Allowed is set to YES, the spread of Lowest Tick - $100.00 is used.
- If net price is within the derived Combination Order spread, the algorithm strives to find single prices that are within single spread, and on tick sizes. To help achieve this, multiple trades can be written for one leg, and/or prices on single legs can be off tick size.
- The Order in which prices are decided for the legs, follows the principles below:
  - Find prices for legs where the tick size is large.
    - For legs with the same tick size, start with legs where the price spread is small
- Please note, that even if current bid is $0.00 (which is not uncommon for deep-out options, that they have a BBO of $0.00 - $0.05), we cannot create single trades at $0.00, they must have a price.

1.2.3.2.1.2 Requirements on calculated leg prices

The calculated leg prices must sum up to the given net price for the Combination Order.

The algorithm shall as first priority create prices on tick. To achieve this, two trades may be created in the individual legs which give the calculated average price.

As a last resort, if creating two trades does not give a correct solution, then the algorithm shall create trades off-tick prices to reach the Combination Order net price.

1.2.3.2.1.3 Price Calculation Rules

In the following sections, descriptions on how to find price and quantities are described, per defined Combination Order:

- Ratio is a positive value, taken from Reference Data for the defined Combination Order Book. BSRatio (BuySellRatio) is defined as follows:
  - If the leg is sold, BSRatio = -1 * Ratio
  - If the leg is bought, BSRatio = Ratio
  - Ratio is specified per Combination leg
- Abbreviations for reference data parameters used in calculation text below:
  - Implied Multiplier (based on Price Quotation Factor*) = IM
    - Leg Prices Outside BBO Allowed = LegPriceOutsideBBO.

Step 1 - Find bid and ask prices to use in coming calculations.

For each leg:
- if neither Bid nor Ask exist (are given in the message), set
  - Bid = Reference – ThSpTicks/2 * ticksize (at reference price)
  - Ask = Reference + ThSpTicks/2 * ticksize (at reference price)
- if Bid exists, but not Ask, set
  - Ask = Bid + ThSpTicks * ticksize (at Bid)
- if Ask exists, but not Bid, set
  - Bid = Lowest Tick

If the extended limit price is inside the calculated Bid - Ask spread, then adjust the spread so that the extended limit price is not violated.

This means that the calculated prices in the legs have to be better than or equal to the extended limit price according to the ranking rules.

Step 2 - Find the lowest possible contribution to the Combination price, that would still have leg prices at the spread, by letting buy legs use leg-bid, and selling legs use leg-ask, and the highest possible contribution, by letting buy legs use leg-ask, and selling legs use leg-bid.

- If BSRatio > 0, calculate:

    o Ratio Leg Low = BSRatio * Bid

    o Ratio Leg High   = BSRatio * Ask

- If BSRatio is not > 0, calculate:

    o Ratio Leg Low = BSRatio * Ask

    o Ratio Leg High = BSRatio * Bid

Step 3 - Find the lowest and highest possible Net price, by summarizing the leg contributions.

For Combination:

- Calculate

    o Combination Bid = SUM(Ratio Leg Low)

    o Combination Ask = SUM(Ratio Leg High)

Step 4 – Decide order to find price.

Sort legs according to the following principles:
- Start with legs where there is no spread (i.e. bid and ask are equal after step 1)
- Then, take legs the in order of their tick size, starting with the largest tick size.
- For legs with the same tick size, take legs in order of their spread, starting with small spreads.

Step 5 – Find Prices for all legs

For each leg, in determined order:

1.2.3.2.1.3.1 A: Find % distance from Combo-Net to Combo-Bid

The basic idea behind the algorithm, is to try to stay with the same distance (in percent) from the Combination Bid Price to the Combination net for all legs. If pursued, the possibility of finding leg prices within the spread, even for the last legs is improved. There might be other restrictions though that must be taken care of as well.

Calculate:

1. Combination Spread (CombSpr) = Combination Ask – Combination Bid

2a. If CombNet is within CombSpread:

- Percent = (CombNet – Comb Bid)/CombSpr
- LegRatioPrice = Percent * (Ratio Leg High – Ratio Leg Low) + Ratio Leg Low

   2b. If CombNet is not within CombSpread:

     2b.1. If LegPriceOutsideBBO, calculate

- Percent = (CombNet – Comb Bid)/CombSpr
  - LegRatioPrice = Percent * (Ratio Leg Ask – Ratio Leg Bid) + Ratio Leg Bid

    2b.2 Else (*Leg Price is **not** allowed to be outside spread, set it **at** the spread*)

- If Net > Comb Ask
  - LegRatioPrice = Ratio Leg Ask
- Else
  - LegRatioPrice = Ratio Leg Bid

1.2.3.2.1.3.2 B: Round calculated leg price

1. If this is not last leg – round LegRatioPrice to tick size

1.2.3.2.1.3.3 C: Try to find 1 match

Try to see if a rounded leg price (without ratio) to an even tick size is possible to find without pushing the Combination Net for the remaining legs to be outside the remaining Combination Order spread:

1. Calculate two possible leg prices, one rounding up and one rounding down:

- LegPricePerContractLow = Round down to closest tick. (example: trunc ((LegRatioPrice / Ratio) / Tick Size, 0) * Tick Size)
- LegPricePerContractHigh = Round up to closest tick. (example: roundUp ((LegRatioPrice / Ratio) / Tick Size, 0) * Tick Size)
- If LegPricePerContractLow is outside the leg spread and LegPricePerContractHigh is inside the spread, then the low price is not a possible choice, and therefore
  - LegPricePerContractLow = LegPricePerContractHigh
- OR if If LegPricePerContractHigh is outside the leg spread and LegPricePerContractLow is inside the spread, then the high price is not a possible choice, and therefore
  - LegPricePerContractHigh = LegPricePerContractLow
- NewCombination Bid = Combination Bid – Ratio Leg Bid
- NewCombination Ask = Combination Ask – Ratio Leg Ask
- NewCombinationMid = (New Combination Ask - New Combination Bid) / 2   (50%)
- CombNetLow = CombNet – LegPricePerContractLow * BSRatio
- CombNetHigh = CombNet - LegPricePerContractHigh * BSRatio

2. To decide which one to use - choose the tick which gives the best "remaining" CombNet, where best means closest to midpoint of CombSpread.
- If CombNetLow is outside New Combination Spread and CombNetHigh is inside, use **LegPricePerContractHigh**
- If CombNetHigh outside New Combination Spread and CombNetLow is inside, use **LegPricePerContractLow**
- If CombNet before this leg was within spread and now both CombNetLow and CombNetHigh are outside New Combination Spread, use algorithm which creates two trades:
  - **Move to algorithm in D for this leg.**

- If CombNet before this leg was outside spread and now both CombNetLow and CombNetHigh are outside, or if both CombNetLow and CombNetHigh are within spread, use the one most favourable for coming calculations, by doing the following:
    - ABSPercentLow = ABS(New Combination Mid - CombNetLow)
    - ABSPercentHigh = ABS(New Combination Mid - CombNetHigh)
        - If (ABSPercentLow > ABSPercentHigh), let LegPricePerContract be = **LegPricePerContractHigh**, otherwise LegPricePerContract = **LegPricePerContractLow**
- Create one trade:
    - Price = LegPricePerContract
    - Quantity = Combination_qty * Ratio * IM

End of calculation for this leg, move to next leg.

Next leg will use the combined spread prices for all legs not yet calculated, and the net price adjusted by the price determined for this leg. This will give the effect that the price of the last leg is more likely to be outside the spread than the others.
- Combination Bid = Combination Bid – Ratio Leg Bid
- Combination Ask = Combination Ask – Ratio Leg Ask
- LegPricePerContract from above
- CombNet = CombNet – LegPricePerContract * BSRatio

1.2.3.2.1.3.4 D: Create Two Trades 980

1. LegPricePerContract = LegRatioPrice / Ratio

2. LegPrice1= LegPricePerContractLow

3. LegPrice2 = LegPricePerContractHigh

4. Quantity 2 = (LegPricePerContract - LegPrice1) * Ratio * IM * Combination_qty/ tick_size

5. Quantity 2 = Round down to integer value. (example: TRUNC(Quantity 2, 0))

6. Quantity 1 = Ratio * IM * Combination_qty – Quantity 2

End of calculation for this leg

Next leg will use the combined spread prices for all legs not yet calculated, and the net price adjusted by the price determined for this leg. This will give the effect that the price of the last leg is more likely to be outside the spread than the others.
- Combination Bid = Combination Bid – Ratio Leg Bid
- Combination Ask = Combination Ask – Ratio Leg Ask
- CombNet = CombNet – LegPricePerContract * BSRatio

Go back to A for next leg

<u>Step 6 – Check if leg prices are OK</u>

If any Leg Price is outside the leg spread, and LegPriceOutsideBBO = False, redo calculation by repeating step 4, but divide all leg tick sizes by 10 first. A prerequisite for this, is that the Trading SystemTrading System has not let any trade match occur if net price was outside combined spread. If net is inside combined spread, the only reason that leg prices are outside leg spread, is that the tick size is too large.

1.2.3.2.1.4 Example 1 983

BREAK COMBINATION MATCHES INTO SINGLE LEGS – EXAMPLE 1:

Combination Order Book C – Buy 2 X A, Sell 1 X B			
		16.00	100

And the following Order Book Legs

Order Book A (Tick Size = 0.50)			
500	10.00	12.00	500

Order Book B (Tick Size = 0.10)			
500	5.00	6.00	500

Step 1:

Not applicable

Step 2:

Ratio Leg A: Low = 2 X 10 = 20

                 High = 2 X 12 = 24

Ratio Leg B: Low = -1 X 6 = -6

                 High = -1 X 5 = -5

Step 3:

The derived Combination Order spread:

(20 – 6) to (24 – 5)

14 – 19 (Combination match price is 16 and therefore in between)

Step 4:

Sequence of the legs:

Leg A first

Leg B second

Step 5A: Start with Leg A

The spread of the derived Combination is 5 (19 – 14)

      A: Find %-distance from CombNet…

      (1) Calculate percentage within the spread.

      (16 – 14) / 5 = **40%**

      (2a) Use same percentage to find initial price: 40 % X (24-20) + 20 = **21.6**

      (2b) Not applicable

5B: Round price

(1) Round price found in step A, to tick if needed

(21.6 / .5 , 0) = 43.2, giving (43 X 0.5) = **21.5**

5C: Try to get one match only

      (1) Calculate leg price per contract

21.5 / 2 = **10.75**

Round Low price down and High Price up =>

LowPrice = 10.50

HighPrice 11.00

Combination Bid (excluding A) = 14 – (2*10) = -6

Combination Ask (excluding A) = 19 – (2*12) = -5

Comb Mid (excluding A) = -5.50

CombNetLow = 16 – 2* 10.50 = - 5.00

CombNetHigh = 16 – 2*11 = -6.00

      (2) Find which one of tested prices to use

Both CombNetHigh and CombNetLow are inside (actually at) the new Combination Spread (excluding A), 10.50 and 11.00 are both fine.

LowPrice = 10.50 is used according to the algorithm

5D: Algorithm for finding two different prices is not needed in this example

      (2) Calculate leg price per contract

          *21.5 / 2 = **10.75***

      (3) Round to tick if needed

          *(19.75 / 0.5, 0) = 21.5 giving 21 X 0.5 = **10.50***

      4 (a) Calculate trade prices of Leg A

      10.50+ 0.5 = 11

      *(10.75 – 10.50) * 2 * 1* 100 / 0.5*

      100 @ 11.00

      100 @ 10.50

MOVE TO NEXT LEG (FINAL LEG)

Step 5A: Leg B

New adjusted spread is

(21 – 6) to (21 – 5)

(16 – 15) / 1 = 10**0%**

Leg B spread is (-6) - (-5), therefore using 100%, gives a price of:

100 @ 5

and a result of:

Leg A 200 @ 10.50

Leg B 100 @ 5

1.2.3.2.1.5 Performance 1002

Unlike other routines for finding single leg prices, this algorithm only performs a given number of calculations per included leg - it is O(n), which makes it not to heavy from a performance aspect.

1.2.4 Matching - Integrated with Single Orders 1003

Combination matching with single Orders is handled as follows:

At each price level, the implied price from single Order Book legs is compared to the price in the Combination Order Book:
- If the implied price is better than the Combination Order Book, the matching is done in the single Order Books
- If the Combination Order Book price is better the matching, matching is done in the Combination Book
- If equal, it's configurable which one is used first.

Matching against single Orders is only made if all Order Books (including the Combination Order Book) are in Continuous Matching in the Open Session.

In addition to matching in the Combination Order Book, when Combination matching is integrated with single Orders, The Trading System checks for matches each time the BBO in any of the single Order Books improves its price.

The following examples assume that no Implieds are generated. See Implied Generation.

1.2.4.1 Example 1

Given the following Combination traded in Net Price:

Buy Instrument A, ratio = 1, Sell Instrument B ratio = 1

Order Book A			
80	$87.60	$88.50	50
50	$87.00	$88.80	100

Order Book B			
40	$80.00	$81.00	110
20	$79.90	$82.00	100

Combination Order Book			
100	$7.50	$8.50	20
50	$7.45	$8.55	20

		$8.75	10

A Combination Order comes in to Buy 120 @ 8.70

Decide if matching should be made against single Order Books or Combination Order Book first (buying at best sell price, selling at best bid):

Calculate net prices by using the formulas specified for the Combination price type:

$$B_{uy}\,N_{et}\,P_{rice} = B_{uy} - S_{ell}$$

(Please note, that the price available to buy at, is the sell price in the Order Book, and vice versa.**)

Matching against single Books, would give $88.50 - $80.00 = $8.50

Matching against Combination Book = $8.50

Prices are equal, configured rules say to start with single Order Books. For all single Order Books, it must be decided how much could be matched at this price level. For A, it could match 50, for B it could match 40 – so, the available quantity at the net price of $8.50 is 40.

After that, matching against single Order Books gives $8.60, so 20 is matched against the Combination Order at $8.50.

After that, matching against single Order Books still gives $8.60, and Combination Book gives $8.55 so another 20 can be matched against the Combination Order at $8.55.

Next step, matching against single Order Books still gives $8.60, but matching against Combination now gives $8.75 (which is not OK to match against), so 10 is matched against single Order Books.

No more matching is possible after that. The rest of the Combination Order is stored in the Combination Order Book:

Order Book A			
80	$87.60	$88.80	100
50	$87.00		

Order Book B			
10	$79.90	$81.00	110
		$82.00	100

Combination Order Book			
30	$8.70	$8.75	10
100	$7.50		
50	$7.45		

** Using the single leg Order Books to derive prices for the Combination Order Book would give the prices at which one could buy at $8.50, and the best price at which one could sell as $6.60, i.e. a BBO of **$6.60 - $8.50**

1.2.5 Updating Combination Orders

Participants can update their Combination Orders by specifying the The Trading System Trading Order identifier.

Conditions for Combination Orders:

Combination Orders can be Limit or Market Orders and support the following conditions (including what is mandatory and optional).

COMBINATION ORDERS	Limit	Market
Time-in-Force	M	M
DAY	O	O
GTC	O	O
GTD	O	O
FOK	O	O
IOC	O	O
Triggering Conditions	O	O
Last Paid Update	O	O

1.2.6 Implied Generation

Implieds can be configured to:

1. Be generated or

2. Not be generated.

When used, Implied Orders are checked every time:
- When an Order is stored, updated or deleted in the Combination Order Book.
- The best price in any of the single Order Books is changed, either improved by a new Order, or worsened by an Order execution or Order cancel.
- The available quantity on best price in any of the single Order Books is changed, either increased by a new Order at best price, or decreased by an Order execution or Order cancel.

When Implied Orders are used, each Implied Order will be displayed to the market per leg Order Book and side, with implied quantity at respective prices.

Implied Out Orders will only be generated if they are at or inside pre-set Order Price Limits.

Trading System. There area number of restrictions related to Implied Order generation, and the manner in which Implied Orders are matched in the Trading System, as noted below. Trading System

1. Implied Orders are never generated from other Implied Orders.   Implied Orders are created from the Orders in thesingle Order Book and the Combination Order Book.

2. Matching an Implied Order will not impact Implied Orders in the single Order Books. Only Implied Orders, the Combination Orders and single Orders in the Order Books will be matched. Other Implied Orders in single Order Books will be unaffected, even if they have a better price and/or time than other Orders.

3. Implied Orders are only generated and disseminated to the market for the legs of the Combination Order (Implied-Out). Thus, no Implied Orderss are generated in the Combination Order Book (Implied-In).

5. Implied Orders cannot be generated from the mass Quotes in the legs of the Combination Order.

1.2.6.1 Implied generation examples

1.2.6.1.1 Example Implied from aggregate of Orders at best price from base

The quantity for Implied Orders are calculated from the quantity of the Combination Order and the aggregate of all Orders at best price (excluding other Implieds Order) from the the legs. The minimum of the quantity from the Combination Order, and the aggregate quantity for each leg (at best price), decides the quantity for the Implied Order.

Assume a Combination Order Book Combo = Buy 1 A Sell 1 B (a calendar spread for example).

Buy Combo = Buy A Sell B			
Buy		Sell	
Quantity	Price	Price	Quantity
20	1.000		

Order Book A			
Buy		Sell	
Quantity	Price	Price	Quantity
		99.000	10

Order Book B			
Buy		Sell	
Quantity	Price	Price	Quantity
		98.000	10 (Implied)

Based on the Orders in the Combination and the Order in the single Order Book (A), one Implied Order can be generated in Order Book B. The price becomes 99.00 – 1.000 = 98.000. The quantity is limited by the available quantity in the leg is only 10, where as the quantity in the Combination Order is 20. Thus the quantity becomes 10 for the Implied Order in Order Book B.

Buy Combo = Buy A Sell B			
Buy		Sell	
Quantity	Price	Price	Quantity
20	1.000		

Order Book A			
Buy		Sell	
Quantity	Price	Price	Quantity
		99.000	10
		99.000	5

Order Book B			
Buy		Sell	
Quantity	Price	Price	Quantity
		98.000	15 (Implied)

Adding another Order in Order Book A, at best price, will increase the available quantity in the leg, and increase the quantity of the Implied Order in A to 15. The quantity for the Implied Order is still limited by the available quantity in the leg though.

Buy Combo = Buy A Sell B			
Buy		Sell	
Quantity	Price	Price	Quantity
20	1.000		

Order Book A			
Buy		Sell	
Quantity	Price	Price	Quantity
		99.000	10
		99.000	5
		99.000	15

Order Book B			
Buy		Sell	
Quantity	Price	Price	Quantity
		98.000	20 (Implied)

Adding another Order in Order Book A, at best price, will increase the available quantity in the leg, and increase the quantity of the Implied Order in B to 20. The quantity for the Implied Order is now limited by the available quantity in the Combination Order, which is 20. A total quantity of 30 is available in the leg.

1.2.6.1.2 Example Implied from every Combination Order

One Implied Order can be created for every Combination Order in the Order Book, if there is enough quantity in the leg at best price.

For example, if there is one Combination Order, and several Orders at best price in the the legs, one Implied Order will be created. If there are two Combination Orders, then two Implieds can be created and so on, if there is enough aggregated quantity from thethe legs.

Buy Combo = Buy A Sell B			
Buy		Sell	
Quantity	Price	Price	Quantity
20	1.000		
15	1.000		

Order Book A			
Buy		Sell	
Quantity	Price	Price	Quantity
		99.000	10
		99.000	5
		99.000	15

Order Book B			
Buy		Sell	
Quantity	Price	Price	Quantity
		98.000	20 (Implied)
		98.000	10 (Implied)

Based on the two Combinations Orders in the Combo Order Book, two Implied Orders can be created, using the available quantity at best price in the single Order Book A.

A total quantity of 30 is available in the leg. The quantity 20 contracts is used for the first Implied Order, so the quantity 10 contract remains available from the base. The second Implied Order is limited by the remaining quantity in the leg, since the quantity 15 contracts is available in the second Combination Order. Thus the second Implied Order has the quantity 10 contracts. See the Order Books above.

Adding another Order in Order Book A, at best price, will increase the available quantity in the leg, and increase the quantity of the second Implied Order in A to 15 contracts. The quantity for the Implied Order is now limited by the available quantity in the Combination Order, which is 15 contracts. The remaining available quantity in the base B is 20 contracts.

The resulting Order Books:

Buy Combo = Buy A Sell B			
Buy			Sell
Quantity	Price	Price	Quantity
20	1.000		
15	1.000		

Order Book A			
Buy		Sell	
Quantity	Price	Price	Quantity

Order Book B			
Buy		Sell	
Quantity	Price	Price	Quantity

		99.000	10
		99.000	5
		99.000	15
		99.000	25

		98.000	20 (Implied)
		98.000	15 (Implied)

When aggregated Implied Orders is used the individual Implied Orders above are not displayed to the market. The aggregated Implied Orders displayed to the market has the following resulting Order Books:

Buy Combo = Buy A Sell B			
Buy			Sell
Quantity	Price	Price	Quantity
20	1.000		
15	1.000		

Order Book A			
Buy		Sell	
Quantity	Price	Price	Quantity
		99.000	10
		99.000	5
		99.000	15
		99.000	25

Order Book B			
Buy		Sell	
Quantity	Price	Price	Quantity
		98.000	35 (Implied)

1.2.6.1.3 Example Implied only from best price in base

An Implied Order will only be generated from the Orders at best price in the the legs.

Other Implied Orders in the leg will not contribute to the leg quantity however, since the Implied Order is never generated from other Implied Orders.

Continuing from Example 2.

Adding another Order in Order Book A, with an improved price 98.990, will decrease the available quantity in the leg for the Implieds Orders (at best price) to only 13 contracts.

Thus the Implied Order in Order Book B becomes 13 @ 97.990.

There is not any remaining quantity available in Order Book A at best price to generate another Implied Order in Order Book B.

There will not be any Implied Order generated from the second Combination Order. Thus the second Implied Order is removed.

The quantity in the leg at the worse price level 99.990 is *not* used when generating Implied Orders.

Buy Combo = Buy A Sell B			
Buy		Sell	
Quantity	Price	Price	Quantity
20	1.000		
15	1.000		

Order Book A			
Buy		Sell	
Quantity	Price	Price	Quantity
		98.990	13
		99.000	10
		99.000	5
		99.000	15
		99.000	25

Order Book B			
Buy		Sell	
Quantity	Price	Price	Quantity
		97.990	13 (Implied)

Assume that another Implied Order in Order Book A has been generated, from another Combination Order = Buy A Sell C, and an Order in another Order Book C. The Implied In Order Book A is 100 @ 98.990 is the best price. However, the Implied Order is not used when generating Implieds Orders in Order Book B. Thus the Implied Order in Order Book B remains unaffected at 13 @ 97.990.

Buy Combo = Buy A Sell B			
Buy		Sell	
Quantity	Price	Price	Quantity
20	1.000		
15	1.000		

Order Book A			
Buy		Sell	
Quantity	Price	Price	Quantity
		98.990	13

Order Book B			
Buy		Sell	
Quantity	Price	Price	Quantity
		97.990	13

		98.990	100 (Implied) from another combo

			(Implied)

1.2.6.1.4 Example Single Order matching Implied Order

An Order will match against the Implied Order, the Combination Order and the Orders in the legs from which the Implied Order s is generated from. Note however that the Order will not be matched against any Implied Orders in the legs, even if the Implieds Orders have better price or time.

Buy Order Book Combo AB = Buy A Sell B

Buy		Sell	
Qty	Prc	Prc	Qty
		1.000	50

Buy Order Book Combo BC = Buy B Sell C

Buy		Sell	
Qty	Prc	Qty	Prc
		0.500	20

Order Book A

Buy		Sell	
Qty	Prc	Prc	Qty
		99.000	10 (b) from AB

Order Book B

Buy		Sell	
Qty	Prc	Prc	Qty
		97.500	20 (b) from BC
		98.000	10

Order Book C

Buy		Sell	
Qty	Prc	Prc	Qty
		97.000	40

The Implied Order in Order Book B, 20 @ 97.500, does not contribute to quantity when generating the Implied Order in Order Book A. Hence the Implied Order in Order Book is only using quantity from the normal Order in Order Book B (base Order Book), 10 @ 98.000.

An aggressive Order Buy 10 A @ 99.000 will match the Implied Order in Order Book A, the Combination Order in Combination AB, and the normal base Order in Order Book B, 10 @ 98.000. The Implied Order in Order Book B, 20 @ 97.500, is not matched, and this Order is skipped. Note that the Implied Order has both better time and price priority, but is skipped anyway.

The Order Books after allocation:

Buy Order Book Combo AB =			
Buy A Sell B			
Buy		Sell	
Qty	Prc	Prc	Qty
		1.000	40

Buy Order Book Combo BC =			
Buy B Sell C			
Buy		Sell	
Qty	Prc	Prc	Qty
		0.500	20

Order Book A			
Buy		Sell	
Qty	Prc	Prc	Qty

Order Book B			
Buy		Sell	
Qty	Prc	Prc	Qty
		97.500	20 (b) from BC

Order Book C			
Buy		Sell	
Qty	Prc	Prc	Qty
		97.000	40

1.2.6.1.5 Example Combination Order matching Implieds in two or more Order Books

An aggressive Combination Order can match Implied Orders that exists in different leg Order Books.

Assume the following Orders and Order Books:

Buy Order Book Combo AC =			
Buy A Sell C			
Buy		Sell	
Qty	Prc	Prc	Qty
		1.000	10

Buy Order Book Combo AB =			
Buy A Sell B			
Buy		Sell	
Qty	Prc	Prc	Qty
10	1.000		

Buy Order Book Combo BC =			
Buy B Sell C			
Buy		Sell	
Qty	Prc	Prc	Qty

Order Book A

Order Book B

Order Book C

Buy		Sell	
Qty	**Prc**	**Prc**	**Qty**
10	98.500	99.000	10

Buy		Sell	
Qty	**Prc**	**Prc**	**Qty**
		98.000	10 (b) from AB

Buy		Sell	
Qty	**Prc**	**Prc**	**Qty**
10 (b) from AC	97.500		

The Implied Orders are not over allocated, since they are based on different Orders in Order Book A (on buy and sell side respectively).

Enter Buy 10 Combination BC @ 0.500. This Combination Order will match the existing Implieds Orders in Order Book B (from AB) and in Order Book C (from AC). Thus when matching these Implieds Orders, the Combination Orders and leg Order that the Implied Orders are based on will also be matched. In this case all Orders will be matched.

The resulting Order Books does not contain any remaining Orders:

Buy Order Book Combo AC = Buy A Sell C			
Buy		Sell	
Qty	**Prc**	**Prc**	**Qty**

Buy Order Book Combo AB = Buy A Sell B			
Buy		Sell	
Qty	**Prc**	**Prc**	**Qty**

Buy Order Book Combo BC = Buy B Sell C			
Buy		Sell	
Qty	**Prc**	**Prc**	**Qty**

Order Book A			
Buy		Sell	
Qty	**Prc**	**Prc**	**Qty**

Order Book B			
Buy		Sell	
Qty	**Prc**	**Prc**	**Qty**

Order Book C			
Buy		Sell	
Qty	**Prc**	**Prc**	**Qty**

1.2.6.1.6 Example Aggregated Implied and Ranking of individual Implieds 68190 (Customized functionality)

When aggregated Implieds are used, increasing the quantity of the Implied, because the leg quantity is increased will not make the Implied lose time priority.

Assume the Combination Order Books:

1. C1: Call Spread. Buy 1 C1 = Buy 1 A Sell 1 B

The following Orders are entered (at time $t_1, t_2, \ldots, t_n$, where $t_1 < t_2 < \ldots < t_n$):

1. Buy 25 C1 @ 0.0000 (at t_1).

2. Buy 10 B @ 99.6600 (at t_2). This creates an aggregated Implied Order in Order Book A: Buy 10 A @ 99.6600.

3. Buy 1 A @ 99.6600 (at t_3). This Order ranked after the individual Implied (internally within the Trading System), but will be displayed before the aggregated Implied, since the aggregated is always displayed last at best price.

4. Buy 10 B @ 99.6600 (at t_4). This will increase the base for the Implied, and Implied in A is regenerated to Buy 20 A @ 99.6600. Note that the individual Implied will not lose priority in this case, it will still be before the normal Order from step 3. This has therefore been changed for aggregated Implieds functionality.

5. Sell 20 B @ 99.6600 (at t_5). This will match all the Implied quantity but leave the single Order Buy 1 A @ 99.6600 (at t_3) unmatched. This is assuming that Price/Time matching is used for the Order Book.

After step 3 (internally within Trading System):

Buy Order Book C1 =

Buy A Sell B

Buy		Sell	
Qty	Prc	Prc	Qty
25	0.0000 (t1)		

Order Book A

Buy		Sell	
Qty	Prc	Prc	Qty
10	99.6600 (b)		
1	99.6600 (t3)		

Order Book B

Buy		Sell	
Qty	Prc	Prc	Qty
		99.6600 (t2)	10

After step 4 (internally within Trading System):

Buy Order Book C1 =

Buy A Sell B			
Buy		Sell	
Qty	Prc	Prc	Qty
25	0.0000 (t1)		

Order Book A			
Buy		Sell	
Qty	Prc	Prc	Qty
20	99.6600 (b)		
1	99.6600 (t3)		

Order Book B			
Buy		Sell	
Qty	Prc	Prc	Qty
		99.6600 (t2)	10
		99.6600 (t4)	10

After step 5:

Buy Order Book C1 = Buy A Sell B			
Buy		Sell	
Qty	Prc	Prc	Qty
5	0.0000 (t1)		

Order Book A			
Buy		Sell	
Qty	Prc	Prc	Qty
1	99.6600 (t3)		

Order Book B			
Buy		Sell	
Qty	Prc	Prc	Qty

Note that for Implieds with quantity restrictions (match increment) is included and displayed in the aggregated Implieds. If this results in displayed crossed prices, the aggregated Implied changes price to one tick worse.

Assume the Combination Order Book:

1. C2 : Butterfly. Buy 1 C2 = Buy 1 A Sell 2 B Buy 1 C

2. C3 Call Spread. Buy B Sell C.

The following Orders are entered (at time $t_1, t_2, \ldots, t_n$, where $t_1 < t_2 < \ldots < t_n$):

1. Buy 5 C2 @ 0.0000 (at t_1).

2. Sell 10 A @ 97.0000 (at t_2).

3. Sell 10 C @ 99.0000 (at t_3). A the aggregated Implied in B is calculated to to Sell 10/2 @ 98.000.

Buy Order Book C3 = Buy B Sell C			
Buy		Sell	
Qty	Prc	Prc	Qty

Buy Order Book C2 = Buy A Sell 2 B Buy 1 C			
Buy		Sell	
Qty	Prc	Prc	Qty
5	0.0000		

Order Book A			
Buy		Sell	
Qty	Prc	Prc	Qty
		97.0000	10

Order Book B			
Buy		Sell	
Qty	Prc	Prc	Qty
		98.00000	10/2 (b)

Order Book C			
Buy		Sell	
Qty	Prc	Prc	Qty
		99.0000	10

4. Buy 1 B @ 98.0000. This Order can not be matched against the Implied, due to the the match increment in the Implied Order, so the prices will be crossed. The aggregated Implied is therefore changed to one-tick worse to 98.0050 in this case (because one tick is 0.0050).

The resulting Order Books:

Buy Order Book C3 = Buy B Sell C			
Buy		Sell	
Qty	Prc	Prc	Qty

Buy Order Book C2 = Buy A Sell 2 B Buy 1 C			
Buy		Sell	
Qty	Prc	Prc	Qty
5	0.0000		

Order Book A			
Buy		Sell	
Qty	Prc	Prc	Qty
		97.0000	10

Order Book B			
Buy		Sell	
Qty	Prc	Prc	Qty
1	98.00000	98.0050	10/2 (b)

Order Book C			
Buy		Sell	
Qty	Prc	Prc	Qty
		99.0000	10

1.2.6.1.8 Example Aggregated Implied and trade trough 68192 (Customized functionality)

An aggregated Implied can be traded trough, and may be skipped if it contains Orders with match increments. Assume the Combination Order Book:

1. C2 : Butterfly. Buy 1 C2 = Buy 1 A Sell 2 B Buy 1 C

2. C3 Call Spread. Buy B Sell C.

Assume the following Order in the Order Books:

Buy Order Book C3 = Buy B Sell C			
Buy		Sell	
Qty	Prc	Prc	Qty
		-1.0000	3

Buy Order Book C2 =

Buy A Sell 2 B Buy 1 C			
Buy		**Sell**	
Qty	**Prc**	**Prc**	**Qty**
5	0.0000		

Order Book A			
Buy		**Sell**	
Qty	**Prc**	**Prc**	**Qty**
		97.0000	10

Order Book B			
Buy		**Sell**	
Qty	**Prc**	**Prc**	**Qty**
		98.0000	10/2 (b)
		98.0050	3 (potential Implied)

Order Book C			
Buy		**Sell**	
Qty	**Prc**	**Prc**	**Qty**
		99.0000	8

The potential Implied above is not displayed to the market, and is not included in the aggregated Implied, since it is not on best price.

Buy 1 B @ 98.0050. The Order is matched against the internal Implied 3 @ 98.0050, which is generated internally within ME. The Implied 10 /2 @ 98.0000 is skipped due to quantity restrictions. The aggregated Implied is unchanged 10 / 2 @ 98.0000.

The resulting OrderBook, with the individual (potential Implied is not displayed to the market) Implied Order:

Buy Order Book C3 = Buy B Sell C			
Buy		**Sell**	
Qty	**Prc**	**Prc**	**Qty**
		-1.0000	2

Buy Order Book C2 = Buy A Sell 2 B Buy 1 C			
Buy		**Sell**	
Qty	**Prc**	**Prc**	**Qty**
5	0.0000		

Order Book A	
Buy	**Sell**

Order Book B	
Buy	**Sell**

Order Book C	
Buy	**Sell**

Qty	Prc	Prc	Qty
		97.0000	10

Qty	Prc	Prc	Qty
		98.0000	10/2 (b)
		98.0050	2 (potential Implied)

Qty	Prc	Prc	Qty
		99.0000	9

1.2.6.2 Regeneration of Implieds during aggressive matching

The Trading System shall regenerate Implieds during the aggressive Order matching, if the Implied Order has been completely matched.

This behavior affects performance in the Trading System, since it requires the Trading System to monitor the Implieds when a Implied has been completely matched, whilst the ME (Genium) core behavior only does it after the aggressive Order matching is finished.

This behavior is controlled via the Matching Extension Point located on the Instrument Type/Class level in CDB.

Note that the Trading System does not regenerate Implieds between individual Orders within a mass quotation transaction.

It is implemented for the following Matcher plugins:
- "One by one generate Implieds matcher" (for Price/Time allocation).
- "Priority sharing" (for Pro-Rata allocation), with Matching Priority field Pro rata matching value "Round down Pro rata".

1.2.6.2.1 Example Allocation Price/Time 59844

Example:

A Implied Order of Sell 10 @ 5.00 is available in Order Book B, based on Orders from Order Book A (Sell 10 @ 9.00) and C (Buy 20 @ 4.00).

Allocation method is Price/Time.

Buy Combo = Buy A Sell B			
Buy		Sell	
Quantity	Price	Price	Quantity
20	4.00		

Order Book A			
Buy		Sell	
Quantity	Price	Price	Quantity
		9.00	10

Order Book B			
Buy		Sell	
Quantity	Price	Price	Quantity
		5.00	10 (Implied)

		9.50	10

		6.00	10

An aggressive Buy Order of 20 @ MKT is sent into Order Book B.

The Trading System will:

1. Match the incoming Order in B with the Implied Order 10 @ 5.00.

2. Thereafter generate a new Implied Sell 10 @ 5.50 in Order Book B, based on Orders from Order Book A (Sell 10 @ 9.50) and C (now Buy 10 @ 4.00).

3. The matching of the incoming Order in B will then continue (now 10 @ MKT), and trade against the new Implied Order.

The resulting Order Books look like:

Buy Combo = Buy A Sell B			
Buy		Sell	
Quantity	Price	Price	Quantity

Order Book A			
Buy		Sell	
Quantity	Price	Price	Quantity

Order Book B			
Buy		Sell	
Quantity	Price	Price	Quantity
		6.00	10

Thus with this method the Combination Order will be matched entirely, where as the Genium standard behavior would have matched the Combination Order partly, and instead matched the Sell Order in Order Book B.

1.2.6.2.2 Example Allocation Pro-Rata 59845

Example:

A Implied Order of Sell 10 @ 5.00 is available in Order Book B, based on Orders from Order Book A (Sell 10 @ 9.00) and C (Buy 20 @ 4.00).

Matcher Plugin is "Priority sharing" (for Pro-Rata allocation), with Matching Priority field Pro rata matching value "Round down Pro rata". Thus allocation is Pro-Rata, using round down, followed by priced/time allocation for remaining quantity.

Buy Combo = Buy A Sell B			
Buy		Sell	
Quantity	Price	Price	Quantity
20	4.00		

Order Book A			
Buy		**Sell**	
Quantity	Price	Price	Quantity
		9.00	10
		9.50	10

Order Book B			
Buy		**Sell**	
Quantity	Price	Price	Quantity
		5.00	10 (Implied)
		5.50	15

An aggressive Buy Order of 20 @ MKT is sent into Order Book B.

The Trading System will:

1. Match the incoming Order in B with the Implied Order 10 @ 5.00.

2. Thereafter generate a new Implied Sell 10 @ 5.50 in Order Book B, based on Orders from Order Book A (Sell 10 @ 9.50) and C (now Buy 10 @ 4.00).

3. The matching of the incoming Order in B will then continue (now 10 @ MKT), and trade against the Sell Order 10 @ 5.50 in B, and the new Implied Order (Sell 10 @ 5.50) according to Pro-Rata. The time-stamp for the new Implied Order is after the existing Order in B. The intermediary Order Book in B (not visible to the market) thus looks like:

Buy Combo = Buy A Sell B			
Buy		**Sell**	
Quantity	Price	Price	Quantity
10	4.00		

Order Book A			
Buy		**Sell**	
Quantity	Price	Price	Quantity
		9.50	10

Order Book B			
Buy		**Sell**	
Quantity	Price	Price	Quantity
10	**MKT**	5.50	15
		5.50	10 (Implied)

- The total quantity among the qualified Orders is 25
- The first Order (single Order) is allocated 15/25 * 10 = 6, rounded to 6. Now 4 remains to be allocated to the last Order (the Implied Order).
- The last Order (Implied Order) is allocated 4.

The resulting Order Books look like:

Buy Combo = Buy A Sell B

Buy		Sell	
Quantity	Price	Price	Quantity
6	4.00		

Order Book A			
Buy		Sell	
Quantity	Price	Price	Quantity
		9.50	6

Order Book B			
Buy		Sell	
Quantity	Price	Price	Quantity
		5.50	9
		5.50	6 (Implied)

1.2.6.2.3 Example No re-generation of Implieds within a mass quotation (Customized functionality)

Mass quote transaction hits Order Books B and A, thus removing the base in B. The Implieds is *not* re-generated between the allocation of B and A.

Buy Order Book C1 = Buy A Sell B			
Buy		Sell	
Qty	Prc	Prc	Qty
		1.000	30

Order Book A			
Buy		Sell	
Qty	Prc	Prc	Qty
		99.000	20 (b) from C1
		99.000	20

Order Book B			
Buy		Sell	
Qty	Prc	Prc	Qty
		98.000	20

The Implied Order in Order Book A is 20 @ 99.000, using the Combination C1 and B. The time stamp for the Implied Order is better than the normal Orders in Order Book A, because the normal Order was entered after the Implied was generated.

Incoming mass quote:

Buy 10 B @ 98.000,

Buy 20 A @ 99.000.

The incoming Order in B is matched, a trades 10 of the quantity in the Order Book B, leaving quantity 10 in Order Book B. The Implied is however not re-generated.

The remaining Order Book looks like:

Buy Order Book C1 = Buy A Sell B			
Buy		Sell	
Qty	Prc	Prc	Qty
		1.000	30

Order Book A			
Buy		Sell	
Qty	Prc	Prc	Qty
		99.000	20 (b) from C1
		99.000	20

Order Book B			
Buy		Sell	
Qty	Prc	Prc	Qty
		98.000	10

The incoming Order in Buy 20 A @ 99.000 is matched. The Trading System will try to allocate 20 to the Implied Order, but when it finds out that there is not enough base quantity in Order Book B, it will skip the Implied Order entirely, and allocate the Order in Order Book A instead.

After allocation of the second Order, the mass quotation ends, and the re-generation of Implieds takes place.

The remaining Order Book looks like:

Buy Order Book C1 = Buy A Sell B			
Buy		Sell	
Qty	Prc	Prc	Qty
		1.000	30

Order Book A	
Buy	Sell

Order Book B	
Buy	Sell

Qty	Prc	Prc	Qty
		99.000	10 (b) from C1

Qty	Prc	Prc	Qty
		98.000	10

If the quantity for the second Order was Buy 30 A @ 99.000, there would be a remaining quantity 10 for the incoming Order at the end of the mass quotation transaction. This quantity would then be matched when the Implied is regenerated, thus at this last step, the Implieds Order would be matched.

When aggregated Implieds is used the individual Implieds above are not displayed to the market.

The aggregated Implied is always ranked last amongst the Orders on the best price, and the ranking of the aggregated Implied does therefore not reflect how the Implied Order will be matched.

The aggregated Implieds displayed to the market has the following original Order Books:

Buy Order Book C1 = Buy A Sell B			
Buy		Sell	
Qty	Prc	Prc	Qty
		1.000	30

Order Book A			
Buy		Sell	
Qty	Prc	Prc	Qty
		99.000	20
		99.000	20 (b) from C1

Order Book B			
Buy		Sell	
Qty	Prc	Prc	Qty
		98.000	20

1.2.6.3 Net Price 1021

Combinations traded in Net Price trade at the sum of all the leg prices. Therefore, if the price of the Combination Order is given, then the prices of the legs can be calculated one leg at a time.

Combination Order 1
ABC (Buy A, Sell B, Buy C), Ratio = 1
Buy 60 @ 47.00

Order Book A			
100	$10.00	$12.00	100

Order Book B			
100	$30.00	$33.00	100

Order Book C			
100	$65.00	$66.00	100

Combination Order is not executable against the single Books (available net price is 48)

$$\mathbf{B_{uy}N_{et}P_{rice}} = \mathbf{B_1} + \mathbf{B_2} + \ldots + \mathbf{B_x} - \mathbf{S_1} - \mathbf{S_2} \ldots - \mathbf{S_x} \implies$$

$$\mathbf{BNP_{ABC}} = \mathbf{B_A} + \mathbf{B_C} - \mathbf{S_B}$$

$$\mathbf{B_A} = \mathbf{BNP_{ABC}} - \mathbf{B_C} + \mathbf{S_B}$$

$$\mathbf{S_B} = \mathbf{B_A} + \mathbf{B_C} - \mathbf{BNP_{ABC}}$$

$$\mathbf{B_C} = \mathbf{BNP_{ABC}} - \mathbf{B_A} + \mathbf{S_B}$$

Using B and C for generating Implieds in A gives 47 – 66 + 30 = 11, i.e. we can buy A at 11, and still get a net of 47.

Using A and C generating Implieds in B gives 66 + 12 - 47 = 31, i.e. we can sell B at 31, and still get a net of 47.

Using A and B generating Implieds in C gives 47 - 12 + 30 = 65, i.e. we can buy C at 65, and still get a net of 47.

Please note that the calculated prices for the Implieds, must be rounded to the given tick size for the single Order Books. Rounding is then always made so that the limit price of the Combination is not violated.

The following Implieds are therefore calculated:

Order Book A			
60 (b1)	$11.00	$12.00	100
100	$10.00		

Order Book B			
100	$30.00	$31.00	60(b1)
		$33.00	100

Order Book C			
100	$65.00	$66.00	100

60 (b1)	$65.00		

where the Orders marked with yellow are Implied Orders.

1.2.6.4 Over Commitment

Over Commitment means that several Implied Orders, in different Order Books, uses the same leg quantity. It is an "over commitment", since all Implied Orders cannot be executed at the same time (by a mass quote transaction for example).

Total over commitment means that the same base quantity is used for several Implied Orders in the same Order Book. The Implied Orders are generated from Orders in the same Combination Order Book. It is a "total over commitment" since all Implied Orders can not be executed at the same time (by a single Order).

Thus over commitment indicates more liquidity in the Implied Order Books than can actually be matched.

The Trading System allows "over commitment", but not "total over commitment" of quantity for Implied Orders. The two following rules applies:

1. When generating Implieds for different single Order Books which have the same base leg in common, the base quantity will be used for all Implieds Orders. Hence "over commitment" is used.

2. When generating Implieds for the different Combination Orders within one Combination Order Book, the base quantity will only be used once. The base quantity will be shared between the Combination Orders, according to Price/Time for the Combination Orders. One Implied can be created for every Combination Order, even if the Combination is not on best price, if there is enough quantity available from the base Orders from the best price (excluding quantity from other Implied Orders). Therefore all Implied Orders in the Order Book can be matched by a single Order. Hence "total over commitment" is not used.

When aggregated Implieds is used, the individual Implieds above are not displayed to the market via ITCH Market Data Protocol. Only one aggregated Implied on best price will be displayed to the market via the Trading System.

The base quantity will be shared between different Combination Order Books according to:

1. Price of the calculated Implieds.

2. Time of the Combination Order used for the Implied.

1.2.6.4.1 Example Over Commitment

The Trading System allows over commitment of quantity for Implieds Orders. Thus when generating Implieds for different Combinations Order Books which have the same base leg in common, the base leg quantity will be used for all Implieds Orders.

This will indicate more liquidity in the Implied Order Books.

Assume a Combination Order Book Buy AB = Buy 1 A Sell 1 B.

Assume a Combination Order Book Buy AC = Buy 1 A Sell 1 C.

Buy Order Book Combo AC = Buy A Sell C			
Buy		**Sell**	
Qty	**Prc**	**Prc**	**Qty**
10	1.000		

Buy Order Book Combo AB = Buy A Sell B			
Buy		**Sell**	
Qty	**Prc**	**Prc**	**Qty**
10	1.000		

Order Book A			
Buy		**Sell**	
Qty	**Prc**	**Prc**	**Qty**
		99.000	10

Order Book B			
Buy		**Sell**	
Qty	**Prc**	**Prc**	**Qty**
		98.000	10 (b) from AB

Order Book C			
Buy		**Sell**	
Qty	**Prc**	**Prc**	**Qty**
		98.000	10 (b) from AC

One Implied is created in Order Book B and one Implied in Order Book C. Both Implieds use the same base leg quantity in Order Book A, which is 10. Therefore if any of the Implieds would be fully traded, the other Implied would no longer have any available base quantity, and would therefore be removed. Thus the quantity in the Implied Orders is over committed since it is not possible to trade the indicated quantity, if all Implieds would be matched at the same time.

1.2.6.4.2 Example Total over commitment

Trading System does not allow total over commitment. In total over commitment, the base quantity can be used many times to create several Implieds from several Combination Orders for one Combination Order Book.

Buy Order Book Combo AB = Buy A Sell B			
Buy		**Sell**	
Qty	**Prc**	**Prc**	**Qty**

	Buy		Sell	
10	1.000		
10	1.000		
10	0.990		

	Order Book A			
	Buy		**Sell**	
Qty	**Prc**	**Prc**	**Qty**
		99.000	15

	Order Book B			
	Buy		**Sell**	
Qty	**Prc**	**Prc**	**Qty**
		98.000	10 (b) from AB
		98.000	10 (b) from AB
		98.010	10 (b) from AB

The second and third Implied Orders are examples of total over committed quantity, because the same base leg quantity is used for all Implied Orders, based on the same Combination Order Book. Note again that total over commitment of Implieds is not supported.

In the Trading System, the following Implieds will be created:

Buy Order Book Combo AB = Buy A Sell B			
Buy		**Sell**	
Qty	**Prc**	**Prc**	**Qty**
10	1.000		
10	1.000		
10	0.990		

	Order Book A			
	Buy		**Sell**	
Qty	**Prc**	**Prc**	**Qty**
		99.000	15

	Order Book B			
	Buy		**Sell**	
Qty	**Prc**	**Prc**	**Qty**
		98.000	10 (b)

Qty	Prc	Prc	Qty		Qty	Prc	Prc	Qty
								from AB
							98.000	5 (b) from AB

However, if more base quantity was available, Trading System would create more Implieds Orders.

Buy Order Book Combo AB = Buy A Sell B

Buy		Sell	
Qty	Prc	Prc	Qty
10	1.000		
10	1.000		
10	0.990		

Order Book A

Buy		Sell	
Qty	Prc	Prc	Qty
		99.000	30

Order Book B

Buy		Sell	
Qty	Prc	Prc	Qty
		98.000	10 (b) from AB
		98.000	10 (b) from AB
		98.010	10 (b) from AB

When aggregated Implieds is used the individual Implieds above are not displayed to the market. Only one aggregated Implied on best price will be displayed to the market:

Buy Order Book Combo AB = Buy A Sell B

Buy		Sell	
Qty	Prc	Prc	Qty

10	1.000		
10	1.000		
10	0.990		

Order Book A			
Buy		**Sell**	
Qty	**Prc**	**Prc**	**Qty**
		99.000	30

Order Book B			
Buy		**Sell**	
Qty	**Prc**	**Prc**	**Qty**
		98.000	30 (b) from AB

1.2.6.5 Quantity Restrictions on the Implied Order

A Implied Order may get Quantity Restrictions if the combination orderbooks have different ratios. -

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1.2.6.5.1 - Example Implied with quantity restrictions 59849

A Implied Order with quantity restrictions.

Assume that Buy 1 Combo = Buy 1 A Sell 2 B Buy 1 C (a butterfly strategy).

The tick size for the Order Books is 0.010. The number of decimals is 3.

Buy Order Book Combo = Buy 1 A Sell 2 B Buy 1 C									
Buy Side					**Sell Side**				
Comment	**Time**	**Order Id**	**Quantity**	**Price**	**Price**	**Quantity**	**Order Id**	**Time**	**Comment**
					1.000	10	1	09:00:00	

Order Book A									
Buy Side					**Sell Side**				
Comment	**Time**	**Order Id**	**Quantity**	**Price**	**Price**	**Quantity**	**Order Id**	**Time**	**Comment**
	09:00:10	2	10	97.000					

Order Book C

Buy Side				Sell Side				
Comment	Time	Order Id	Quantity	Price	Price	Quantity	Order Id	Time	Comment
	09:00:20	3	10	99.000					

This will create an internal Implied Order in Order Book B with a time stamp when the Implied Order is generated, which in this case is the time when the Order in C is entered (09:00:20). The quantity for the Implied will be 20 (with quantity restriction 2), because the ratio for the Combination is 1:2:1. Thus the maximum quantity of 20 can be matched in Order Book B, but it must be matched in multiples of the quantity 2 (2,4, 6, ..., 20), for the Implied Order.

The price for the Implied is calculated from the leg Orders in A and C, and from the Combo Order:

Buy Net Price = BNP = Buy Legs – Sell Legs = A + C – 2* B.

Hence 2* B = A + C – BNP.

Thus B = (A + C - BNP) / 2 = (97.000 + 99.000 – 1.000) / 2 = 195.000 / 2 = 97.500. Thus the price for the Implied Order is on-tick.

Note that this Implied Order is not disseminated to the market via ITCH Market Data Protocol.

Order Book B								
Buy Side					**Sell Side**			
Comment	Time	Order Id	Quantity	Price	Price	Quantity	Order Id	Time	Comment
	09:00:20	1	20 / 2 (internal Implied)	97.500					

1.2.6.6 Single Price Limits 1030

If checking of single limit prices is required, then it is considered also when generating the Implieds. An Order used as a base for a Implied, will never brake a given limit price, and a generated Implied will never brake a given limit price.

1.2.6.7 Executing Implieds 1031

Implied Orders are ranked and matched as any other Orders in the Trading System .

When a Implied Order is executed, it is treated as any other passive Order, and then the other legs of the Combination will be matched against their respective Order Books as aggressive Orders.

1.2.6.7.1 Off Tick Executions due to different tick size

Passive Implied Orders can be executed off tick. This can occur when Combination Order Books trade at smaller tick sizes than their single legs.

When two (or more) passive Orders in the Combination Order Books at different prices generate Implieds at the same price due to the tick size rounding, the Implied from the better priced Combination Order will be ranked ahead in the Order Book leg. At execution, the price of the Combination is used to calculate an off tick price of

the single leg, as opposed to using a rounded value. The Implied will be displayed rounded, however, will be executed off tick.

If the passive Implied Order is executed off tick, the rounding benefit goes to the aggressive Order (i.e. gets a better price than expected).

1.2.6.7.2 Off Tick Execution for Implieds with Quantity Restriction

This can also occur for a Implied, if the Combination legs have different ratios. Thus for a Implied for a leg with ratio higher than 1, the calculated price can be off tick. This Implied then have a Quantity Restriction, and is not disseminated., see "Quantity Restrictions on the Implied Order". The Implied can still be executed off tick though.

1.2.6.7.2.1 Example Implied on off-tick price

A Implied Order with quantity restrictions may be off-tick, and can be skipped when matching trough the Order Book.

Assume that the Buy 1 Combo = Buy 1 A Sell 2 B Buy 1 C.

The tick size for the Order Books is 0.010. The number of decimals is 3.

| Buy Order Book Combo = Buy 1 A Sell 2 B Buy 1 C | | | | | | | | | |
| Buy Side | | | | | Sell Side | | | | |
Comment	Time	Order Id	Quantity	Price	Price	Quantity	Order Id	Time	Comment
					1.000	10	1	09:00:00	

| Order Book A | | | | | | | | | |
| Buy Side | | | | | Sell Side | | | | |
Comment	Time	Order Id	Quantity	Price	Price	Quantity	Order Id	Time	Comment
	09:00:10	2	10	97.000					

| Order Book C | | | | | | | | | |
| Buy Side | | | | | Sell Side | | | | |
Comment	Time	Order Id	Quantity	Price	Price	Quantity	Order Id	Time	Comment
	09:00:20	3	10	99.010					

This will create a internal Implied Order in Order Book B, with a time stamp when the Implied Order is generated, which in this case is the time when the Order in C is entered (09:00:20). The quantity for the Implied will be 20 (with quantity restriction 2), because the ratio for the Combination is 1:2:1. Thus the quantity of 20 can be matched in Order Book B, but it must be matched in multiples of the quantity 2, for the Implied Order.

The price for the Implied is calculated from the leg Orders in A and C, and from the Combo Order:

Buy Net Price = BNP = Buy Legs – Sell Legs = A + C – 2* B.

Hence 2* B = A + C – BNP.

Thus B = (A + C - BNP) / 2 = (97.000 + 99.010 – 1.000) / 2 = 197.010 / 2 = 97.505.

Thus the price for the Implied Order is off-tick. However since there a 3 decimals used in the price, the off-tick price can be represented in the number format, and no further rounding of the Implied price is required.

The Order Id is 1, based on the Combination Order.

Note that this Implied Order is not disseminated to the market , nor can be seen by the Exchange in the internal Order Book in Trading Workstation.

Order Book B									
Buy Side					Sell Side				
Comment	Time	Order Id	Quantity	Price	Price	Quantity	Order Id	Time	Comment
Price is off-tick	09:00:20	1	20 / 2 (internal Implied)	97.505					

Enter a non-Implied Order Buy 1 B @ 97.500. This Order is on a worse price than the Implied Order. It is not possible to enter a normal Order at 97.505, since it is off-tick.

Order Book B									
Buy Side					Sell Side				
Comment	Time	Order Id	Quantity	Price	Price	Quantity	Order Id	Time	Comment
Price is off-tick	09:00:20	1	20 / 2 (internal Implied)	97.505					
	09:00:30	4	1	97.500					

Enter Sell 1 B @ MKT. This Order will try to match the Implied Order. However, due to the Quantity Restriction of 2, the Implied Order can not be matched, so the Implied Order is skipped.

Instead the Order is matched with the Order on the next price level, 97.500, which is a worse price.

The Order Book after allocation:

Order Book B									
Buy Side					Sell Side				
Comment	Time	Order Id	Quantity	Price	Price	Quantity	Order Id	Time	Comment

Price is off-tick	09:00:20	1	20 / 2 (internal Implied)	97.505					

1.2.6.7.2.2 Example Implied on off-tick price rounded to worse price 59853

A Implied Order with quantity restrictions can be off-tick, and may be rounded to a worse price if the number of decimals is too low to represent the price.

Assume that the Buy 1 Combo = Buy 1 A Sell 2 B Buy 1 C.

The tick size for the Order Books is 0.005. The number of decimals is 3.

Buy Order Book Combo = Buy 1 A Sell 2 B Buy 1 C									
Buy Side					Sell Side				
Comment	Time	Order Id	Quantity	Price	Price	Quantity	Order Id	Time	Comment
					1.000	10	1	09:00:00	

Order Book A									
Buy Side					Sell Side				
Comment	Time	Order Id	Quantity	Price	Price	Quantity	Order Id	Time	Comment
	09:00:10	2	10	97.000					

Order Book C									
Buy Side					Sell Side				
Comment	Time	Order Id	Quantity	Price	Price	Quantity	Order Id	Time	Comment
	09:00:20	3	10	99.005					

This will create an internal Implied Order in Order Book B, with a time stamp when the Implied Order is generated, which in this case is the time when the Order in C is entered (09:00:20). The quantity for the Implied Order will be 20 contracts (with quantity restriction 2), because the ratio for the Combination is 1:2:1. Thus the 20 contracts can be matched in Order Book B, but it must be matched in multiples of the quantity 2, for the Implied Order.

The price for the Implied Order is calculated from the leg Orders in A and C, and from the Combination Order:

Buy Net Price = BNP = Buy Legs – Sell Legs = A + C – 2* B.

Hence 2* B = A + C – BNP.

Thus B = (A + C - BNP) / 2 = (97.000 + 99.005 – 1.000) / 2 = 197.010 / 2 = 97.5025.

Thus the price for the Implied Order is off-tick. However since there a 3 decimals used in the price, the off-tick price can not be represented in the number format.

Since there are only 3 decimals in the price format, the Implied price is truncated to 97.502, a worse price.

If the Order had been a Sell Order, then the price would have been rounded up to 97.503, thus to a worse price. Note that this is not the next valid tick. Thus the Implied price is still off-tick.

The Order Id is 1, based on the Combination Order.

Note that this Implied Order is not disseminated to the market via ITCH Market Data.

Order Book B									
Buy Side					Sell Side				
Comment	Time	Order Id	Quantity	Price	Price	Quantity	Order Id	Time	Comment
Price is off-tick	09:00:20	1	20 / 2 (internal Implied)	97.502					

1.2.6.8 Boundaries for Implied Generation

Regarding Implieds:
- Implied Orders are not generated for Quotes (when quoting in the Combination Order Book itself);
- Implied Orders are only generated, using the best single prices as a base; and
- Implied Orders are never used as a base for other Implied Orders.