



Confidential

QCC with Stock Net Price

Version: ~~1.6~~1.7

Issue date: July 2014

Print date: ~~9/8/2014~~7/11/2014

Produced by:
International Securities Exchange
60 Broad Street, New York NY 10004
www.ise.com

Table of contents

| | |
|--|-----------|
| 1. Introduction..... | 5 |
| 1.1. Business Case | 5 |
| 1.2. Scope | 5 |
| 1.3. Planned Benefits | 5 |
| 1.4. Priority | 6 |
| 1.5. Key Definitions, Acronyms, and Abbreviations..... | 6 |
| 2. Overview..... | 7 |
| 2.1. Current Behavior | 7 |
| 2.2. Proposed Solution | 8 |
| 2.3. Assumptions | 10 |
| 3. Detailed Requirements | 11 |
| 3.1. PreclSE | 11 |
| 3.2. SOR | 25 |
| 3.3. DTI | 26 |
| 3.4. Matching Engine..... | 26 |
| 3.5. Trade Manager..... | 42 |
| 3.6. Audit Trail | 42 |
| 3.7. POB / Broadcaster | 42 |
| 3.8. Reference Data | 42 |
| 3.9. IORS | 44 |
| 4. Non-Functional Requirements..... | 47 |
| 4.1. Connectivity | 47 |
| 4.2. Member Impact | 47 |
| 4.3. Monitoring..... | 47 |
| 4.4. Security..... | 47 |
| 4.5. Reliability | 47 |
| 4.6. Availability..... | 47 |
| 4.7. Auditability | 47 |
| 4.8. Documentation | 48 |
| 4.9. Data Requirements | 48 |
| 4.10. Billing | 48 |

| | | |
|-----------|---|-----------|
| 4.11. | Acceptance Criteria | 48 |
| 4.12. | Legal | 48 |
| 4.13. | Rollout Strategy | 48 |
| 4.14. | Future Enhancement | 48 |
| 5. | Appendix | 52 |
| 5.1. | More examples for Options and Stock Ratios, Order Quantity, and Stock Relative Side..... | 52 |

Related documents

DFS3810 Production Matcher R8.0 Part B-I v1.5

DFS3810 Production Matcher R8.0 Part B-II v1.4

Summary of changes

A history of significant changes to this template is described in the table below.

| Issue | Date | Author | Change |
|---------------------|----------------------------|---|--|
| 0.1 | 10/10/2013 | J. Frondoso | Initial draft |
| 0.2 | 12/05/2013 | J. Frondoso | Incorporated new BRD sections |
| 0.3 | 12/23/2013 | K. Rathi | Draft Matcher details |
| 0.4 – 0.6 | 03/04/2014 | J. Frondoso K. Rathi | Update after mtg with Dev |
| 1.0 | 03/31/2014 04/04/2014 | J. Frondoso | First issue |
| 1.1 | 04/08/2014 | J. Frondoso | Incorporated review comments from Dev |
| 1.2 | 04/21/2014 | J. Frondoso | Incorporated comments from Dev |
| 1.3 | 05/23/2014 | K. Rathi M. DiBenedetto J. Frondoso | Updated Matcher Pricing Algorithm Updated Reference Data Section for new matcher parameters. Updated PrecISE and IORS sections based on additional team feedback |
| 1.4 | 05/29/2014 | M. DiBenedetto | Updated Reference Data Section – removed CustIBBOTickImprovement |
| 1.4 | 06/6/2014 | M. DiBenedetto | Updated Reference Data Section – changed N/A to None, changed order of CUSTIBBOTickImprovementMethod to be in sync with Matcher section. |
| 1.4 | 06/17/2014 | J. Frondoso | Updated IORS section – made distinction between trade and order drop copy behavior Updated PrecISE section – clarification on truncating decimal places, updated Stock Relative Side table and moved up the section for clearer flow. |
| 1.5 | 07/07/2014 | R. Bhotika | Core Updates |
| 1.6 | 07/22/2014 | J. Frondoso | PrecISE updates/clarifications for Pricing View default. Corrected typo in Example 4 calculation in appendix. |
| 1.7 | 08/02/2014 | J. Frondoso | Updated 3.1.5.1 – completed “Multiple option legs” table with missing scenarios. |

Reviewers and approvers

Reviewers

This document was reviewed by:

| Name | Title | Date |
|------------------|-------|------|
| John Palmer | | |
| Mike DiBenedetto | | |
| Roli Bhotika | | |
| Jon Dowd | | |
| Binita Adhikari | | |
| Katrina Lukacs | | |

Approvers

This document was approved by:

| Name | Title | Date |
|-----------------|-------|------|
| Kapil Rathi | | |
| Geralyn Endo | | |
| Rich Wieszczeck | | |
| Eric Salem | | |
| Mike Marinich | | |
| Bonnie Bradley | | |
| Dan Amar | | |
| Khalid Essafi | | |

1. Introduction

1.1. Business Case

Several users have expressed difficulty in trading QCC w/ Stock orders via PrecISE due to the lack of a Net Price feature for the entire package. Today, the user has to enter the options and stock prices separately. They miss the market by the time they submit the order because they have to manually figure out where to price the options and stock portion based on a net price. Missing the market results in an order reject or users not using the order ticket at all

Additionally, this order type is limited to PrecISE users. Member firms that do not have PrecISE are not able to use QCC with Stock.

To provide members the ability to enter a net package price for their QCC with Stock order we can leverage the current Matching Engine's ability to price the options and stock portions based on the entered net price. Leveraging matching engine calculation has multiple benefits including:

- The Matching Engine (Matcher) calculation is proven and used over the years.
- The Matching engine has the most updated view of ISE BBO, away BBOs, customer presence on ISE BBO and underlying BBO. All of these variables are important for successful execution of options and stock components.
- Keeping the calculation in one place reduces future maintenance of the complex logic of options and stock pricing from a net price.

1.2. Scope

We will provide a net price option that will be available only to PrecISE users. The QCC with Stock order type will not be available for DTI and IORS users yet. The available Stock Execution Venues (SEV) for QCC with Stock will be the current configured SEV choices. There will be no changes to the stock routing process i.e. the stock portion will continue to route from PrecISE to the SEV via the SOR Stock API.

Future enhancement:

The team plans to eventually support the Matcher sending the stock portion to the stock venue so that QCC with Stock will be available for DTI and IORS users.

See Future Enhancements section in this document for more details on this option.

1.3. Planned Benefits

Providing a net price for the QCC with Stock order type will attract additional QCC with Stock business. This order type is only available via PrecISE. We will be able to acquire new PrecISE users while retaining the existing users. They already have the ease of order entry, electronic recording, and the ability to select the stock venue. Providing them the net price feature means we lessen the number of reject occurrences when a QCC with Stock order misses the market. When we eliminate the need for manual options and stock price entry, the order entry process is faster and the Matcher's calculations will determine the best price for the options and stock legs while honoring the net package price and the current market prices. Less rejects for the user means more confidence in our system and the order type.

1.4. Priority

Priority is high. Requested release is R10.

1.5. Key Definitions, Acronyms, and Abbreviations

| Acronym | Description |
|---------|--|
| QCC | Qualified Contingent Cross |
| ME | Matching Engine |
| TM | Trade Manager |
| SOR | Smart Order Router |
| SEV | Stock Execution Venue |
| RDS | Reference Data System |
| RDFE | Reference Data Front End |
| RDA | Reference Data Access |
| ASTPR | Away Stock Trade Price Range |
| ABBO | Away Best Bid and Offer |
| UBBO | Underlying Best Bid and Offer |
| MPID | Market Place ID? |
| GU | Give Up |
| SPTA | Stock Post Trade Allocation |
| SLA | Service Level Agreement (e.g. the designated span of time we give a SEV time to respond to an order) |
| DTI | Direct Trading Interface |
| IORS | ISE Order Routing Service |
| POB | Private Order Broadcast |
| ER | Execution Report |
| DK | Don't Know |
| GCD | Greatest Common Divisor |
| BWRT | Buy-Write |
| STD | Straddle |
| SPRD | Spread |
| SRM | Simple Rounding Mechanism |
| DK | Don't Know |
| ORA | Order Router Adapter |
| DCA | Drop Copy Adapter |
| CI | Complex Instrument |

2. Overview

2.1. Current Behavior

QCC orders allow customers to send an options crossing order without exposure as long as the order is tied to stock, the options portion trades at or within the NBBO, the order has a minimum quantity of 1,000 contracts (applied to quantity on the lowest leg for complex orders), and does not trade ahead of a priority customer order.

Today, there is a distinction between a QCC and QCC with Stock order. We offer QCC for PreclSE, DTI, and FIX/IORS users. If members use QCC, they send us the options portion of the order, but the onus is on them to execute the stock portion of the order through another means (not via PreclSE/ISE). QCC with Stock is different because we provide an order ticket that allows PreclSE users to trade both options and stock legs at the same time. The ease of use through one front-end and the electronic recording are favorable features to our customer base. QCC with Stock is only offered via PreclSE. Therefore, DTI and IORS users cannot use the order type unless they have access to PreclSE.

There are additional differences between QCC with Stock and the other existing combo stock auctions and crosses:

1. **Stock Portion.** The stock portion of a QCC with Stock does not come to the Matcher. Instead, PreclSE routes the stock leg to the SOR via a Stock API. Other combo stock orders get their stock portion routed to SOR via the Matcher.

Additionally, the IORS/FIX drop copy application (DCA) does not process the QCC stock trade or stock order status reports since the stock portion of a QCC with Stock order is not processed by the core.

2. **Stock Execution Venues:** Majority of stock orders tied to a QCC orders are executed at CHX based venues (Cheevers, Libucki and FOG). Equity orders related to other double sided stock/options orders are executed at BNY. The major difference between CHX and BNY is speed. While BNY execution process is fully automated, the CHX based process involves human intervention by a broker.
3. **Execution Sequence.** Due to speed difference in equity execution flow the execution sequence for QCC with Stock and other stock combos is different:
 - a. For QCC with Stock orders that use CHX-based venues, since there is a human intervention involved, printing an equity order can take up to three minutes. Keeping orders locked for three minutes and not confirming order execution for such a long time to customer is not possible. Moreover in three minutes, options market may move significantly and equity DKs will increase. To avoid this issue, options legs are printed first and options trade confirmations are sent to customer right away. Once option legs are printed, equity orders are sent out to CHX by PreclSE. Since all two sided stock/options orders qualify for QCT contingency under Reg NMS, the equity legs can be printed outside the equity NBBO hence movement in equity market is not an issue. If for some reason the stock portion does not execute, Market Ops receives an alert to call the customer and advise them to resend the stock portion through another means (not PreclSE/ISE). The options portion remains in its current state unless the customer requests a bust.
 - b. For the stock combo orders that use BNY, the equity leg is printed before option legs. Option orders are set in locked state by the Matcher while equity leg is being printed. If for some reason the option execution cannot

be completed, an automated DK (Don't Know) procedure allows reversal for equity print. This process ensures that customers have no legging risk i.e. they either get both equity and options trades completed or nothing.

4. **Trade Confirmation.** For other double sided trades, the trade confirmation (POB from the Matcher) is sent when the entire contents, options and stock, of a combo stock order is completed. For QCC with Stock, trade confirmation is sent to the user as they occur, with option fills coming from the Matcher POB and stock fills coming from Stock API.
5. **Stock Delta.** PrecISE allows QCC with Stock users to enter the stock delta in decimal format. PrecISE allows the delta in decimal format only so the user has more control over how many shares they want to send. However, stock delta in decimal format is not allowed by the Matcher. PrecISE will send the shares to SOR and to the Matcher in integer format.
6. **Stock Post Trade Allocation (SPTA).** SPTA of a QCC with Stock trade requires the CHX based venues to reach out to the member if there are any post trade clearing changes for stock trades. SPTA is done electronically through PrecISE for other combo stock orders with a BNY stock destination. Regular options PTA is done directly through PrecISE.
7. **Net Package Price.** The QCC with Stock order ticket in PrecISE requires the user to enter the options and stock prices separately. A net package price is not applicable because the stock portion does not come to the Matcher. Therefore, the Matcher's pricing calculation cannot apply.
8. **Trade ticks.** For all with stock orders, options can trade in pennies while stock can trade up to 6 decimals. For QCC w/Stock orders with multiple option legs, options can trade in pennies while stock can trade up to 6 decimals. For QCC w/Stock orders with one option leg, option can only trade in legal ticks while stock can trade up to 6 decimals.

For other combo stock orders, the Matcher's calculation for stock and options print prices can be found in Part B II of the Matcher Specs.

2.2. Proposed Solution

PrecISE will provide users the ability to enter a net package price for their QCC with Stock orders. In summary, to achieve this:

- PrecISE sends options and stock legs to the Matcher
- The Matcher keeps/prints options, and sends the calculated stock price back to PrecISE
- PrecISE sends the stock portion to the stock venue via Stock API

PrecISE will not send QCC w/Stock orders for a stock combination instrument (as it does for other w/Stock orders such as Facilitation w/Stock order). If the QCC w/Stock order has one option leg, the order will be sent as an order for simple instrument. If the QCC w/Stock order has multiple option legs, the order will be sent as an order for standard combination instrument. With this concept the stock information will not be provided on the stock leg. It will be provided by using new fields described in rest of this document.

2.2.1. New Cross Types

Two new cross types will be created in core: QCCNet_Simple and QCCNet_Complex. PrecISE will send the 'New Order Cross' Transaction to core with these two new cross types. QCCNet_Simple will be used when a QCC with Stock order is entered with one option leg only. QCCNet_Complex will be used when a QCC with Stock order is

entered with more than one option legs. The new cross types will be common to DTI and IORS users so that they can take advantage of the QCC with Stock order type when it's made available to them in a separate, future release. Validations for these new cross types will be separate from the validations of the current QCC cross configured in reference data.

The Matcher needs the side and ratio information to calculate the options and stock price based on a given net price. The New Order Cross transaction will be modified to provide the option ratio, stock ratio, and stock relative side. The stock relative side determines the stock side based on the options side.

2.2.2. Updated Private Order Broadcast (POB)

The POB will be updated to communicate the stock price back to PreclSE. Updating the broadcast would be a non-mandatory member impact. The stock price field will be on the DTI. DTI will be backward compatible; IORS can ignore the stock price field. Only members who wish to use the new cross types will need to code to the new stock price field.

2.2.3. Stock Price and Record

PreclSE will send the order into the Matcher for the options print and to utilize the Matcher's stock price calculations. The Matcher will not route the stock portion to the SEV. Instead, the Matcher will provide the stock price on the POB for PreclSE to use when PreclSE routes the stock portion to the SEV via the Stock API. The QCC with Stock order and trade information will be reported in the PreclSE Order History Report. QCC with Stock trade volume will continue to be published in ISE's internal statistical reports dashboard. Trade Manager is not impacted.

2.2.4. Drop Copy Adapter (DCA)

DCA will process only stock trade reports for QCC with Stock orders. Members who already subscribe to DCA for trade execution reports will automatically receive stock trade reports for the stock portion of a QCC with Stock order. PreclSE will send DCA the stock information and DCA will convert the message to the execution report format.

2.2.5. QCC with Stock Rejects

If the PreclSE user selects the "Net Price" Pricing View option and for whatever reason the Matcher cannot price the stock leg, the entire order/transaction will be rejected. This is a different behavior from today's behavior when the "Stk and Opt" Pricing View option is selected. When "Stk and Opt" is selected on the front-end, the options portion will print even if the stock leg receives a reject (or DK) from the stock venue. This is because the Matcher has been given the options net price on the order.

2.2.6. Stock Post Trade Allocation (SPTA)

The current PTA process will remain as is: CHX based venues will contact the member firm for post trade allocations. This will not be an electronic process at this time.

2.2.7. Alternate Solution Discussed

The team discussed the following alternate solutions to provide QCC with Stock net price:

1. PreclSE sends options + stock legs to the Matcher. The Matcher keeps options,

and sends stock to SEV. Due to the current Matcher design (print stock before options), this is a desired future solution for DTI/IORS users who want to send the stock to BNY only.

2. Build a library that houses the Matcher's calculations/logic that PrecISE and other applications can leverage. This solution required a longer time to market.
3. Build a "simpler logic" in PrecISE, i.e. PrecISE can exclude logic such as trade value error, rounding management, etc. This solution potentially decreases the fill rate by excluding some logic/calculations.
4. Build the same calculation/logic in PrecISE. This solution required maintaining the logic in multiple applications, as well as implementing highly complex logic in PrecISE.

2.3. Assumptions

1. Electronic stock PTA (SPTA) is allowed only for the BNY venue. All other stock venues require manual SPTA (e.g. Market Ops to call venue). Note: enabling a SEV for electronic SPTA is configurable in the SOR configuration client, where each SEV has their set of configurations.
2. Trade Value Error calculation is required for QCC w/ Stock.
3. It is acceptable for the quantity of an options leg to trade at different price points as long as the traded quantity for the leg is equal to or greater than the minimum order quantity of 1,000 contracts. Eg. 999 contracts traded at \$1.00 and 1 contract traded at \$1.01. However, the QCC with Stock Options Net Price must print all 1000 contracts of the standard complex instrument at a single options net price. Hence Simple Rounding Mechanism will not be applied for QCC with Stock Net Price Transactions. In a case where the application of the Simple Rounding Mechanism is required to produce the stock and options print prices, the transaction will be rejected instead.
4. IBBO validations will be applied with respect to the single leg book for a QCC w/Stock that has one option leg. IBBO validations will be applied with respect to the standard complex book and the simple instrument book for a QCC w/Stock that has multiple option legs unless stated otherwise. Validations with respect to the stock combination instrument book are not required.
5. The Market Place ID (MPID) is maintained in the Reference Database. PrecISE users will continue to enter 5-letter MPID values and PrecISE will drop the last character, usually a 'X', since only 4-letter MPIDs are currently processed.

3. Detailed Requirements

3.1. PrecISE

3.1.1. Introduction

PrecISE is ISE's trading application that provides the ability to enter and trade orders using specific order tickets. The status of these orders and trades are reflected in the Order Status and Trades View windows. QCC with Stock is an order ticket exclusive to PrecISE EAM users – the order type is not offered in IORS or DTI. Like QCC, QCC with Stock orders allow customers to send an options crossing order without exposure as long as certain order attributes are adhered to. If members use QCC, they send us the options portion of the order, but the onus is on them to execute the stock portion of the order through another means (not via PrecISE/ISE). QCC with Stock is different because we provide an order ticket that allows PrecISE users to trade both options and stock legs at the same time. The ease of use through one front-end and the electronic recording are favorable features to our customer base.

3.1.2. Current Behavior

PrecISE supports order entry of a QCC with Stock order via the QCC w/ Stock order ticket. QCC with Stock orders are available several places in the PrecISE Trade interface:

- The Entry Tickets button on the toolbar to select With Stock > QCC with Stock
- Within an order ticket, select With Stock > QCC with Stock from the menu bar
- Right-click in the Regular Orderbook window to select Spread With Stock - QCC

The user can create a complex instrument with as many as ten legs: nine options legs and one stock leg. However, at this time the core will only support nine legs: eight options legs and one stock leg. The order is sent to the core as a cross order type.

3.1.3. Proposed Changes

The following are enhancements to PrecISE to support the Net Price feature:

1. Add the "Net Price" Pricing View option and its respective field to enter a price, up to four decimal places. Selecting Net Price will hide the individual fields for Stock Price and Options Net Price.
2. The "Stk and Opt" pricing view will have two versions:
 - a. Stk & Opt: Current feature. This means the user wants the separately entered prices to be retained. SOR will receive the stock price specified on the ticket; the core will receive the options net price specified on the ticket. **This will continue to be the current Pricing View default selection. Users can change this default using the order ticket's Save Default feature.**
 - b. Net Stk&Opt: The user will enter separate stock and options net prices, but will leave it up to PrecISE to combine both price entries and calculate a net price to send to the Matcher.

The value names will be shortened (as shown above points a and b) to fit the Pricing View drop down space.

3. Pricing View and Delta are two independent fields without any logic/connection based on the values.
4. In the Order Status view the Price column (Prc) should reflect the net price, the way it does today with other stock comb orders. If the net price has been adjusted, then the adjusted net price will be displayed. If the net price has not been adjusted, then it will be displayed as is.
5. The order confirmation will reflect the final adjusted full quantity of each leg (total shares and total contracts of each option leg), delta, and the net price. If there is no quantity/net price reduction/adjustment, then the prompt will display as is. An example – this layout is taken from the current QCC with Stock:

Submit QCC with Stock Order to
Buy 100,000 shares (100 delta) GOOG and
Buy 1,000 GOOG4MAR705.0C
at Net debit of 1300.00?
6. Route the entire QCC with Stock order to the Matcher via the existing New Order Cross transaction and new cross type with the following *new* fields:
 - a. Options ratio in its reduced form
 - b. Stock ratio in its reduced form
 - c. Stock Relative Side

Calculations will be done in PrecISE based on the algorithm described in section 3.1.5.
7. Values in the existing DTI fields may be adjusted by PrecISE during the stock and option ratio reduction explained in section 3.1.5:
 - a. Order Quantity (tag 38)
 - b. Price (tag 44)
 - i. If the adjusted Net Price has more than four decimal places, PrecISE will truncate the price so that it has a max of four decimal places.
8. Receive a stock price from the Matcher via the POB. This is the price to use when sending the stock portion to the Stock Venue via the Stock API.
9. Execution reports will be present on the FIX drop copy. The stock leg executions will also be present on the drop copy.

No change to the Order and Trade views and the Change Clearing window.

Additionally, the QCC with Stock order ticket will have the following enhancements:

10. The “Order 1” label will be renamed to “Originating” and the “Order 2” label will be renamed to “Contra”.
11. The “Orig” and “Cntr” position values will behave the following way:

| Stock Leg B/S (user selects) | Orig | Cntr |
|---------------------------------|-----------------------------|--|
| <i>Sell</i> | <i>Short</i> (user selects) | Defaults to <i>Long</i> |
| <i>Sell</i> | <i>Long</i> (user selects) | Defaults to <i>Long</i> |
| <i>Sell</i> | <i>Exempt</i> (user select) | Defaults to <i>Long</i> |
| <i>Buy</i> | Defaults to <i>Long</i> | No default – it’s blank for user to select |

| | | |
|-----|--|--|
| Buy | Defaults to <i>Long</i> , but user changes value | No default – it's blank for user to select |
|-----|--|--|

Anytime the user changes the Stock Leg side, the previously entered/defaulted values will be reset to what is listed in the table above.

Other QCC related changes:

12. The Qualified Contingent Cross order ticket's Price field will display a max of two decimal places.
13. The Qualified Contingent Cross Spread order ticket's Net Price field will display a max of two decimal places.

3.1.4. Common Business Rules

This section outlines common PrecISE business rules/requirements for QCC with Stock. The common requirements are further refined in each use case.

The following outline the common business rules for QCC with Stock:

1. The order ticket defaults the order quantity to 1,000.
2. There will be three ways the user can specify a price on the order:
 - a. Net Price (new feature): The Net Price field will display a max of four decimal places. See section 3.1.5 for details.
 - b. Net Stk&Opt (new feature): The user will enter separate stock and option net prices the way they do today. However, the difference is that PrecISE will combine those prices treat it as a single net price. This means the fields and calculations described in 3.1.5 will apply. The stock and/or options may be priced slightly differently based on the Matcher's calculations; the print prices will not be held to the separately entered prices. The stock and options print prices net out to the calculated net price on order entry. The stock price field will display a max of four decimal places. The Options Net Price field will display a max of two decimal places.
 - c. Stk & Opt: This is current behavior. The stock will be sent to SOR with the price specified in the Stock Price field. The option net price will be sent to the core with the price specified in the Opt Net Price field. The stock price field will display a max of four decimal places. The Options Net Price field will display a max of two decimal places.

We will allow the user to set one as the default. For the new front-end version, the default will be Net Price.

3. Originating and contra sides of the cross have no client category limitations.
4. Mandatory fields are validated with a value, if there is no default value, before order submission.
5. A PrecISE user's BU must be entitled in Reference Data to enter QCCNet crosses. See Reference Data Section 3.8 for entitlement details.
6. The following new fields will be sent to the DTI if the Net Price or Net Stk & Opt Pricing View is selected:
 - a. Options ratio

Comment [I1]: RB: Can be configured at the user level. Discuss roll out plan.

- b. Stock ratio
 - c. Stock Relative Side
7. Selecting a SEV is required. The SEV options are configured per BU. If SEV options are not configured for a particular BU, then the user cannot send a QCC with Stock order. The default SEV is blank.
 8. PreclSE does not perform validation on whether or not the user is configured in Reference Data for a specific stock venue. SOR will continue to perform this validation and PreclSE will process any reject SOR may provide.
 9. PreclSE will check the availability of SOR before sending the Options leg(s). If SOR is not available, the entire QCC with Stock order will receive a reject message.
 10. While the QCC with Stock order is being worked on by ISE and SOR processes, the order will be locked and the PreclSE customer cannot cancel the order.
 11. PreclSE will continue to validate the stock Giveup value before sending the options portion to the Matcher.
 12. Step Up functionality does not apply to QCC with Stock.
 13. PreclSE GTS Adapter will continue to send stock information to the core in the DTI free text field AgreementDesc (tag 913) as such:
`<AgreementDesc value="PRC:$535 QTY:100000 DELTA:100"/>`
 The stock price ("PRC") will not be present for the new QCC with Stock cross transaction. Per Surveillance, they do not need to know the stock price, the stock quantity matters to them.
 14. The stock execution will be present on the FIX drop copy.
 15. Should the Matcher reject the QCC with Stock cross transaction, PreclSE will communicate rejects from the Matcher in a user-friendly format.

3.1.5. Calculations: Options and Stock Ratios, Order Quantity, Net Price, & Stock Relative Side

To decide the stock and options trade prices the Matcher expects the following information:

- Option ratio (new field)
- Stock ratio (new field)
- Order Qty (existing field, tag 38) with respect to the reduced stock and option ratios
- Net Price (existing field, tag 44)
- Stock Relative Side (new field)

The following section describes the algorithm to deduce each value expected by the Matcher.

3.1.5.1. Determine the Stock Relative Side and Net Price Sign

The option side will play a role in deciding the net price sign and stock relative side. To determine the options side:

- For a QCC w/ Stock order with a single option leg, the option side will be what the user specifies on the option leg.
- For a QCC w/ Stock order with multiple option legs, the option side will be the CI instrument side. If the CI created by the Matcher is the same as requested by PrecISE, the CI instrument side is considered 'Buy'. If the CI created by the Matcher is opposite of what is requested by PrecISE, the CI instrument side is considered 'Sell'.

Net Price Sign

A change to an existing PrecISE behavior will be the inversion of the net price sign from the PrecISE GTS Adapter to the Matcher. If the option leg is a sell, the GTS Adapter will invert the sign of the net price, e.g. if the price was a +10, it will become -10. This inversion is done in order to preserve the core's current expectation, which is:

- If the originating option side is a buy and a positive net price is sent, the Matcher will interpret this as the user expecting to pay.
- If the originating option side is a buy and a negative price is sent, the Matcher will interpret this as the user expecting to receive money.
- If the originating option side is a sell and a positive price is sent, the Matcher will interpret this as the user expecting to receive money. This is when PrecISE will flip the sign on the net price in order to adhere to the user's intent while using the core's translation.
- If the originating option side is a sell and a negative price is sent, the Matcher will interpret this as the user expecting to pay money. This is when PrecISE will flip the sign on the net price in order to adhere to the user's intent while using the core's translation.

See tables below.

Stock Relative Side

The stock relative side will be deduced using the originating options side and the stock side as follows:

Single option leg

| PrecISE QCC w/Stock Ticket | | Option Order Side sent from PrecISE to Matcher | Stock Relative Side sent from PrecISE to Matcher | Net Price Sign Matcher expects | |
|----------------------------|-----------|--|--|--------------------------------|------------------------|
| Option Leg | Stock leg | | | If Debit on order tkt | If Credit on order tkt |
| Buy | Buy | Buy | Same | Positive | Negative |
| Sell | Sell | Sell | Same | Negative | Positive |

| | | | | | |
|------|------|------|----------|----------|----------|
| Sell | Buy | Sell | Opposite | Negative | Positive |
| Buy | Sell | Buy | Opposite | Positive | Negative |

Multiple option legs

| PrecISE QCC w/Stock Ticket | | | Assume CI Instrument created by Matcher | Option Order Side sent from PrecISE to Matcher | Stock Relative Side sent from PrecISE to Matcher | Net Price Sign Matcher expects | |
|----------------------------|--------------|-------------|---|--|--|--------------------------------|------------------------|
| Option Leg 1 | Option Leg 2 | Stock leg | | | | If Debit on order tkt | If Credit on order tkt |
| Buy | Buy | Buy | Buy, Buy | Buy | Same | Positive | Negative |
| Buy | Sell | Sell | Buy, Sell | Buy | Opposite | Positive | Negative |
| Sell | Sell | Buy | Buy, Buy | Sell | Opposite | Negative | Positive |
| Sell | Buy | Sell | Buy, Sell | Sell | Same | Negative | Positive |
| <u>Sell</u> | <u>Sell</u> | <u>Sell</u> | <u>Buy, Buy</u> | <u>Sell</u> | <u>Same</u> | <u>Negative</u> | <u>Positive</u> |
| <u>Buy</u> | <u>Buy</u> | <u>Sell</u> | <u>Buy, Buy</u> | <u>Buy</u> | <u>Opposite</u> | <u>Positive</u> | <u>Negative</u> |
| <u>Buy</u> | <u>Sell</u> | <u>Buy</u> | <u>Buy, Sell</u> | <u>Buy</u> | <u>Same</u> | <u>Positive</u> | <u>Negative</u> |
| <u>Sell</u> | <u>Buy</u> | <u>Buy</u> | <u>Buy, Sell</u> | <u>Sell</u> | <u>Opposite</u> | <u>Negative</u> | <u>Positive</u> |

3.1.5.2. Determine Options and Stock Ratios, Order Quantity, Net Price

At a high level, in order to provide the Matcher with the options ratio, stock ratio, net price, and order quantity, PrecISE needs to do the following:

- Calculate each leg quantity
 - The total number of shares of the stock leg = Delta x Total Qty
 - The total number of contracts for each option leg = Option leg Ratio x Total Qty
- Derive the GCD (Greatest Common Divisor) across all the legs of the order. The GCD will be the adjusted order quantity sent to the Matcher.
- Divide each leg quantity by the GCD to obtain the ratio for each leg.
 - The GCD is the order quantity (tag 38) that will be sent to the Matcher.
 - The final reduced stock ratio will be the stock ratio sent to the Matcher.
 - For a QCC with Stock order with a single options leg, the options ratio sent to the Matcher will be the reduced options leg ratio.
 - For a QCC with Stock order with multiple options legs: Determine the GCD between the reduced ratio of each option leg. This GCD will be the options ratio sent to the Matcher.

- Calculate a new net price based on the adjusted quantity. If no quantity adjustments were made, then no need to adjust the original net price. If quantity adjustments were made then the net price will also be adjusted using the following formula:

New Net Price = Original price / (The GCD in Step 2[†] / Original Order Quantity)

[†]The GCD in Step 2 is also known as the adjusted order quantity.

If the new net price has more than four decimal places, then PrecISE will truncate the price such that only a max of four decimal places will be displayed on the order confirmation pop-up and sent to the Matcher. Rounding will not occur. The net price will be sent to the Matcher in tag 44.

- Determine the stock relative side based on the options side.
- For a QCC with Stock order with multiple options legs, create the standard complex instrument with reduced options leg ratios.

QCC with Stock with one option leg

We will use the following example to calculate each of the expected information. A PrecISE user enters the following order information:

| PrecISE QCC w/Stock Ticket | | | |
|----------------------------|------|-------|-----------|
| CI | Side | Ratio | Order Qty |
| Stk | Buy | 10 | 1,000 |
| Opt1 | Sell | 5 | |
| Net Price = \$5 | | | |

- PrecISE will calculate the total number of shares for the stock leg and the total number of contracts for each option leg.

| PrecISE QCC w/Stock Ticket | | | | Calculations |
|----------------------------|------|-------|-----------|-------------------------------|
| CI | Side | Ratio | Order Qty | Total # of shares / contracts |
| Stk | Buy | 10 | 1,000 | 10,000 |
| Opt1 | Sell | 5 | | 5,000 |
| Net Price = \$5 | | | | |

- Reduce the quantities by the GCD. GCD = 5,000. This is the adjusted order quantity PrecISE will send to the Matcher.

| PrecISE QCC w/Stock Ticket | | | | Calculations | |
|----------------------------|------|-------|-----------|-----------------------------|---------------------------|
| CI | Side | Ratio | Order Qty | Total # of shrs / contracts | Reduced quantities by GCD |
| Stk | Buy | 10 | 1,000 | 10,000 | 2 |
| Opt1 | Sell | 5 | | 5,000 | 1 |

| | |
|-----------------|--|
| Net Price = \$5 | GCD = Adjusted (new) Order Quantity = 5,000 |
|-----------------|--|

3. Since quantities cannot be further reduced, adjust the net price.

Original price / (Adjusted Order Quantity/Original Order Quantity) = Adjusted Net Price

$$\$5 / (5,000 / 1,000) = \$1$$

| PrecISE QCC w/Stock Ticket | | | | Calculations | |
|----------------------------|------|-------|-----------|--|---------------------------|
| CI | Side | Ratio | Order Qty | Total # of shrs / contracts | Reduced quantities by GCD |
| Stk | Buy | 10 | 1,000 | 10,000 | 2 |
| Opt 1 | Sell | 5 | | 5,000 | 1 |
| Net Price = \$5 | | | | New Net Price (tag 44) = \$1 | |
| | | | | Stock reduced ratio = 2 | |
| | | | | Options reduced ratio = 1 | |
| | | | | Adjusted Order Quantity (tag 38) = 5,000 | |
| | | | | Stock Relative Side = Opposite | |

To summarize: based on the above calculations, the Matcher receives:

- Stock reduced ratio = 2
- Option reduced ratio = 1
- Order Qty (tag 38) with respect to the reduced stock and option ratios = 5,000
- Adjusted Net Price (tag 44) = \$1
- Stock Relative Side = Opposite

QCC with Stock with multiple option legs

We will use the following example to calculate each of the expected information. A PrecISE user enters the following order information:

| PrecISE QCC w/Stock Ticket | | | |
|----------------------------|------|-------|-----------|
| CI | Side | Ratio | Order Qty |
| Stk | Buy | 10.5 | 1,000 |
| Opt1 | Sell | 9 | |
| Opt2 | Sell | 3 | |
| Net Price = \$10 | | | |

1. PrecISE will calculate the total number of shares for the stock leg and the total number of contracts for each option leg.

| PrecISE QCC w/Stock Ticket | | | | Calculations |
|----------------------------|------|-------|-----------|-------------------------------|
| CI | Side | Ratio | Order Qty | Total # of shares / contracts |
| Stk | Buy | 10.5 | 1,000 | 10,500 |
| Opt1 | Sell | 9 | | 9,000 |
| Opt2 | Sell | 3 | | 3,000 |
| Net Price = \$10 | | | | |

2. Reduce the quantities by the GCD. GCD = 1,500. This is the adjusted order quantity PrecISE will send to the Matcher.

| PrecISE QCC w/Stock Ticket | | | | Calculations | |
|----------------------------|------|-------|-----------|---|---------------------------|
| CI | Side | Ratio | Order Qty | Total # of shrs / contracts | Reduced quantities by GCD |
| Stk | Buy | 10.5 | 1,000 | 10,500 | 7 |
| Opt1 | Sell | 9 | | 9,000 | 6 |
| Opt2 | Sell | 3 | | 3,000 | 2 |
| Net Price = \$10 | | | | GCD = Adjusted (new) Order Quantity = 1,500 | |
| | | | | Stock ratio = 7 | |

3. Further reduce the options ratios, if possible. GCD of options ratio = 2.

| PreciSE QCC w/Stock Ticket | | | | Calculations | |
|----------------------------|------|-------|-----------|---------------------------------|---------------------------|
| CI | Side | Ratio | Order Qty | Total # of shrs / contracts | Reduced quantities by GCD |
| Stk | Buy | 10.5 | 1,000 | 10,500 | 7 |
| Opt1 | Sell | 9 | | 9,000 | 3 |
| Opt2 | Sell | 3 | | 3,000 | 1 |
| Net Price = \$10 | | | | Adjusted Order Quantity = 1,500 | |
| | | | | Stock Ratio = 7 | |
| | | | | Option Ratio = 2 | |

4. Since quantities were reduced, the net price will be adjusted.

Original price / (Adjusted Order Quantity/Original Order Quantity) = Adjusted Net Price

$\$10 / (1,500 / 1,000) = \$6.666666666666667 = \$6.6666$ (PrecISE will truncate to four decimal places if necessary)

| PrecISE QCC w/Stock Ticket | | | | Calculations |
|----------------------------|--|--|--|--------------|
|----------------------------|--|--|--|--------------|

| CI | Side | Ratio | Order Qty | Total # of shrs / contracts | Reduced quantities by GCD |
|------------------|------|-------|-----------|---------------------------------|---------------------------|
| Stk | Buy | 10.5 | 1,000 | 10,500 | 7 |
| Opt1 | Sell | 9 | | 9,000 | 3 |
| Opt2 | Sell | 3 | | 3,000 | 1 |
| Net Price = \$10 | | | | New Net Price = \$6.6666 | |
| | | | | Adjusted Order Quantity = 1,500 | |
| | | | | Stock Ratio = 7 | |
| | | | | Option Ratio = 2 | |
| | | | | Stock Relative Side = Opposite | |

To summarize: based on the above calculations, the Matcher receives:

- Stock reduced ratio = 7
- Option reduced ratio = 2
- Order Qty (tag 38) with respect to the reduced stock and option ratios = 1,500
- Adjusted Net Price (tag 44) = \$6.6666
- Stock Relative Side = Opposite

See the appendix for more examples.

3.1.6. Functional Areas and Use Case Summary

This section contains functional area break down, corresponding use cases, and the detailed business rules and functional flows for each use case.

1. Order management
 - a. New Order with individual Stock and Options Net prices
 - b. New Order with Net Price
2. Trade management
 - a. Front-end: No change to trade management functionality
 - b. FIX drop copy: will need to process stock execution reports

3.1.7. Detailed Use Cases

3.1.8. Submit a new QCC with Stock order with individual Stock and Options Net prices

| | |
|------------------|--|
| Use Case | Submit a new QCC with Stock order with individual Stock and Options Net prices |
| Description | PrecISE users creates and submits a new QCC with Stock order intraday through PrecISE, entering Stock Price and Opt Net Price. |
| User(s)/Actor(s) | PrecISE Users |
| Detailed | 1. PrecISE user should be able to create and submit a QCC |

| | |
|-------------------------|--|
| Business Rule(s) | <p>with Stock at any point while he is online with PrecISE front-end.</p> <ol style="list-style-type: none"> Entitlement to use QCC with Stock will be validated by the RSA ClearTrust entitlement. PrecISE front-end will validate that all mandatory fields are populated with a value. The following are the mandatory fields: Spread Strategy, Stock leg Side, Originating and Contra Positions, Total Qty, Shares, Debit/Credit selection, Stk Venue, Client Category for both Agency and Contra sides PrecISE will default the Total Qty on the order ticket to 1000. There will be three Pricing View options: Net Price, Stk & Opt, and Net Stk&Opt The default Pricing View value will be Net Price. For this use case, the user selects the Stk & Opt Pricing View option Stock Price and Opt Net Price fields are mandatory. If the Mkt Price button is pressed, then the synthetic high (highest price of the Bid/Ask range) is calculated and populated for the Stock Price and Opt Net Price. PrecISE will provide relevant values in the QCC with Stock drop downs: configured Stock Venue(s) per BU, supported Client Category (Customer, Prop-Firm, Prop-Cust, B/D-Firm, B/D-Cust, ISE MM, FARMM, Cust-Professional) The Step Up functionality does not apply to QCC with Stock. If the user sets defaults for certain fields using the ticket's Set/Save Defaults feature, those fields will be pre-populated when a new QCC with Stock order ticket is accessed. Using the copy functionality on an existing QCC with Stock order will copy all the order details of the selected order for the new order. |
| Front End Flow | <p>QCC with Stock orders are available at several places in the PrecISE Trade interface:</p> <ul style="list-style-type: none"> The Entry Tickets button on the toolbar to select With Stock > QCC with Stock Within an order ticket, select With Stock > QCC with Stock from the menu bar Right-click in the Regular Orderbook window to select Spread With Stock - QCC <p>The user enters order details and ensures mandatory fields are populated with a value. Mandatory fields are marked with an orange circle.</p> <p>New QCC with Stock is submitted and validated against business rules.</p> <p>In case validation fails, the user is prompted of the error and has a chance to correct and resubmit the order without the ticket closing.</p> |

| | |
|------------------------------------|--|
| | When validation passes, the QCC with Stock order is persisted in the system and also dynamically delivered to all running instances of PrecISE within a BU. |
| Order Processing | <p>There will be no change to the current process if the “Stk & Opt” pricing option is selected: The Options portion will be sent to the Matcher and the Stock portion will be sent to the Stock API.</p> <p>The options portion will print ahead of the stock leg. If the stock leg is rejected or DK’d after the options portion has traded, Market Operations will receive an alert to contact the member have them execute/send the stock portion (not via ISE/PrecISE). This is the current behavior.</p> |
| Pre-conditions | <p>Users must have:</p> <ul style="list-style-type: none"> • Access to the PrecISE front-end trading application • SEVs assigned to their BU via the StockExecutionVenues configuration in ITradeConfig. Selecting a SEV before QCC with Stock order submission is required in the front-end. |
| Post-conditions | <p>Upon successful creation and submission, the QCC with Stock order is displayed in the Order Status with the most current order status and information.</p> <p>If a trade occurs, the trade will be displayed with trade details in the multiple available trade views (My Trades, Desk Trades, Fills, Trades and Statistics).</p> <p>If the stock leg is rejected or DK’d after the options portion has traded, Market Operations will receive an alert to contact the member have them execute/send the stock portion (not via ISE/PrecISE). This is the current behavior.</p> |
| Non-Functional Requirements | Upon successful creation and submission, the QCC with Stock order is displayed in MPT for our internal operations team to track and/or reference if needed. Market Operations will be alerted to any delayed/rejected/don’t know stock status updates. |

3.1.9. Submit a new QCC with Stock order with Net Price

| | |
|----------------------------------|---|
| Use Case | Submit a new QCC with Stock order with Net Price |
| Description | PrecISE user creates and submits a new QCC with Stock order intraday through PrecISE, entering a Net Price. |
| User(s)/Actor(s) | PrecISE Users |
| Detailed Business Rule(s) | <p>Same business rules as the use case of “Submit a new QCC with Stock order with individual Stock and Options Net prices”. Differences are:</p> <ol style="list-style-type: none"> 1. For this use case, the user selects the Net Price Pricing View option 2. Net Price field is mandatory. 3. The Pricing View and Delta fields are independent of each other. The delta value will not affect the Pricing View field, |

| | |
|-------------------------|--|
| | <p>and vice versa.</p> <ol style="list-style-type: none"> PrecISE will use one of the new order cross types to send the order to the core (DTI): <i>QCCNet_Simple</i> for a QCC with a single option leg or <i>QCCNet_Complex</i> for a QCC with multiple option legs. PrecISE does not need to send a stock leg's short sale information to DTI because PrecISE will send it to SOR. PrecISE must extract the stock price from the broadcast generated from the Matcher. PrecISE will send the stock portion with the stock price from the Matcher to Stock API. |
| Front End Flow | <p>QCC with Stock orders are available several places in the PrecISE Trade interface:</p> <ul style="list-style-type: none"> The Entry Tickets button on the toolbar to select With Stock > QCC with Stock Within an order ticket, select With Stock > QCC with Stock from the menu bar Right-click in the Regular Orderbook window to select Spread With Stock - QCC <p>The user enters order details and ensures mandatory fields are populated with a value. Mandatory fields are marked with an orange circle. The FE will alert the user if a value for a mandatory field is missing upon order submission.</p> <p>QCC with Stock order is submitted and validated against business rules.</p> <p>In case validation fails, the user is prompted of the error and has a chance to correct and resubmit the order.</p> <p>When validation passes, the QCC with Stock order is persisted in the system and also dynamically delivered to all running instances of PrecISE within a BU.</p> |
| Order Processing | <p>The core will expect the following information for a QCC with Stock:</p> <ol style="list-style-type: none"> One of the two new Cross Order Types "QCCNet_Simple" and "QCCNet_Complex" in the existing CrossType field (tag 549) Net price – will use the existing Price field (tag 44) Order Quantity – will use the existing OrderQty (tag 38) on both sides of the cross. See section 3.1.5. Options ratio – This is a new field in the new QCC with Stock Cross transaction. It will be sent to the DTI in a new field/tag on the New Order Cross transaction. <ol style="list-style-type: none"> For QCC with one option leg: the options ratio is entered on the order ticket. PrecISE will send the reduced stock and options ratios to the Matcher. See section 3.1.5. For QCC with multiple option legs: the options ratio for |

| | |
|------------------------|---|
| | <p>each options leg is entered on the order ticket. PreclSE will send the reduced options ratio to the Matcher. See section 3.1.5.</p> <p>5. Stock ratio – This is a new field in the New Order Cross transaction. It will be sent to the DTI in a new field/tag on the New Order Cross transaction. The stock ratio is entered on the order ticket. PreclSE will send the reduced stock ratio to the Matcher. See section 3.1.5</p> <p>6. Stock relative side – This is a new field in the New Order Cross transaction. The valid values are “Same” or “Opposite” and rely on the option side for QCC with one option leg and rely on the Complex Instrument side for QCC with multiple option legs. The value for QCC with multiple option legs is determined by the following logic in section 3.1.5.</p> <ol style="list-style-type: none"> If the option side is different than the stock side, then send “Opposite” to the Matcher. If the option side is the same as the stock side, then send “Same” to the Matcher. <p>7. If the stock price from the Matcher has 6 decimal places, then PreclSE can handle this – as it does today.</p> |
| Pre-conditions | <p>Users must have:</p> <ul style="list-style-type: none"> Access to the PreclSE front-end trading application QCCNet Cross trading entitlements in Refdata. SEVs assigned to their BU via the StockExecutionVenues configuration in ITradeConfig. Selecting a SEV before QCC with Stock order submission is required in the front-end. |
| Post-conditions | <p>Upon successful creation and submission:</p> <ul style="list-style-type: none"> The order confirmation will reflect the final adjusted total shares, delta, total contracts of each option leg, and the net price. If there is no quantity/net price reduction/adjustment, then the prompt will display the quantities and price as is. An example of the prompt language: <p style="margin-left: 40px;">Submit QCC with Stock Order to Buy 100,000 shares (100 delta) GOOG and Buy 1,000 GOOG4MAR705.0C at Net debit of 1300.00?</p> QCC with Stock order is displayed in the Order Status with the most current order status and information. <p>If a trade occurs, the trade will be displayed with trade details in the multiple available trade views (My Trades, Desk Trades, Fills, Trades and Statistics).</p> <p>If the stock leg cannot be priced by the Matcher for any reason, the entire order will be rejected with a core reject of NET_TRADE_PRICE_DETERMINATION_FAILED. PreclSE will process and communicate the reject to the front-end with the pop-up text: <i>“Unable to find a valid print price based on the order price</i></p> |

| | |
|------------------------------------|---|
| | <i>and market.”</i> |
| Non-Functional Requirements | Upon successful creation and submission, the QCC with Stock order is displayed in MPT for our internal operations team to track and/or reference if needed. |

3.1.10. Drop copy for QCC with Stock trade

| | |
|------------------------------------|---|
| Use Case | The FIX drop copy adapter will process the stock trades from QCC with Stock orders. |
| Description | Upon a successful QCC with Stock trade, PrecISE will send the stock trade information to the drop copy adapter. |
| User(s)/Actor(s) | PrecISE Users, drop copy trade report subscribers |
| Detailed Business Rule(s) | <p>Upon successful trade of the order:</p> <ol style="list-style-type: none"> 1. Front-end will record trade, trade details, and update the order status. This is the current front-end behavior. 2. Trade reports and order execution reports for the options print will continue to be processed on the order and trade drop copy. This is current behavior. 3. The trade reports for the stock print will be sent to the drop copy adapter. There will be a configuration switch that will turn this feature on/off. 4. The stock trade reported on the drop copy will be from the QCC with Stock order using any of the pricing view options. |
| Front End Flow | No changes to the front-end flow for order entry and order and trade updates |
| Order/Trade Processing | <p>No change to the way option trades are reported down the drop copy.</p> <p>Stock trades from QCC with Stock will be reported on the drop copy adapter. See IORS section for a detailed table that maps the PrecISE FIXML fields to the existing IORS/FIX drop copy tags. In the comments, the GTS Adapter will ensure fields such as ExecRpt/TypOrd and ExecRpt/CIOrdID2 are on the message to the drop copy.</p> |
| Pre-conditions | Users must be listening to trade reports off the drop copy to receive stock trade reports from QCC with Stock orders. |
| Post-conditions | N/A |
| Non-Functional Requirements | N/A |

3.2. SOR

There are no changes required to SOR. SOR will continue to validate the stock MPID, receive and route the stock portion of a QCC with Stock order from PrecISE via the Stock API.

3.3. DTI

The existing **New Order Cross** transaction will be used with following additional fields:

- Option Ratio
- Stock Ratio
- Stock Relative Side

A detailed usage of above fields is described in section 3.1.5.2. of this document.

In phase 1 only PrecISE BSI users will be entitled to use the new values on the existing transaction. See Section 3.8 for reference data entitlement. In future, these values may be used by IORS and DTI users. If a non-entitled user enters new values on the New Cross Transaction, the entire transaction must be rejected.

1. There are no explicit stock leg details provided. The only two required fields for stock are Stock Ratio and Stock Relative Side. These two values will be communicated at the transaction level i.e. not at the leg level.
2. Same as current New Cross transaction behavior the new fields must only be allowed during regular business hours i.e. during instrument state of Regular or Fast.
3. If there is more than one options leg, the clearing information must be entered for all legs.
4. Two new Cross Order Types "QCCNet_Simple" and "QCCNet_Complex" will be introduced. Note: Current New Cross Transaction allows following five cross order types:
 - a. Customer to Customer Cross Simple
 - b. Customer to Customer Cross Standard Combination
 - c. Customer to Customer Cross Stock Combination
 - d. QCC Simple
 - e. QCC Standard

PrecISE will not send the stock leg's sell short information to the core because PrecISE will route the stock leg to the SEV.

3.4. Matching Engine

Matching Engine will perform the following functions:

1. Validate the transaction values against various settings in reference data and according to rules described in section 3.4.1.
2. Determine stock side and quantity as described in section 3.4.15.
3. Determine options and stock trade prices as described in section 3.4.15.
4. Execute options trades and return stock trade price to PrecISE.

3.4.1. Differences between QCCNet and Other Crosses matching:

This section describes the differences between currently available crosses in production and QCCNet crosses:

1. The option leg of a QCCNet_Simple cross must trade in legal tick. Currently in a single option leg stock/options cross, the option leg can trade at penny.

2. Since the sequence of QCC with Stock is different than other stock crosses and there is a delay in printing of the stock leg, the NBBO restriction can be relaxed and a stock leg tied to QCC can print far outside the stock NBBO compared to other auctions and crosses.
3. Currently in stock combination crosses the cross net price must be at or better than the stock combination IBBO. For QCCNet_Simple, the calculated Option price (not the cross net price) must be at or better than the simple instrument IBBOs. For QCCNet_Complex, the calculated Options net price must be at or better than both simple instrument IBBOs and the standard combination BBO.
4. Currently in stock combination crosses the cross net price must be better than the stock combination IBBO if there is a customer on the IBBO. For QCCNet_Simple, the calculated Option price (not the cross net price) must improve the simple instrument IBBO by a legal tick (penny, nickel or dime) if there is a customer on it. For QCCNet_Complex, the calculated Options net price must improve the standard combination IBBO by penny which is the legal tick of standard combinations. Additionally for QCCNet_Complex, the calculated options leg prices must improve the IBBO on all simple instrument legs that have customers on it at least by a penny each.
5. The net price of QCCNet_Simple or QCCNet_Complex cross can be up to four decimals.
6. For current stock combination crosses the stock leg validations (such as deliverable, stock ratio etc.) are done at the time of stock combination instrument creation. Since for QCCNet crosses the stock combination instruments are not created, these validations must be performed for each QCCNet cross at order entry.

In matcher the cross validations are controlled by various configurations in reference data. Above differences will be addressed by modifying behavior of existing configurations as well as by adding two new configurations as described below.

3.4.2. ASTPR Switch

The option portion of a QCC order must trade at or within options NBBO while stock can trade outside the stock NBBO. Currently there are independent contingency buffers that control how far options and stock trade prices can be outside the options and stock NBBOs respectively. These buffers are common for single sided orders, auctions and crosses. Since the sequence of QCC with Stock is different than other stock trades and there is a delay in stock prints, the stock leg tied to QCC can print far outside compared to other auctions and crosses. To achieve these objectives a new set of contingency buffers must be added in crosses that will be independent of contingency buffers used in regular and auctions matching. On day one the Options and Stock buffers for existing and new cross types will be set as follows:

1. C2C_Simple: Option – NA, Stock – NA
2. C2C_Complex: Option – 5c/500%, Stock- NA
3. C2C_Stock: Option – 5c/500%, Stock- 5c/5%
4. QCC_Simple: Option – NA, Stock – NA
5. QCC_Complex: Option – 5c/500%, Stock- NA
6. QCCNet_Simple: Option – 0/0%, Stock- 10c/1000%
7. QCCNet_Standard: Option – 0/0%, Stock- 10c/1000%

Since Options and Stock extensions will be controlled by independent buffer values the current ASTPR switch configuration can be removed from cross types. The ASTPR switch for auctions will remain unchanged.

3.4.3. Check ABBO

The 'Check ABBO parameter' controls if a cross can trade outside the ABBO or not. It must be set to "Both Sides Check". Currently for single leg crosses this check is used to verify if the cross price must be at or within ABBO. In Standard and Stock Combination instruments this check controls if option legs must trade at or within ABBO or not (Note, this does not function as desired currently but will be fixed via SIR 272593). For QCCNet crosses (both simple and standard), this check will control if option legs must trade at or within ABBO or not. Note: the Buffer parameters defined in previous section are used only if Check ABBO parameter is set to "Both Sides Check".

3.4.4. Check IBBO

The 'Check IBBO parameter' controls if a cross can trade outside the ISE BBO or not. Currently for single leg crosses this check is used to verify if the cross price must be at or within ISE BBO. For Standard and Stock Combination crosses this check controls if cross price must be at or within CIBBO. For QCCNet crosses this check will not be used for net cross price validation rather it will be used to decide whether the option trades (excluding stock leg) can happen at or within the standard combination books. For QCCNet_Simple, this check will not be used as current stock and option price calculation mechanism always makes sure options are traded at or within simple instrument BBO. For QCCNet_Complex this check will control whether CIBBO for the standard instrument must be used in determining the range of prices where options can trade. On Day one this parameter will be set to "Both Sides Check" i.e. the options portions of a QCCNet_Complex cross must trade at or within the CIBBO of the standard instrument.

3.4.5. Check Customer IBBO

The 'Check Customer IBBO parameter' controls if a cross can trade at the same price as a resting customer order on the IBBO. Currently for single leg crosses this check is used to verify if the cross price must be better than ISE BBO if there is a customer on it. For Standard and Stock Combination instrument this check controls if cross price must be better than CIBBO if there is a customer on it. For QCCNet crosses this check will not be used for net cross price validation rather it will be used to decide whether option trades (excluding stock leg) can happen at or within customer improved standard combination books.

For QCCNet_Simple this check will control whether customers on the simple instruments must be improved in determining the range of prices where options can trade. On Day one this parameter will be set to 'Both Sides Check'. If it is set to 'No Check' options can trade at the same price as a customer on the simple instruments.

For QCCNet_Complex this check will control whether customer on the standard instrument book must be improved in determining the range of prices where options can trade. On Day one this parameter will be set to "Both Sides Check" i.e. a QCCNet_Complex cross must trade better than customer on the CIBBO of the standard instrument.

Note the amount of improvement that must be given over resting customer order(s) will be controlled by the tick value new configuration explained in section 3.4.6.

3.4.6. Tick Value

Entry Price Check

QCCNet crosses can be entered up to four decimal prices. The net price for QCCNet crosses must be same as legal tick for stock combination instruments which is currently set to four decimals. Currently the tick of cross order price is validated against the Tick Value parameter in cross type table. For QCCNet_Simple and QCCNet_Complex the tick value in cross type table will not be used for entry price check. Rather tick setting for stock combination instrument in the market model must be used for net price tick validation.

Execution Check:

Instead of using Tick parameter for entry price validation in QCCNet crosses, the Tick parameter serves two different purposes:

- The options portion of a QCCNet_Simple will print at the legal tick of the simple instrument while the options portion of a QCCNet_Complex cross will print at a penny price which is the legal tick for standard combinations. This print price is controlled by the tick parameter in QCCNet crosses i.e. the tick parameter is used to round the option prices of individual legs to the configured tick value. For example when configured to Penny tick the price will be rounded to a penny multiple. For QCCNet_Simple, the tick parameter will be set to Legal Tick and the the option price will be rounded to the legal tick of the simple instrument. For QCCNet_Complex, the tick parameter will be set to Legal Tick and the option price of individual legs is rounded to legal tick of complex instruments.
- Also in Net crosses, the tick parameter is used to determine the amount of improvement that must be given over the customer IBBO. For example, when set to "Penny Tick", the options net price must be better than the IBBO by a penny, when set to "Legal Tick" the options net price must improve over the customer by a legal tick of the simple instrument in the case of QCCNet_Simple and by a legal tick of the complex instrument in the case of QCCNet_Complex.

For QCCNet_Simple, this parameter will be set to Legal tick to ensure that the amount of improvement is equal to legal tick of simple instrument. For QCCNet_Complex this parameter will be set to Legal tick to ensure that the amount of improvement over the CIBBO customer is equal to legal tick of standard combination instruments. The improved CIBBO will be included in the STPR calculation.

Note: Currently in regular crosses, there is no need to do any extra calculation for amount of improvement since net price legal tick entry check ensures customers get required improvement.

3.4.7. Cross Category (New)

Since behavior of various configurations settings is different in existing and QCCNet crosses, a new reference data parameter "Cross Category" will be introduced to control these differences. This parameter will have two values: 'Regular' and 'Net'. For existing crosses this parameter will be set to 'Regular' and for new QCCNet crosses this parameter will be set to 'Net'. Adding this parameter provides flexibility of adding new crosses in future without a code change.

3.4.8. Method for Customer Improvement over Simple Instruments (New)

A multi option leg QCC must improve upon resting customer prices on both simple and complex books. Currently the improvement for resting customer orders on simple instruments is hard coded in matcher. Other auctions and crosses can trade at the same price as a resting customer order on single leg as long as one leg is given full tick improvement or if penny improvement is provided on each customer leg. However a multi option leg QCC must improve all customer legs by a penny. To make this calculation configurable a new configuration (Customer ISBBO Tick Improvement Method) must be added. This parameter will have following values and behavior:

1. None – This value is not used.
2. Penny on Cust Leg: Only Method 1 is used.
3. Tick on one leg: Only Method 2 is used.
4. Both - Indicating both Method 1 and Method 2 must be used in calculating trade price ranges. See of DFS Part B1 for detailed descriptions about Method 1 and Method 2.

On day one this parameter will be set as follows:

1. C2C_Simple: None
2. C2C_Complex: Both
3. C2C_Stock: Both
4. QCC_Simple: None
5. QCC_Complex: Penny on Cust Leg
6. QCCNet_Simple: None
7. QCCNet_Complex: Penny on Cust Leg

3.4.9. Reference data settings to address functional differences

Following is a summary of how various functional differences between QCCNet Crosses and other crosses are handled by reference data settings discussed in previous bullets:

Difference 1: The option leg of a QCCNet_Simple cross must trade in legal tick.

| Cross Type | Cross Category (New) | Tick Value |
|----------------|----------------------|------------|
| C2C_Simple | Regular | Legal_Tick |
| C2C_Complex | Regular | Legal_Tick |
| C2C_Stock | Regular | Legal_Tick |
| QCC_Simple | Regular | Legal_Tick |
| QCC_Complex | Regular | Legal_Tick |
| QCCNet_Simple | Net | Legal_Tick |
| QCCNet_Complex | Net | Legal_Tick |

Difference 2: For QCCNet_Simple, the calculated Option price (not the cross net price) must be at or better than the simple instrument IBBOs and for QCCNet_Complex, the calculated Options net price must be at or better than both simple instrument IBBOs and standard combination BBO.

| Cross Type | Cross Category (New) | Check IBBO | Note |
|----------------|----------------------|------------------|---|
| C2C_Simple | Regular | BOTH_SIDES_CHECK | Net Price Check |
| C2C_Complex | Regular | BOTH_SIDES_CHECK | Net Price Check |
| C2C_Stock | Regular | BOTH_SIDES_CHECK | Net Price Check |
| QCC_Simple | Regular | BOTH_SIDES_CHECK | Net Price Check |
| QCC_Complex | Regular | BOTH_SIDES_CHECK | Net Price Check |
| QCCNet_Simple | Net | NA | STPR calculation already ensures IBBO restriction |
| QCCNet_Complex | Net | BOTH_SIDES_CHECK | Include CIBBO in STPR |

Difference 3: For QCCNet_Simple, the calculated Option price (not the cross net price) must improve the customer on simple instrument IBBO by a legal tick (penny, nickel or dime). For QCCNet_Complex, the calculated Options net price must improve the customer on standard combination IBBO by penny which is the legal tick of standard combinations. Additionally for QCCNet_Complex, the calculated options leg prices must improve the IBBO on all simple instrument legs that have customers on it at least by a penny each.

| Cross Type | Cross Category (New) | Check Customer IBBO | Customer ISBBO Tick Improvement Method |
|----------------|----------------------|---|--|
| C2C_Simple | Regular | BOTH_SIDES_CHECK | NA (not used) |
| C2C_Complex | Regular | BOTH_SIDES_CHECK | Both |
| C2C_Stock | Regular | BOTH_SIDES_CHECK | Both |
| QCC_Simple | Regular | BOTH_SIDES_CHECK | NA (not used) |
| QCC_Complex | Regular | BOTH_SIDES_CHECK | Penny on Cust Leg |
| QCCNet_Simple | Net | BOTH_SIDES_CHECK (i.e. use customer adjusted ISBBO in STPR) | NA (not used) |
| QCCNet_Complex | Net | BOTH_SIDES_CHECK (i.e. use customer adjusted CIBBO in STPR) | Penny on Cust Leg |

3.4.10. Min Qty

The minimum quantity check must be applied for QCC_Net crosses. This check does not take the stock leg into account. For day one, the Min Qty for new QCCNet crosses must be 1,000 contracts (this value is configurable in reference data – Min Qty in Cross Type Table). The order quantity must be validated as follows:

- a. For QCCNet_Simple (with one options leg): The Quantity x Option Ratio must be more than 1000 (configurable).
- b. For QCCNet_Complex (with multiple options leg): The Quantity x Option Ratio x Ratio on smallest leg must be greater than or equal to 1000 (configurable).
Note: currently for standard combinations, the auctions and crosses quantity validation can be configured in following two ways:
 - Use lowest ratio of option legs times the order quantity to validate against the Minimum Quantity for a cross.
 - Use cumulative sum of all the options legs ratios of the order, i.e. the cross order quantity times sum of the leg ratios to validate against the Minimum Cross Quantity.

On day one this configuration will be set to not use the cumulative sum for QCCNet_Complex cross type. This configuration doesn't apply to QCCNet_Simple. With day one configuration set to use lowest ratio the option ratio x lowest leg ratio x order quantity must be validated against the Min Qty reference data setting. If this parameter is set to cumulative sum, the sum of all option leg ratios x option ratio x order quantity must be validated against the Min Qty reference data setting.

3.4.11. Client Categories

The client category settings will be same as current QCC_Simple client category settings. On day one, all client categories will be allowed.

3.4.12. IAM/ ISO/ Stopped

The new cross types cannot be marked as IAM, ISO or Stopped. The settings "Allow IAM", "Allow ISO" and "Allow Stopped" will be set to false.

3.4.13. Instrument Validations

The complex instrument creation must follow existing complex instrument validation.

A QCC with stock order involves calculating the stock price without creating a stock combination instruments. In normal stock combination trading certain validations are performed on stock legs. As described below, these validations must be performed with each QCC with stock order entry:

1. The Matcher will assume default underlying on the crossing transaction.
2. Option legs of a QCCNet cross must not have a deliverable ID.
3. The stock leg of a QCCNet cross must not have a deliverable ID.

Note: The Option Ratio and Stock Ratio are **not** validated against the Max Option Ratio and Max Stock Ratio values set in reference data. This is because these validations were already performed at the time of complex instrument creation.

3.4.14. Other Validations

1. To ensure total order quantity on options and stock leg doesn't exceed the

maximum thresholds setup in reference data, the order quantity must be validated as minimum of following:

- a. The Maximum Stock Order quantity setup in reference data (for stock combo instrument type) divided by Stock Ratio
- b. For one option legs: the Maximum Options Order quantity setup in reference data (for the simple instrument type) divided by Option Ratio
- c. For multiple option legs, if the cumulative quantity validation is set to false: the Maximum Options Order quantity setup in reference data (for standard combination instrument type) divided by (Option Ratio * Maximum leg ratio on the complex instruments).
- d. For multiple option legs, if the cumulative quantity validation is set to true: the Maximum Options Order quantity setup in reference data (for standard combination instrument type) divided by (Option Ratio * sum of leg ratios on the complex instruments).

For example:

Assume the setup in reference data on the instrument type level for Maximum Options Order quantity is set to 999,999 and Maximum Stock Order quantity is set to 9,999,999.

| Instrument | Order Qty | Option Ratio | Stock Ratio | Option Qty | Stock Qty | Validation Result |
|--------------------------|-----------|--------------|-------------|---|------------|---|
| OPT1 | 999,999 | 1 | 1 | 999,999 | 999,999 | Pass |
| OPT1 | 999,999 | 2 | 1 | 1,999,998 | 999,999 | Fail (Option threshold reached) |
| OPT2 | 999,999 | 1 | 100 | 999,999 | 99,999,900 | Fail (Stock threshold reached) |
| CI: 2 OPT1, 1 OPT2 | 999,999 | 1 | 10 | OPT 1: 1,999,998 OPT2: 999,999 | 9,999,999 | Fail (Option Threshold on OPT1 reached) |

2. If there is no bid or no offer in an underlying, the Stock BBO of that underlying is undefined. If the Stock BBO is undefined, then no trade will occur. Note: This is the intended Matcher behavior. However, there is a bug in the Matcher that causes us to print regardless of the underlying price (SIR# 244143).
3. If there is no offer on any of the option legs, a QCC w Stock trade cannot be executed. If there is no bid in any of the option legs, the QCC w Stock trade can still be executed.
4. Spread Price Protections (i.e. Vertical and Calendar Min/Max Price checks) do not apply to QCC orders.
5. The Price Reasonability check does not apply to QCC orders.

6. If any of the above validation fails, the request is rejected with appropriate reject reason. These reject reason will be specified in the Matcher DTS document.

3.4.15. Options and Stock Price Determination

The current matcher algorithm to determine stock and option prices will be used to determine individual trade prices with following changes for QCCNet crosses (controlled by Cross Category Parameter). See DFS Part BII for details about current matcher algorithm.

1. Currently if an Options Match Price cannot be determined at penny prices the Option match price is rounded to penny.

For QCCNet Simple the options trade must print in the legal tick of the simple instrument. To achieve this, the tick value parameter (See Section 3.4.6) is set to Legal tick and the Options Match Price is rounded to a multiple of "Options ratio times the value configured in the tick value parameter". Multiplying the Tick with Options ratio ensures that the final print for each trade will be in legal ticks.

For QCCNet_Complex the options trade must print in the legal tick of complex instruments i.e. penny. To achieve this, the tick value parameter (See Section 3.4.6) is set to Legal tick and the Options Match Price is rounded to a multiple of "Options Ratio times the value configured in the tick value parameter".

This rounding ensures trades on standard instruments are printed in allowed ticks (as explained in section 3.4.6.)

2. Minimum tick increments are dependent on the options trade prices. For example in non-penny symbols options trading up to \$2.99 trade in nickels while options trading in \$3.00 and above trade in dimes. For penny symbols, options trading up to \$2.99 trade in pennies while \$3.00 and above trade in nickels. Today simple leg trade prices for all standard and stock combination instruments trade in pennies. Going forward for QCCNet_Simple, the option leg must trade in legal ticks. Since the option match price is a multiple of option ratio, to obtain the accurate tick value, the option match price must be divided by the Options Ratio and then checked against the tick table to obtain the tick applicable. Example 1 in section 3.4.16.3. explains this concept.
3. If a valid Options Match Price cannot be determined at valid prices described above the Options Match Price will not be rounded and the transaction will be rejected. Note: Simple Rounding Mechanism is not applied for QCC Net Crosses.

4. For QCCNet_Complex crosses, the Options Synthetic Trade Price Range must be adjusted based on Check IBBO and Check Customer IBBO Parameters. If these parameters are set to Both Side Check the Options Synthetic Price Range must consider Standard combination CIBBO on the corresponding side as follows:

Final Option Synthetic Trade Price Bid = Max (CI Bid* Option Ratio, Initial Option Synthetic Trade Price Bid)

Final Option Synthetic Trade Price Offer = Min (CI Offer*Option Ratio, Initial Option Synthetic Trade Price Offer)

Note: If there is a customer on CI bid or CI offer, the CI bid/ offer are ticked in by a penny (configured via cross type tick value parameter) in above formula.

3.4.16. QCCNet Cross Matching Algorithm

Following is a brief description of matching algorithm to determine options and stock prices for a QCCNet cross. This algorithm will be finalized by development and updated as required. The match prices are determined in following steps:

1. Create a faux stock/ combination instrument as specified in section 3.4.16.1. This instrument will be used to perform stock/ combination calculations. This instrument is not disseminated on the reference data feed.
2. The Options Match Price is determined as specified in Section 3.4.16.1.
3. The Stock Match Price is determined as specified in Section 3.4.16.4.
4. If the Options Match Price is not in multiples of a option ratio times tick value (as set in reference data) then this transaction cannot be completed and the QCC Net Cross is rejected. Note: Simple Rounding Mechanism is not applied.
5. Perform the Trade Value Error Check. If the Trade Value Error Check is not passed, then no trade occurs.
6. The Option Match Price is distributed across the option legs using the Spread Fraction Procedure. For a QCCNet_Simple cross, trades are reported on simple instrument. For a QCCNet_Complex cross, trades are reported on simple instruments and standard instrument.
7. The stock price is returned on Private Order Broadcast to requesting user.

The matching algorithm described in following sections is illustrated with examples. Following assumptions are made for each of the example:

Example 1:

PrecISE QCC Order:

- Buy 31 Stock,
- Sell 3 Opt1
- Net Px = 2.00,
- Qty = 1000

Opt1 BBO: 1.00 (c) x 2.00 (c). Note: Customer on both sides of the BBO.

Opt 1 Tick: 5c/10c

Stock BBO: 22.51 x 22.53

Stock Buffer: 0.01/ 1%

Example 2:

PrecISE QCC Order:

Sell 62 Stock,

Sell 6 Opt 1,

Buy 18 Opt 2,

Sell 6 Opt 3

Net Px = -16.00,

Qty = 1000

Opt1 BBO: 1.00 (c) x 2.00 (c). Note: Customer on both sides of the BBO.

Opt2 BBO: 2.00 (c) x 3.00 (c). Note: Customer on both sides of the BBO.

Opt3 BBO: 4.00 (c) x 5.00 (c). Note: Customer on both sides of the BBO.

All Options Tick: 5c/10c

Stock BBO: 22.51 x 22.53

Stock Buffer: 0.01/ 1%

CIBBO: -1.85 x 12.00

Standard Combination Instrument Tick: Penny

3.4.16.1. Stock/ Combination Instrument creation

For a QCCNet_Simple cross a single option leg and one stock leg stock combination instrument is created with following logic:

- Option ratio is set to 'Option Ratio' provided on the new field in the New Cross Transaction.
- Option side is same as the order side
- Stock ratio is set to 'Stock Ratio' provided on the new field in the New Cross Transaction.
- Stock Side is calculated as follows:

| Option Order Side on New Cross Transaction | Stock Side on New Cross Transaction | Stock Side of the stock/combination instrument |
|--|-------------------------------------|--|
| Buy | Same | Buy |
| Sell | Same | Sell |
| Sell | Opposite | Buy |
| Buy | Opposite | Sell |

For a QCCNet_Complex cross a multi option legs and one stock leg stock combination instrument is created with following logic:

- Ratio for each option leg is set to option ratio on each leg as defined in the standard combination instrument times 'Option Ratio' provided on the new field in the New Cross Transaction.
- Stock ratio is set to Stock Ratio provided on the new field in the New Cross Transaction.
- The sides of option legs are same as the sides on each leg as defined in the standard combination instrument.
- The stock leg side is determined by using the order side and stock relative side. If stock relative side is same, the stock side is set to same as order side. If stock relative side is opposite, the stock side is set to opposite of order side. Following examples illustrate how sides are determined for faux stock/combination instruments.

| CI Instrument | Option Order Side on New Cross Txn | Stock Relative Side on New Cross Txn | Stock/ Combination Instrument | | |
|---------------|------------------------------------|--------------------------------------|-------------------------------|--------------|-----------|
| | | | Option Leg 1 | Option Leg 2 | Stock leg |
| Buy, Buy | Buy | Same | Buy | Buy | Buy |
| Buy, Sell | Buy | Opposite | Buy | Sell | Sell |
| Buy, Buy | Sell | Opposite | Buy | Buy | Sell |
| Buy, Sell | Sell | Same | Buy | Sell | Buy |

Example 1:

| PrecISE QCC w/Stock Ticket | | | | Final Calculation | |
|----------------------------|------|-------|-----------|-----------------------------|---------------------------|
| CI | Side | Ratio | Order Qty | Total # of shrs / contracts | Reduced quantities by GCD |
| Stk | Buy | 31 | 1,000 | 31,000 | 31 |
| Opt1 | Sell | 3 | | 3,000 | 3 |
| Net Price = \$2.00 | | | | New Net Price = \$2.00 | |

The order is sent by PrecISE as:

Order Side: Sell

Option Ratio: 3

Stock Side: Opposite

Stock Ratio: 31

Net Px = \$2.00

Qty = 1000

A stock/combination instrument is created as follows:

| Leg | Side | Ratio |
|-------|------|-------|
| Stock | Sell | 31 |
| Opt 1 | Buy | 3 |

Example 2:

| PrecISE QCC w/Stock Ticket | | | | Final Calculation | |
|----------------------------|------|-------|-----------|-----------------------------|---------------------------|
| CI | Side | Ratio | Order Qty | Total # of shrs / contracts | Reduced quantities by GCD |
| Stk | Sell | 62 | 1,000 | 62,000 | 31 |
| Opt1 | Sell | 6 | | 6,000 | 1 |
| Opt 2 | Buy | 18 | | 18000 | 3 |

| | | | | | |
|----------------------|------|---|--|---------------------------------|---|
| Opt2 | Sell | 6 | | 6,000 | 1 |
| Net Price = -\$16.00 | | | | New Net Price = -\$8.00 | |
| | | | | Adjusted Order Quantity = 2,000 | |
| | | | | Stock Ratio = 31 | |
| | | | | Option Ratio = 3 | |
| | | | | Stock Relative Side = Opposite | |

PrecISE creates a Complex Instrument:

- Sell 1 Opt 1
- Buy 3 Opt 2
- Sell 1 Opt 3

Let's assume matcher creates the complex instrument as requested.

The order is sent by PrecISE as:

Order Side: Buy

Option Ratio: 3

Stock Side: Opposite

Stock Ratio: 31

Net Px = -\$8.00

Qty = 2000

A stock/combination instrument is created as follows:

| Leg | Side | Ratio |
|-------|------|-------|
| Stock | Sell | 31 |
| Opt 1 | Sell | 3 |
| Opt 2 | Buy | 9 |
| Opt 3 | Sell | 3 |

3.4.16.2. Options Synthetic Price Range Determination

Once the instrument is created the initial calculation for Options Synthetic Price Range is same as described in DFS3810 Production Matcher Part BII.

For QCC_Complex the Options Synthetic Price Range is further adjusted by the CIBBO as:

Final Option Synthetic Trade Price Bid = Max (CI Bid*Option Ratio, Initial Option Synthetic Trade Price Bid)

Final Option Synthetic Trade Price Offer = Min (CI Bid*Option Ratio, Initial Option Synthetic Trade Price Offer)

Example 1:

Opt1 BBO: 1.00 (c) x 2.00 (c). Note: Customer on both sides of the BBO.

Customer adjusted Opt1 BBO: 1.05 (c) x 1.95 (c). Note: Tick = 0.05

Options Synthetic Price Range bid = $-1.95 \times 3 = -5.85$ (Note: Option is being sold)

Options Synthetic Price Range offer = $-1.05 \times 3 = -3.15$

Example 2:

Opt1 BBO: 1.00 (c) x 2.00 (c). Note: Customer on both sides of the BBO.

Opt2 BBO: 2.00 (c) x 3.00 (c). Note: Customer on both sides of the BBO.

Opt3 BBO: 4.00 (c) x 5.00 (c). Note: Customer on both sides of the BBO.

Options Synthetic Price Range Bid = $9 \times 2.01 - 3 \times 1.99 - 3 \times 4.99 = -2.85$ (a penny improvement is given on each leg)

Options Synthetic Price Range Offer = $9 \times 2.99 - 3 \times 1.01 - 3 \times 4.01 = 11.85$ (a penny improvement is given on each leg)

The CIBBO on standard instrument is: $-1.85 \times 3 \times 12.00 \times 3$

Final Option Synthetic Trade Price Bid = $\text{Max} (-2.85, -5.55) = -2.85$

Final Option Synthetic Trade Price Offer = $\text{Min} (11.85, 36.00) = 11.85$

3.4.16.3. Options Match Price Determination

Determine the Options Match Price Range as follows:

Upper Bound of the Options Match Price Range = QCCNet Cross Price

- Delta Adjusted Bid Price of Buy Stock Leg (Extended by buffer)

+ Delta Adjusted Offer Price of the Sell Stock Leg (Extended by buffer)

Lower Bound of the Options Match Price Range = Net Match Price

- Offer Price of Buy Stock Leg (Extended by buffer)

+ Bid Price of the Sell Stock Leg (Extended by buffer)

The Options Match Price is the price in this Options Match Price Range which is closest to the mid-point of the Options Synthetic Trade Price Range.

If the Options Match Price does not fall on a option ratio times 'tick value' boundary, and it is possible to round to a option ratio times 'tick value' within the Options Synthetic Trade Price Range, we round to the closest option ratio times 'tick value' within the range. If there is no such price in the range, we leave the net options price unrounded and instead use Simple Rounding Mechanism (Section 3.4.16.5.) for each trade.

Continuing the examples from previous section:

Example 1:

Extended Stock Bid = $\text{Max} (22.51 - .01, 22.51 - 1\% \text{ of } 22.51) = 22.50$

Extended Stock Offer = $\text{Min} (22.53 + .10, 22.53 + 10\% \text{ of } 22.51) = 22.54$

Delta Adjusted Extended Stock Bid = $22.50 \times .31 = 6.975$

Delta Adjusted Extended Stock Offer = $22.54 \times .31 = 6.9874$

Upper Bound of the Options Match Price Range = $2.00 - 6.975 = -4.975$

Lower Bound of the Options Match Price Range = $2.00 - 6.9874 = -4.9874$

Round the Options Match Price Range to a multiple of Option Ratio * Tick Value

Since Opt 1 is set to trade in 5c/10c ticks, the tick table in reference data is set as follows:

| Low Range | High Range | Ticks |
|-----------|------------|-------|
| 0.01 | 2.99 | 0.05 |
| 3.00 | NA | 0.10 |

To get the tick value for -4.975, it is divided by the Options Ratio and the resultant price is used to reference the tick table. $4.975 / 3 = 1.658333$. So the tick applicable is 0.05.

Option Ratio times Tick Value = $3 \times 0.05 = 0.15$

Round down (-4.975) Upper bound = - 5.10

To get the tick value for -4.9874, it is divided by the Options Ratio and the resultant price is used to reference the tick table. $4.9874 / 3 = 1.662466$. So the tick applicable is 0.05.

Option Ratio times Tick Value = $3 \times 0.05 = 0.15$

Round up (-4.9874) lower bound = -4.95

Since the range is crossed, no print price can be found in the above example and the QCC with Stock Net Price transaction will be rejected.

Example 2:

Extended Stock Bid = $\text{Max}(22.51 - .01, 22.51 - 1\% \text{ of } 22.51) = 22.50$

Extended Stock Offer = $\text{Min}(22.53 + .10, 22.53 + 10\% \text{ of } 22.51) = 22.54$

Delta Adjusted Extended Stock Bid = $22.50 \times .31 = 6.975$

Delta Adjusted Extended Stock Offer = $22.54 \times .31 = 6.9874$

Upper Bound of the Options Match Price Range = $-8.00 + 6.9874 = -1.0126$

Lower Bound of the Options Match Price Range = $-8.00 + 6.975 = -1.025$

Option Ratio times Tick Value = $3 \times 0.01 = 0.03$ (Tick for standard combinations is penny)

Round Up Lower Bound (-1.025) = -1.02

Round Down Upper Bound (-1.0126) = -1.02

-1.02 is in the OSTPR and will be the Options print price.

3.4.16.4. Stock Match Price Determination

Stock Match Price = $\text{abs}(\text{Inverse Delta Adjustment} * (\text{Net Match Price} - \text{Options Match Price}))$

In the above case inverse delta adjustment has been applied to eliminate the effect of

the delta adjustment that was applied at the time of synthetic price calculation.

The Stock Match Price is rounded to MaxDecimalPlacesOnStockPrint.

The absolute value of Stock Match Price is used to obtain a positive match price for the stock leg in the event that the stock leg is being sold.

Continuing the examples from previous section:

Example 1:

N/A.

Example 2:

Stock Match Price = $\text{abs}((1/.31)*(-8.00 - (-1.02))) = 22.516129$

3.4.16.5. Simple Rounding Mechanism

If a rounded net options price cannot be found, the transaction is rejected. Simple rounding mechanism is not applied.

Example 2:

There is no need for Simple Rounding Mechanism.

3.4.16.6. Trade Value Error Check

There is no change required to Trade Value Error Check. See DFS3810 Production Matcher Part BII for detailed description of Trade Value Error Check.

Example 2:

Actual Trade Value = $(-22.516129 * 31 * 2000) + (-1.02 * 2000 * 100) = -1599999.998$

Notional Trade Limit Value = $-8.00 * 2000 * 100 = -1600000$

Trade Value Limit Violation = $(\text{Abs}(-1600000 - (-1599999.998)) / -1600000) * 100 = 0.000000125$

As done today, the Trade Value Limit Violation is compared against members setting for Trade Value Error in reference data. If the violation is more than expected, entire cross order is rejected.

3.4.17. Options and Stock Trades

After determining Options and Stock prices Matcher completes the option trades. For multiple option legs standard trade price determination procedures are used for each leg. See DFS Part BII – Spread Fraction procedure.

The POB will contain the stock price for PreclSE. PreclSE will process the stock price and use existing procedures to trade stock leg via SOR.

3.4.18. Maker/Taker Scenario

For one option leg QCC w/Stock orders the maker/taker scenario "Qualified Contingent Cross (both sides)" is applied.

For multiple option legs QCC w/Stock orders the maker/taker scenario "Complex

Comment [I2]: Mike Di to update addition of new cross type in the Maker Taker tables.

Qualified Contingent Cross (both sides)" is applied.

3.4.19. Trade Condition

The trade conditions on QCC w/Stock orders will follow standard QCC conditions. The single option legs QCC will print as Normal and Multi-Leg QCC will print as SPRD, STDL etc based on complex instrument type. These orders will **NOT** be marked as BWRT. See DFS Part I and Part II for detailed descriptions of trade conditions.

3.5. Trade Manager

QCC w/Stock trades will follow existing QCC_Simple or QCC_Complex trades and no adjustment is required in trade manager to support the new transaction.

3.6. Audit Trail

There will be some changes required in audit trail to capture the price calculation for stock and options component. Details can be found in the Matcher DTS.

3.7. POB / Broadcaster

The new broadcast will have a new field for the stock price. Members who wish to send QCC with Stock orders can subscribe to the new broadcast.

3.8. Reference Data

3.8.1. Cross Type Table

Several new fields should be added to the RDS Cross Type table to support the new QCC with stock net price functionality:

1. **Field Name:** CustISBBOTickImprovementMethod

Description: Currently, the method of improving the price over resting customer orders on simple instruments is hard coded in the matching engine. This must be made configurable per cross type, as a complex QCC must be treated differently than other complex cross types. More information can be found in section 3.4.1.9 above.

Data Type: Enumeration

Valid Values:

1. None – This value is not used.
2. Penny on Cust Leg: Only Method 1 is used.
3. Tick on one leg: Only Method 2 is used.
4. Both - Indicating both Method 1 and Method 2 must be used in calculating trade price ranges. See of Matcher DFS Part B1 for detailed descriptions about Method 1 and Method 2.

Day One Values: A database conversion should set this field as follows for the existing cross type table records:

Table: Cross Type

| ID | Name | Instrument Type | CustISBBOTickImprovementMethod |
|----|------------|----------------------------|--------------------------------|
| 1 | C2C_Simple | CLEARING_INSTRUMENT_OPTION | None |

| | | | |
|---|-------------|----------------------------|-------------------|
| 2 | C2C_Complex | STANDARD_COMBINATION | Both |
| 3 | C2C_Stock | STOCK_COMBINATION | Both |
| 4 | QCC_Simple | CLEARING_INSTRUMENT_OPTION | None |
| 5 | QCC_Complex | STANDARD_COMBINATION | Penny on Cust Leg |

2. Field Name: CrossCategory

Description: This field distinguishes the new 'net' cross types from the original 'regular' cross types. This will allow us to add new cross types in the future without coding for a specific cross type in the matching engine.

Data Type: Enumeration

Valid Values:

1. Regular.
2. Net

Day One Values: The database conversion should set this field to **Regular** for all existing cross type records.

3. Field Names: Stk Cont Buffer Abs/ Stk Cont Buffer Prc

Stk Cont Buffer Abs and Stk Cont Buffer Prc should be copied from the Market Model table.

Description: We will need to create a separate Stock Contingent Buffer (Stk Cont Buffer Abs and Stk Cont Buffer Prc) for QCC with Stock orders. The stock contingent buffer defines the allowable deviation from the stock NBBO for trading through the away market, applicable to stock combos. A separate stock buffer for QCCNet _Simple and QCCNet _Complex will allow us to:

- Set a wider range in order to better guarantee execution on the stock portion. Today's stock buffer of \$0.05 for other stock combos will remain.
- Better guarantee execution of the options portion

Day One Values: The database conversion should set these fields as follows:

Table: Cross Type

| ID | Name | Instrument Type | Stk Cont Buffer Abs | Stk Cont Buffer Prc |
|----|-------------|----------------------------|---------------------|---------------------|
| 1 | C2C_Simple | CLEARING_INSTRUMENT_OPTION | 0.1 | 1 |
| 2 | C2C_Complex | STANDARD_COMBINATION | 0.1 | 1 |
| 3 | C2C_Stock | STOCK_COMBINATION | 0.05 | 5 |
| 4 | QCC_Simple | CLEARING_INSTRUMENT_OPTION | 0.1 | 1 |
| 5 | QCC_Complex | STANDARD_COMBINATION | 0.1 | 1 |

4. Field Names: Opra Buffer Abs/ Opra Buffer Prc .

Opra Buffer Abs and Opra Buffer Prc should be copied from the Market Model Discriminator table.

Description: The OPRA buffer defines the allowable deviation from the NBBO from trading through the away market. We will need a separate OPRA buffer (Opra Buffer Abs and Opra Buffer Prc) for each cross.

Day One Values: The database conversion should set these fields as follows:

Table: Cross Type

| ID | Name | Instrument Type | Opra Buffer Abs | Opra Buffer Prc |
|----|-------------|----------------------------|-----------------|-----------------|
| 1 | C2C_Simple | CLEARING_INSTRUMENT_OPTION | 0 | 0 |
| 2 | C2C_Complex | STANDARD_COMBINATION | 0.05 | 500 |
| 3 | C2C_Stock | STOCK_COMBINATION | 0.05 | 500 |
| 4 | QCC_Simple | CLEARING_INSTRUMENT_OPTION | 0 | 0 |
| 5 | QCC_Complex | STANDARD_COMBINATION | 0.05 | 500 |

5. Remove Field: Cross Type.ASTPR Switch

Since Options and Stock extension will be controlled by independent buffer values the current configuration ASTPR switch can be removed from cross types. The ASTPR for auctions will remain.

3.8.2. New Entitlement

Reference Data will need a new entitlement to allow usage of the new fields in the existing Cross transaction. The new entitlement will be at the User level.

3.8.3. RDA

The new fields added to the RDS cross type table should be added to the matcher cross type parameters view. These include:

- CustISBBOTickImprovementMethod
- CrossCategory
- Stk Cont Buffer ABS
- Stk Cont Buffer Prc
- Opra Buffer Abs
- Opra Buffer Prc

The Cross ASTPR Switch should be removed from the matcher cross type parameters view.

3.9. IORS

The drop copy application will process the stock trade reports of a QCC with Stock order. Today, there are three versions of the drop copy:

- Trade drop copy: this only has trade reports generated from the core.
- Order drop copy: this has both order status and trade reports generated from the core.
- PrecISE AMR drop copy: this only has trade reports for AMR orders generated from PrecISE.

Members who are already subscribed to trade reports from the core will only receive stock trade reports from QCC with Stock orders if they are configured for it. The default and Day 1 setting will be such that stock trade reports from QCC with Stock orders are *not* processed by the drop copy. If configured to receive the QCC stock trade reports, the member will receive the stock trades on their drop copy for the existing and new QCC with Stock pricing feature. The stock trade information will be

generated from PrecISE. The existing order and trade drop copies will continue to process options execution reports of a QCC with stock because the core will continue to print the options portion.

The stock trade reports on the drop copy will be based on the entering/originating BU. The BU information can be found in the FIXML ExecRpt Header field "BU".

The exchange order ID behavior will be applied to the stock trades of QCC with Stock orders. This will enable the members to tie together all the legs of a QCC with Stock order. The table below has the FIXML mapping for the exchange order ID.

Upon receiving the stock trade report, DCA will map each tag using the rules specified in the table below. DCA will send the newly formatted ER to the member.

| Tag | FIX Field in DCA | FIXML Field in PrecISE for Stock Leg | Req | Trade Drop Copy stock trade reports | Order Drop Copy stock trade reports |
|-----|------------------|--------------------------------------|-----|--|--|
| 0 | Standard Header | N/A | Y | MsgType = 8 | MsgType = 8 |
| 1 | Account | ExecRpt/Acct | N | [pass value through] | [pass value through] |
| 6 | AvgPx | ExecRpt/AvgPx | Y | 0 (zero) | [pass value through] |
| 11 | ClOrdID | ExecRpt/ClOrdID2 | Y | Unique order identifier. Not guaranteed to be same as original order. GTS Adapter will ensure it is on the msg to DCA. | Unique order identifier. Not guaranteed to be same as original order. GTS Adapter will ensure it is on the msg to DCA. |
| 14 | CumQty | ExecRpt/CumQty | Y | 0 (zero) | [pass value through] |
| 17 | ExecID | ExecRpt/ExecID | Y | [pass value through] | [pass value through] |
| 18 | ExecInst | ExecRpt/ExecInst | N | [pass value through] | [pass value through] |
| 20 | ExecTransType | N/A | Y | 0=New | 0=New |
| 30 | LastMkt | ExecRpt/LegTrade/TrdVenue | N | Not required on msg but a requirement to have | Not required on msg but a requirement to have |
| 31 | LastPx | ExecRpt/LegTrade/Px | N | [pass value through] | [pass value through] |
| 32 | LastShares | ExecRpt/LastQty | N | [pass value through] | [pass value through] |
| 37 | OrderID | ExecRpt/BackEndNo | Y | Exchange Order ID | Exchange Order ID |
| 38 | OrderQty | ExecRpt/OrdQty/Qty | Y | 0 (zero) | [pass value through] |
| 39 | OrdStatus | ExecRpt/IsStat | Y | 0 = New | [pass value through] |
| 40 | OrdTyp | ExecRpt/TypOrd | Y | GTS Adapter will ensure it is on the msg to DCA. | GTS Adapter will ensure it is on the msg to DCA. |
| 48 | SecurityID | ExecRpt/Legtrade/Series/oSym | N | Same as Symbol (55) | N/A |
| 54 | Side | ExecRpt/Side | Y | [pass value through] | [pass value through] |
| 55 | Symbol | ExecRpt/Legtrade/Series/oSym | Y | [pass value through] | [pass value through] |
| 59 | TimeInForce | ExecRpt/TmInForce | Y | [pass value through] | [pass value through] |
| 60 | TransactTime | ExecRpt/TxnTm | Y | [pass value through] | [pass value through] |
| 76 | ExecBroker | ExecRpt/Hdr/BU | Y | DCA to map the BU to the ExecBroker in RefData | DCA to map the BU to the ExecBroker in RefData |
| 109 | GiveUp | ExecRpt/LegTrade/GiveUp | N | N/A | [pass value through] |
| 150 | ExecType | ExecRpt/ExecTyp | Y | 0 = New | [pass value through] |

Confidential

| Tag | FIX Field in DCA | FIXML Field in PrecISE for Stock Leg | Req | Trade Drop Copy stock trade reports | Order Drop Copy stock trade reports |
|------|------------------|--------------------------------------|-----|---|-------------------------------------|
| 151 | LeavesQty | ExecRpt/LeavesQty | Y | 0 (zero) | [pass value through] |
| 167 | SecurityType | ExecRpt/Leg/CFI | Y | CS | CS |
| 204 | CustomerOrFirm | ExecRpt/AccType | Y | 0=Customer 1=Proprietary — Firm 5=Far Market Maker Additional values can be enabled by request: 2=Broker/Dealer — Firm 3=Broker/Dealer — Customer 4=ISE Market Maker 7=Proprietary — Customer 8=Customer Professional | [pass value through] |
| 207 | SecurityExchange | ExecRpt/DestExch | Y | [pass value through] | [pass value through] |
| 9205 | DealSource | ExecRpt/DealSrc | Y | [pass value through] | [pass value through] |
| | Standard Trailer | N/A | | | |

4. Non-Functional Requirements

4.1. Connectivity

There are no new changes to how the PreclSE will connect to the core.

4.2. Member Impact

No member impact. The new stock price field in the POB will be optional in order not to impact DTI members.

4.3. Monitoring

4.3.4. MPT

MPT will continue to display QCC with Stock the way it currently does today – the stock view will be in a separate panel view. If the net price is entered on the order, it will not show up in the main order grid. The stock cross price and quantity will continue to be displayed in MPT via MPT's access to the SOR database.

The existing alerts to Market Operations will remain for a QCC with Stock order with "Stk and Opt" pricing view:

- Market Ops will be alerted via email of a stock leg reject, stock execution delay by a configurable amount of time, or stock leg execution turns into a DK (Don't Know).
- Once Market Ops receives any of the email alerts or DK messages, they will contact the member.

4.3.5. Query Viewer (QV)

The net price, stock cross price and stock quantity will be on the Audit Trail and added to QV.

4.4. Security

The new cross transaction will be available for any BU entitled to use the new transaction.

4.5. Reliability

The applications will continue to generate the current alerts to Market Ops and Computer Ops if there are errors or disconnections. There will be no new alerts.

4.6. Availability

The functionality is available during regular trading hours and when the supporting applications are available.

4.7. Auditability

- Order and trade activity – logs are available for each component
- System requirements and specifications –documented in the BRD and DTS

4.8. Documentation

External documentation: The PrecISE Help File will be updated with the QCC with Stock net price feature

Internal documentation: Each application's respective documentation(s) will be updated with the new messaging specification.

In phase 1 the new transaction will not be made available to IORS and DTI members. A DTI and FIX manual update is not necessary for this change.

4.9. Data Requirements

Current EOD reports (e.g. Order History Report) that consume data from the Trade Manager will display QCC with Stock order/trade details for the options portion.

The PrecISE generated report PrecISE Order History Report will record QCC with Stock order/trade details for both the options and stock portions. The net price will be displayed in the Price field, the way it is displayed today for tied orders with a net price.

Internal [Statistical Reports](#) will continue to record QCC with Stock volume:

1. Crossing Activity (daily, monthly)
2. Member Crossing Activity (daily, monthly)
3. Multi-legged Crossing Activity (daily, monthly)
4. Member Multi-legged Crossing Activity (daily, monthly)

No changes to Cognos.

4.10. Billing

Billing will continue charging these orders as existing QCC orders. No change is required to billing.

4.11. Acceptance Criteria

The application must confirm to ISE Operations standards. Specifically, the application must go through BAT, OAT, PAT and MAT process for acceptance.

4.12. Legal

No rule filing required.

4.13. Rollout Strategy

TBD

4.14. Future Enhancement

4.14.1. Offer QCC w/Stock for DTI and IORS users

We will provide our DTI, and IORS users the ability to enter a QCC With Stock order with a net package price. The best way to do this is to route the stock portion into the Matcher and use the Matcher's calculation for stock and options print prices. This

ensures the same and accurate pricing calculation the Matcher performs today for other combo stock orders. The Matcher will print the options portion and route the stock portion to the SEV.

In order to identify a QCC with Stock order, a new cross type will be introduced to the core system (Matcher, TM, RDS, RDFS, RDA) and other user interfaces (DTI and IORS). This new cross type will come with settings specific to the current QCC with Stock behavior, i.e. the options portion can only trade at or within the NBBO, but the stock portion can trade outside of the BBO with a greater stock contingency buffer.

SOR will be required to send the SEVs certain options information that is tied to the stock trade. More specifically, for each QCC with Stock order the Matcher will provide SOR the stock venue, leg instrument ID, leg quantity, and a QCC with Stock identifier. Existing Stock API configurations will be ported over to SOR because SOR will now route the stock portion to SEVs.

We can only use this future enhancement for DTI and IORS that use BNY as their stock venue. Since this solution will use the Matcher's print sequence of stock before options, the stock venue will need to execute the stock portion in a considerable fast time (less than a second) before the market moves and the options price goes outside the market. BNY is an appropriate stock venue for this option because it executes the stock in less than one second. However, CHX venues take up to three minutes to print the stock due to the human touch. To route orders to CHX venues, users will have to use PrecISE. Current PrecISE users can route to both CHX and BNY venues. There is no demand for BNY as stock destination for QCC with Stock orders.

The main benefit for this enhancement is being able to offer QCC with Stock to DTI and IORS users. Today, the only way a user can use this order type is through PrecISE. Not all of our member firms have PrecISE. DTI and IORS users each comprise about 40% of our volume. With such a presence in our market, offering the additional crossing order type to DTI and IORS will attract more business. Additionally, routing the stock leg to the Matcher means that the Matcher and its subsequent components will have a record of the stock portion (ack, trade, reject, etc.). This provides our users an electronic record of the stock execution via drop copy and EOD reports. Additionally, the information in our Matcher allows the opportunity for internal analysis of stock fills.

Following are recommended settings for various reference data parameters for this new cross order type:

| Name | QCC_Stock |
|--------------------------------|-------------------|
| Allow IS Order | FALSE |
| Allow Stopped Order | FALSE |
| ASTPR Option Switch (modified) | NOT_EXTENDED |
| ASTPR Stock Switch (new) | EXTENDED |
| OptionAbsBuffer (new) | 0.00 |
| OptionPrcBuffer (new) | 0.00 |
| StockAbsBuffer (new) | 0.10 (TBD) |
| StockPrcBuffer (new) | 0.10 (TBD) |
| Check ABBO | BOTH_SIDES_CHECK |
| Check Customer IBBO | BOTH_SIDES_CHECK |
| Check IBBO | BOTH_SIDES_CHECK |
| instrumentType | STOCK_COMBINATION |

| | |
|--------------------------------------|---|
| Min Qty | 1000 |
| Tick Value | Legal_Tick(Sub Penny for Stock Instruments) |
| Other Client Category related values | Same as QCC |

4.14.2. Switch Stock and Options Trade Sequence:

The current matcher algorithm to determine stock and option prices has the stock leg print before the options legs in order to keep option prices towards the mid-point of options BBOs. However, the current QCC with Stock process has the stock print after the options leg(s). This means the matcher algorithm can be modified to keep stock towards the mid-point of stock BBO. The steps to calculate options and stock prices will be as follows:

1. Determine Stock Side by using Relative Stock side as described in Section 3.1.5.
2. If there are multiple option legs, determine synthetic BBO for the Complex Instrument and adjust it by customer on any legs and away market prices. See Matcher DFS Part B1 and BII for detail about how synthetic BBOs are calculated.
3. Determine Synthetic BBO for w/Stock Package by using stock BBO (using new extended stock buffer) and options synthetic BBO.
4. Determine Stock Match price that will be sent back to PreclSE as follows:
 - a. Determine the Stock Match Price Range as follows:
 - i. Upper Bound of the Stock Match Price Range = Net Match Price - Bid Price of Buy Option Leg (or Synthetic Bid) + Offer Price of Sell Option Leg (or Synthetic Offer)
 - ii. Lower Bound of the Stock Match Price Range = Net Match Price - Offer Price of Buy Option Leg (or Synthetic Offer) + Bid Price of Sell Option leg (or Synthetic Bid)
 - b. The Stock Match Price is the price in this Stock Match Price Range which is closest to the mid-point of the Stock Trade Price Range.
5. Determine Options Match price for options part of the package.
 - a. The Stock Match Price obtained in previous step is reverse Delta Adjusted.
 - b. Options Match Price = abs((Net Match Price - Delta Adjusted Stock Match Price).
 - c. If the Options Match Price does not fall on a penny boundary, and it is possible to round to a penny because price divisible by \$0.01 falls within the range, the Option Match price is rounded to the closest penny within the range. Similarly for orders with one leg the option match price must be in minimum tick increment. If there is no such price in the range, the net options price is left unrounded and Simple Rounding Mechanism is used for each trade. See DFS Part BII for details about Simple Rounding Mechanism.
6. Determine if stock and options prices need any rounding or Trade Value Error Check is required. See DFS Part BII for details about Trade Value Error check.

4.14.3. Minimum Quantity Validation for Minis

In a future release, the core will validate the minimum order quantity is 10,000 contracts for mini options. Today, Surveillance checks if minis are relevant sizes.

4.14.4. Simple Rounding Mechanism.

When the options price obtained cannot be rounded to a valid tick, Simple Rounding Mechanism is used. The Simple Rounding Mechanism determines the quantity of the complex instrument to be printed at a tick above (hi-tick) and the quantity to be printed a tick below (lo-tick) the calculated price in order to average at the calculated options match price. Currently the lo-tick and hi-tick are considered at penny prices. For QCCNet_Simple the lo-tick and hi-tick must be in multiple of Options Ratio and Legal Tick of the Simple instruments. For QCCNet_Complex the lo-tick and hi-tick must be in multiple of Options Ratio and Legal Tick of the Complex instruments.

Examples related to Section 3.4.16.5

The option legs of a stock combination can only print in multiples of its 'tick value' times option ratio. Hence, the net options match price must also be a multiple of 'Option Ratio' times 'tick value'. The Options Match Price determined in Section 3.4.16.3. can be up to 6 decimal places.

The Simple Rounding Mechanism determines the quantity of the complex instrument to be printed at a tick above (hi-tick) and the quantity to be printed a tick below (lo-tick) the calculated price in order to average at the calculated options match price. The lo-tick and hi-tick must be a multiple of 'Option Ratio' times 'tick value'.

$$\text{Lo Qty} = \text{Total Qty} * (\text{Net Option Match Price} - \text{Hi-tick Price}) / (\text{Lo-tick price} - \text{Hi-tick Price})$$

If the Lo Qty thus obtained is not an integer number, then it is mathematically rounded to an integer value.

$$\text{Hi Qty} = \text{Total Qty} - \text{Lo Qty}$$

If the Lo Qty thus obtained is not an integer number, then it is mathematically rounded to an integer value.

Continuing the examples from previous section:

Example 1:

Lo Tick that is a multiple of 0.15 = - 5.10

Hi Tick that is a multiple of 0.15 = - 4.95

$$\text{Lo Qty} = 1000 * (- 4.975 - (- 4.95)) / (- 4.95 - (- 5.10)) = 167$$

$$\text{Hi Qty} = 1000 - 167 = 833$$

Example 2:

There is no need for Simple Rounding Mechanism.

Currently, we are not allowed to print the complex contracts such that 1000 contracts are split between 2 different options net prices. Hence, simple rounding will not be performed in the current release.

Note. An optimization that can be built in the future is: if all legs at least have a 1000 contracts each after multiplying the split qty with the leg ratio, then we should print the QCC and perform Simple Rounding. In this release, in order to keep the implementation less complex, this optimization will not be built.

5. Appendix

5.1. More examples for Options and Stock Ratios, Order Quantity, and Stock Relative Side

See section 3.1.5 for detailed step-by-step calculations.

5.1.5. Example 1

| PrecISE QCC w/Stock Ticket | | | | Final Calculation | |
|----------------------------|------|-------|-----------|-------------------------------|---------------------------|
| CI | Side | Ratio | Order Qty | Total # of shrs / contracts | Reduced quantities by GCD |
| Stk | Buy | 10.3 | 1,000 | 10,300 | 103 |
| Opt1 | Buy | 9 | | 9,000 | 3 |
| Opt2 | Sell | 3 | | 3,000 | 1 |
| Net Price = \$10 | | | | New Net Price = \$100 | |
| | | | | Adjusted Order Quantity = 100 | |
| | | | | Stock Ratio = 103 | |
| | | | | Option Ratio = 30 | |
| | | | | Stock Relative Side = Same | |

5.1.6. Example 2

| PrecISE QCC w/Stock Ticket | | | | Final Calculation | |
|----------------------------|------|--------|-----------|--------------------------------|---------------------------|
| CI | Side | Ratio | Order Qty | Total # of shrs / contracts | Reduced quantities by GCD |
| Stk | Buy | 101.25 | 2,000 | 202,500 | 405 |
| Opt1 | Sell | 2 | | 4,000 | 2 |
| Opt2 | Sell | 3 | | 6,000 | 3 |
| Net Price = \$15 | | | | New Net Price = \$60 | |
| | | | | Adjusted Order Quantity = 500 | |
| | | | | Stock Ratio = 405 | |
| | | | | Option Ratio = 4 | |
| | | | | Stock Relative Side = Opposite | |

5.1.7. Example 3

| PrecISE QCC w/Stock Ticket | | | | Final Calculation | |
|----------------------------|------|-------|-----------|---------------------------------|---------------------------|
| CI | Side | Ratio | Order Qty | Total # of shrs / contracts | Reduced quantities by GCD |
| Stk | Buy | 10 | 1,500 | 15,000 | 10 |
| Opt1 | Buy | 1 | | 1,500 | 1 |
| Opt2 | Sell | 3 | | 4,500 | 3 |
| Net Price = \$10 | | | | Net Price = \$10 | |
| | | | | Adjusted Order Quantity = 1,500 | |
| | | | | Stock Ratio = 10 | |
| | | | | Option Ratio = 1 | |
| | | | | Stock Relative Side = Same | |

5.1.8. Example 4

| PrecISE QCC w/Stock Ticket | | | | Calculations | |
|----------------------------|------|-------|-----------|---------------------------------|---------------------------|
| CI | Side | Ratio | Order Qty | Total # of shrs / contracts | Reduced quantities by GCD |
| Stk | Buy | 10.5 | 1,000 | 10,500 | 7 |
| Opt1 | Sell | 9 | | 9,000 | 36 |
| Net Price = \$10 | | | | New Net Price = \$6.6666 | |
| | | | | Adjusted Order Quantity = 1,500 | |
| | | | | Stock Ratio = 7 | |
| | | | | Option Ratio = 26 | |
| | | | | Stock Relative Side = Opposite | |