



NYSE PILLAR FOR OPTIONS

May 20, 2021

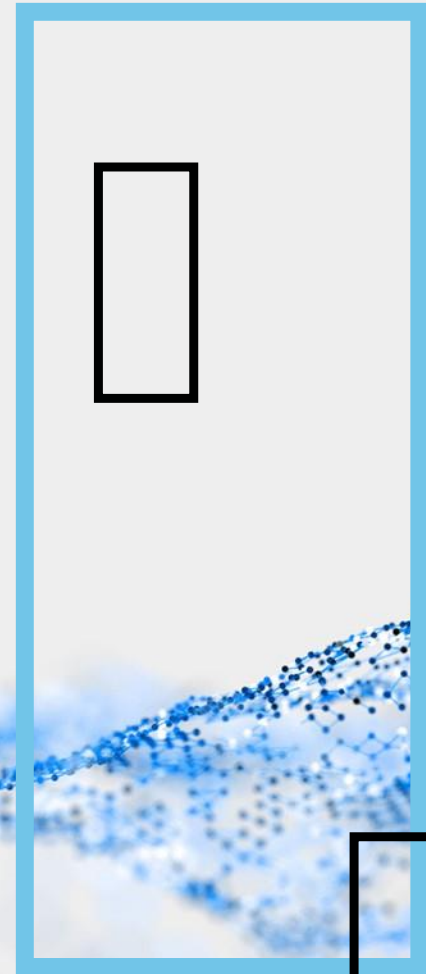


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INTRODUCTION AND OPENING REMARKS

Meaghan Dugan, Senior Director
Head of NYSE Options Product and
Competitive Strategy



AGENDA

- Migration Timeline
- Migration Strategy - Overview, Portals, Tools, Communication
- NYSE Pillar Architecture, Design and Performance
- Functional Differences
- Arca Options Pillar Certification and Customer Testing
- Q&A

MIGRATION TIMELINE

Date		Event
October 21, 2020	✓	<ul style="list-style-type: none"> ▪ NYSE Options Virtual Forum ▪ Launched NYSE Pillar migration website https://www.nyse.com/pillar-migration
November 10, 2020	✓	<ul style="list-style-type: none"> ▪ Initial specifications for outright order entry, MM quoting and Proprietary Market Data
January 25, 2021	✓	<ul style="list-style-type: none"> ▪ Certification environment opened for session requests and connectivity provisioning
February 8, 2021	✓	<ul style="list-style-type: none"> ▪ Certification opens for electronic Outright functional testing
March 15, 2021	✓	<ul style="list-style-type: none"> ▪ Pillar Functional Differences document published ▪ Updated Specs including Complex Order Book and Risk Controls posted on website
May 2021		<ul style="list-style-type: none"> ▪ Certification available for Risk Controls
June 2021		<ul style="list-style-type: none"> ▪ Certification available for Complex Order Book
July - October 2021		<ul style="list-style-type: none"> ▪ Production order entry/quoting and market data retransmission session provisioning - Certification required (July) ▪ 7 Weekend production test dates <ul style="list-style-type: none"> › Jul. 24, Aug. 7, Aug. 28, Sept. 11, Sept. 18- mandatory, Oct. 16- mandatory, Oct.30 – final confidence test › Weekend testing will include T+1 outputs and CAT submissions (Sept. – Oct.) ▪ Pillar is available for weekday Production trading with test symbols after July 24
November 1, 2021		<ul style="list-style-type: none"> ▪ 3 week symbol migration starting 11/1st and will finish before Thanksgiving

MIGRATION STRATEGY - OVERVIEW

- 3 week symbol migration to NYSE Pillar begins **November 1, 2021**
- Legacy order, quote, market data protocols will not be supported
- Pillar gateways are sole entry point for orders and quotes
 - › Certification required
 - › Existing LCN and IGN Connectivity can be utilized
- Migration from TPIDs to MPIDs
- Proprietary Market Data
 - › Top, Deep and Complex Market Data Feeds
 - › Pillar Deep Feed modified to order-by-order feed
 - › Top and Deep Feeds shift from alpha alignment to symbol TXN alignment
 - › Gap fill and refresh replaces existing legacy in-line periodic refresh

MIGRATION STRATEGY – PORTALS, TOOLS, COMMUNICATION

Portals & Tools

- NYSE Pillar Trade Operations Portal (TOP) replaces GEMS and Client Management Tool (CMT)
 - › Clients need to request TOP connectivity
- Drop Copy and customer reports replace GEMS On-Line Extract

Client Communication

- Pillar Options [webpage](#) is available with latest information
 - › Specification documents, Order Type matrices, Functional Differences
- Second Virtual Forum update planned for August 2021
- **New** Hosting 45 minute monthly calls focusing on specific Pillar migration topics

ARCHITECTURE, DESIGN AND PERFORMANCE



Hayk Mkrtchyan, Senior Director

NYSE Pillar Architect, Co-Head of Pillar Development

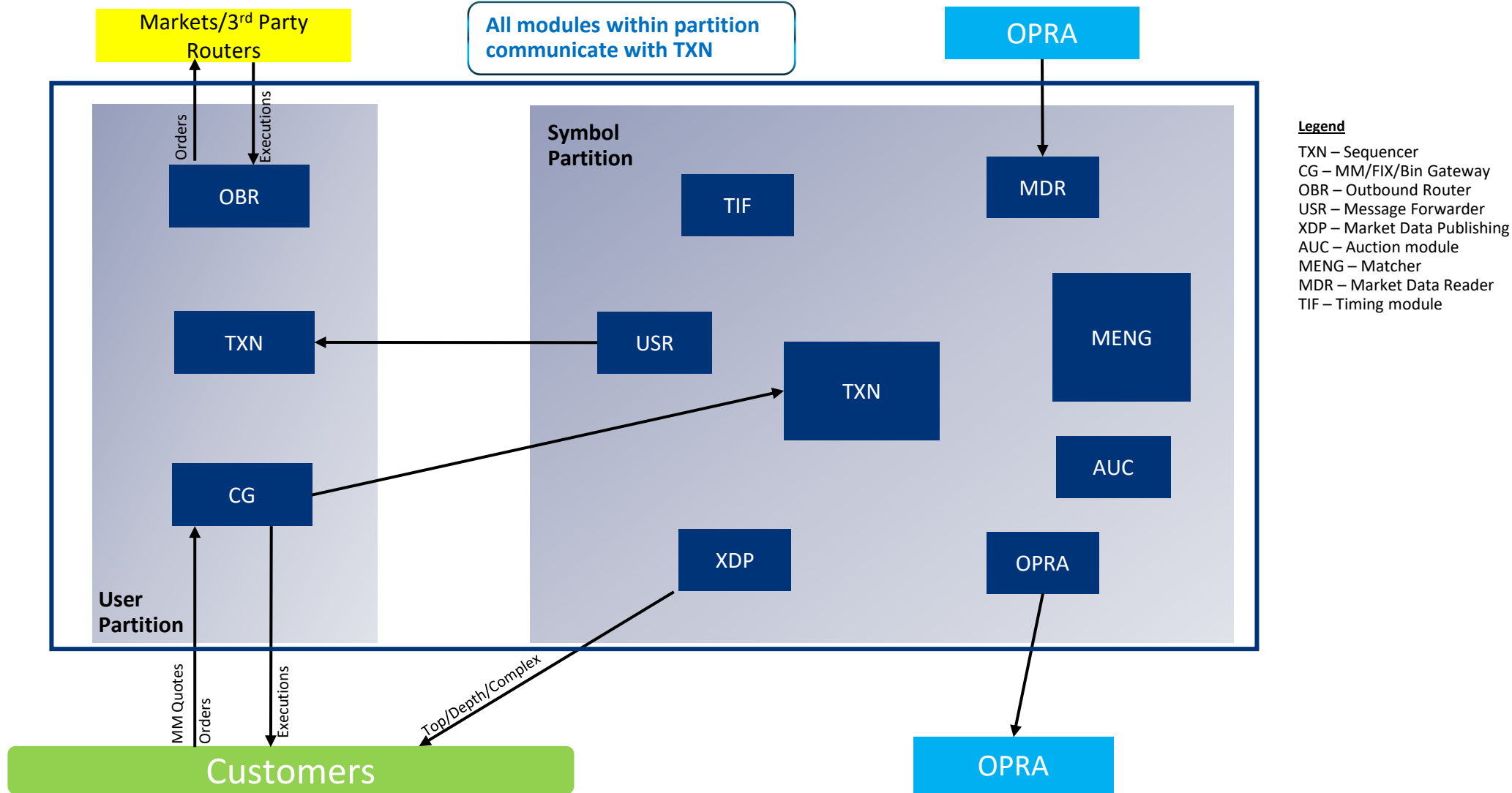
SYSTEM OVERVIEW

- Integrated trading platform with:
 - › Order entry gateways
 - › Matching engines
 - › Market data systems
- Single codebase and connection specification supporting equities and options exchanges
- Reduced complexity, enhanced performance, resiliency and improved time to market
- Full hardware and network redundancy

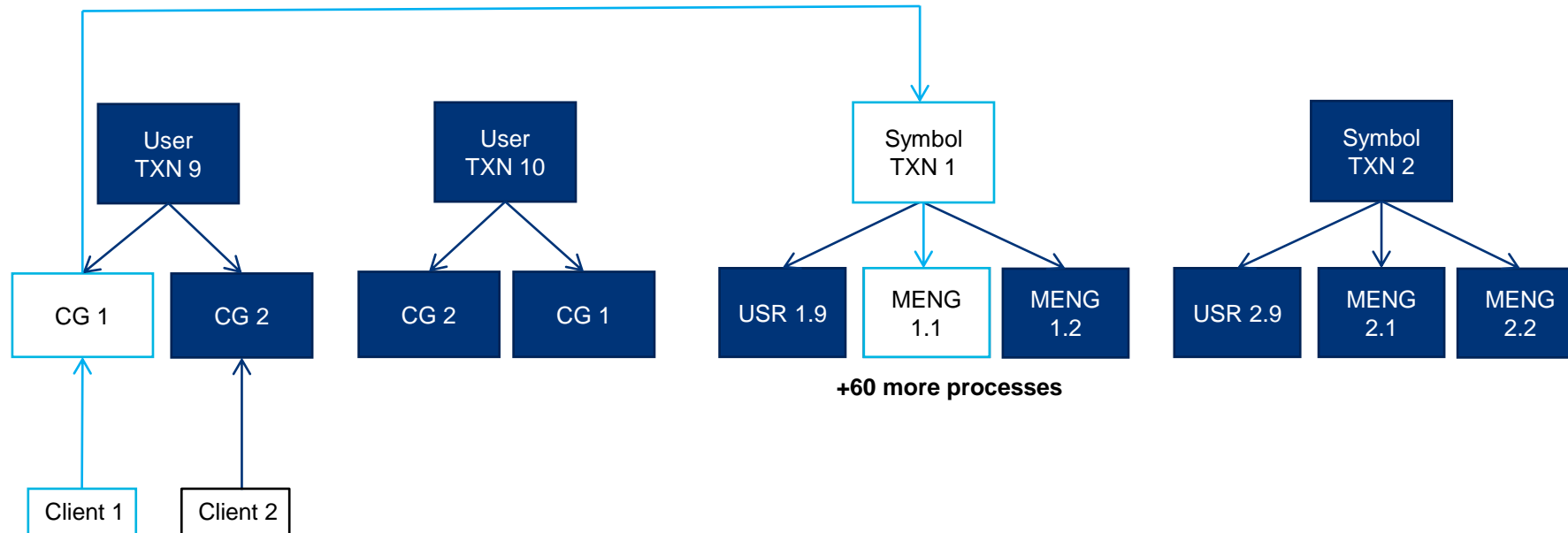
ARCHITECTURE

- Physical Architecture
 - › Blade server architecture
 - › Hundreds of cores communicating through Infiniband
- System Architecture
 - › Processes are single-threaded
 - › Each process is assigned:
 - Single isolated core
 - Fixed memory to operate
- Application Architecture
 - › Append only ledger (TXN)
 - › Ledger and processes around it is a transaction partition
 - › Globally unique identifier for each message

MESSAGE FLOW

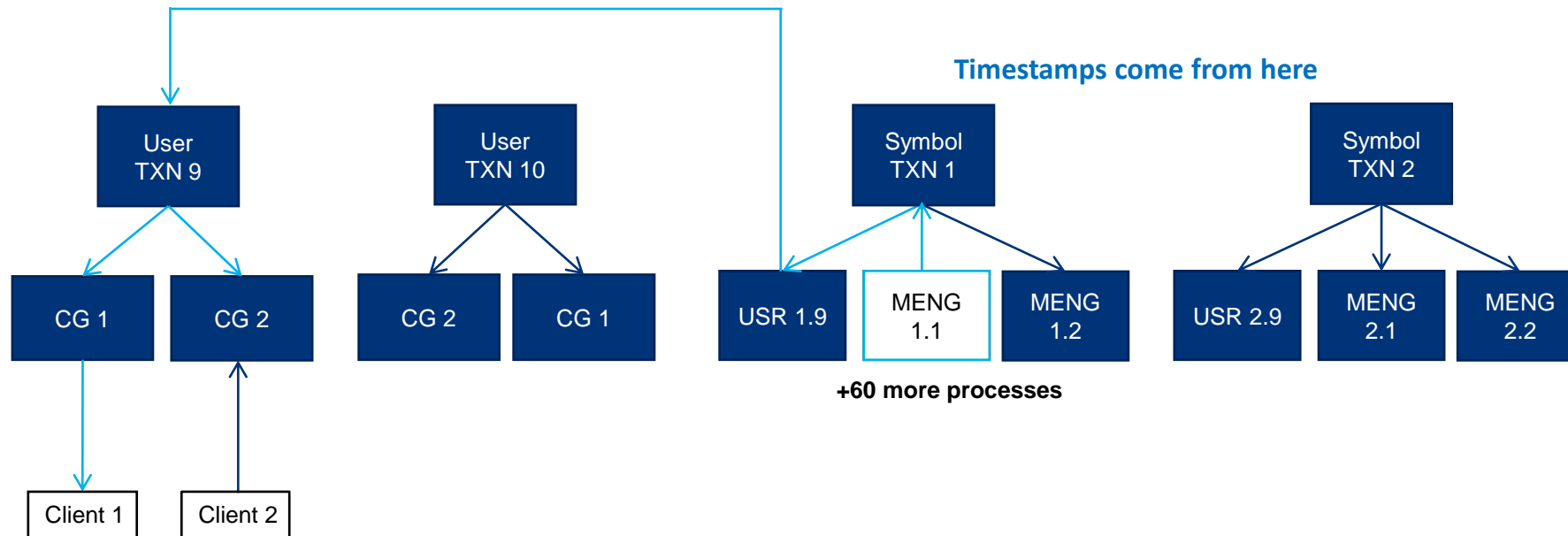


DATA FLOW FOR AN ORDER



- CGs spend the same amount of time processing different order types
- CGs publish incoming messages to Symbol TXN
- At this point, transaction order is fully determined: whichever message gets to the TXN first, trades first. No racing
- CGs use edge triggered epoll

DATA FLOW FOR AN ORDER

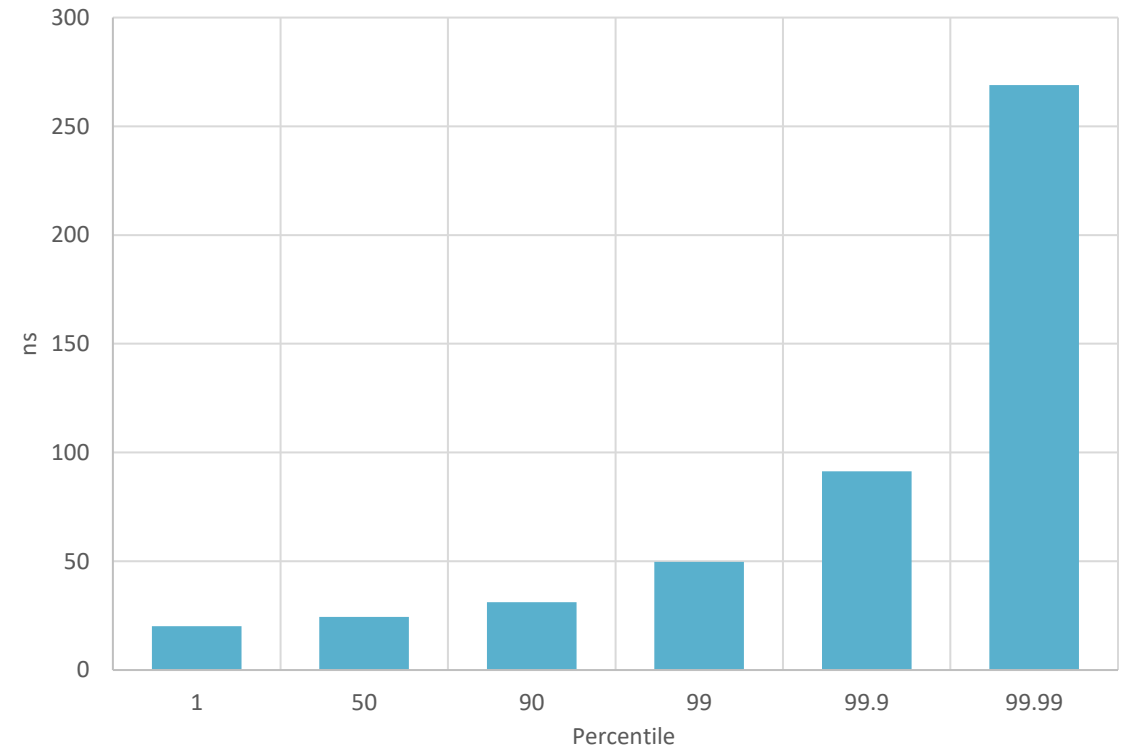


- Timestamps are produced by the Symbol TXN and are consistent for all messages for a given underlying

BY THE NUMBERS

- NYSE Arca Equities*
- 1344 isolated cores on 96 nodes
- 128 matchers (64 + 64)
- 8 symbol partitions
- 96 market data processes (including persistence, publication, retransmission)
- 216 gateway processes (Binary, MM, FIX)
- Median latency: 24 μ s; 90% latency: 30 μ s

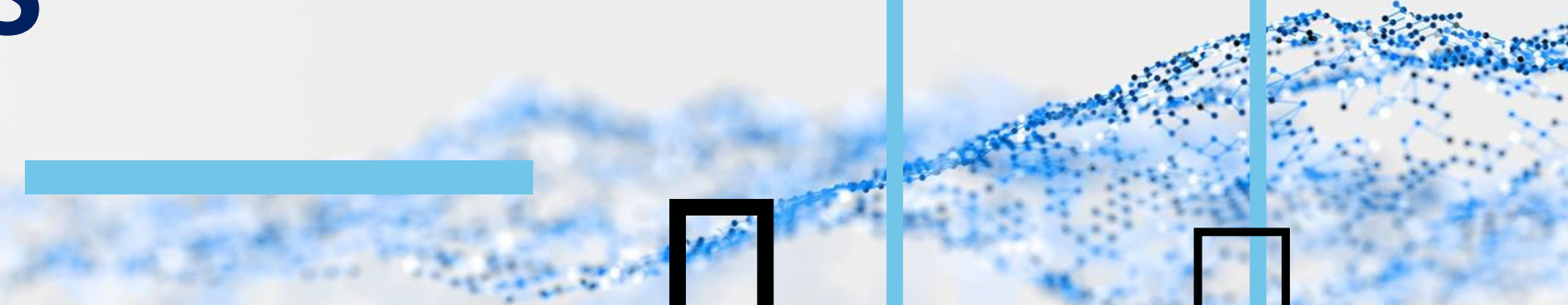
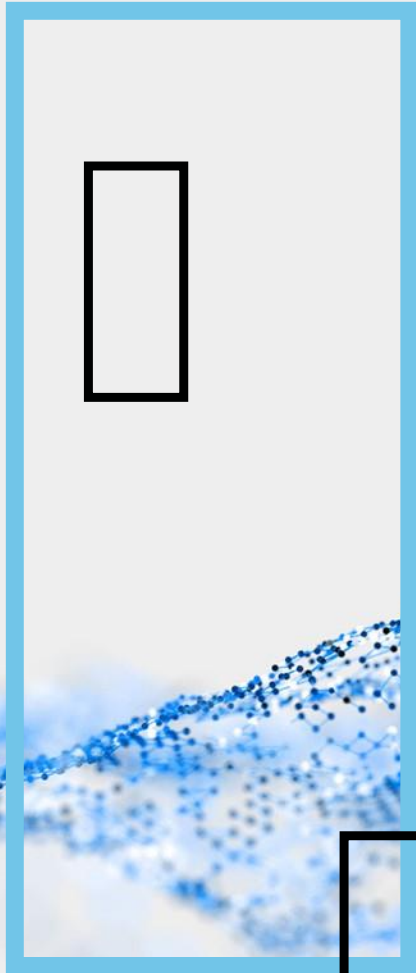
Latency Distribution



*NYSE Pillar architecture processes are subject to change without notice

FUNCTIONAL DIFFERENCES

Michael DeGaeta, Director
NYSE Product Management



AGENDA

- Gateways
- Market Maker Quoting
- Order Types and Order Handling
- Complex Order Book
- Risk Controls
- Market Data
- Opening Auctions
- Floor Trading
- Customer Portals

GATEWAYS

- New Order/Quote Entry and Drop Copy Gateways
 - › Binary and FIX Order Entry, FIX Drop Copy, Binary Market Maker Quoting
 - FIX protocol version 4.2
 - › No gateway adapters for legacy protocols
- Binary gateways will utilize the Pillar stream protocols
 - › Trader to Gateway (TG) and Gateway to Trader (GT)
 - › Reference data stream:
 - Firm, Underlying Symbol, Outright Series, Market Maker Appointment
 - Series ID numbers for outright series identification in the Pillar Binary gateway, Market Data protocol and all other Exchange outputs remain the same

GATEWAYS

- Order and Quote require explicit entry of a Market Participant ID (MPID) on each message
 - › Market Maker Orders and Quotes require a Market Maker ID (MMID)
- Sub Accounts for 'Give-Up's no longer be supported
- Session level defaults available:
 - › Cancel-on-Disconnect
 - › Order Priority
 - › Test Symbol Only
 - › Self-Trade Prevention
 - › Max Order/ Quote Quantity
 - › BOLD (American Options Only)

MARKET MARKER QUOTING

- Pillar Binary gateway will support both order and quote entry
 - › Same session can be used to send orders and quotes
- Symbol appointments available from Exchange via Binary gateway messages or End-of-Day files
- Bulk quoting supported with maximum of 20 single sided quotes
 - › Quote layering is permitted for the same MMID or multiple MMIDs
 - › Quote types offered: Standard, Repricing, ALO and Repricing ALO
 - › User Defined GroupID links quotes within an underlying or across multiple underlying symbols

MARKET MARKER QUOTING TAKEDOWNS

- No dedicated “Takedown” Gateways
- Bulk “Takedown” Cancellation offered for quotes and orders
 - › Bulk Cancel Acknowledgements to identify orders/quotes have been removed
 - › Explicit cancel message for each order/quote is provided
 - › Filter Settings for Bulk Cancel include:
 - Quotes only, Orders only, Orders and Quotes
 - Firm (MPID), MMID, Session, Underlying Symbol, Series and User Defined Group ID
 - › Blocking of quote entry will no longer be implicit
 - Blocking is available via the Risk API only
 - › Quote reductions maintain ranking on the Book

ORDER TYPES + ORDER HANDLING

- Most existing order types offered
- Naming conventions harmonized with Pillar nomenclature and certain order handling characteristics will be modified
- Conditionally displayed orders – ALO, Non-Routable – reprice on arrival (if necessary) plus one additional time
- Aggressively priced Limit and Market orders collared on arrival off the contra side NBBO

■ New Order Types

- › Electronic Cabinet
- › Imbalance Offset
- › Limit Day ISO
- › Limit Day ISO ALO
- › Limit Non Displayed
- › Limit Non-Routable Reserve
- › Electronic FLEX (Floor Brokers Only)
- › Customer-to-Customer Cross (American Options Only)

■ Eliminated Order types

- › Market AON
- › PNP Blind
- › PNP Light Only

COMPLEX ORDER BOOK

- Consistent Complex series ID numbers utilized between Binary order entry and Pillar Market Data
- Electronic Complex strategies with up to 12 legs supported
 - › Strategies of 6 legs or more not eligible for legging
 - › Non-standard complex strategies accepted for complex to complex only
- PNP+ Complex Order renamed as Complex Only Order
- Complex Debit/Credit pricing aligned to industry standards
- Enhancements to Complex Order Auctions
- Focus on enhancing COB fill rates with the component leg markets
- Tied-to-Stock offering planned for a future date

RISK CONTROLS

- Pre-Trade and Activity-Based Risk Controls configurable via Binary Protocol or TOP

- Pre-trade Risk Controls:

› Single Order Max Quantity	› Single Order Max Notional Value
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- › Controls set at MPID with availability to segregate within an MPID

- Activity-Based Risk Controls:

› Transaction	› Volume	› Percentage
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- › New client-configurable rolling timer

- › New choice of automated breach action:

› Notify Only	› Block Only	› Cancel and Block
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- Global Risk Controls:

› Arbitrage Check	› Intrinsic Value Check	› Limit Order Price Check	› Complex Net Debit/Credit
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- Enhanced Self-Trade Prevention

- › Self-Trade support for all clients with availability to segregate within an MPID

- › Complex to Complex Self-Trade Prevention available

MARKET DATA

■ Pillar Options Proprietary Market Data Products:

Product	Description
Deep Feed	Integrated Feed Order Book for outright option series
Top Feed	Top of Book, Trades and Auction information for outright options series
Complex Feed	Top of Book, Trades and Auction information for complex options series

■ Migration period requires both Legacy XDP and Pillar feed handlers

- › Format changes for Options Symbol/Series mapping files

■ **New** Open/Close volume summary (by capacity) report available intraday and/or end of day

■ Deep Feed Message

- › Comprehensive order-by-order view of events for outright option symbols
- › All Order/Quote Add, Modifications, Execution messages directly from Pillar

■ NYSE Pillar Request Server

- › Gap fill and Refresh capabilities supported via dedicated retransmission servers and channels
- › Certification required for firms not already certified for Pillar refresh/retransmissions

■ All feeds follow Pillar TXN Based Channelization for proper load balancing

- › Top feed includes dedicated Channel for Trades and dedicated Channel for Auctions which includes Opening Imbalance and RFQ messages

OPENING AUCTIONS

■ Enhanced Opening process

- › Predefined time interval to conduct Opening Auctions following rotational quote publication
- › Predefined time interval for opening on a quote without Legal Width Quote
- › Additional quoting criteria required for issues with assigned Market Markers

■ Auction Imbalance Publication

- › Imbalance publication begins 90 minutes prior to the Opening
- › New Imbalance message disseminated every 1 second
 - If no crossing interest available, an initial imbalance message with zero Indicative Price, Paired Quantity and Unpaired Quantity published
- › Additional Imbalance message fields:
 - Indicative Match Price, Continuous Book Clearing Price, Auction Interest Clearing Price, Auction Status, Auction Collars

■ New 'Imbalance Offset' order supported in Opening and Re-Opening Auctions

OPEN OUTCRY TRADING

- Migration of Floor OMS communication via NYSE Pillar FIX Gateway
- Electronic outcry support of FLEX and Cabinet orders
- Trade Official support migrated to internal NYSE system
- Floor Broker and Market Maker contra-side trade acknowledgements facilitated using TOP interface
- Split pricing on Complex transactions supported by the Floor OMS (and no longer need a Trade Add)
- FIX Drop Copies available for all Open Outcry transactions

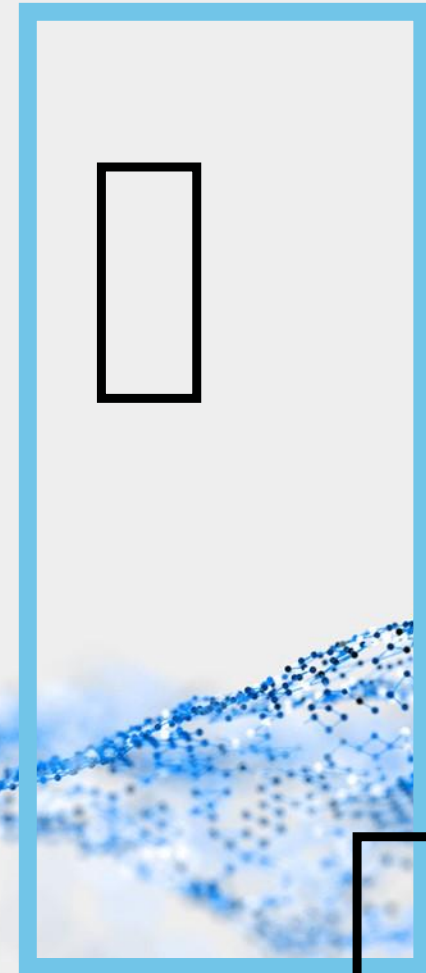
CUSTOMER PORTALS

- The GEMS and CMT applications replaced by TOP
- GEMS Online extract replaced with real time FIX Drop Copy
 - › Final order status and all state changes communicated
 - › SenderCompID, MMID, MPID, Clearing number filters supported
- GEMS Batch extract replaced with new end of day reports
 - › File formats available in July 2021

CERTIFICATION & CUSTOMER TESTING

Jignesh Desai, Director

NYSE Technology Member Services



CERTIFICATION ENVIRONMENT

- Opened in January 2021
- Mirrors Production Structure
- Supports Floor Trading Workflow
- Incorporates TOP
- OPRA Test System Connectivity and Proprietary Market Data Feeds
- Available Weekdays With Dedicated Support Staff

CERTIFICATION TESTING AND FUNCTIONALITY TIMELINE

Now Available

- All outright order types and processing (except for QCC and Cabinet)
- Entitlements
- Market Maker Quoting (including Bulk Quotes on Binary Gateway)
- Ranking and Priority
- Bulk Cancel

Certification Feature Drops	
End of May	Risk Controls <ul style="list-style-type: none"> ■ API Controls ■ Activity Based Controls
	Trading Floor <ul style="list-style-type: none"> ■ Gateway Order and Trade Processing
End of June	Market Data <ul style="list-style-type: none"> ■ Complex Market Data Feed
	Complex Features <ul style="list-style-type: none"> ■ All order types, except Complex QCC and Complex Only
	Risk Controls <ul style="list-style-type: none"> ■ Kill Switch ■ Global Risk Controls
End of July	Trading Floor <ul style="list-style-type: none"> ■ OMS Allocation Processing (Gateway APIs)
	Complex Order Book <ul style="list-style-type: none"> ■ Single-Leg and Complex QCC ■ Complex Only Orders
End of August	Trading Floor <ul style="list-style-type: none"> ■ Clear-the-Book and Cabinet Order handling (Using gateway APIs)
	Complex Order Book <ul style="list-style-type: none"> ■ Auctions, Complex Order Auctions and Complex Risk Controls
End of August	Trading Floor <ul style="list-style-type: none"> ■ Complex Order Book, FLEX Using TOP ■ TOP Allocation Handling

PRODUCTION TESTING

■ Weekend Tests

- › 7 Functional Product tests and 3 Disaster Recovery (DR) tests
- › Pillar and Legacy UTP available in parallel
- › OCC and FINRA test data submission
- › Billing and Trading Report Outputs

■ Weekday Production Trading in Shadow mode

- › Limited to Test Symbols Only
- › Run Regular Trading Cycle
- › No OPRA or OCC Data Submission

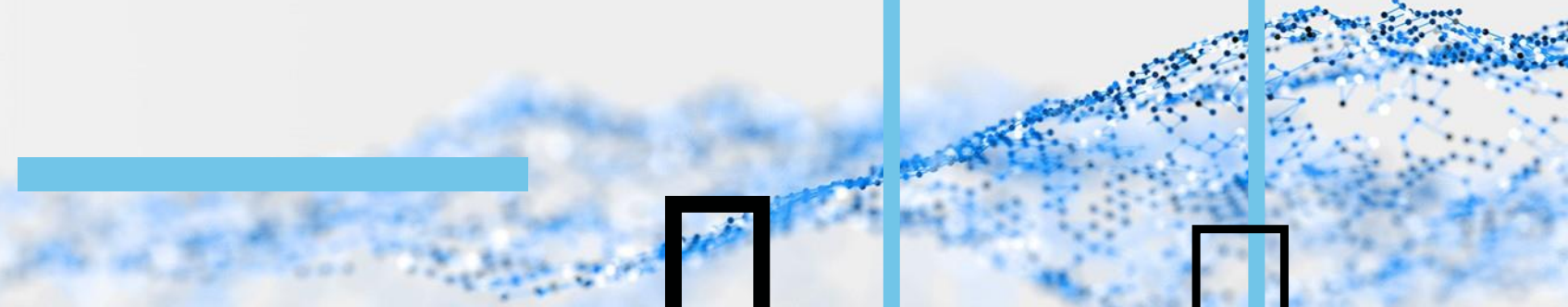
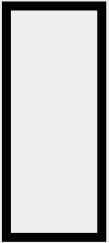
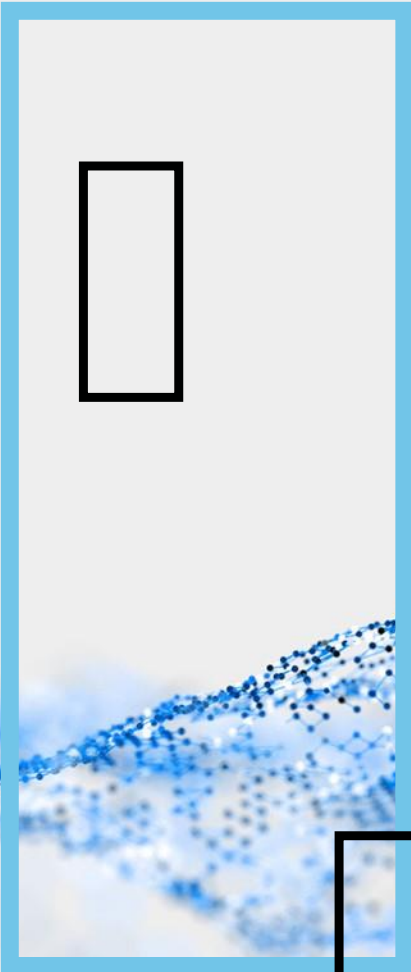
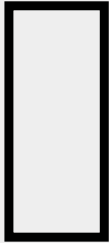
Saturday Test Dates		Notes
7/24/2021	Prod. Test #1	Subset of symbols available
8/7/2021	Prod. Test #2	Subset of symbols available
8/28/2021	Prod. Test #3	Subset of symbols available
9/11/2021	Prod. Test #4	Subset of symbols available
9/18/2021	Prod. Test #5 - Mandatory	
9/25/2021	DR Test # 1 - Connectivity	All Prod symbols available
10/2/2021	DR Test #2 - Pre-Test	
10/16/2021	Prod. Test #6 - Mandatory	All Prod symbols available
10/23/2021	Reg. SCI DR Test	
10/30/2021	Prod. Test #7 - Final Confidence Test	Symbol ICE only

RESOURCES + SUPPORT CONTACT

- Dedicated migration web site
 - › www.nyse.com/pillar-migration
- Relationship Management
 - › RMTeam@nyse.com , +1 855 898 9012
- NYSE Trading Operations
 - › trading@nyse.com , +1 212 896 2830, Options, 1, 2
- Technology Member Services
 - › tms@nyse.com, +1 212 896 2830, Options, 2, 2

NYSE PILLAR FOR OPTIONS

Q & A



THANK YOU

