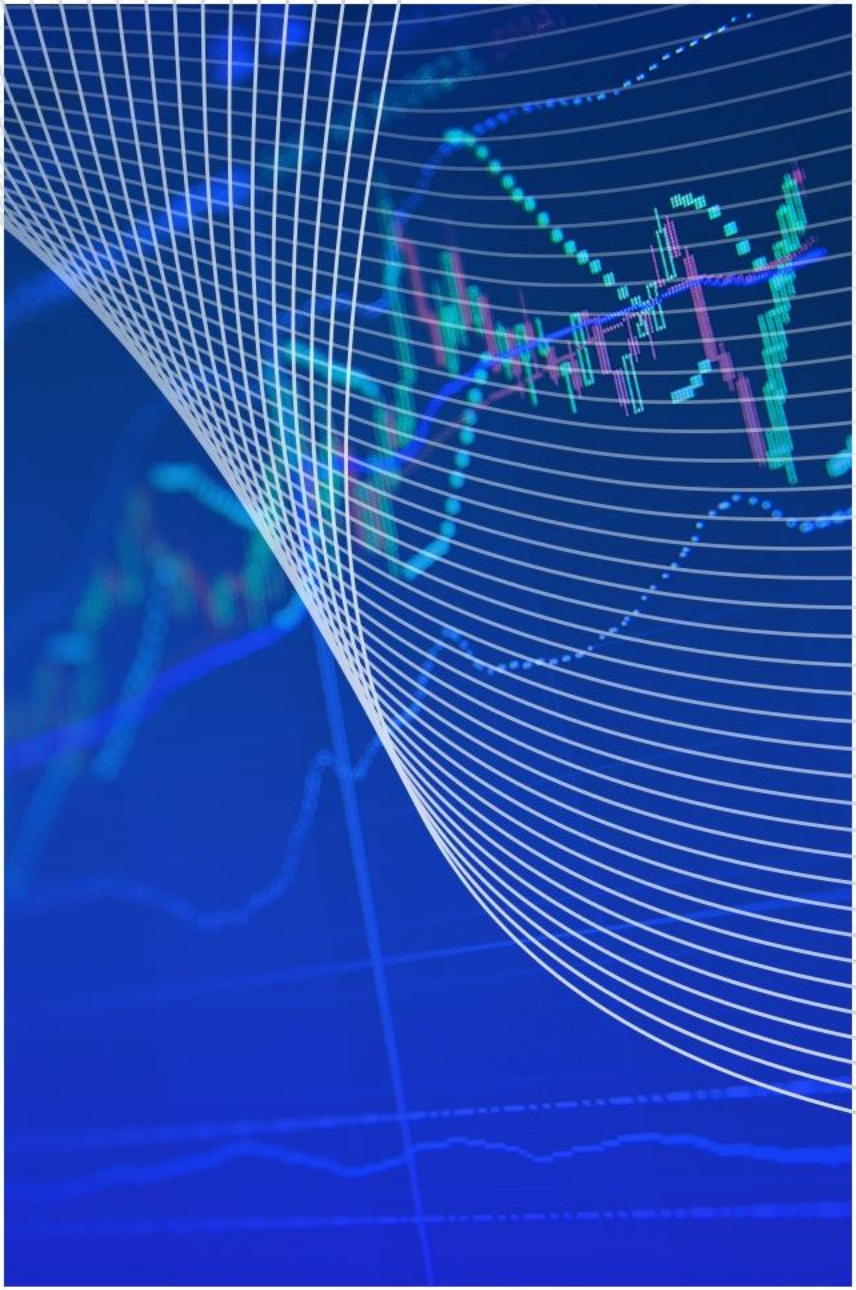

CTA SIP MIGRATION TO NYSE PILLAR TECHNOLOGY

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SIAC

FRIENDLY REMINDER

- This document highlights the high level changes that will take place during the CTA Migration to the Pillar platform
- CTA Data Subscribers are strongly encouraged to read the **CTA SIP Current vs Pillar Output Differences** document for a list of all changes including (but not limited to):
  - Block/Message Sequence Number functional changes
  - Message routing difference for Market Status Messages
- The CTA Pillar SIP Certification Environment is available daily for testing. Data Subscribers should test and validate changes prior to implementation in order to avoid data loss on migration

CTA PILLAR SIP

Agenda:

- CTA Pillar SIP Benefits
- Schedule and Migration Plan
- Changes Between Legacy CTS/CQS and CTA Pillar SIP
- Testing Opportunities
  - Certification Environment
  - Production Environment
  - Six Weekend Industry Tests
- Fallback / Contingency Plans

PILLAR BENEFITS

Architecture
Designed for low latency and high throughput, the NYSE Pillar platform is distributed, scalable and resilient.

Latency & Capacity
Enhanced performance with transparent, automated load balancing. Highly deterministic, low latency processing. Increased overall system capacity.

Resilient & Reliable
Production tested with hot-hot local site redundancy, automated recovery, dynamic failover and hot-hot DR.

Scalability
Allows for addition of computing nodes without impacting Participants or Subscribers when more processing capacity is required.

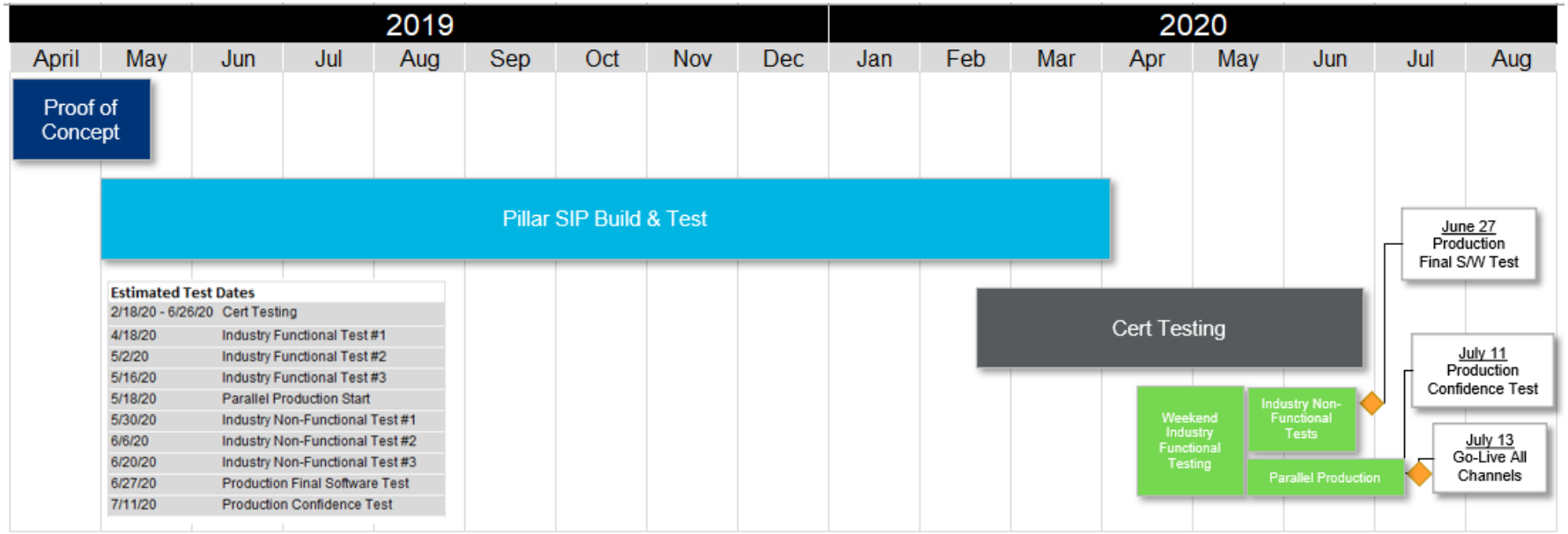
PILLAR SIP LATENCY

Based on Pillar SIP Testing expected latency is as follows:

Application	Msg/Sec	Mean	Median
CTS	4M	< 20 µs	< 20 µs
CQS	10M	< 20 µs	< 20 µs

CTA PILLAR PROJECT PLAN

Target go-live shortly after major 2020 index rebalances



- Industry Functional Testing – Includes all message types and trade/quote processing
- Industry Non-Functional Testing – Includes failure/recovery scenarios
- Parallel Production Period – Live Participant Data for comparison to legacy CTS/CQS

MIGRATION PLAN

- **Certification Testing**
  1. Subscribers are encouraged to participate in certification testing.
  2. Certification testing will include functional verifications.
- **Industry Testing**
  1. 3 weekend production functional tests will occur prior to the production parallel period.
  2. 4 weekend non-functional tests will occur to allow firms to test failure handling, DR activation, and intraday fallback to the legacy SIP.
- **Parallel Production**
  1. Participants are required to publish trade & quote input to both SIPs.
  2. Pillar SIP will publish a subset of multicast channels during production hours and on all channels at night and on weekends.
  3. SIAC will perform daily message comparisons between all legacy and Pillar SIP lines.
- **Production Cutover**
  1. Pillar SIP will migrate to production on cutover weekend.

     -- Participants will continue to dual publish to both SIPs for 2 weeks to support fallback.

     -- Participants and Subscribers will be required to support intraday fallback to the legacy SIP
  2. SIAC will hold a Saturday confidence test on cutover weekend.

CTA SIP CHANGES

Functional Output Protocol Differences - Current Platform vs Pillar Platform

	CTA SIP Behavior - Current Platform	CTA SIP Behavior - Pillar Platform
Output Protocol - Version	• Output blocks are published with Block Header Version 0 (zero) on the Block Header	• Output blocks are published with Block Header Version 2 (two) on the Block Header
Output Protocol - Block Sequence Numbers	• The Sequence Number field of the Block Header is incremented per block irrespective of the number of messages in the block. Data recipients request retransmissions based on Block sequence number. A Retransmitted block matches the original block data and SIP Block Timestamp contains the original time of the Block that was transmitted.	• The Sequence Number field of the Block Header indicates the sequence number of the first message in the block. If there is more than one message contained in a block, any messages following the first message are implicitly numbered sequentially. Data recipients need to request retransmissions based on message sequence number. The retransmission blocks can be packed differently than the original blocks and would have SIP Block Timestamp of the first message in the retransmitted block.
	• Once the Block Sequence Number reaches a value of 999,999,999, it rolls over and the subsequent block is published with a Sequence Number of 1	• The Block Sequence Number rolls over when the u32 maximum limit is reached (4,294,967,295)

CTA SIP CHANGES

Functional Output Protocol Differences - Current Platform vs Pillar Platform

	CTA SIP Behavior - Current Platform	CTA SIP Behavior - Pillar Platform
Output Protocol - Multicast Setup	• For each unique NMS message, there are two redundant multicast data streams. To leverage the redundancy, it is suggested that recipients read from the redundant data feeds • Retransmitted data is published via a single multicast data stream	• Recipients must subscribe to both A and B Multicast channels like any standard multicast data product instead of just one channel, so that if there is any issue with one feed, recipients are able to receive data from the other. • Retransmitted data is published via two distinct multicast data streams for redundancy
Output Protocol - Start of Day	• Start of Day message is published three times with a quiescent period of one minute following each of the three transmissions	• Start of Day message is published only once
Output Protocol - End of Day	• End of Day (Category C Type Z) message is published three times with a quiescent period of one minute following each of the three transmissions • The End of Day message contains a Block Sequence Number one greater than the highest Block Sequence Number previously transmitted	• End of Day (Category C Type Z) message is published only once • The End of Day message contain Block Sequence Number of Zero

CTA SIP CHANGES

Functional Output Protocol Differences - Current Platform vs Pillar Platform

	CTA SIP Behavior - Current Platform	CTA SIP Behavior - Pillar Platform
Output Protocol - Test Cycles	• Test Cycle Data is published every day between 2:00 - 2:45 am prior to the publication of Start of Day message at 3:30 am.	• Test data publication starts after the Start of Day message and continues throughout the day. Test data is published only for Test Symbols.
Output Protocol - Time Beacon	• Selected nodes that source multicast data within the IP Multicast distribution network generate a single Time Beacon packet every six seconds	• Time Beacon message is not published
Closing Quotes	• CQS publishes Closing Quotes on behalf of Participants upon reaching the closing time configured for each participant, or, upon receipt of the End of Participating Quoting (EOPQ) message from the participants	• Closing Quotes are not published systematically. Participants may choose to submit Closing Quotes which are then published on the multicast lines

CTA SIP CHANGES

Functional Output Protocol Differences - Current Platform vs Pillar Platform

	CTA SIP Behavior - Current Platform	CTA SIP Behavior - Pillar Platform
Message Routing	• Market Status Messages - 'Approximate Adjusted Volume Market Center (Category M Type N)' and 'Approximate Trades and Total Dollar Value (Category M Type O)' are distributed only over Network 'A' L1 and Network 'B' L1 lines for respective network	• Market Status Messages - 'Approximate Adjusted Volume Market Center (Category M Type N)' and 'Approximate Trades and Total Dollar Value (Category M Type O)' are distributed over all lines for their respective Network
Administrative Unformatted Message	• Administrative Unformatted (Category A Type H) message is supported on output lines. Any Administrative Unformatted messages submitted by participants are published on the output lines. Also, SIP generated Administrative Unformatted messages are published to provide system information	• Administrative Unformatted (Category A Type H) message is not supported

CTA SIP CHANGES

Functional Output Protocol Differences - Current Platform vs Pillar Platform

	CTA SIP Behavior - Current Platform	CTA SIP Behavior - Pillar Platform
Line Integrity	• Line Integrity (Category C Type T) message is transmitted over the multicast lines at intervals of sixty seconds to verify continued integrity of multicast transmission	• Line Integrity (Category C Type T) message is transmitted over the multicast lines at intervals of ten seconds to verify continued integrity of multicast transmission
Timestamp 1	• For any messages generated by SIP, e.g., Messages generated on behalf of a Participant, Price Band messages and Market Status messages, the Timestamp 1 field is set to zero	• For any messages generated by SIP, e.g., Messages generated on behalf of a Participant, Price Band messages and Market Status messages, the Timestamp 1 field is set to current system time

CTA SIP CHANGES

For Outbound Data Publication from the SIP to Subscribers during Parallel Phase:

- New Multicast IP Addresses associated with the CTA SIP Pillar system are now available and can be located in Appendix E in the Common IP Multicast Distribution Network Specification document.
- Data will be published simultaneously via existing Multicast IP Addresses for the current CTA SIP system and via a subset of new Multicast IP Addresses for Pillar SIP system. Data Recipients shall subscribe to both sets of Multicast IP Addresses.
  - Subset of Pillar Parallel Lines
    - CQS Tape A, Line 1
    - CQS Tape B, Line 1
    - CTS Tape A, Line 1
    - CTS Tape B, Line 1
    - CTS Tape B, Index Line 1
- Upon cutover, data publication will cease over current Multicast IP Addresses and data via the Pillar SIP system will be published over the new Multicast IP Addresses.

FALLBACK AND IMPACT

- A two week fallback period will occur from July 13th until July 24th whereby the legacy CTS/CQS applications are available for processing in the event of a Pillar SIP system issue requiring a fallback.
- During the fallback period CTA Subscribers are expected to support both legacy CTS/CQS SIP and Pillar SIP feeds.
- If a system issue occurs necessitating a fallback, Pillar SIP data will terminate over the new multicast addresses, and will be disseminated over the legacy CTS/CQS multicast addresses
- Legacy CTS/CQS SIP multicast lines will publish the Reset Block Sequence Number (Category C, Type L) messages to higher block sequence numbers.
- After fallback, Pillar SIP retransmissions will not be available. Subscribers must request retransmissions from legacy CTS/CQS beginning from Start-of-Day, since sequence numbers across both systems are independent.

CTA SIP RESOURCES

- Additional information including system specifications can be found on the CTA Pillar landing page at www.ctaplan.com\pillar.

CTA SIP SUPPORT CONTACTS

- NMS Product Planning and Management:
  CQS-CTS-OPRA@siac.com
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- Technology Member Services:
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  212-896-2825

Q & A

- Questions ?

Thank You