FINANCIAL INFORMATION FORUM

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June 12, 2013

Dear SRO Representatives,

The Financial Information Forum (FIF)[1] Consolidated Audit Trail (CAT) Working Group has reviewed the Selected Topics of the NMS Plan feedback request[2] and would like to offer the following comments for consideration when drafting the CAT NMS Plan. In summary, our position is as follows:

Primary Market Transactions: FIF recommends that the focus of primary market allocation reporting be on sub-account allocations. CAT reporting for primary market allocation events would be a unique CAT reporting event because there are not the other associated life-cycle event (orders and executions) linkages. Sub-account allocation instructions are received prior to settlement day and would be reported to CAT by 8AM of the following business day from receipt of the sub-account allocation instruction.

Advisory Committee: FIF recommends an expansion of the proposed Advisory Committee to approximately 20 participants, with multiple participants included from each category to allow representation from a broader cross-section of industry participants. Of the 20 participants, at least 12 should be SRO member firms. Some category adjustments are suggested (see answer to SRO Questions). Adding industry associations such as FIF and SIFMA would provide the broad industry perspective that otherwise would not be possible. A three year term with one-third turnover per year is recommended to provide improved continuity given the complexity of CAT processing.

Time Stamp Requirement: FIF recommends a millisecond time stamp for electronic order and execution events and a time stamp in seconds for manual order handling. Please note that time stamps are not required for allocation reports.[3] A grace period of two years is requested after the CAT requirements are finalized to allow firms sufficient time to meet the millisecond time stamp granularity.

Clock Synch: FIF recommends a clock drift tolerance requirement in concert with its time stamp recommendation – a one second clock drift tolerance for electronic order handling and execution events and no clock drift tolerance requirement for manual order entry and allocation events, because these events inherently have no meaningful time precision. It is recommended that clock drift tolerance requirements rather than clock synchronization frequency be specified in the NMS plan for order and execution events, because the clock management protocols used

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[1] FIF (www.fif.com) was formed in 1996 to provide a centralized source of information on the implementation issues that impact the financial technology industry across the order lifecycle. Our participants include trading and back office service bureaus, broker-dealers, market data vendors and exchanges. Through topic-oriented working groups, FIF participants focus on critical issues and productive solutions to technology developments, regulatory initiatives, and other industry changes.

[2] See http://catnmsplan.com/web/groups/catnms/@catnms/documents/appsupportdocs/p246652.pdf

[3] SEC, 17 CFR Parts 242 (Release No. 34-67457; File No. @7-11-10) RIN 3235-AK51, Consolidated Audit Trail,, (c)(vi)(A-C)

to manage millisecond timestamp granularities automatically synchronize the clocks based on the specified clock drift tolerance.

A detailed discussion of each of these topics follows. In order to place FIF comments in context, each section includes appropriate extracts from Rule 613, the FIF response to the specific SRO questions, as well as a summary of the FIF position. We look forward to working with the SROs as these concepts are further developed.

Sincerely,

Manisha Kimmel
Executive Director
Financial Information Forum

FIF Consolidated Audit Trail (CAT) Working Group
Response to SRO Questions on Selected Plan Topics

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1 Primary Market Transactions

1.1 Rule 613

Rule 613(a)(1)(vi) requires the CAT NMS Plan submitted by the SROs to discuss "[t]he feasibility, benefits, and costs of broker-dealers reporting to the consolidated audit trail in a timely manner:

> (A) The identity of all market participants (including broker-dealers and customers) that are allocated NMS securities, directly or indirectly, in a primary market transaction;
> (B) The number of such securities each such market participant is allocated; and
> (C) The identity of the broker-dealer making each such allocation." [4]

Six months from the date of effectiveness of the NMS plan approved by the Commission, the SROs must submit an "expansion document" should provide details for each order and reportable event that "may" be required to be provided, and which market participants "may" be required to provide the data. The expansion document must include a discussion of primary market transactions in equity securities that are not NMS securities.

1.2 Commentary from Rule 613

Possible surveillance uses of primary market transaction data captured in the Consolidated Audit Trail include:

- Regulators could more quickly identify whether any participant in an offering sold short prior to the offering in violation of Regulation M.[5]
- Identification of the cost basis for purchases by intermediaries and make it easier to assess whether subsequent mark-ups to investors in primary offerings are fair and reasonable and, if not, whether there has been a violation of the antifraud provisions of the federal securities laws, including Rule 10b-5.[6]
- Combining primary and secondary market data to be collected by the consolidated audit trail could allow regulators to calculate investor positions, and when and how the investors receiving allocations sell their securities. Such data could also facilitate a better understanding of how securities are allocated in a primary market transaction, how allocations differ across broker-dealers and investors, and what types of investors are allocated securities.[7]
- Investigators could run surveillance on whether sales in the IPO auction were marked accurately (i.e., "long" or "short") and in compliance with applicable requirements.[8]
- Examinations if employees of a regulated entity are in compliance with the rules applicable to their transactions related to primary market transactions.[9]
- Conduct surveillance for "red flags" they might develop regarding potential suitability issues related to customer allocations, as well as potentially improper allocations to customers (such as kickbacks).[10]

[4] SEC, 17 CFR Parts 242 (Release No. 34-67457; File No. @7-11-10) RIN 3235-AK51, Consolidated Audit Trail, (a)(1)(vi)
[5] SEC, 17 CFR Parts 242 (Release No. 34-67457; File No. @7-11-10) RIN 3235-AK51, Consolidated Audit Trail, p. 89
[6] SEC, 17 CFR Parts 242 (Release No. 34-67457; File No. @7-11-10) RIN 3235-AK51, Consolidated Audit Trail, p. 89
[7] SEC, 17 CFR Parts 242 (Release No. 34-67457; File No. @7-11-10) RIN 3235-AK51, Consolidated Audit Trail, p. 269
[8] SEC, 17 CFR Parts 242 (Release No. 34-67457; File No. @7-11-10) RIN 3235-AK51, Consolidated Audit Trail, p. 270
[9] SEC, 17 CFR Parts 242 (Release No. 34-67457; File No. @7-11-10) RIN 3235-AK51, Consolidated Audit Trail, p. 270
[10] SEC, 17 CFR Parts 242 (Release No. 34-67457; File No. @7-11-10) RIN 3235-AK51, Consolidated Audit Trail, p. 270

1.3 Specific SRO Questions

- **How do broker-dealers generally maintain this information? Do they maintain it in a reportable, electronic format or other format that is easily or readily convertible into a reportable format? What specific type of information is collected?**

There are two levels of allocations in primary market transaction processing:

- "Top Account" allocations – represent the institutional client or retail broker dealer that is being allocated shares of the initial public offering
    - Top account allocations are in flux up until the syndicate terminates
    - Top account allocations are stored in book-building systems that are different from systems used for secondary market transactions
- Sub-account allocations – represent the actual account receiving the shares based on an allocation process that is similar to secondary market transactions.
    - Sub-account allocations are received from the buy-side in a manner similar to secondary transactions
    - Sub-account allocations are made by the top account entities before settlement.
    - CAT reporting of sub-account allocations would be unique in that there would be no other order-lifecycle events associated with the sub-account allocation report.

As stated above, top account allocations are stored in book-building systems. The sophistication of book-building systems differs across the industry and includes the use of applications provided by third-parties (e.g., Dealogic), in-house systems as well as spreadsheets for smaller firms. It is not recommended that top-account allocations be reported to CAT.

Generally, the same middle and back office systems that are used for secondary market sub-account allocation processing are also used for the primary market transactions. These systems could report the sub-account allocations to CAT. Sub-account allocations are in an electronic format that could be converted into a CAT reportable format.

The same level of detail is captured for sub-account allocation processing of secondary and primary market transactions. FIF recommends that the focus of primary market allocation reporting be on sub-account allocations from which top account allocations may be derived.

- **Do broker-dealers use systems and methods to handle information regarding allocations that differ from those used to handle information regarding secondary market transactions in such securities?**

  The book-building process that generates the top account allocations employs different systems than secondary market transaction processing. Additionally, there are typically different compliance systems used by the investment banking arm of a broker-dealer as opposed to their retail arm.

  As indicated earlier, generally, the same middle and back office systems used for sub-account allocation processing for the secondary markets within a firm are also used for handling the sub-account allocation process for the primary market transactions.

- **What are the general timeframes for when determinations are made regarding primary market allocations? What are the different "stages" of these allocations? Is there a tentative allocation that is subject to change? What would prompt changes? When is the allocation final and not subject to change? What format are allocation determinations in at the various stages? When would allocation (preliminary or final) information be available for submission? Please comment on what a reasonable expected timeframe is to report allocations.**

The syndicate desk collects and collates indications of interests throughout the book-building process. When the deal is priced, the top account allocations are not considered final until the syndicate terminates. As with secondary market transactions, the top account firm provides allocation instructions to the broker-dealer for allocations to sub-accounts. This generally occurs prior to settlement date.

CAT reporting of secondary market transactions for allocations is required to be reported to the CAT by 8AM following the business day of the reportable event. A similar reporting pattern should be considered for primary market transactions. Upon integration of primary market transactions into CAT reporting, the discontinuation of FINRA Rule 5130(j) could be achieved given the link between distributions to top accounts and sub-account allocations.

1.4 Summary of FIF Position

FIF recommends that the focus of primary market allocation reporting be on sub-account allocations from which top account allocations can be derived. CAT reporting for primary market allocation events would be a unique CAT reporting event because there are not the other associated life-cycle event (orders and executions) linkages. Sub-account allocation instructions are received prior to settlement day and would be reported to CAT by 8AM of the following business day from receipt of the sub-account allocation instruction.

2 Advisory Committee

2.1 Rule 613

"The national market system plan submitted pursuant to this section shall include an Advisory Committee which shall function in accordance with the provisions set forth in this paragraph (b)(7). The purpose of the Advisory Committee shall be to advise the plan sponsors on the implementation, operation, and administration of the central repository.
(i) The national market system plan submitted pursuant to this section shall set forth the term and composition of the Advisory Committee, which composition shall include representatives of the member firms of the plan sponsors.
(ii) Members of the Advisory Committee shall have the right to attend any meetings of the plan sponsors, to receive information concerning the operation of the central repository, and to provide their views to the plan sponsors; provided, however, that the plan sponsors may meet without the Advisory Committee members in executive session if, by affirmative vote of a majority of the plan sponsors, the plan sponsors determine that such an executive session is required."[11]

2.2 Commentary from Rule 613

Other comments on composition and use of an Advisory Committee from the SEC's commentary on Rule 613 include suggestions for broad industry membership with a cooperative and participatory rule to assist the SROs in the complex task of operating and guiding the CAT to be a cost-effective and useful tool for both the regulatory bodies and the industry at large.

- "Because members of the SROs will be required to report data pursuant to the NMS plan, the Rule provides that the plan must require that the Advisory Committee include representatives of the member firms of the SROs. However, the Commission believes that it is advisable for the SROs to consider including other interested parties such as SIPs, vendors, investors, and/or

[11] SEC, 17 CFR Parts 242 (Release No. 34-67457; File No. @7-11-10) RIN 3235-AK51, Consolidated Audit Trail, (b)(7)

academics on the Advisory Committee. In addition, the Commission expects that the Advisory Committee would include the Commission's Chief Technology Officer as an observer." [12]

- "…requires the NMS plan to include an Advisory Committee, which includes members of the plan sponsors and other interested parties as set by the NMS plan, that would be available to provide consultation on matters concerning the central repository, including the securities subject to the Rule. Therefore, the Commission believes that the participation of FINRA, the public, and the Advisory Committee should assist the SROs in devising a document outlining the expansion of the consolidated audit trail to other securities."[13]
- "These provisions also will allow the Commission to assess any such potential improvements, accounting for the considerations contemplated by Rule 613(a)(1), the specific requirements of the approved NMS plan, and any changes or additions to these requirements that the Advisory Committee, the SROs, or the Commission may wish to consider in the future."[14]
- "The Commission believes that the Advisory Committee could provide members of the SROs with a forum for informing the plan sponsors of any potential implementation or operational issues faced by them in connection with the consolidated audit trail. Plan sponsors also will be able to draw on the knowledge and experience of these members to help assure the Commission and market participants that any requirements imposed on SRO members will be accomplished in a manner that takes into account the costs to SRO members. The Commission also believes that an Advisory Committee could help foster industry consensus on how to approach and resolve possible issues that may be disputed, and approaches that may conflict, regarding operation of the consolidated audit trail."[15]
- "In addition, because the members of the Advisory Committee will have the right to attend all meetings of the plan sponsors (with the exception of executive sessions), to receive information concerning the operation of the central repository, and to provide their views to the plan sponsors, the governance process of the central repository will be more transparent to all market participants that will be affected by Rule 613. Further, the Commission believes the inclusion of SRO members on the Advisory Committee will increase the efficacy of the central repository. These market participants will have first-hand experience with the operation of the central repository, as they are required to report data to the facility, allowing them to provide informed input on any problems currently facing the central repository of which they are aware, and on any future actions that the central repository might or should take to address such problems."[16]

2.3 Specific SRO Questions

- ***Do the nine proposed representative categories adequately capture the needed breadth of the Advisory Committee? Should additional categories, such as issuers, academics, or securities information processors, be added? Is there a category that should not be included?***

    - An Advisory Committee comprised of more than nine members is suggested to be more reflective of the breadth of various types of firms with different business models servicing the industry.

[12] SEC, 17 CFR Parts 242 (Release No. 34-67457; File No. @7-11-10) RIN 3235-AK51, Consolidated Audit Trail, Footnote 215
[13] SEC, 17 CFR Parts 242 (Release No. 34-67457; File No. @7-11-10) RIN 3235-AK51, Consolidated Audit Trail, p. 90
[14] SEC, 17 CFR Parts 242 (Release No. 34-67457; File No. @7-11-10) RIN 3235-AK51, Consolidated Audit Trail, p. 245
[15] SEC, 17 CFR Parts 242 (Release No. 34-67457; File No. @7-11-10) RIN 3235-AK51, Consolidated Audit Trail, p. 246
[16] SEC, 17 CFR Parts 242 (Release No. 34-67457; File No. @7-11-10) RIN 3235-AK51, Consolidated Audit Trail, p. 248

- Expanding the Advisory Committee to approximately 20 participants with at a minimum representation of 12 SRO member firms would ensure broad representation from the industry.
- While most of the categories of industry participants are listed in the SRO proposed composition, having only one member from a category (e.g., clearing firm) would not permit adequate coverage from that class because there is a wide divergence of business models within these classes. It is recommended that multiple members in each category be included to cover the divergence of business practices.
- Two categories of participants that should be considered to be added to the Advisory Committee are order management and trade processing service bureaus in order to cover both front office and back office operational issues.
- Additionally, adding industry associations such as FIF and SIFMA would provide the Advisory Committee with a broader perspective than otherwise possible given the size of the group.
- It is unclear what value data vendors and individuals (categories 8 and 9) would add to the committee.
- A few classes of participants included in the SRO proposed composition may be collapsed without losing significant representation in operational differences, specifically:
    - The first three groups (broker-dealers with a substantial investor customer base and with registered persons numbering between less than 150 registered persons up to more than 500 registered persons) can be collapsed into one group without significantly losing representation of industry participants. As mentioned above, multiple members from this one collapsed category would be recommended.
- The SROs should retain the right to adjust from time to time (with the concurrence of the Advisory Committee members) the categories of the Advisory Committee participants in order to allow for additional member firms that focus on new or different products.

- ***Does a two-year term strike the proper balance between ensuring new members can participate on the Advisory Committee while maintaining some degree of continuity?***

    - A three year term duration should be considered. This could allow better continuity of participants especially when dealing with complex issues and annual or bi-annual review of topics, or operational performance of the CAT. Additionally, terms should be staggered such that only a third of the committee is turning over at a time.

2.4 Summary of FIF Position

FIF comments are mindful that the SROs exclusively hold the governing responsibility for the CAT and statutory obligation for regulating the markets.[17] FIF suggestions are presented for consideration to make the Advisory Committee a responsible and effective participant for the SROs' benefit in the issue analysis and decision formation process.

- An Advisory Committee comprised of approximately 20 participants with a minimum of 12 SRO member firms represented on the Advisory Committee is recommended to allow representation from a broad selection of different types of firms within the industry,
- Multiple participants from each category should be considered because one firm cannot represent all of the possible business models in use by firms within the business category.
- Categories of participants that should be added are trade processing and order management service bureaus, as well as adding the industry associations, such as FIF and SIFMA, to provide insight from a broader industry perspective not possible with limited Advisory Committee membership.

[17] SEC, 17 CFR Parts 242 (Release No. 34-67457; File No. @7-11-10) RIN 3235-AK51, Consolidated Audit Trail, p. 248

- Some categories of participants could be combined or eliminated (see answer to SRO Questions).
- A three year team should be considered for improved continuity on long-range directions and operational issues.
- FIF requests that the SROs consider the definition of the Advisory Committee to reflect a more participatory, active role in the formulation of decisions and directions being reviewed by the SROs. This should include:
    - Presenting recommendations to the SROs,
    - Having a non-binding vote on issues being reviewed by the SROs,
    - Recommending (selected) items to be published for public comment.

3 Time Stamp Requirement

3.1 Rule 613

(d) "Clock Synchronization and Time Stamps. The national market system plan submitted pursuant to this section shall require:

(3) Each national securities exchange, national securities association, and member of such exchange or association to utilize the time stamps required by paragraph (c)(7) of this section, with at minimum the granularity set forth in the national market system plan submitted pursuant to this section, which shall reflect current industry standards and be at least to the millisecond. To the extent that the relevant order handling and execution systems of any national securities exchange, national securities association, or member of such exchange or association utilize time stamps in increments finer than the minimum required by the national market system plan, the plan shall require such national securities exchange, national securities association, or member to utilize time stamps in such finer increments when providing data to the central repository, so that all reportable events reported to the central repository by any national securities exchange, national securities association, or member can be accurately sequenced. The national market system plan shall require the sponsors of the national market system plan to annually evaluate whether industry standards have evolved such that the required time stamp standard should be in finer increments."[18]

3.2 Commentary from Rule 613

The Commentary from Rule 613 discusses the fast moving clock management technology and the need for the Rule to maintain currency with the technology. It also stresses the importance of time stamp accuracy to be effective for the CAT in sequencing of events.

- "The Commission acknowledges that changes (with their associated costs) might be required to internal broker-dealer systems to comply with a millisecond time stamp requirement. However, given the benefits outlined above, and the apparent widespread use of millisecond time the Commission believes the cost of requiring the SROs to develop a plan that provides for millisecond time stamps, and to discuss the costs and benefits of the specific solution chosen, is justified."[19]
- "In essence, the Commission believes these provisions (*CAT Reporting)* are appropriate because they require each party – whether a broker-dealer, exchange or ATS – that takes an action with respect to an order, and thus has the best information with respect to that action, to record and report that information to the central repository. For example, the broker-dealer originating an order – whether received from a customer or generated as a principal order – is in the best position to record the

[18] SEC, 17 CFR Parts 242 (Release No. 34-67457; File No. @7-11-10) RIN 3235-AK51, Consolidated Audit Trail, (d)(3)
[19] SEC, 17 CFR Parts 242 (Release No. 34-67457; File No. @7-11-10) RIN 3235-AK51, Consolidated Audit Trail, p. 154

terms of that order, including the time of origination, as well as the unique customer and order identifiers. If the originating broker-dealer is required to record the time each order in a rapid series of principal orders is generated, for example, regulators will be able to more accurately reconstruct the sequence of those orders for purposes of conducting market surveillances for manipulative or other illegal activity, or for performing market reconstructions. In addition, requiring the originating broker-dealer to record the time an order was received from a customer could then help regulators more accurately determine whether the broker-dealer quickly traded ahead of the customer order. On the other hand, if the recording and reporting requirements initially applied only to the executing or routing broker-dealer, or the exchange in the case of market maker quoting, regulators would not know the precise time the order or quote was originated, and would not be able to implement or perform as efficiently effective surveillances, such as those discussed above. In addition, the lack of precise order origination time could interfere with the ability of regulators to perform accurate market reconstructions or analyses, particularly with respect to high frequency trading strategies. Thus, the Commission believes that every broker-dealer (and exchange) that touches an order must record the required data with respect to actions it takes on the order, contemporaneously with the reportable event, to ensure that all relevant information, including the time the event occurred, is accurately captured and reported to the consolidated audit trail."[20]

- "The Commission believes that, given the speed with which the industry currently handles orders and executes trades, it is important that the consolidated audit trail utilize a time stamp that will enable regulators to better determine the order in which reportable events occur. The entry time of orders can be critical to enforcement cases. For example, the timing between order origination and order entry is important in investigating possible market abuse violations, such as trading ahead of a customer order. In general, determining whether a series of orders rapidly entered by a particular market participant is manipulative or otherwise violates SRO rules or federal securities laws, otherwise being able to reconstruct market activity, or performing other detailed analyses, requires the audit trail to sequence each order accurately. The Commission believes that, for many types of common market activities that operate at the level of milliseconds or less, time stamps in increments greater than a millisecond would not allow this sequencing with any reasonable degree of reliability."[21]

3.3 Specific SRO Questions

- ***What level of granularity do firms currently capture on order information? Does the level of granularity differ depending on the particular order event (e.g., order entry, route, execution)?***

A current snapshot of time stamp and clock synchronization practices implemented today across the broker-dealer community can be summarized as shown in the below chart:

Table 1. Common Time stamp and Clock Synch Practices

Function	**Most Common Time Stamp Granularity**	**Most Common Clock Synch Frequency**
Manual Order Handling	Seconds	Manual
Electronic Order Handling	Milliseconds	Handled automatically within timer protocol
High Frequency Trading	Microseconds	Handled automatically within timer protocol
Trading	Milliseconds	Handled automatically within timer protocol
Allocation	Seconds	Manually/handled automatically within timer protocol

[20] SEC, 17 CFR Parts 242 (Release No. 34-67457; File No. @7-11-10) RIN 3235-AK51, Consolidated Audit Trail, p. 101
[21] SEC, 17 CFR Parts 242 (Release No. 34-67457; File No. @7-11-10) RIN 3235-AK51, Consolidated Audit Trail, p. 152

- There is a wide array of granularities captured for time stamps today across the industry – commonly ranging from seconds, to milliseconds to micro-seconds for latency sensitive applications. The disparity of granularity is attributed to the age of the system on which the application executes as well as the purpose of the application (back office accounting application requirements vs. high-frequency trading application requirements). In general, technology embedded in older systems either does not support or is costly to support a time stamp granularity under a second. In contrast, the newest systems today fully support time stamp protocols that provide millisecond level time stamps with little delta cost to the firm. (See Attachment for broader discussion on time stamps).
- Some examples of current time stamp granularities:
    - OATS reporting specifies an optional time stamp to the millisecond granularity.
    - The FIX message protocol supports time stamps with a maximum granularity of a millisecond.
    - Some exchanges return fills at a second level time stamp.
- While some trading applications support timestamps at increments more granular than milliseconds, there may also be a need to be upgrade databases, internal messaging applications/protocols, data warehouses, and reporting applications to enable the reporting of such timestamps to CAT. The requirement to report such finer timestamps should take into consideration the ability to capture and report such timestamps rather than just looking at a particular system in isolation.
- To comply with a singular time stamp requirement for all CAT reporting, firms will face significant costs in both time and resources to implement the consistent time stamp policy across multiple systems. Although many systems currently have granularity to milliseconds, some front office systems only have granularity to the second.
- One recommended exception to the millisecond time stamp granularity is manual order handling events (e.g., order receipt or routing via phone).
- The quality and performance of the software used by each system to capture the time and embed in a report can also affect the accuracy of the time stamp.
- CAT should not use time stamps as a matching criteria because of issues associated with clock drift. This would be consistent with changes made to OATS in October 2011 as part of OATS for NMS, where a change was made to no longer match on time stamps due to the challenges with clock drift and inconsistent time stamps.

While some high frequency trading currently demands time stamps of more granularity than milliseconds, most electronic order handling applications are currently time stamped to a granularity of milliseconds. FIF acknowledges the advances in clock technology over the past few years and consequently is now recommending the following time stamp granularity, contingent on a grace period of two years, allowing firms to upgrade their systems to incorporate more modern clock management technology to achieve these granularity levels:

Table 2. FIF Recommended Time stamp Granularity and Clock Synch Frequency

CAT Reporting Event	Recommended Time Stamp Granularity	Recommended Clock Drift
Manual Order Handling	Seconds	Not specified*
Electronic Order Handling	Milliseconds	Second
Execution	Milliseconds	Second
Allocations	Not Required by Rule 613	Not specified*

*The CAT NMS Plan should not specify clock drift for manual order handling or allocations, allowing firms to maintain current standards. Both manual entry of order and receipt of allocation instructions from the client, due to the nature of these business processes today, are not sensitive to precise time stamps. Additional discussion on manual order processes will be raised by FIF with the SROs in the DAG.

- ***Do firms typically have a means by which to sequence events occurring during the same time increment?***

    - For events where it is important to maintain sequence, an application typically associates a sequence number to that event. The sequence number can vary in format. One format is time stamp in seconds appended by a sequence number. However, sequencing is generally not supported across different applications or sub-systems on different hardware platforms unless there is a logical sequence associated with the events (e.g., routes happen after order receipts).
    - The sequence protocol can vary. One protocol is to determine sequence based on when an event (e.g., an order) arrived on that system, using a FIFO queue. Standard FIX message tagging is another example of a protocol for maintaining order status within an application. Complex logic is sometimes required to order events for OATS reporting.
    - Sequencing is usually maintained within an application within an event class (e.g., orders, or trades). Firms do not sequence between applications and event classes (e.g., across orders and trades).
    - The CAT will not be able to order events solely on the time stamp of the CAT report. Due to the technical challenges discussed under Clock Synchronization, sequencing of events based purely on time stamps across disparate systems cannot be guaranteed and is likely to be error-prone.
    - The CAT must determine the sequence of events as it moves through the lifecycle of an order (order, execution, allocation) through the linkages being defined into the CAT reporting protocols.
    - Event sequencing is already built into the exchange protocols, which imposes sequencing and determines the true market environment. The exchange sequence should be the definitive sequence pattern used for market reconstruction. It would be beneficial if the exchanges could be consistent and provide milliseconds on executions.

3.4 Summary of FIF Position

FIF recommends that time stamp requirements be based on event types. Electronic order and execution related events, which are time sensitive and currently managed in many firms by systems which have modern clock management functions, should support time stamp granularity at the millisecond level. It is recommended that a two year grace period be granted for those firms which must upgrade their systems to accommodate the millisecond granularity.

Manual orders which have a significant time variances due to the human component of order entry should support time stamp granularity at the second level. To upgrade these systems to more modern systems that support the time stamp granularity of a millisecond would be a significant cost to many firms. There does not appear to be any offsetting benefit to justify this cost.

4 Clock Synchronization

4.1 Rule 613

(d) "The national market system plan submitted pursuant to this section shall require:

(1) Each national securities exchange, national securities association, and member of such exchange or association to synchronize its business clocks that are used for the purposes of recording the date and time of any reportable event that must be reported pursuant to this section to the time maintained by the National Institute of Standards and Technology, consistent with industry standards;

(2) Each national securities exchange and national securities association to evaluate annually the clock synchronization standard to determine whether it should be shortened, consistent with changes in industry standards;"[22]

4.2 Commentary from Rule 613

The Commentary emphasizes the importance of managing the clock drift within reasonable tolerances to ensure accuracy of the time stamps for sequencing purposes.

- "The Commission recognizes, … , that computers have a certain rate of deviation when keeping time. The requirement that clocks be synchronized within a level of granularity to be specified in the NMS plan is designed to ensure that time drift does not exceed a defined level of deviation. However, the Commission believes that time stamps reported with a millisecond or finer granularity would still provide significant benefits even, … , if the time drift between systems is larger than a millisecond. This is because such time stamps would still allow an accurate sequencing of reportable events as may commonly occur within in a single system, tied to a single clock, at levels of a millisecond or finer (e.g., high-frequency trading algorithms). Any drift of such a system's clock relative to the clocks of other systems may of course hinder the time-sequencing of cross-system events, but it would not preclude the ability of regulators from performing a detailed, accurate time-sequenced analysis of all the orders, cancellations, modifications, and executions performed by the specific system of interest. [23] In this regard, the Rule is analogous to the current requirements for OATS reporting: FINRA requires clocks to be synchronized to the second, and requires time stamps to be reported to FINRA in seconds, unless those time stamps are captured by the FINRA member in milliseconds, in which case they must reported to FINRA in milliseconds (notwithstanding the clock sync remaining at a second)."[24]
- "Effective clock synchronization is essential to maintaining an accurately time-sequenced consolidated audit trail, particularly one where time stamps will be in millisecond increments or less. Because the consolidated audit trail will capture trading activity occurring across markets, if the business clocks used by SROs and their members for the purposes of recording the date and time for reportable events are not properly and consistently synchronized, the consolidated audit trail data will not be accurately time-sequenced. It is critical for the consolidated audit trail to allow regulators the capability to accurately determine the order in which all reportable events occur."[25]

[22] SEC, 17 CFR Parts 242 (Release No. 34-67457; File No. @7-11-10) RIN 3235-AK51, Consolidated Audit Trail (d)(1-2)

[23] SEC, 17 CFR Parts 242 (Release No. 34-67457; File No. @7-11-10) RIN 3235-AK51, Consolidated Audit Trail; Footnote 424, - "Similarly, although reporting in increments finer than a millisecond would also enable the accurate time-sequencing of events originating from within a single system or systems operating off the same clock, the Commission recognizes that the effects of time drift across the clocks of different systems could limit the efficacy of time-sequencing sub-millisecond events across those systems."

[24] SEC, 17 CFR Parts 242 (Release No. 34-67457; File No. @7-11-10) RIN 3235-AK51, Consolidated Audit Trail, p. 154

[25] SEC, 17 CFR Parts 242 (Release No. 34-67457; File No. @7-11-10) RIN 3235-AK51, Consolidated Audit Trail, p. 198

- "… the Commission expects the NMS plan that is submitted to specify the time increment within which clock synchronization must be maintained, and the reasons the plan sponsors believe this represents the industry standard. The Commission notes that FINRA currently requires its members to synchronize their business clocks used for OATS reporting to within one second of the time maintained by NIST. The Commission believes that the current industry standard for conducting securities business is more rigorous than one second. For example, … , technology used today by exchanges and high frequency trading firms synchronizes clocks to increments well within the millisecond level."[26]
- "… that time drift is an issue that must be addressed by the plan sponsors, to prevent a deterioration of the accuracy of the data in the consolidated audit trail. Therefore, the Commission expects the NMS plan to address the maximum amount of time drift that would be allowed before clocks must be re-synchronized, and why this is consistent with the industry standard."[27]

4.3 Specific SRO Questions

- ***How frequently should broker-dealers be required to synchronize their clocks?***

    - Many systems today use a clock synchronization protocol called NTP (Network Time Protocol), and less frequently, a more advanced protocol called PTP (Precision Time Protocol). Included within these protocols is automatic synchronization with a clock, within the specified tolerances. FIF recommends that Rule 613 should specify the accepted clock drift, and leave the clock synchronization frequency required to maintain clock drift to be managed by the clock synchronization protocols used within the firms.
    - For manual synchronization, the accuracy cannot be more than a second, and may be more if synchronization is not performed on a frequent basis. The frequency of manual synchronization required to maintain a sub-second clock drift is time consuming and burdensome.
    - It must be cautioned that clock synchronization cannot be used to support the sequencing of events being reported to the CAT (as discussed above). E.g., CAT reports from disparate systems which are logically sequenced may be time stamped out of sequence due to clock drift. This should not generate false error conditions to be addressed by the CAT Reporters.
    - Given that allocation events do not require time stamps and are often handled by legacy systems with less sophisticated clock management capabilities, it is recommended that current practices should be acceptable and that no clock drift or associated clock synch be required.

- ***How much drift should be allowed between broker-dealers' clocks and the time maintained by the National Institute of Standards and Technology?***

    - OATS reporting and Reg NMS require a 1 second clock drift with the time maintained by the NIST. CAT should maintain the 1 second clock drift standard.
    - It is important to recognize that meeting the clock synch requirement is more than just a technology challenge. There are additional challenges with the clock synch requirement that are related to the operational oversight and monitoring processes for the required infrastructure. Even with the automated clock server technology that synchronizes and adjusts

[26] SEC, 17 CFR Parts 242 (Release No. 34-67457; File No. @7-11-10) RIN 3235-AK51, Consolidated Audit Trail, p. 198
[27] SEC, 17 CFR Parts 242 (Release No. 34-67457; File No. @7-11-10) RIN 3235-AK51, Consolidated Audit Trail, p. 200

for drift, research, follow-up and corrective action is required of the operational staff associated with sales and trading systems when application servers stop communicating with the clock synch servers or clocks drift more than the specified tolerance. Additional operational staff may be required as CAT reporting broadens reporting requirements to systems other than sales and trading and if clock synchronization requirements are reduced from the current 1 second tolerance.

As noted in Table 2 above (Recommended Time stamp Granularity and Clock Synch Frequency), FIF recommends that the current clock drift of one second required by both OATS and Reg NMS be maintained for order and execution CAT reporting. FIF also recommends that no clock drift be specified for CAT reporting of allocation events and manual order handling. Given the manual nature of these business process, the lack of any business driver for more time precision, and the cost to impose more granular clock synchronization on the systems which handle manual execution entry and allocations, it is recommended that CAT reporting not require a clock drift for these events. Matching and sequencing associated with these two events are irrelevant so that the additional cost of imposing management of clock drift in these systems is difficult to business-justify.

4.4 Summary of FIF Position

FIF recommends maintaining the current OATS rule of a one second clock drift tolerance for electronic order and execution events. Any change to the current 1 second clock drift will result in a significant burden to industry participants in terms of operational overhead to support new requirements. FIF recommends gaining experience with CAT processing before altering clock drift requirements.

It is recommended that no clock drift requirements be specified for manual order and allocation events because the time stamps associated with these events are less meaningful.

Given the automated clock management protocols associated with managing millisecond level time stamps and clock drift tolerances, FIF recommends that no specific clock synchronization frequency be required to maintain the clock drift tolerance. This is managed automatically by the clock management protocols, given the specified clock drift tolerance.

5 Appendix. Background on Time-Stamping and Clock Synchronization Protocols

Time stamps

Modern operating systems generally allow application software to retrieve high resolution time with microsecond granularity or better. Careful programming may be required in some cases. Application software often chooses to save on space or bandwidth by using a lower granularity for any exposed time stamps that might be used for reporting purposes. For example standard logging facilities, such as syslog or Windows Event Logging, use time stamps in seconds only. Time stamps exposed in standard FIX or FAST trading messages can be in seconds or milliseconds. Exchange-specific order-entry and market data messages do commonly contain microsecond-granular time stamps. Thus while newly developed software systems should be able to provide millisecond or microsecond-level granularity with little difficulty, legacy systems will often require an upgrade to achieve this.

Highly granular software time stamps are not always highly accurate, because generating a time stamp in software incurs an unknown delay which can be several microseconds or longer. As an alternative some firms use hardware time-stamping of network-level events. Equipment used for this purpose typically provides nanosecond granularity and resolution within 10 nanoseconds. Hardware time-stamping is becoming easier to access as commercial network switches are now available that provide this function, but is mostly used today for dedicated monitoring systems.

Note that when time stamps are made in different places, using different clocks, their accuracy for the purpose of event sequencing is dependent on clock synchronization and also on precisely where the time stamps are made. Processing delays within individual network and application components within a trading system can introduce variable lags that often reach hundreds of microseconds or millisecond timescales. Therefore time stamps made at different processing stages in different systems may not be directly comparable at sub-millisecond timescales, unless the location of time-stamping is known with precision (and the clocks used are accurately synchronized).

Synchronizing to NIST Standard Time

Accuracy of computer clock synchronization is influenced both by the quality of the time-source to which the clock is synchronized, and the method/technology used to maintain synchronization. To synchronize to standard Universal Coordinated Time (UTC) as defined by the NIST, the time-source should ultimately be a radio-synchronized or atomic master clock. Time synchronization can be distributed from this master source to multiple further clocks and computers, using IP network technologies such as Network Time Protocol (NTP) and Precision Time Protocol (PTP/IEEE 1588), or using low level signal technologies such as Pulse-Per-Second (PPS).

Firms do not necessarily need to operate their own master clock since in many cases they can access a time-service from a hosting provider or other party, using one of the distribution technologies listed above. Those who do choose to deploy their own master clock typically use a device that is radio-synchronized via GPS or CDMA. Clock devices and servers that can take these radio signals as input and provide time synchronization via NTP, PTP, or PPS are available from several technology vendors. Note that access to GPS radio signals requires the use of roof-based antennas installed by data center hosting providers. CDMA is easier to access but has lower intrinsic accuracy (about 10 microseconds, versus sub 10 nanoseconds for GPS systems), and is dependent on continued operation of commercial CDMA telecoms networks (where it is likely to eventually be replaced by the newer LTE technology).

Network Time Protocol

Network Time Protocol is a long-established method of synchronizing computers over standard IP networks both large and small. No special hardware is required to run the protocol, and there are many client software

implementations available both free and commercial. NTP supports the use of time-server hierarchies, in which client computers use the protocol to access time-servers which themselves are synchronized via NTP to further layers of time-servers, ultimately reaching a set of 'stratum-1' time-servers that are directly connected to accurate master clocks.

Synchronization accuracy on any particular NTP client system is affected by the distance and quality of the network that links it back to a stratum-1 time-server. Long and variable network delays, or asymmetric delays, reduce the achievable accuracy. In a switched local area network where the time-server is located in the same facility as the client and network delays are relatively low and constant, accuracy in the range of 1-10 milliseconds can be expected using standard implementations. Over wide area or routed networks which are subject to longer delays and more jitter, accuracy can degrade to the range of 10-100 milliseconds (see reference 1).

Periodic versus Continuous Synchronization

Several operating systems include tools that allow users to synchronize periodically (or occasionally) instead of running continuous synchronization. Examples include Microsoft Windows Time Service, and the 'ntpdate' tool (which is based on NTP). These tools have less opportunity to monitor and compensate for network conditions or clock behavior, compared with a continuously running NTP service. In addition it's worth noting that unsynchronized computer clocks accumulate drift error over time, at rates that can be up to150 parts-per-million or larger (corresponding to 150 microseconds per second, in this context). For example a clock that is synchronized once per hour can potentially drift by up to hundreds of milliseconds between synchronizations. A clock synchronized once per day can drift by several seconds.

Precision Time Protocol (PTP – IEEE 1588)

PTP is a more recent technology for distributing time synchronization over IP networks, developed over the past 10 years. It incorporates many innovations designed to improve its accuracy relative to NTP, including more frequent exchange of timing information (up to many times per second, versus once per minute for NTP) and supporting features in network switches and interface cards that reduce the impact of communication jitter. A fully PTP-enabled system, based on synchronizing to a co-located master clock using switches and interfaces with hardware-assisted PTP support, can achieve accuracy in the sub-microsecond range. Synchronization to within 100 nanoseconds is often reported in ideal conditions; in practice, allowing for equipment imperfections and network load and topology, accuracy to within hundreds of nanoseconds can be expected (see reference 2).

PTP is primarily designed to operate in a highly accurate regime with hardware-assistance throughout the network. However switches and interface cards with PTP support have become commercially available only within the past 5 years, and therefore legacy networks and systems usually don't have ubiquitous PTP support. It is possible to run PTP without full hardware assistance but the achieved level of accuracy will be lower - typically within tens or hundreds of microseconds, depending on network load and topology (see reference 3).

Pulse-Per-Second

Many clock devices provide a so-called Pulse-Per-Second (PPS) output, via co-axial or serial cable, which can be used as input to a time-stamping or time-server system equipped with the appropriate interface. For example this approach is often used to directly connect an NTP or PTP server to an accurate radio-synchronized time-source. It can also be used to directly connect dedicated or strategically placed monitoring equipment for the purpose of generating time stamps. The advantage of PPS is that it avoids any possible impact from delay variation in propagating time signals. The disadvantage is that, as a non-networked technology, it is less scalable than NTP or PTP.

As its name implies PPS provides an electrical pulse every second, synchronized with the UTC second boundary - but it does not provide any means of identifying the actual time. It is therefore usually combined

with a technology such as NTP to determine which second each pulse is for. Inaccuracies in NTP used for this purpose will not affect the result provided they are much less than one second.

The PPS output from a high quality GPS-synchronized clock will often be accurate to within tens of nanoseconds. Practical deployments using time-stamping equipment directly connected to PPS can expect to be accurate to within less than 100-200 nanoseconds.

Summary

The table below provides a (not exhaustive) list of different synchronization options used in the industry today.

In terms of ease of use, options 1 and 2 in the table provide maximum flexibility since they allow computers in any facility with a network connection to be synchronized to a remote time-server. Options 3-6 require access to an accurate master clock located in the same facility.

Options 1-3 are based on the widely used NTP technology, while 4-5 are based on PTP which is becoming more common but is not yet widely used today. Option 6 is mainly used with dedicated monitoring systems. To get the full advantage of sub-microsecond accuracy provided by options 5 and 6, they should ideally be used in conjunction with hardware time-stamping.

	Method	**Typical Accuracy Range**
1	Periodic synchronization to a local or remote time-server	Seconds
2	Continuous NTP synchronization to a wide area time-server hierarchy	10-100 milliseconds
3	NTP synchronization across a switched LAN to a co-located master clock	1-10 milliseconds
4	PTP synchronization without hardware assistance across a switched LAN to a co-located master clock	100 – 1000 microseconds
5	Fully hardware assisted PTP synchronization to a co-located master clock	100 – 1000 nanoseconds
6	PPS synchronization to a co-located master clock	100 – 500 nanoseconds

The above accuracy ranges are indicative only and can probably be bettered by careful implementations in ideal conditions. On the other hand, faulty equipment, loss of network connectivity or severe congestion on network interfaces could cause accuracy to degrade outside the ranges cited above.

References

[1] Executive Summary: Computer Network Time Synchronization. David L. Mills, http://www.eecis.udel.edu/~mills/exec.html#precise.
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