

# Electronic Trading in the Secondary Fixed Income Markets

## **Treasury Borrowing Advisory Committee – Charge #1**

*Over recent years, technological advances have had a significant impact on the way assets are traded in fixed income markets. Specifically, with the rise in electronic trading, its associated participants and execution strategies have accounted for an increasing percentage of the traded volume in secondary fixed income markets.*

*We would like the Committee to comment on the increase of High Frequency Trading (HFT) and Algorithmic Trading (AT) in fixed income markets, and specifically in the Treasury market. To what extent has this trading technology permeated fixed income trading? How has it changed market dynamics?*

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# Agenda

- Definitions, Protocols, Methods and Venues
- Overview and Evolution of Electronic Trading in the Fixed Income Markets
- US Treasuries
- Foreign Exchange
- Takeaways and Discussion Topics
- Appendix – Change Management, Access Controls and Security for Automated Trading
- Appendix – Fixed Income Market DtC Volumes

# Electronic Trading – Definitions

**Execution Strategies** employ technology to optimally execute an order (or multiple orders). Investment decisions such as instruments to trade, total size, target levels, etc. are made independently of the execution strategy

	Definition	< 1 sec	1 sec– 1 min	1m – 15min	15min – 1d	> 1d
Direct Market Access (DMA)	Direct access to send / execute orders in a given pool of liquidity	✓				
Smart Order Routing	Taking a single order and dividing it up to be routed to multiple pools of liquidity	✓	✓			
Algo Execution	Use of an algorithm to enter in a single or multi-legged order over a period of time to minimize market impact		✓	✓	✓	

**Automated Trading Strategies** use algorithms to make investment decisions and to electronically execute these decisions (via an Execution Strategy)

	Definition	< 1 sec	1 sec– 1 min	1min – 15min	15min – 1d	> 1d
HFT Market Making	Market making in highly liquid markets with a short time horizon, typically requiring a Central Limit Order Book (CLOB)	✓	✓			
HFT Alpha Seeking	A strategy of price taking based on projections of short term market moves, typically requiring a CLOB	✓	✓			
Liquidity Transfer	Providing liquidity in a market where it is in demand by transferring it from another related market through spread trading		✓	✓		
Relative Value	Entering into multi-legged trades that seek to profit from value differentials across related markets			✓	✓	✓

# Electronic Trading – Protocols

- Trading protocols (offered by a given electronic venue) determine the type of electronic trading strategies that are able to be deployed
- Most trading protocols allow market participants to use automated strategies. However, certain venues either do not offer an Application Programming Interface (API) for liquidity takers, or the protocol itself does not facilitate automated trading
- Protocols such as RFQ and RFS/RFM automate the communication process between parties to a transaction, but do not materially change the nature of execution when compared with traditional voice transactions
- Other protocols (e.g., FX-style streaming) create direct linkages between name-disclosed counterparties that can either be traded directly or aggregated by the liquidity takers (via APIs) and have no manual equivalent
- A Central Limit Order Book (CLOB) protocol creates anonymous pools for order matching

Protocol	Description	Liquidity Taker	Market Makers
Request For Quote (RFQ)	Liquidity taker requests a one-sided price from multiple market makers on a name-disclosed basis	Automation Not Possible	Automation Possible
Request For Stream or Market (RFS/RFM)	Liquidity taker requests a two-sided market from multiple market makers on a name-disclosed basis	Automation Not Possible	Automation Possible
FX-Style Streaming	Market makers provide continuous, executable two-sided markets	Automation Possible	Automation Required
Central Limit Order Book (CLOB)	Anonymous limit orders provided by any market participant that are executed through a matching engine	Automation Possible	Automation Required

# Electronic Trading – Methods and Venues

Methods / Venues	Definition
Dealer to Client Platform (DtC)	A venue which connects dealers to their clients on a name-disclosed basis. These platforms are known as “Multi-Dealer Platforms” since they connect multiple dealers to multiple clients. All parties must be enabled on a bi-lateral basis in order to see quotes and execute
Inter Dealer Broker (IDB)	IDBs evolved from venues for Dealer to Dealer (DtD) trading that have since opened up to additional active participants, such as proprietary trading firms. Execution is typically anonymous and does not require enablement. Trades clear through a central party
Single Dealer Platform (SDP)	Proprietary platforms provided by a dealer that allows their clients access quotes and execute trades with that dealer. The dealer must enable each client and all activity is on a name-disclosed basis
Direct Market Access (DMA)	A liquidity provider, Electronic Communication Network (ECN) or exchange offers a direct API to a market participant which streams prices and allows direct execution. Each direct connection is from a single source of liquidity, and often the market participant will aggregate connections across multiple sources of liquidity
Swap Execution Facility (SEF)	A SEF is a platform established under Dodd-Frank for the execution of certain derivatives. These platforms will likely share many characteristics of the electronic trading methods and venues that currently exist for Rates, FX and Futures
Exchange	An organized exchange that is open to all market participants either through DMA or through a sponsoring broker (SMA). Execution is always anonymous in an all-to-all manner. Electronic exchanges typically have a Central Limit Order Book (CLOB), a matching engine which determines when orders are executed, and a central counterparty or clearing firm

# Conditions for Automated Trading Strategies

The following conditions typically need to be met for a given instrument to be included in an Automated Trading Strategy

- Homogenous
- Liquid
- Commoditized
- Centrally Cleared or settled within a set of established conventions which minimize counterparty credit risk (as in the case of FX Prime Brokerage)
- Executable on an electronic venue that
  - Allows API connectivity for all participants
  - Has a trading protocol which enables all participants to be fully automated and typically anonymous
    - Protocols such as CLOB and FX Style Streaming enable this
    - Protocols such as Request for Quote (RFQ) and Request for Stream or Market (RFS/RFM) do not enable this

# Non-Dealer Electronic Trading Market Participants

Given the variety of requirements and constraints among the diverse set of non-dealer market participants, there is understandably no consensus regarding the optimal choice for electronic trading protocols, methods and venues. Additionally, evolution necessarily occurs slowly as many end users are risk averse and comfortable with the status quo

- Traditional Asset Managers, GSEs, Bank Portfolios, Non-Financial Corporations, Pension Funds and Mortgage Companies
  - Desire price transparency
  - Have historically used RFQ, RFS or RFM platforms as proof of “best execution”
  - Typically prefer trading on a name-disclosed basis with their counterparties
  - Are increasingly leveraging third-party execution algorithms
  - Rarely require API access to liquidity pools
- Hedge Funds and Active Trading Accounts
  - Often use their own execution algorithms
  - Desire sophisticated leg-trading capabilities
  - Typically prefer API access to liquidity pools
  - Execute on both RFQ and Streaming Venues
- Non-Bank Market-Makers, High- and Medium-Frequency Alpha Seekers
  - Strongly prefer anonymity
  - Do not use RFQ platforms
  - Actively seek API access to liquidity pools
  - Typically require Exchanges / Central Limit Order Books

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# Evolution of Electronic Trading in Fixed Income

The adoption of electronic trading in the Fixed Income markets has been extremely gradual

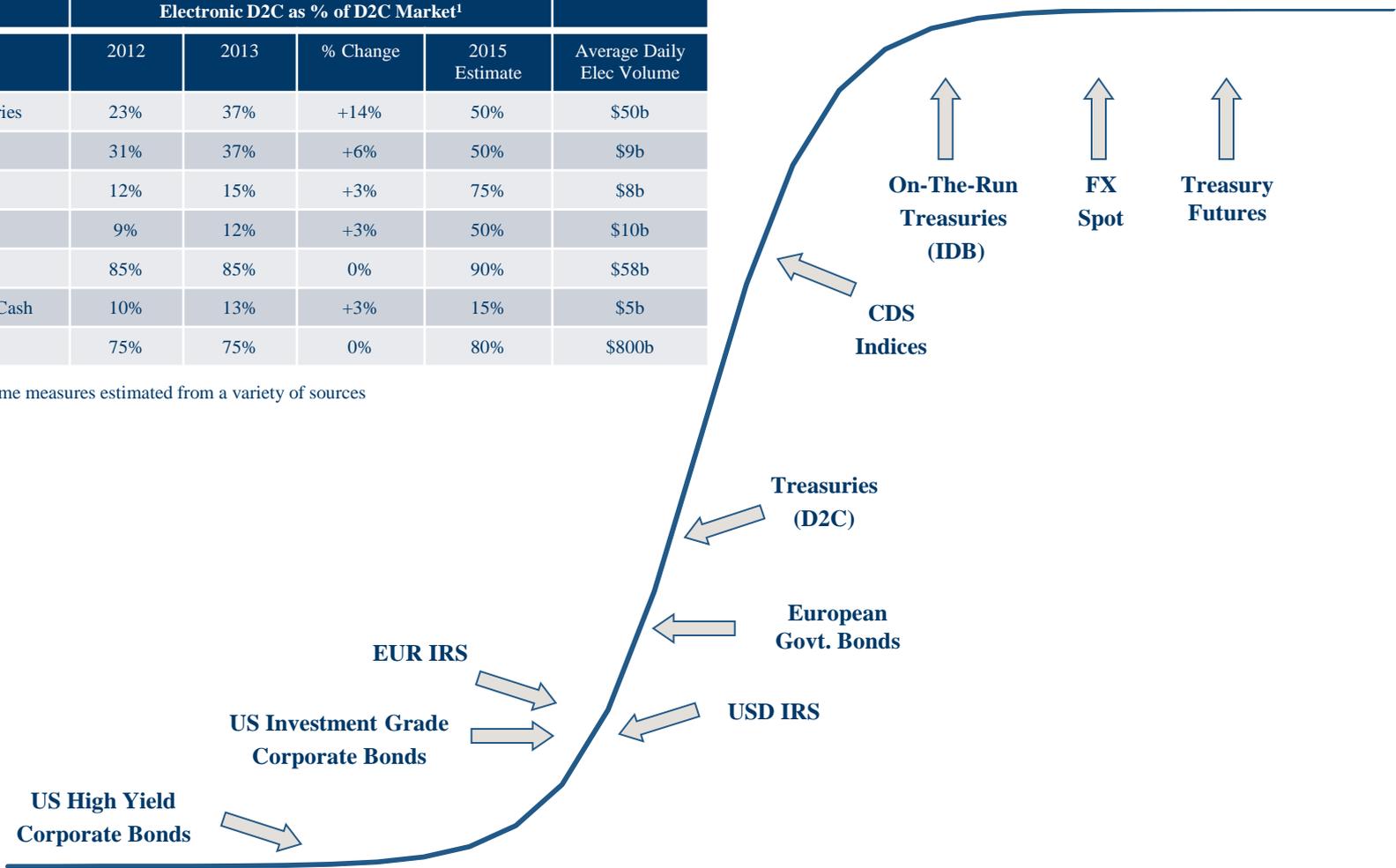
Year	Who	What
1992	CME	➤ Launch of the Globex electronic platform
1994	CBOT	➤ Launch of Project A for electronic trading of US Treasury Bond Futures
1998	TradeWeb	➤ Launches first multi-dealer online marketplace of Treasuries
1999	eSpeed	➤ Launches as Cantor-Fitzgerald's electronic Treasury bond trading platform for IDBs
2000	BrokerTec	➤ Launches competing electronic Treasury bond trading platform for IDBs
2000	TradeWeb	➤ Adds US Agencies and European Government Bonds
2001	TradeWeb	➤ Adds Agency MBS TBAs and Commercial Paper
2003	BrokerTec	➤ Acquired by ICAP and together launch the first combined voice and electronic pools
2004	TradeWeb	➤ Adds US Corporate Bonds
2005	TradeWeb	➤ Adds US Interest Rate Swaps, CDS Indices and Repo
2011	TradeWeb	➤ Launches Dealerweb electronic IDB marketplace for Off-the-Run Treasuries
2012	Multiple	➤ Dealers launch client algorithmic execution platforms for US Treasuries
2013	CFTC	➤ Mandatory clearing of swaps begins under Dodd Frank
2013	CFTC	➤ Swap Execution Facilities (SEFs) commence operations

Sources: BGC, Cantor Fitzgerald, ICAP, NASDAQ, TradeWeb

# Fixed Income: Current State of Electronic Trading

	Electronic D2C as % of D2C Market <sup>1</sup>			2015 Estimate	Average Daily Elec Volume
	2012	2013	% Change		
US Treasuries	23%	37%	+14%	50%	\$50b
EGB	31%	37%	+6%	50%	\$9b
USD IRS	12%	15%	+3%	75%	\$8b
EUR IRS	9%	12%	+3%	50%	\$10b
CDS Index	85%	85%	0%	90%	\$58b
Corporate Cash	10%	13%	+3%	15%	\$5b
FX Spot	75%	75%	0%	80%	\$800b

1. All volume measures estimated from a variety of sources



Electronic Trading Percentage Uptake by Product

# Observations of Electronic Trading in Fixed Income

There are distinct differences between the Fixed Income and Currency (FIC) markets and the cash Equity markets

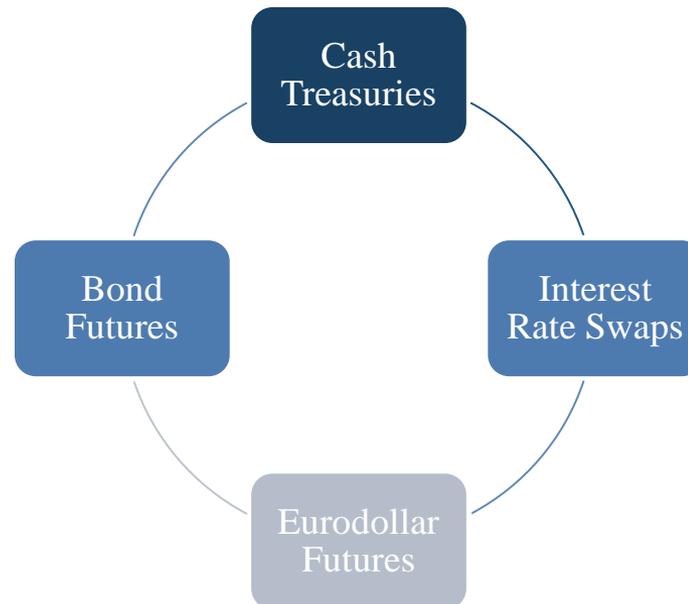
- FIC markets have historically traded on a bi-lateral basis, whereas equity markets have historically traded on exchanges
- In the FIC markets, market-makers are compensated implicitly via bid/offer, rather than explicitly via commissions
- FIC markets have historically traded on a principal-to-principal basis, where the market-maker is compensated for warehousing the resulting risk
  - Bid/offer is generally a function of the volatility of the positions and the time required to distribute the risk
- Equity markets have typically traded on an agency basis (in the case of block trades, the resulting risk can often be disseminated into the market relatively quickly)
  - During periods of imbalanced flows or market stress, designated specialists were required to step in and warehouse the temporary miss-match between supply and demand
- In FIC markets, the most successful market-makers have been the largest banks, which have significant internal flows due to their global footprints and their multiple lines of business
  - These activities give them an inherent advantage in their ability to provide liquidity to the markets
- Of the FIC markets, the FX Markets are the most highly evolved with respect to electronic trading. As the state of fixed-income electronic trading advances, it should more closely parallel the evolution of the FX markets (rather than the equity markets) for reasons outlined above
  - Both the Equity and FX markets share the characteristic that the instruments being traded are extremely commoditized and homogenous
  - However, the Government Bond, Corporate Bond and CDS, and IRS markets have a more complex product set relative to the Equity and FX markets
    - All of these markets have a term structure of maturity tenors for a given issuer
    - All of these markets have a broad array of benchmark and non-benchmark instruments across the maturity spectrum

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# Treasuries as part of the Duration Spectrum

- Many market participants view Bond Futures, Eurodollar Futures, On-The-Run Cash Treasuries and Benchmark IRS as fungible sources of duration and yield curve exposure
- Given this fungibility, many market participants perform some degree of liquidity transformation across these markets
- All of these instruments currently can be traded electronically. However, there is significant variability in protocols, methods and venues
- There continues to be a gradual convergence of trading protocols between On-The-Run Cash Treasuries, Benchmark IRS, Bond Futures and Eurodollar Futures



# Treasury Market Activity Structure and Implications

	% of US Treasury*	
	Market Value	Total Volume**
<b>On-the-Run</b>	1.5%	60%
<b>Liquid Off-the-Run***</b>	7%	23%
<b>Illiquid Off-the-Run/ Strips/ TIPS</b>	91.5%	17%

\* Estimates; Includes Nominal Coupons, Strips, TIPS  
 \*\* D2C  
 \*\*\* First 3 Off-the-Run and CTDs

- Within the Treasury market, there are clear tiers of liquidity
  - 60% of the trading activity is concentrated in the on-the-run securities, despite their small share of total outstanding Treasury issuance
  - Older, less liquid securities trade infrequently in less transparent markets
- As a greater share of Treasury volumes trade electronically, there may be even further concentration of activity in the on-the-run issues (along the lines of the cash equity experience in large caps versus small caps)
- This shift may benefit the Treasury as an issuer since further enhancement of liquidity in on-the-run issues may lead to reduced borrowing costs
- However, increasing bifurcation of activity between on-the-runs and off-the-runs may result in a continued divergence of liquidity between issues, which ultimately could lead to higher borrowing costs as participants demand a premium for eventual diminished liquidity in their aged holdings
- The net impact of these effects remains to be seen, but encouraging the liquidity of off-the-runs will help the Treasury Department keep borrowing costs down as other competing sources of liquid duration become more frequently electronically traded

**Sources:** Federal Reserve, US Treasury and other sources

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# Evolution of Electronic Trading in the FX Markets

Electronic trading in FX Spot began over 10 years ago. The migration to and evolution of electronic FX markets has been somewhat disjointed. The current state of the electronic FX markets is highly fragmented with a significant array of offerings and pools of liquidity

~ Year	Who	What
1992	Reuters & EBS	Interbank platforms enable anonymous click-to-trade capabilities leveraging bi-lateral credit lines
1999	FX All & FX Connect	ECNs which enable Multi-Dealer (DtC) platforms for RFQ on FX Spot and Forwards
2001	Hotspot	ECN all-to-all platform for executing on streaming FX Spot levels with full anonymity
2002	FX Prime Brokers	Enable non-Dealers to access Reuters & EBS anonymously
2003	Bank Portals	Banks begin to invest heavily in proprietary SDPs, providing both RFQ and streaming capabilities
2004	HFT	Dealers and Proprietary Traders began to heavily invest in algorithmic market-making capabilities
2004 – 2012	ECNs	Proliferation of ECNs with a broad variety of capabilities
2005 – 2013	Aggregators	Aggregators emerge to consolidate fragmented liquidity across numerous platforms
2007 – 2013	Bank Portals & ECNs	Expand product offerings and invest in developing execution algorithms for clients
2009 – 2013	Bank Portals	Bank's centralize their internal flows across their disparate lines of business

ECNs: Electronic Communication Networks

SDPs: Single Dealer Platforms

# Observations of Electronic Trading in the FX Markets

FX spot is a highly standardized and commoditized product. However, CLOB structures have not become the predominant electronic method and venue

- Recently, there has been some evolution away from further market fragmentation due to a variety of forces
  - Increasing sophistication of Bank SDPs and larger ECNs has pushed some Aggregators and smaller ECNs out of the market (they have lost market share and they cannot afford the ongoing R&D costs in execution algorithms)
  - ECNs are seeing less activity as liquidity has been migrating back towards large Banks
- Electronic market share has been gravitating back towards Bank SDPs as
  - They have largely succeeded at centralizing all internal order flows across their various lines of business (Retail, Capital Markets, Treasury, Custody, etc.)
  - Because of their global footprints, the largest banks also have the broadest liquidity pools for EM currencies, which have exhibited significant growth in volumes
  - Bank portals have increased the breadth of their electronic offering to include complex Spot FX order types and execution capabilities for vanilla FX options
  - A variety of End Users are increasingly relying on the Banks' proprietary algorithmic execution tools
  - Banks have become increasingly sophisticated in adjusting prices based upon their target risk profile and the types of order flows they are seeing

ECNs: Electronic Communication Networks

SDPs: Single Dealer Platforms

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# Takeaways and Discussion Topics

- There is not a universal definition of, or model for, electronic trading in Fixed Income
- The evolution of electronic trading in the Fixed Income markets continues to be a gradual and highly fluid process
- High-Frequency and Algorithmic Trading market participants help provide liquidity to the Treasury markets, given the high degree of correlation across other duration-sensitive products
  - Firms that participate in HFT and AT are acutely cognizant of the risks of these activities, and have a strong incentive to implement the appropriate quality control measures (see Appendix)
- Based upon the Equity and FX experiences, there is the potential for significant fragmentation of liquidity. This is further compounded by the fact that the Fixed Income product set is typically more heterogeneous and less commoditized than the cash equity and spot FX markets
- It is highly unlikely that a singular end-state electronic trading solution will emerge across Fixed Income due to the heterogeneous product set and the diversity of needs across various market participants
  - Anonymous central limit order books are suitable for fully standardized and commoditized products with well-developed real-time mandatory Central Clearing
  - Even for products meeting this criteria, the evolution towards a CLOB model can cause near-term liquidity stresses as traditional providers of liquidity are disrupted
  - For less-standard, less-commoditized or non-cleared products, attributes such as anonymity, CLOBs, and streaming executable pricing are not ideal (and potentially not even appropriate)

# Takeaways and Discussion Topics (continued)

- Asynchronized mandates for Central Clearing and electronic trading are creating stresses on the tight linkages between the Government Bond (and Repo), Interest Rate Swap, Listed Interest Rate Futures (Eurodollar and Treasury) and Corporate Credit (Bond and CDS) markets
- There are many types of transactions across the Fixed Income markets that involve the simultaneous and/or contingent execution of two or more instruments (referred to as “Package Transactions”)
  - Forcing part of a Package Transaction (e.g., an Interest Rate Swap) onto a SEF on a standalone basis could disrupt the liquidity of the whole package (e.g., a Swap Spread or Invoice Spread package) absent a reliable mechanism for simultaneous execution (such as the Exchange for Risk (EFR) process in the futures market, which allows an IRS and a bond future to be traded together off-exchange)
  - This could have serious adverse knock-on effects, as the markets in Package Transactions greatly contribute to, and facilitate liquidity provisioning in, the markets for the individual component instruments of such Packages
  - Treasury liquidity could be negatively impacted by a disruption to the IRS markets during SEF implementation
- Implications for SEF implementation and Made Available for Trade (MAT) determinations for IRS and CDS
  - To avoid liquidity disruptions to the Fixed Income markets, MAT determinations for the IRS and CDS markets could be done in a phased approach, with Phase 1 being limited to only the most liquid USD and EUR IRS (i.e., spot starting benchmark swaps) and Current Series Index CDS
  - Subsequent Phases could then incorporate additional outright swaps, as well as certain Package Transactions
  - A data-driven / metrics-based approach should be used to determine which additional products / packages are best suited for inclusion in the future Phases
  - At each phase, it is essential to maintain a reliable mechanism for Package execution, such as EFR
  - A phased implementation approach proved successful during the roll-out of mandatory central clearing

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# Automated Trading Standard Protocol – Change Management

## ➤ Software Development

- Maintain separate yet identical development, testing, and production environments
- Utilize source code management tools to identify why, when, who, and what was changed
- Define deliverable-oriented methodology to mitigate the risk of actual results not matching expected results
- Take into account the size of team and safeguard sensitive information as appropriate
- Ensure traceability of support code to enable recall of the state of the system (i.e., reproduction of issues)
- Establish physical and technological security measures as well as authentication mechanisms
- Use a software framework with well defined interfaces for maximum reuse which has a clear delineation between separate shared, common libraries and functions and business specific libraries and functions
- Build in automated fail-over and recovery mechanisms

## ➤ Software Testing

- Segregation of duties between development and testing to avoid conflicts of interest
- Simulation – Backtest the performance of an algorithm and compare to actual results
- Unit/Functional – Test that the system functions as designed
- Quality – Test how well the system performs under extreme scenarios
- User Acceptance – Test that the work flow is as expected
- Conformance Testing – Where appropriate and available certify that the system passes exchange / ecn tests

## ➤ Release Management

- Segregation of duties between development and production to avoid conflicts of interest
- Centralized control of all releases with a release management team
- Conduct cross functional meetings prior to releases with appropriate approval and signoff
- Deploy Pilot releases (by trade, symbol, position limit, markets, etc.) to ensure cautious and controlled rollout

**NOTE:** Additional information can be found in Futures Industry Associations (FIA) Principal Traders Group (PTG) European Principal Traders Association (EPTA) “Software Development and Change Management Recommendations “ document which contains best practices for software development, testing, and change management

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# Automated Trading Standard Protocol – Access Controls

## ➤ Published Rules

- Many regulatory agencies have published rules related to market access controls
  - SEC – Rule 15c3-5 market access controls effective 7/14/2011
  - FSA – ESMA guidelines on systems and controls in an automated trading environment for trading platforms, investment firms and competent authorities effective 5/1/2012
  - SFC – Code of conduct for electronic trading effective 1/1/2014

## ➤ Goals

- In general they aim to
  - Promote fair and orderly trading in automated trading environments
  - Prevent market abuse in automated trading environments
  - Prevent uncontrolled direct market access and or sponsored access in automated trading environments

# Automated Trading Standard Protocol – Access Controls

- Compliance with the Goals of Access Controls
  - Preventative/Pre-Trade controls which ensure appropriate market access controls are built into the system to prevent
    - Clearly erroneous orders both in size and price relative to a reference price
    - Duplicative and/or replayed orders
    - Thrashing orders
    - Orders (including open and executed) which would exceed established capital limits
  - Detective controls which ensure appropriate monitoring tools are built into the systems with multiple automated and human groups monitoring system
    - System – Hardware/Software components functioning properly
    - Market – market interactions are online – market data publishing, order messages and latency, and trade matching
    - Performance – P&L monitoring is functioning, actual P&L matches expected P&L
  - “Fuse Box” or “Kill Switch” controls which warn and if need be shut down trading; thereby, minimizing the impact of erroneous code, processes or orders on firm and marketplace
    - Warn via real time monitors and email alerts when defined warning threshold is breached
    - Shut down when defined error threshold is reached
  - Supervisory Procedures, Reviews, and Training which ensure goals are documented and clearly communicated to responsible parties

# Automated Trading Standard Protocol – Security

- Physical access
    - Office
      - Access controlled by key cards or similar means of security enabled for access to only appropriate floors/areas
      - Monitoring provided by dedicated security team
      - Periodic tests of security access policies and procedures
    - Data Center
      - Access to data center and co-location cages controlled by key cards or similar means of security
      - Utilize providers with access governed by standards such as SAS 70
      - Monitoring provided by dedicated security team
      - Periodic audits of access to cages and who has approval rights
      - Periodic tests of security access policies and procedures
  - Logical access
    - Access
      - Use of a single directory store for authentication and authorization to systems with auto-provisioning/de-provisioning
      - Annual review of access and entitlements by the business users
      - Segregation of duties/access to avoid conflicts of interest across business lines
    - Two factor authentication for remote access
  - Protection against unauthorized access/intrusion
    - Monitoring of network traffic to determine non-standard outbound communications
    - Decrypting and filtering of network traffic with blocking of unacceptable web sites
    - Detection tools to capture outbound files for review of potential data leakage
    - Block Denial of Service attacks with assistance from Internet Service Providers
    - Network and host-based detection and blocking of spam and malware
    - Patches are reviewed, tested and deployed in a timely fashion
    - Monitoring of communication lines for high bandwidth utilization not associated to business processing
    - 24x7 monitoring and responding of operational/security events by a Network Operations Center
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# Fixed Income Market DtC Volumes

	D2C Market			D2C Trading Protocol					IDB / Exchange	
	ADV (\$ MM)	ADV (Trade Count)	Avg. Trade Size (\$ MM)	RFQ	ALLQ	Firm-Specific Streaming	Co-Mingled Streaming	FX-Style	Fully Electronic IDB	Voice-Hybrid IDB
US Treasuries										
Nominals										
OTR	27,555	3,693	7.46	✓	✓	✓		✓	✓	
OFTR	22,545	3,540	6.37	✓	✓					✓
Total Nominals	50,100	7,234	6.93							
Bills										
TIPS	1,274	621	2.05	✓	✓					✓
STRIPS	483	193	2.50	✓	✓					✓
EGB - Core										
Nominal	7,169	2,390	3.00	✓	✓				✓	✓
Inflation	167	186	0.90	✓	✓				✓	✓
EGB Non-Core	1,319	925	1.43	✓	✓				✓	✓
Gilts										
Nominal	1,324	415	3.19	✓	✓				✓	✓
Inflation	62	191	0.32	✓	✓				✓	✓
IRS										
EUR	10,491	221	47.46	✓	✓	✓	✓		✓	✓
USD	8,124	195	41.65	✓	✓	✓	✓		✓	✓
GBP	4,265	153	27.84	✓	✓	✓			✓	✓
Cash Credit										
US Cash Credit (IG)	1,432	2,386	0.60	✓	✓					✓
US Cash Credit (HY)	120	239	0.50	✓	✓					✓
European Cash Credit	3,428	8,563	0.40	✓	✓					✓
CDS										
NA Single Name	4,459	637	7.00	✓						✓
EUR Single Name	4,140	414	10.00	✓		✓			✓	✓
NA Indices	28,280	618	45.76	✓	✓	✓	✓			✓
EUR Indices	21,439	618	34.69	✓	✓	✓	✓		✓	✓

**Sources:** DTCC and other sources. **Notes:** Average Trade Sizes are notional values traded in \$MM. EGB Core includes France, Germany, Netherlands, Italy. IRS data excludes cross-currency swaps.