You operate in a demanding 24x7 global environment. You need a system that does too.

FXL: the industry's most flexible cross-product, front-to-back transaction processing solutions

Broadridge®

Introduction

The financial services market is one of the most dynamic industries in the world. In recent years, the credit crisis, increasing consolidation, a growing and stricter regulatory environment, and globalization – and all that follows from it – have had considerable impact on the way organizations conduct business.

As market conditions change, financial services organizations must adapt. Remaining competitive often necessitates new business practices, new operational processes and being active in new markets.

Underlying all of these changes is an organization's technology infrastructure. Today's key business support systems need to be more flexible and configurable than ever before to support evolving business requirements.

The fall-out of the credit crisis has seen the strategies, structures, and cultures of financial services organizations radically change. This brings with it significant operational challenges, particularly for those having to work with costly, high-maintenance legacy systems or manual processes they are not familiar with. As a result, change and innovation are required. Ensuring the technology within the organization is suited to the new era and able to provide support in terms of scale, flexibility, consistency, and the ability to reduce cost and risk. To help move away from hindering legacy operations, firms are partnering with FXL.

FXL provides global, 24x7 transaction processing solutions your organization needs to improve operating performance and stay ahead of the competition.

Service and support

Broadridge FX & Liquidity Solutions Professional Services team can help you:

- Analyze current system needs
- Define business and technical requirements
- Document requirements and workflows
- Implement and manage projects
- Improve quality assurance
- Tune system performance
- Convert and migrate data
- Perform custom development

FXL

- Provides global data communications on a real-time basis.

- Improves user efficiency and productivity.

- Reduces system hardware, system implementation, integration, and maintenance costs.

- Increases the percentage of Straight Through Processing (STP) transactions.

- Reduces overhead traditionally needed for transaction processing.

Broadridge FX & Liquidity Solutions

Broadridge FX & Liquidity Solutions improves operational performance and efficiency **around the globe & around the clock.**

FXL provides comprehensive transaction processing solutions for front, middle and back office processing across financial products. FXL facilitates an organization's global trading activities in a flexible, efficient and cost effective way.

FXL provides a singular application platform and offers the following solutions:

- **FXL** – FX & FX Derivatives *Componentized Front, Middle & Back Office Solution*

- **FXL CM**– Cash Management *Real-time Global Liquidity Views Across Asset Classes & Entities*

- **FXL RM**– Risk Management *Real-time Global Limit Monitoring, Margin Monitoring & VaR*

- **FXL OMS** – Order Management Solution *Market & Limit Orders for FX & FX Options*

- **FXL Treasury** – Treasury Management *Global Treasury Management Across Asset Classes & Entities*

FXL seamlessly integrates with an organization's existing systems and is designed to support 24x7 trading around the globe. Organizations can easily configure workflow processes to support (changing) operational practices, and traders can view consolidated information across all products according to personal preferences and requirements.

FXL is a scalable, n-tier application based on Window's .NET framework. As one of the few market entrants in more than 10 years, FXL is designed to address today's market needs using the latest technologies:

- **Global 24 x 7 trading & operations** – FXL enables global trading and operations around the clock. No system down time means more productive traders and fewer missed opportunities. And because global operations can be supported from a single data center, ongoing operating and maintenance costs are low.

- **Front-to-back Straight Through Processing (STP)** – FXL supports front, middle and back office processing. This reduces initial integration costs, increases the percentage of STP transactions, and lowers processing overhead costs.

- **Cross-product processing** – FXL is a multi-asset class transaction processing system. Traders can view consolidated position information, process settlements andconfirmations, and manage accounting across all asset classes, making them more productive and able to make better decisions more quickly. Additional products can be added to the system with minimal effort and without compromising FXL's cross-product functionality.

- **Multi-asset class support** – FXL supports front, middle and back office processing across an extensive set of financial asset classes, including Foreign Exchange, Money Markets, Internal Arbitrage, Cash Management, Financial Futures, Exchange Traded Options, OTC Options, Unallocated Metals, Interest Rate Swaps, and Fixed Income.

- **High volume transaction support** – FXL's state of the art technology supports large volumes of transactions and scales for peak loads as necessary. FXL's processing capacity handles hundreds of thousands of trades per day.

- **Multi-entity multi-organization support** – FXL supports any organizational structure. Data can be classified globally, by organization or entity, and information is easily viewed and processed at aggregate or individual levels.

- **Workflow-based processing** – FXL is workflow based to facilitate smooth and consistent operations, improve trader productivity, and reduce operational risk. Workflows are a flexible set of rules, business objects and tasks that are easily configurable to support an organization's specific business requirements and operational priorities.

- **Unattended end-of-day processing** – FXL's end-of-day activities are disconnected from ongoing trading activities and run automatically, at easily configurable times, with no user intervention.

- **Flexible and configurable information views** – FXL provides a highly customizable user interface. Users can configure how data is displayed to increase their efficiency, productivity and levels of service. And because data is published in real-time, traders can monitor position, rate, cash and P/L changes as they occur.

- **Seamless integration with existing systems** – FXL integrates smoothly with all corporate support systems, regardless of technology, data type and format, or communication requirements. FXL's Gateway links the system with internal and external systems, and manages all incoming and outgoing data to ensure integrity and consistency.

System Architecture

FXL's flexible **workflow-based processing** & robust architecture **seamlessly conforms** to your organization's operational practices & infrastructure.

FXL is a comprehensive 24x7 trading solution designed for real-time, high volume, Straight Through Processing (STP) of transactions. As one of the few market entrants in more than 10 years, FXL truly addresses today's market needs using the latest, state of the art technology.

FXL's system architecture is an n-tier client-server platform based on Windows .NET technologies. The application server scales seamlessly for operations across one or many locations, and your organization can create components in-house to modify, replace or extend application functionality.

FXL is made up of components. Each component is designed to be maintainable, consistent, secure and highly available.
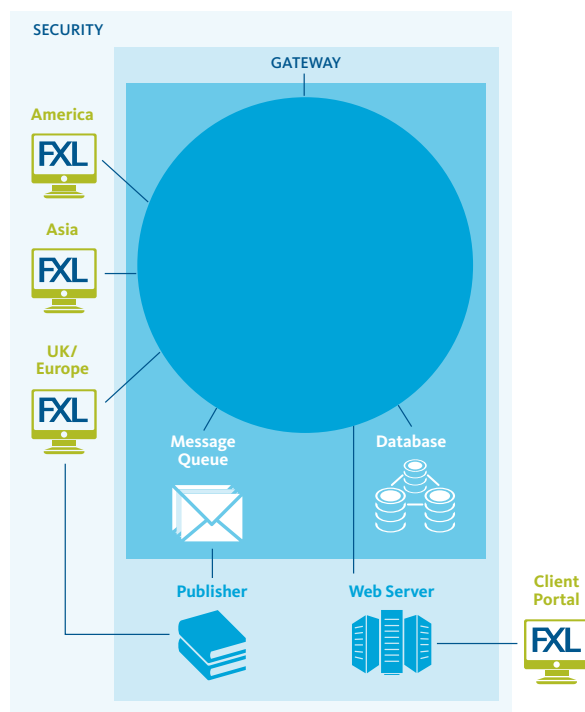
1. Workflow director

Workflow Director is the Application Server component of FXL. It is a scalable and flexible rules-based engine that manages the processing of rules, tasks and business objects. These elements are interchangeable, enabling easy customization of the system to meet organizational needs.

Features:

• **Scalable:** Supports high transaction volumes and scales to handle increasing volumes as needed.

• **24x7 Operations:** Supports around the clock processing, with no system down time.

• **Configurable:** Easily configured to meet organizational requirements with plug and play components, and the ability to replace and enhance business objects with company-specific calculations and algorithms. Workflow Director's business logic rules are highly configurable to suit company-specific rules and tasks, and are simple to set up and maintain.

• **(A)Synchronous processing:** Processes transactions either synchronously or asynchronously, enabling lower priority tasks to be handled in the background without impacting time-critical tasks. For example, positions can be updated in real-time, while confirmations are generated in the background.

• **Efficient:** Business objects manage corresponding Transaction Objects to update the in-memory repository, the Database and the Workflow Message Engine through the entire processing of a transaction. This prevents unnecessary or extensive Database table locking and reduces redundant data selection.

• **Secure and robust:** Built with robust error handling and fault tolerance to provide a secure environment for handling financial transactions. Workflow Director contains comprehensive auditing and logging capabilities that can be configured to meet organizational requirements.

2. Client Application

The Client Application is FXL's Windows-based front end. This multi-threaded, rich user interface runs on any .NET framework compliant operating system, locally or remotely. FXL also provides a thin client application which is FXL's browser based interface.

Features:
- **International:** Supports the capture and display of internationalized data throughout the application and database. Information views, captions, literals and messages are based on an individual user's regional Windows setting.

- **Customizable:** Users can effortlessly customize screens and information views to suit personal preferences and operational needs using a graphical screen designer. Screens are dynamically created as needed and are based on underlying templates and user preferences stored in the database. Customization features are based on user group permission, allowing functionality to be limited if necessary.

- **Zero administration:** Zero Administration means all software updates are automatically downloaded and installed at user sign on to reduce administration costs and maintenance effort.

- **Efficient:** Network traffic from client to server is minimized for WAN and LAN based clients: static data is cached (encrypted) in the Client Application; transactions are designed to have one (1) round trip to the server; and transactions send minimal data from client to server as part of a transaction.

- **Secure and robust:** Provides a secure environment for processing financial transactions on a local area network, a wide area network or across the Internet. The Client Application contains comprehensive auditing and logging capabilities that can be configured to meet organizational
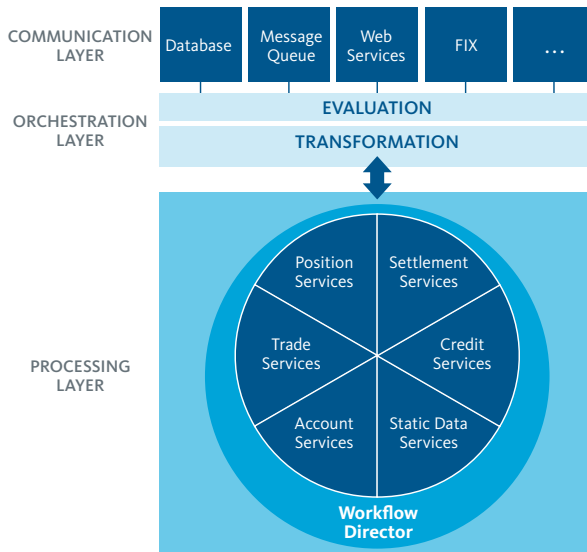
3. Interface Gateway

The adapter-based Gateway links FXL with an organization's other (internal and external) systems, processing all incoming and outgoing data. The FXL Gateway supports all types of data and modes of data entry, and ensures data integrity and consistency.

Features:
- **Configurable and extensible:** Communication adapters are easily configurable for interfacing with external systems and their specific requirements. Adapters are based on plug-and-play components, and allow data type, server and priority definition. Standard FXL adapters include Database, FIX, Message Queue, XML, File and .NET Remoting. Additional adapters can be built to connect to internal client systems.

- **Evaluation and transformation:** A 2-step data processing procedure provides optimum flexibility and ease in integrating FXL with other components. Data is first evaluated to determine how it will be processed according to a set of configurable rules. It is then transformed before being sent to its destination, whether inbound or outbound. FXL's integrated GUI mapping tools allow clients to easily configure and modify interfaces.

- **Scalable:** The FXL Gateway supports high data volumes, and can be scaled to process across multiple servers by data type and priorities. Transaction processing is multi-threaded, and multiple concurrent executions are used to ensure that one interface is transparent to the next.

- **Data integrity:** Data received from external sources is processed using the same workflow rules, validations, calculations and database updates as data originating from the Client Application, ensuring integrity and consistency. Interface data that does not pass integrity validations is sent to an interface repair queue. From the repair queue, the data can be manually fixed and re-processed or removed.

- **Direct processing:** APIs can be used to bypass the FXL Gateway and communicate directly with Workflow Director to process transactions or select data.

- **Secure and robust:** Built with robust error handling and fault tolerance to provide a secure environment for handling financial transactions. The FXL Gateway contains comprehensive auditing and logging capabilities that can be configured to meet organizational requirements.

4. Workflow schedule engine

The Workflow Schedule Engine schedules bulk processing to begin at specific times, intervals or after a specified event has occurred.

COMMUNICATION LAYER	Database	Message Queue	Web Services	FIX	...

ORCHESTRATION LAYER — EVALUATION / TRANSFORMATION

PROCESSING LAYER — Position Services, Settlement Services, Trade Services, Credit Services, Account Services, Static Data Services — **Workflow Director**

Features:

• **Scheduling:** The Workflow Schedule Engine can be configured to run continually, periodically or at specified times, or can be linked to a prerequisite event. Scheduled events can be scaled across servers. Manual intervention is unnecessary for scheduled events, including end of day processes.

• **Configurable:** Configurable parameters can be used to modify the data being processed and the type of processing employed.

• **Robust:** A reschedule event time interval can be configured to resubmit processing in the event that a scheduled event fails to run.

• **Secure:** Built with robust error handling and fault tolerance to provide a secure environment for handling financial transactions. The Workflow Schedule Engine contains comprehensive auditing and logging capabilities that can be configured to meet organizational requirements.

• **Restartable:** Scheduled events are designed to be restartable. In the case that a scheduled event is re-run due to changed configurations or failure, timely and inefficient database restore procedures

are not necessary. In the unlikely event of failure, the scheduled event is automatically rescheduled based on configurable parameters.

5. Publication engine

The Publication Engine evaluates and delivers data in real-time to the appropriate, subscribed users. Message Queue technology manages the information to be published and guarantees data delivery. Users subscribe to publications based on permissions set for user groups.

Features:

• **Configurable:** Easily configurable, with new types of publication data based on plug-and-play components.

• **High-performance:** Optimizes performance and reduces network load by supporting a hierarchy of local Publication Engines, instead of using a single, centralized engine. For example, when a local New York office Publication Engine receives a new trade, it passes the data to a local London office Publication Engine, which is responsible for delivering the data to local London subscribers.

• **Efficient:** Further reduces network traffic by employing a Bulletin Board service on Client Applications. The Bulletin Board is responsible for managing client-side subscriptions and delivering data (which is received once) to all relevant components of the user interface. To minimize traffic across a wide area network, the Publication Engine uses a bridge to distribute data.

• **Scalable:** Supports high data volumes, and can be scaled across multiple servers to balance load. Publication Engines can be configured to manage specific types of data, and multiple engines can be used to manage the same type of data. User subscription permissions can also be distributed across different engines, even for the same type of data. As an example, multiple engines can be used to publish trade data, with different user groups assigned to receive the information from different Publication Engines.

• **Robust:** Robust error handling ensures data integrity and data publication is guaranteed. If a user is unable to subscribe to one Publication Engine or an error occurs during publication,

the user is automatically subscribed to a secondary or tertiary engine. Any Publication Engine experiencing problems automatically restarts and subscribed users are automatically re-subscribed.

- **Data-level security:** Data-level security limits the data published to a user. Because only the data a user has access to is published, network traffic is reduced.

- **Fault tolerant:** Workflow Director periodically pulses each Publication Engine to check connectivity. The Publication Engine then pulses the Client Applications that are currently connected to it, ensuring that data delivery is possible. If a Client Application does not receive a pulse within a specified timeframe, the user is alerted and the Client Application automatically re-subscribes.

- **Secure:** Provides a secure environment for handling financial transactions. The Publication Engine contains comprehensive auditing and logging capabilities that can be configured to meet organizational requirements.

6. Database

FXL uses a Relational Database Management System (RDBMS) to store data, provide easy access to information and enforce data-level security. FXL supports Microsoft SQLServer, and can work with other database systems as required. Differences in the underlying database technology are isolated by a data abstraction layer.

Trade model:

FXL's core data model supports multi-asset class transaction processing: one set of tables is used to consistently handle all product types. Additional products can be added to the system with minimal effort and without compromising FXL's ability to view consolidated positions information, process settlements and confirmations, and manage accounting across all asset classes.

Features:

- **24x7 Operations:** Supports 24 hour a day processing, 7 days a week.

- **International:** The Database supports all character sets installed in the RDBMS, including the double byte characters. Dates and times are stored in Universal Coordinated Time (UCT).

- **Volume processing:** Supports high performance cursor processing for individual operations on large data sets (e.g. revaluation, accounting, confirmations).

- **Hierarchical:** The data model is hierarchical in design. Data only needs to be set up once to support all products, and can be customized at different levels to support individual product requirements.

- **Data-level security:** Segregates data in order to provide data level security. Users only have access to view or modify data to which they have been granted permission.

- **Efficient:** Groups dynamic SQL statements together to send to the RDBMS, which minimizes network calls and reduces the time tables are locked. Configurable table ordered updates prevent programmer-created deadlocks.

- **Secure and robust:** Built with robust error handling and fault tolerance to provide a secure environment for handling financial transactions. The Database contains comprehensive auditing and logging capabilities that can be configured to meet organizational requirements.

7. Security layer

The Security Layer authenticates users and controls access to screens, data and processes. Unauthorized access to business objects is prevented using a combination of IDs and passwords, password policies, tokens, encryption and code access security. The Security Layer controls access from FXL Client Applications and external users, and manages all aspects of the system.

Features:

- **Authentication:** User ID and password are used to authenticate the user. The user ID and password can be authenticated against the following:
    - FXL Application,
    - Active Directory,
    - Federated authentication system leveraging SAML 2.0,
    - Third party product leveraging API.

When leveraging the FXL application for authentication, the entered password is salted and hashed and compared with the hashed password that is stored on the database. Once authenticated, a token is generated and used for subsequent requests.

STP2

Broadridge FX & Liquidity Solutions is committed to providing top quality Service, Technology, People and Product – a philosophy we call STP2:

- **Service** – Working together with our clients to ensure their needs are always met.

- **Technology** – Building a system with state-of-the-art technology that can adapt as technologies evolve and develop.

- **People** – Working with the industry's best and brightest people to support our clients and develop our systems.

- **Product** – Providing a flexible, cross-product, 24x7 trading solution that handles all asset classes and new products on demand.

- **Session Management:** Tokens generated are for both internal and external users. Tokens are salted and hashed and have 2 forms of expiry. The first form of expiry is a sliding expiry based on activity. Each user action resets this inactivity timeout for the token. Tokens also have a maximum timeout. After this maximum timeout, the token expires and cannot be extended. Whenever a token expires, the user is prompted to re-enter both their user ID and password, initiating the authentication process. The inactivity timeout is configurable, and is the same for both internal and external users. The maximum timeout is configurable; there are different parameters for internal and external users, allowing the clients to set different timeouts for different types of users. The tokens are shared across application servers.

Note: Session management and tokens are not used for communication between different FXL components and the workflow engine.

- **Authorization:** After a user is authenticated, the screens, controls, workflows, publications, roles, reports and types of data that the user has access are associated with the user account. Entitlements are set up at a group level and users can be associated with multiple groups.

- **Audit:** All valid and invalid attempts at logging into the application are captured and stored on the FXL User Account table. For valid logins, the time, the computer and the expiry of the token are captured.

- **Communication:** Communication between end users (client applications) and the FXL Workflow Engine is via HTTPs. The communication travels through the IIS web server and gets redirected based on the configured servers in the Request Module associated with the website.

The communication only supports HTTPs communication through the use of HTTP headers. In addition, clients should shutdown access to the website through HTTP.

- Communication between FXL server components and the FXL Workflow Engine is via TCP.

8. Monitoring, auditing and logging
Data logging and auditing are associated with FXL's Security Layer. All historical data can be captured, enabling auditors to monitor what data is changed, by who and when. Logging is configurable and can be set at system level and user levels.

Features:
- **Configurable:** Configurable and based on plug-and-play components at the system level which can be overridden at the user level.

- **Standard:** FXL supports logging to all standard formats.

- **Errors:** All errors are automatically logged.

- **Thorough:** Capturing historical system changes provides a comprehensive reporting mechanism, and enables auditors to monitor what data has changed, by whom and when.

- **Secure and robust:** Built with robust error handling and fault tolerance to provide a secure environment for handling financial transactions. Auditing and Logging functionality contains comprehensive auditing and logging capabilities that can be configured to meet organizational requirements.

Deploying FXL

FXL – the industry leader in **global, 24x7 transaction processing**

Organizations deploying FXL install the application in one data center. This single installation point reduces the overall cost of ownership by centralizing administration and maintenance at one location. FXL's high availability infrastructure ensures built-in system redundancy to safeguard against processing or operational downtime.

FXL can be accessed either directly through a local area network (LAN), or from around the world over a wide area network (WAN). FXL's open architecture means the system easily integrates with all other in-house systems, and a high-degree of configurability guarantees that FXL matches your organization's specific business processes and requirements.
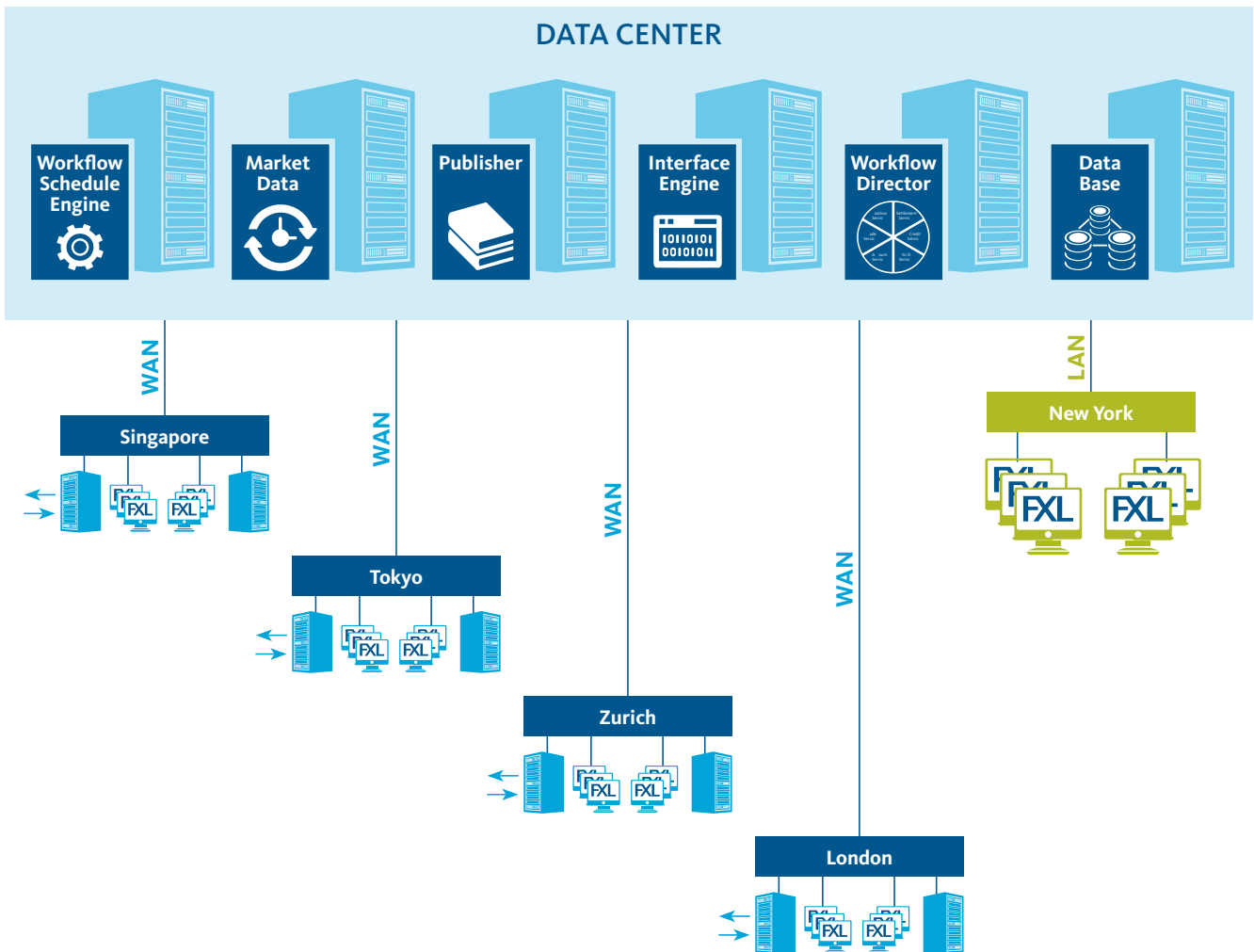
Contact us

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About Broadridge FX & Liquidity Solutions

FXL offers, global, workflow-based transaction processing software solutions in FX, treasury cash management, limit monitoring, and order management across multiple asset classes. FXL products enable real-time, high volume trading–around the clock, and are used by leading financial services organizations to improve speed and agility, enable better decision-making, reduce risk and drive down costs. Designed for quick implementation and integration, FXL uses the latest technologies, including C# and Microsoft's .NET framework, to ensure the highest levels of scalability and flexibility.

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