dxFeed MARKET DATA SERVICES





Customer Management Standard Development Consistency Business Optimat

> Manufacturing Supply chain Produkt Cargo Customer Derivery Inventory Manacement

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1.1 About dxFeed

dxFeed is the subsidiary of Devexperts, with the primary focus of delivering financial markets information and services to buyside and sell-side institutions of the global financial industry, specifically to traders, data analysts, quants and portfolio managers.

Since its inception, dxFeed has built one of the most comprehensive ticker plants in the world, in addition to offering the broadest range of data services currently available by a single company in its space.

dxFeed today serves over 6 million end-users globally through direct and B2B2C relationships. Data services are streamed to approximately 200,000 end-clients simultaneously, delivering financial information for more than 1.7 million instruments (equities, futures, options, indices, FX, cryptocurrencies, etc.), from a variety of exchanges in North America, Europe and around the world. Headquartered in Munich, Germany, with offices in New York, Chicago, Istanbul, Porto and Tokyo, the company delivers an unparalleled portfolio of cloud-based data solutions. Among them are on-demand, real-time and historical market data services, reference data and corporate actions, "time machine" market replay, charting and aggregated data services. Also available is fraud detection and advanced calculated data, multi-asset pricing engines, market scanners and alerts, as well as a unique set of index automation and maintenance solutions which are all delivered via a wide-ranging and feature-rich set of APIs and UI tools.

Pioneering the development of the first VR/AR financial data visualization solution, dxFeed also offers a suite of sophisticated data analytics tools and terminals.

dxFeed is proud to work with some of the most recognized experts in the Big Data sector, including those ranked among the top 10 programmers in the world. This has enabled dxFeed to develop one of the most advanced compression, storage, extraction and streaming protocol mechanisms in the industry; seamlessly combining efficiency, reliability and speed.

MARKET DATA SOLUTIONS OVERVIEW

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An architectural diagram of dxFeed ticker plant infrastructure

2.1. Overview

dxFeed is a fully managed ticker plant, sourcing and storing direct market data feeds from a variety of exchanges in the US, Canada and Europe and delivering streaming tick-by-tick data in a consolidated format. It is accessible via a simple and efficient API with very low latency.

In addition to its high-volume streaming data capabilities, the platform includes a completely managed, scalable solution for the storage and retrieval of historical data, including tick-level market replay technology, providing a very efficient and cost-effective trading strategy back testing facility for companies trying to enter new markets.

Designed with the most advanced technology, including efficient and cost-effective hardware and software components, dxFeed brings unprecedented speed, resilience and flexibility to data management as well as ease of integration due to carefully engineered market data APIs which require very low effort to build robust and fully functional market data interfaces. dxFeed IT engineers expertise in hardware, OS, networking, RDBMS, storage, enterprise grade software result in the most flexible, scalable and reliable solutions available on the market.

Hosted at Devexperts facilities in a resilient setup, the dxFeed platform provides a functional layer on top of a low latency consolidated data feed. The dxFeed platform components can also be offered as a licensed technology in a deployed solution, if the customer wishes to utilize its own infrastructure.

The variety of services available with the platform, provides the benefits of computing, networking and storage services in a colocation environment, without the typical headaches associated with system monitoring, troubleshooting and management. Each service is designed to significantly lower the client total cost of ownership (TCO) while delivering high performance; whether through low latency access to trading capabilities or high bandwidth access to databases and applications.

The full scope of dxFeed Data Services consists of the following:

- Real-time and delayed streaming normalized consolidated market data feed including equities, futures, options, indexes
- Basic reference data (instrument definitions and essential information + trading hours)
- Charting aggregation streaming data (ready-made charting candles or on-the-fly calculations)
- Enhanced reference data (stock fundamentals, corporate actions, events, ownership, etc.)
- Historical tick data services (unique cloud-based zero client

footprint tick level market replay, tick-level and aggregated data extraction)

- Calculated data services (market indicators, gainers/ losers live watch lists, theoretical arbitrage-free option prices, Greeks)
- Live alerts services
- A set of APIs and technologies to integrate (Java, C, C#, JavaScript, REST).

These services are designed to interoperate with, and leverage the complete set of dxFeed solutions and services.

dxFeed offers the following benefits:

- Consolidation of a variety of equities, options, FX and derivatives market data feeds from different exchanges and sources in a single optimized format
- High performance, up to 4 million messages per second over a million instruments with sub-millisecond platform latency on a mid-range commodity server, and able to efficiently handle microbursts
- Scalable solution, ranging from a basic, simple, low cost solution and able to be quickly expanded to accommodate a large number of feeds and very high message volumes
- Hardware footprint with best of breed technology maximizes performance. Data rates and volumes are very efficiently managed and scale both vertically and horizontally, distributing the load and utilizing parallelization
- Subscription, on-demand management up to per instrument level avoiding the management of unnecessary instruments, which can save substantial effort and investment in client side data management
- Easy Data Integration through advanced APIs including Java and C/ C++.

The dxFeed ticker plant consists of the following components: feed handlers, feed utilities, multiplexers, delayers, storers / replayers, calculated data engine, data aggregations engine and database, historical data cloud storage access engine.

All the services are accessed through corresponding APIs, and typically, clients only need to plug into the dxFeed API and connect to dxFeed server in order to access all data services. dxFeed works collaboratively with clients to integrate its services with their critical applications and help them address key business challenges. We look forward to demonstrating our focus on cultivating mutually beneficial long term relationships with our clients.

2.2. Data Centers

Our choice of colocation data centers is always carefully made to enable our clients to rationalize their infrastructure, decrease their technology spending and be connected to a broad community of market participants including exchanges, execution brokers, buy sides and other technology service providers.

Our present U.S. managed services infrastructure is hosted at two of the US Financial Industry's most important data centers — the 350 East Cermak CH1 Equinix facility in Chicago and the NY4/ NY5 Equinix facilities in Northern New Jersey — and includes a high performance, state-of-the-art fully managed blade footprint, OS/Hypervisor, and all related computing and networking elements required to run our applications and services with 100% uptime.

The two locations were specifically chosen for space, resiliency and power availability. The Chicago CH1 Equinix data center is a business hub for more than 500 companies. Our customers here can choose from a broad range of network services from more than 130 providers. They can also interconnect directly to customers and partners in their digital supply chain.

Our European infrastructure is at present hosted at primary financial data hubs: Equinix FR2 facility in Frankfurt where the Deutsche Boerse is located, Equinix ZH4 data center in Zurich, Switzerland, Borsa Istanbul data center in Istanbul and Equinix LD4 data center in London.

dxFeed has put together an ambitious plan to expand the present data infrastructure to accommodate most of the world's most important financial markets data.

Chicago	New Jersey	Frankfurt	Istanbul	London	Zurich

2.3. Data Services

2.3.1. Data Coverage

Data feeds

Equities:

- Cboe BZX&EDGX
- Borsa Istanbul
- Euronext Cash Markets Level 1
- NYSE/ NYSE MKT (CTS/ CQS)
- NASDAQ Level 1 (UQDF/ UTDF)
- NASDAQ Level 2
- NASDAQ TotalView
- OTC Markets Level 1
- OTC Markets Level 2
- OTCBB

Derivatives:

- OPRA
- ISE Spread Book
- Borsa Istanbul
- Cboe Futures Exchange (CFE) Futures & Options
- CBOT Futures & Options
- CME Futures & Options
- COMEX Futures & Options
- ICE Futures U.S. (Futures & Options)
- ICE Europe Commodities (Futures and Options)
- NYMEX Futures & Options

European Market Data:

- Cboe Europe equities
- Eurex

Indexes:

- Baltic Exchange
- Borsa Istanbul
- Bovespa Indexes
- CBOE MDI Indexes
- Deutsche Boerse Indexes
- Dow Jones Indexes
- Euronext Indexes
- FTSE Indexes
- Hang Seng Indexes
- NASDAQ GIDS Global Indexes
- Nikkei Indexes
- NYSE GIF Global Indexes
- RussellTick
- S&P Indexes

Mutual Funds:

NASDAQ MFDS

FX:

- Indicative FX B/ A feed (20+ contributors, 1500+ pairs)
- TrueFX

Cryptocurrencies:

- All cryptocurrencies spot
- Bitcoin Futures

Fundamentals and Corporate Actions

Company's balance sheet, income statement, statement of cash flows, and select footnotes are available for over 25,600 publicly traded companies worldwide along with custom metrics. Data sets include company classification, company profile, corporate actions, fundamentals, ownership, price and security master with over 670 data points overall, tiered:

- 1-10.000 end users
- 10.001-25.000 end users
- 25.001-50.000 end users
- 50.001-100.000 end users

Corporate events calendar data, dxFeed Java API and snapshot REST API, tiered:

- 1-10.000 end users
- 10.001-25.000 end users
- 25.001-50.000 end users
- 50.001-100.000 end users

Tick-level historical data for all U.S. market and market replay service, Unlimited Enterprise License

"Time machine" for the market, data history starting January 1, 2010, cloud-based, massively parallel tick-level access to the whole market, zero client footprint.

Basic Aggregated Data Services, Unlimited Enterprise License

Pre-aggregated OHLCVs for a basic set of aggregation periods.

Advanced Aggregated Data Services, Unlimited Enterprise License

Non-standard aggregations (bid/ask, on-the-fly custom ticks, volume-by-price, etc.).

Basic set of calculated market indicators

Advancers, decliners, Arms index, for NYSE, NYSE MKT and Nasdaq.

Extended set of calculated market indicators

New highs, lows for different periods, major indexes constituents tracked, composite and per-exchange indicators, top gainers, losers, etc.

Theoretical option prices, option analytics

Real-time calculation service for arb-free theoretical option prices, volatility and Greeks.

Alerts

Real-time alerts service.

Federal Reserve Economic Data (FRED)

Global Macroeconomic Data Series from Federal Reserve Bank of St.Louis.

2.3.2. Reference Data

Instrument definitions and essential attributes	Exchange data compiled and maintained by dxFeed.
Trading hours and holiday data for all instruments	Exchange data compiled and maintained by dxFeed.
Futures symbols mapping: current month futures product codes and other shortcuts	Mapping provided by dxFeed. Mapped product shortcut symbols are available in the data feed and other data services (charting - providing consolidated chart by product code, historical and reference data) along with original products (e.g./ES for current month's CME E-Mini S&P along with original symbol/ESH2).
Fundamentals, corporate actions, ownership and corporate events for complete symbol universe for US and Canada, UK and Ireland, EU, Asia Pacific	Comprehensive database of essential reference data from Morningstar Inc. and Mergent Inc. Asset classification, company profiles, company fundamentals, corporate actions, corporate events and ownership data.
Macroeconomic data	FRED data series accessible via API and chart server.

2.3.3. Historical Data

Tick-level and aggregated historical data dy	lxFeed own data store.
Ti	Tick-level history — since January 1, 2010 for all U.S. instruments.
Hi	Historical aggregates — since 1993.

2.3.4. Aggregated Data and Charting

Pre-aggregated charting OHLCs	dxFeed managed charting services delivered over the real-time feed.
for all instruments	Pre-loaded historical charting information available up to 1993.

2.3.5. Calculated Data

Market indicators (advancers, decliners, TRINs, etc)	Calculated by dxFeed in real-time.
Top N gainers / losers lists	Calculated by dxFeed in real-time.
Alerts	Simple alerts service sending signals by configurable expressions on real-time feed.
Options theoretical arbitrage free price and Greeks feed	dxPrice calculation engine provides real-time arbitrage-free theoretical option prices calculation based on real-time or historical data. Pricing data may be delivered along with real-time data feed in dxFeed API or calculated based on historical on-Demand data store.

2.4. dxFeed Global Infrastructure Expansion Plan

The proposed solution is fully hosted by dxFeed. No dedicated hardware is required on the customer's side.



The final planned global dxFeed infrastructure can be seen in the live map accessible via the following link: https://earth.dxfeed.com

dxFeed is amiable to accommodate further requests that are not part of this plan – we look forward to discuss more details and evaluate feasibility, time for implementation and cost.



2.5 Application Programming Interfaces

The following APIs are available for dxFeed data services (sample code can be provided):

API	Description/Function	Availability
dxFeed API	Flagship API for dxFeed real-time data services. Includes an API for event-based data feed subscription for level 1 and level 2 data, Scheduling API for convenient parsing and navigation through trading schedules for all instruments (includes holidays and short days), Instrument Profile API for parsing basic reference data, charting API to request time series and aggregated charting data.	Java, C, C++, C#, JavaScript, REST Windows, Linux, Unix 32/64 bit
Fundamentals and Corporate Actions Data Requester API	Requesting comprehensive fundamentals, corporate actions and corporate events data.	Java, REST Windows, Linux, Unix 32/64 bit
Market Replay API	Request to replay entire subscribed portion of market at tick-level from a given point in time utilizing the power of cloud-based on-demand historical tick data service.	Java, JavaScript Windows, Linux, Unix 32/64 bit
QDS API	High-performance messaging core designed from the ground up to deliver millions of quotes on hundreds of thousands financial instruments to virtually unlimited number of destinations in a scalable way, while supporting fully individual subscription for each recipient. Low-level components to build data delivery infrastructure.	Java Windows, Linux, Unix 32/64 bit

2.6 Symbology and Essential Symbol Reference Data

Please refer to the links below for information on symbology and instrument profile specifications.

dxFeed symbology reference dxFeed Instrument Profile Format

http://www.dxfeed.com/downloads/documentation/dxFeed_Symbol_Guide.pdf http://www.dxfeed.com/downloads/documentation/dxFeed_Instrument_Profile_Format.pdf

2.7 Performance, Throughput and Microburst Handling

2.7.1 Performance

In order to minimize latency, data is processed locally as close to its source as technically possible. Regional markets are collected into these ticker plants, before being normalized, stored and distributed globally.

The dxFeed feed handlers and ticker plant software are designed for performance and sub-millisecond average latency. Current Intra-U.S. data delivery latencies over dedicated infrastructure are as follows:

	NY	СНІ	BOS	РНІ
NY	< 1 ms	< 12 ms	< 5 ms	< 3 ms
CHI	< 12 ms	< 1 ms	< 14 ms	< 12 ms

Detailed latency measurements can be provided on demand for a known customer location and the selected array of services.

2.7.2 Throughput

Current throughput of dxFeed for consolidated U.S. market data is about 10,000,000 messages per second in intraday peaks.

2.7.3 Burst-Handling Techniques

Volatility in the markets implies rate spikes of the quote data – spikes that are measured in tens to hundreds of thousands messages per second:



The dxFeed market data service provides a number of ways to handle spikes: automatic intelligent conflation, rate throttling and rate limiting, thus ensuring a graceful burst handling fitting to the customer's system operating standards. Setting up and adjusting these parameters allow clients to establish precise control over the pressure on downstream applications.

2.8 Reliability and Resilience

2.8.1 Source Data Connectivity

Data is sourced via resilient circuits, directly from the exchanges/sources into our redundant ticker plants. The process ensures continued availability of the data feeds in the event of an outage on an inbound circuit or on the exchange feed itself. Our support services operate 24x7 with automated monitoring of all incoming sources.

2.8.2 Feed Handlers and Ticker Plant Infrastructure

Each data source undergoes a rigorous integration process, involving our development team. The full integration of the content must be signed-off by our Quality Assurance team. Our Q&A and Development groups operate hand-in-hand in an iterative approach to tracking, managing and releasing updates to all feed handlers.

Experienced project managers oversee exchange integration and migration projects, to ensure customer impact is fully assessed and minimized and that the project is run to meet required deadlines. All of dxFeed's data collection, processing and delivery are engineered to provide maximum uptime on a 24x7x365 basis. All inbound sources are dual fed into diverse ticker plants. Data delivery is also available to clients via redundant, diverse points of presence allowing dual connections to be deployed to data centers of clients' choice.

dxFeed ticker plant infrastructure is reviewed regularly with capacity levels of 60% throughput being the trigger to upgrade the hardware and/or network components.

2.8.3 Customer Connectivity Infrastructure

The proposed solution is fully hosted by dxFeed. No dedicated hardware is required on customer's side.

The services can be accessed via the Internet, secure VPN, cross connect (within the same data center), or extranet connection.

Bandwidth estimates can be provided, based on the instrument universe required by Client.



Connections to dxFeed utilize the industry standard TCP/ IP protocol, and are fully managed by the APIs provided. Full resilience is built into the hosted platform, meaning there is only a single hostname for clients to connect into.

Connections are fully load-balanced to ensure clients do not need to take any action in their applications in the event of an outage or failure of an upstream component.

Below is a diagram illustrating a sample connectivity diagram to receive US feeds.

For the client side, dxFeed can also recommend a suitable hardware setup fitting the required level of resilience.

By utilizing these processes dxFeed comfortably achieves a feed uptime in excess of 99.98%.

dxFeed provides full solution deployment and migration

support as well as personalized consulting services to assist clients with complex project management, research and design, existing electronic trading system infrastructure reviews, network capacity and utilization reports, network performance assessment and tuning, and network risk analysis.

Connectivity costs depend on the chosen model and set of services and may vary.

dxFeed supports direct connectivity, Internet connectivity, connectivity via extranets (SFTI, TNS) and major leased line providers such as Radianz or SAVVIS. We can help order and manage leased lines for our clients (these would be ordered under dxFeed name and then licensed to Client) or provide overall guidance with the connectivity project.

If requesting quotes for leased lines, please provide exact address of the installation sites including termination points. No fees for leased lines are included in this document.

2.9 Historical Tick Data Storage, Replay and Analytics

2.9.1 Overview

Tick level market data storage and replay services are powerful tools for historical insight and model back-testing. But present options market data rates are very high and official forecasts indicate that volumes are nearly doubling each year. This makes it increasingly difficult and costly to store tick data as it necessitates the parsing, indexing and storing of enormous volumes of raw data volumes for future replay and analysis:



DATA FLOW PEAK, MESSAGES/SECOND





REQUIRED RAW DATA STORAGE SIZE, GB/DAY

Our solution provides:

- Direct feed capture, storage and instant access to hundreds of terabytes of historical market data at millisecond-time stamped tick level.
- Unlimited capacity for data storage.
- Unlimited full order book depth storage.
- High redundancy of storage ensuring service availability and resiliency.



- Data security and privacy no client data is stored in or transferred to the cloud
- Elastic scalability for end-client connectivity
- Seamless technology integration
- No client-side hardware installation is required and no client resources are used to store data
- Instantaneous access times under 1 second full day extraction time, under 400 microsecond full book snapshot access time
- Various means of data access
- Time machine-like market replay for the full market or in part by subscription
- Data extraction
- Data exploration
- API access for streaming or snapshot analytics.

dxFeed is a market data vendor since 2008 for a majority of exchanges in U.S., our current historical data solution is in operations since January 2010 and captures every tick from every exchange on the U.S. market: NYSE, NYSE MKT, NASDAQ, OTC, CME, CBOT, NYMEX, COMEX, ICE US, OPRA (including regional exchange quotes), S&P, Dow Jones, NASDAQ GIDS indexes, NYSE GIF indexes, CBOE MDI indexes, etc. – please refer to the list of exchanges on dxfeed.com.

2.9.2 Product Vision and Roadmap

Our vision and investment direction is to create a data service that provides the industry's most sophisticated market replay, extraction and analytics functionality for historical tick-level data for all global markets.

We envision this service to be delivered worldwide, in emerging and mature markets, in a seamless time-machine fashion via a common set of APIs, services and tools, with the objective of facilitating foreign markets entry to the global buy side community. Our existing dxFeed services with emphasis on its "strategy test lab" functionality — is already proving to be an important tool to help European and Latin American buy side companies entry the US market with lower technology costs.

Our product roadmap until Q4'2018 is as follows:

- Add data feeds from other market centers in selected geographies (European feeds already in process).
- Evolve charting and aggregated services directly on top of the existing historical tick data services.
- Evolve our option analytics solutions on top of historical tick data service.
- Implement various visualizing instruments such as VR/ AR interface and revolutionary Zooming UI for advanced financial data analytics.
- Retail onDemand service both for real-time and historical data.

2.9.3 Availability

Instead of building locally vulnerable and expensive storage infrastructures, dxFeed provides high system availability. We ensure a robust operation through the use of inherent cloud storage redundancy and independent availability zones (with geographical distribution of content storage).

2.9.4 Security

Data access security is ensured via a gateway service, which processes the data requests, secures the communication protocol and the encryption. Authorization takes place on the customer side authorization servers. As such, no client data is transferred to or stored in the cloud; only time-limited identity agnostic security tokens are used.

2.9.5 Scalability and Performance

Client application connectivity end-points are hosted in the cloud and can be easily scaled depending on the volume of data requests. State-of-the-art end-client components seamlessly integrates into the client applications and provide tick data request, download and replay directly from the cloud — anywhere, anytime. Replays can be cached locally, eliminating the need to download the data that has been already accessed.



Historical replays can be handled by existing real-time components, with the addition of the following replay controls:

- Replay of the whole market data feed at arbitrary speed
- Charting
- Timespan trade and quote analysis
- Model back-testing

2.9.6 Historical Data APIs

The following APIs are available for the service:

- dxFeed Java API: gives control over the full functionality of dxFeed real-time, historical and aggregated data (including market replay).
- dxFeed web service and JavaScript API: JavaScript API mirrors dxFeed Java API in JavaScript and provides easy widgets and shortcuts to integrate streaming market data into web apps.
- REST web services and APIs:
 - Instrument profile web service providing essential symbol attributes and symbol discovery.
 - onDemand tick data extraction web service: extracts tick data for given symbols, time and event types from our cloud storage.
 - onDemand tick data audit web service: extracts data from onDemand cloud storage for given symbols, events and timeframes keeping the order. Used for trade audit purposes primarily, currently provides access only to 1 month of data on all symbols. Limitations are configurable.

Online version of API overview document can be found here:

dxFeed onDemand APIs

http://www.dxfeed.com/downloads/documentation/dxFeed_onDemand_APIs-Quick_Overview_and_Samples.pdf

2.9.7 Tools

Our standard tools are simple and efficient command line, desktop and web-based data extraction, streaming and exploration tools on desktop and on the web:







2.9.8 Approach to Product Development and Process for Product Enhancements

Product enhancements are inspired by internal vision, in-depth understanding of the industry's pain points, product plan, customer feedback and monitoring results for performance and related measurements.

Required changes are planned into development sprints and delivered in parts or as whole (passing $Dev \rightarrow QA \rightarrow Preview \rightarrow$ Production cycle). Our Q&A process is one of the most stringent in the industry; we have a total 60 people (about 20% of our total development force) dedicated to it.

Product development is done in 2-4 week development sprints resulting in working product increments and deliverables.

2.9.9 Options to receive the dxFeed Data

- 1. Market replay services and APIs this is a "time machine" function. The client subscribes to a number of selected/permitted symbols (or to all of them), and then sets start time (up to milliseconds), and replay speed. The replay starts immediately, the data being streamed directly from the cloud to the end user.
- 2. Web services a REST web service allowing for the extraction of data for a given set of symbols. Through a simple API clients indicate start time, end time, event categories and flags. This type of service can be performed inside the cloud or via public internet connection.

A tick data audit REST web service (allowing to extract tick data in original order across many sources) is also available. Technical data availability is immediate near real-time (1–5 seconds depending on market volatility and the volume of data being immediately stored and processed). Web-services allow to stream extracted data to the client directly or to produce files to be downloaded from the cloud, scripting and accessing directly from client applications.

- 3. Low-level API to access data on storage block level.
- **4. File storage is** produced for plain file delivery to the clients preferring file download current setup by default stores 1 minute and daily aggregations.
- **5. Desktop UI terminal application** dxFeed Inforider terminal provides desktop terminal application with tick-level market replay and extraction capabilities from the cloud service.
- 6. Tick data is readily available since 2010 please refer to the exact list of exchanges on dxfeed.com. Additional history and data sources could be uploaded without limitations.





2.9.10 Data Normalization and Consolidation Options

Both real-time and historical data are normalized and consolidated in our solution.

The following event categories are defined:

Quote	Bid/Ask related information
Trade / TradeETH	Last trade + day volume in regular or extended hours for exchanges that support ETH
TimeAndSale	Full tape of trades, price/size/exchange/flags
Summary	Daily OHLC, previous day close/settlement
Order	Order book, exchange/price/size/side/aggressor side/maps regionals/price levels/top of MM/full order depth
Profile	Symbol, description, halt status, flags
Candle	OHLC aggregations
Greeks	Option greeks, options analytics add-on
TheoPrice	Option theo.price, options analytics add-on)
Underlying	Option underlying stats, options analytics add-on
Series	Option series stats, options analytics add-on

For data extraction, clients can run any number of queries requesting these events for specific sets of symbols. Results can be merged easily since the format is the same (e.g. in CSV or dxFeed API text dump format).

For data replay functionality, subscriptions could be aggregated on client or on multiplexor node.

Please note that our data scheme is flexible allowing to add and store additional event categories in an organized manner quickly thus allowing adding virtually any types of events/records (e.g. execution statistics records or non-structured BLOBs) into storage.

2.9.11 Data Delivery Formats

There are predefined formats for data delivery in the different functionality sets:

- 1. Market replay Java API event format, Javascript JSON event streaming.
- 2. Extraction CSV, dxFeed API text format, dxFeed API binary format (all dxFeed formats are readable by dxFeed utilities). Fields that need to be included into the result could be selected in the REST web services queries.
- 3. Aggregation files could be downloaded in CSV format.

Additional formats may be added as plug-ins in the existing APIs.

2.9.12 Handling of Large Data Sets

Large datasets could be delivered in a number of ways:

- 1. Accessed inside the cloud leveraging proximity and 10G+ access speeds.
- 2. Split into manageable parts and delivered via cloud storage/ftp/cloud streaming.

3. Delivered via storage media (HDD, Blu-ray, etc.).

Please note that our solution is genuinely streaming one and we are able to stream any subsets of data directly from the cloud over internet or within the cloud.

2.9.13 Query Analytics and Statistics

The historical engine optimizes access internally by identifying the most popular query results and storing statistics on all the queries. This function could be used to automatically determine the most common queries. We provide standard web-dashboard for query analytics, any third-party tools could be used on the analytics data as well.



2.9.14 Derived and Calculated data

The following derivations are available out-of-the box for storing and accessing along the historical data as well as for calculations based on historical data:

1. Calculated data in form of indexes and indicators coming under separate symbols (all events/records).

2. Options analytics available in separate events/records (Greeks, TheoPrice, Series, Underlying).

2.9.15 dxFeed Appliances

Customers can quickly build their systems with the dxFeed Appliance solution - a preconfigured 1RU server with dxFeed feed handlers and Devexperts MARS remote monitoring suite preinstalled in a tested, stable configuration. This appliance is ready for installation at customer's premise or available as a ready-made managed services collocation server.

Its virtual twin is dxFeed EC2 Appliance, which is a preconfigured Amazon EC2 instance with pre-installed dxFeed feed handlers and Devexperts MARS remote monitoring suite - combining the benefits of our proven technology with the elastic cloud capacity for market data processing.

IMPLEMENTATION AND SUPPORT SERVICES

3.1 IMPLEMENTATION AND SUPPORT SERVICES

3.1.1 Implementation Milestones

dxFeed provides a highly redundant configuration, which ensures overall resiliency, security and availability of the data. Feed servers, directly connected to real-time feeds, pre-stage the data and upload it into the cloud where it is parsed, repartitioned, indexed, cached and stored for efficient access.

The following table details a typical implementation schedule of the proposed solution for a feed already included in the dxFeed infrastructure:

Step	Duration	Resources
Proposal: identify detailed customer requirements	1 week	Sales, Product Management
Proposal: finalize solution and pricing	1 day	Product Management, Sales
Trial: configuring trial access, free of charge	Up to 2 weeks	Sales, Service Desk
Trial: commencement of developer support	Up to 30 days	Service Desk
Contract: customer services agreement signed	1 day	Sales, Legal, Product Management
Exchange Agreements: execution	Up to 30 days	Legal, Product Management
Connectivity: setup and test	5–20 days, depending on connectivity options chosen	Engineering
Go live	1 day	Engineering, Product Management, Sales
Handover to M&S	1 day	M&S, Sales

3.1.2 Availability

Instead of building locally vulnerable and expensive storage infrastructures, dxFeed provides high system availability. We ensure a robust operation through the use of inherent cloud storage redundancy and independent availability zones (with geographical distribution of content storage).

3.1.3 Security

Data access security is ensured via a gateway service, which processes the data requests, secures the communication protocol and the encryption. Authorization takes place on the customer side authorization servers. As such, no client data is transferred to or stored in the cloud; only time-limited identityagnostic security tokens are used.

3.1.4 Scalability and Performance

Client application connectivity end-points are hosted in the cloud and can be easily scaled depending on the volume of data requests. State-of-the-art end-client components seamlessly integrates into the client applications and provide tick data request, download and replay directly from the cloud — anywhere, anytime. Replays can be cached locally, eliminating the need to download the data that has been already accessed.

3.2 Support

3.2.1 Customer Support

dxFeed multilayered ITIL support structure is based on industry standard processes, providing convenience and transparency for customers. The high level of our maintenance and support processes was confirmed by the numerous audits run by several U.S. and Japanese companies.

A key element in any support service is the ability to detect the first signs of an upcoming problem. For monitoring purposes dxFeed uses its flagship product MARS — a state-ofthe art monitoring system capable of monitoring most types of IT environments (Web, DB, OS, network, hardware, etc.) and offering the unique option of easily embedding monitoring code directly into the software solution. This allows Client and the dxFeed Service Desk to monitor any required software parameter or business value.

The uptime for the services we support is as high as 99.98% (Year Average Uptime) for real-time trading systems.

dxFeed provides dedicated 24x7x365 support for all dxFeed products and handles technical issues via phone and email. In addition to telephone and email support, the Customer Support team provides instant messenger support and an email service that keeps customers immediately informed of events that affect the dxFeed family products and services.

Incoming calls and emails from Client's staff to the dxFeed support team will be entered into the dxFeed call tracking database by dxFeed support person. Calls entered into this database are electronically time stamped and assigned a reference ID. All incidents raised by the customer will remain "Open" until specifically confirmed closed by the customer; dxFeed support staff will confirm with the Client that an incident raised by them is closed, before closing it and then informing the Client's contact person. The reference ID is used to trace the status of outstanding issues.

Our support services include:

- A single phone number to communicate service issues via 24x7x365 global customer support help desk
- Remote monitoring of the service status 24x7x365
- Monitoring system indicating % utilization, CPU, RAM, Disk
- Standby availability of dxFeed personnel to react to production issues, and on-going maintenance of the monitoring service itself
- Infrastructure change management notifications
- Rollout and testing of new operating system software in response to new features upgrades and bug fixes
- Incident reports and root cause analysis are supplied upon request
- dxFeed provides not only incident resolution for their customers but also 24x7 Request Service.

3.2.2 Exchange Relations

Exchange market data fees and policies for index calculation and derived data are set independently by each exchange, controlled by regulatory authorities and are not of the responsibility of dxFeed.

dxFeed nevertheless volunteers to work closely with Client in contacting the exchanges, and liaising between Client and exchanges to ensure a smooth and quick exchange agreement approval process, and the sourcing of data in the most efficient and cost effective way.

If Client already has arrangements in place with the corresponding exchanges, dxFeed also volunteers to contact those exchanges and confirm their authorization for dxFeed to deliver the data to Client, and subsequently, seamlessly, entitle the corresponding data for the Client.

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3.2.3 Developer Support

DdxFeed will provide dedicated resources to support Client's testing and implementation of the feed. Development documentation, including information on the data flow within the platform, an API user manual, symbol lists, data source documentation and development samples will also be provided. Basic use-cases in dxFeed API are extremely easy to understand and implement, requiring only 15-20 lines of code for quote listener/printer application.

dxFeed offers both test and production environments. The test environment allows developers to test their applications with the dxFeed APIs, to ensure their application is well integrated with the platform. A restricted set of non-fee-liable exchange data is made available on the test environment. The production environment offers the ability for customers to test using live exchange data, for the purposes of performance and content quality assurance.

dxFeed will provide advance notice in the form of development bulletins for any changes to the sources and data content except in some circumstances where the change is outside of dxFeed control (e.g. an exchange or a source enforced at a short notice) or in the case of urgent bug fixes.

System developers will manage the feed changes imposed by Exchanges, to ensure the platform is able to continue to correctly process any applicable data feed.

3.2.4 Connectivity Fees

Connectivity costs depend on the chosen model and set of services and may vary.

dxFeed supports direct connectivity, Internet connectivity, connectivity via extranets (SFTI, TNS) and major leased line providers such as Radianz. We can help order and manage leased lines for our clients (these would be ordered under dxFeed name and then licensed to Client) or provide overall guidance with the connectivity project.

If requesting quotes for leased lines, please provide exact address of the installation sites including termination point.

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