

CELENT

THE CLOUD COMES OF AGE IN CAPITAL MARKETS

ALL CLEAR FOR MORE CLOUD

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CONTENTS

Executive Summary	1
Key Findings	1
Key Research Questions	2
About this Research	3
Introduction.....	4
A Brief Overview of Cloud Models.....	7
Models for Delivery and Distribution in the Capital Markets	8
Cloud Service Models.....	10
Cloud Deployment Models	11
Cloud-Based Managed Service.....	12
Cloud Acceptance in the Capital Markets	14
Reaching the Cloud: Connectivity and Accessibility	18
Internet.....	19
Private Network	19
Managed Connectivity Service	20
Capital Market Use Cases	22
TradingTech as a Service.....	23
RegTech as a Service	24
Market Data as a Service	24
Challenges in Cloud Adoption and the Way Forward	26
Overcoming the Challenges	28
Conclusion.....	30
Leveraging Celent's Expertise	32
Support for Financial Institutions	32
Support for Vendors	32
Related Celent Research	33

EXECUTIVE SUMMARY

KEY FINDINGS

We are at a major inflection point in the capital markets. As capital-constrained and regulatory-burdened firms remap their future architectures and businesses, more and more are looking to create much more scalable, cheaper, and safer infrastructure via a cloud model.

A major architectural and business question is centered on the desire to outsource infrastructure vs. the desire to outsource and manage applications. Most firms are looking to focus on core strengths and shifting other areas to managed approaches.

The most innovative firms are allowing their capital market clients to shed internal costs. Capital market participants are looking for clear solutions from providers that can solve their data concerns, regulatory demands, and specialized market access issues for new demand.

There is a marked difference in adoption rates by the buy and sell sides. The buy side is quite comfortable with a variety of cloud and as a Service models (XaaS). This is particularly true in the delivery of many core front-office systems.

Innovative service providers are creating business models that allow buy side and sell side firms to focus on their core activities and not be bogged down on waiting for infrastructure and connectivity, developing better regulatory solutions or faster compliance tools, and offering easy scalability and agility.

Models for cloud delivery of specialized data, trading and regulatory solutions for delivery of end-to-end, and cloud-based solutions are emerging in RegTech (regulatory compliance), TradingTech (Trading Platform as a Service), and market data (Market Data as a Service).

Firms of all sizes are looking for easy ways to access data and test theories in a low cost, low risk fashion.

The speed and impact of the public cloud are remapping the way CTOs are looking at their internal clouds, virtualization models, and infrastructure spending.

As firms map their present and future cloud strategies they increasingly focus on flexibility, around type of clouds, costing models, architecture, and connectivity. Increasing the flexibility in routing, topology, processing power, and costs are key considerations.

Regulation, data privacy, and security are the key questions for firms looking to managed offerings and cloud solutions. The irony is many regulators already use public cloud for storing trade and execution data.

Public cloud will exhibit the fastest growth of the deployment models in the capital markets, growing from less than 1% of capital market IT budgets to 7% in five years.

KEY RESEARCH QUESTIONS

1 <i>What are the cloud deployment models in the capital markets?</i>	2 <i>What are the emerging capital market use cases?</i>	3 <i>What are the key challenges for moving forward with cloud service and managed offerings?</i>
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Capital market firms have been operating in an increasingly challenging business environment: regulation, competition from lower-cost asset management models, restructuring of their counterparties, and a shifting demographic of investors. This in turn has changed the ability of firms to generate revenues in the same fashion as before the crisis. All this is occurring in a macroeconomic environment that is increasingly difficult.

The perfect storm of forces has caused a new ecosystem for the capital market that puts unnecessary spending and unnecessary infrastructure under a greater microscope. Resources need to be focused on core business solutions and creating a more effective model for client engagement.

Hence, there is tremendous pressure to reduce the cost structure within capital market firms. This path requires critical choices on where to compete, which clients to serve, what business lines to grow, and which business lines to divest. It has also brought into view the high levels of complexity that are resident in technology architectures and business lines.

This is all a backdrop to a rapidly changing technology cycle and rapidly maturing models for offering holistic solutions to client challenges. Access to connectivity, alternative business models, and acceptance, combined with the changes in the ability of firms to access capital and a global regulatory model that has focused on risk mitigation, have left the capital market in flux. There are many pain points for capital market firms, and a new generation of innovative firms is entering this space with point solutions, as well as visions of remapping the entire architecture. Innovative firms are striving to create a better and more robust financial center, impacting the core of trading, markets, and security servicing — the entire value chain.

All these factors are accelerating demand for most participants to expand their engagement with cloud solutions. The cloud model has been around for a while now and has made headway in quite a few segments, including banking. The capital market space, usually a leader in technology adoption, is waking up to the greater possibilities of cloud. The trading community, particularly the buy side and their solution providers, driven by extreme cost and regulatory pressures, are looking at the cloud more favorably and overcoming apprehensions. Rapid improvement in security and speed from cloud providers is paving the way for faster adoption.

Whether it is the cost structure changes caused by regulatory, market structure, and macroeconomics, or the increasing comfort with deployment models, the cloud is coming of age in the capital markets. Cloud is a nebulous term; Celent sees multiple models for capital markets to further engage cloud models across the spectrum to drive efficiency, increase ease, reduce data burdens, leverage better analytics, and reduce costs, all with the goal of a more flexible infrastructure in sight.

Capital market participants from the buy side, sell side, and infrastructure providers are exploring new models for deploying and accessing the myriad points of connectivity in the sophisticated world of today. These models are leveraging a variety of as a Service (XaaS) options using on-premise clouds, off-site clouds, and a

variety of hybrid combinations. Each week the workloads sent to the public cloud providers are increasing.

ABOUT THIS RESEARCH

The evolution of technology and operations within capital markets has been a constant theme in Celent's research. Even though the cloud model has been gaining traction for some time now in other industries, its appeal and adoption within capital markets have undergone a sea of change in the last 12 to 18 months. The "we will never use the cloud" attitude of 18 months ago has given way to "how to use the cloud" as financial institutions and their service providers look to leverage the cloud to solve the industry's numerous challenges.

In this report Celent discusses the current state of affairs and likely evolution regarding cloud adoption in capital markets. We begin with a discussion on key challenges facing capital market firms, and the potential of cloud based solutions to mitigate them. We analyse various models of engagement using the cloud and discuss which players and functions within the capital market ecosystem are likely to move to cloud now and in the near future. Through selected case studies we illustrate potential of cloud- based solutions to solve specific industry challenges. We also highlight the key questions and concerns financial institutions need to consider in finalizing their cloud strategy. Lastly we provide Celent's views regarding the outlook for cloud adoption in capital markets. This report was commissioned by Colt¹, while Celent kept full editorial control over its content.

¹ <http://www.colt.net/capitalmarkets/>

INTRODUCTION

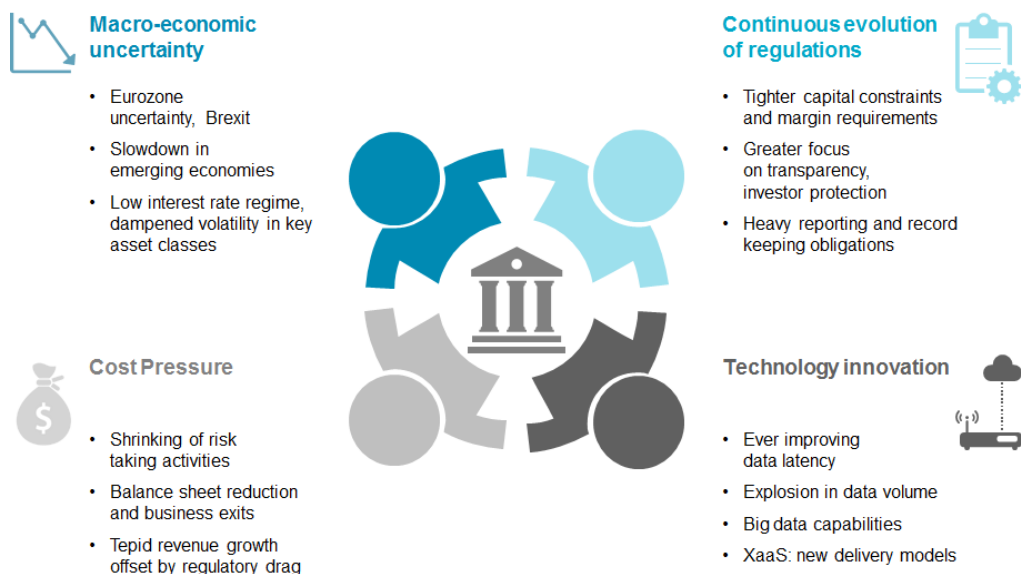
Macroeconomic and Regulatory Changes

The global economy has experienced moderate but steady growth since the crisis of 2008; but persistent uncertainty over Eurozone economies compounded by the recent Brexit vote, and uneven growth in Chinese economy continue to adversely impact capital-raising and return-generating opportunities in global capital markets. Monetary policies from major central banks aimed at maintaining very low interest rates continue to depress volatility in key asset classes, resulting in low trading volumes.

While macroeconomic uncertainty constrain opportunities for revenue growth, regulatory changes (such as Dodd-Frank, Basel, MiFID, EMIR, CSDR, AIFMD, and Market Abuse Regulations (MAR)) aimed at curbing risk in capital markets, and bringing more transparency and investor protection have resulted in balance sheet shrinkage, business line exits, and added to cost burdens for capital market participants.

Technology will be a key determinant of success in this phase of industry evolution as players in the capital market ecosystem are forced to reinvent themselves. Legacy operations and technology can limit firms' ability to respond quickly to market changes, and put them at a disadvantage compared to new and innovative players.

Figure 1: Forces Influencing the Evolution of Capital Market Ecosystem



Source: Celent

Restructuring of the Capital Market Ecosystem

The forces of change are significantly altering the traditional roles played by various players in the capital market ecosystem. Figure 2 highlights the forces and their impact on different segments in capital market. As the role of sell-side in market making activities diminishes, particularly in key asset classes such as fixed income, currency, commodities, they are increasingly focusing on execution business and improving client experience.

The buy side players are looking to fill this void by assuming greater prominence as providers of liquidity, but they are plagued by greater regulatory burden demanding

greater transparency and investor protection. Their ability to generate alpha through trading in new asset classes and markets is constrained by limited availability of affordable and flexible infrastructure and connectivity tools.

Proliferation of trading venues is adding to connectivity and execution challenges of buy and sell side players. Venue operators on the other hand have to find new revenue sources to beat competition. Exchanges are looking to add new products (such as FX, fixed income, indices, and ETFs) as well as clearing (exchange-traded and OTC derivatives) and reporting services. The shifting balance of power from the sell side to buy side and infrastructure players has highlighted the need to strengthen their infrastructure and operational risk measures to support existing business and growth strategies.

Figure 2: Impact of Changes on Different Segments in Capital Markets

Player	Driver	Impact
Broker-dealers	<ul style="list-style-type: none"> Capital constraints limiting ability to leverage and engage in market-making Regulatory scrutiny on order routing and best execution Cost pressure limiting budget for in-house systems for non-core activities 	<ul style="list-style-type: none"> Focus on execution tools, price engines, liquidity aggregation, connectivity across markets, asset class Need to develop heavy data and record storage and reporting capabilities Willingness to outsource and mutualize costs through shared service and utilities
Asset Managers	<ul style="list-style-type: none"> Expansion into new geo and asset class; growing role in liquidity provision Move from asset class based approach towards risk factor-based framework Regulatory demand for fuller access to audit, review of operational procedures 	<ul style="list-style-type: none"> Drive for consolidation in platform, visualization tools; connectivity to execution venues Need to develop decision support tools, e.g., better reporting and communication, risk factor transparency Operational reengineering, move toward outsourcing, SaaS, hosted services seeking variable cost model
Trading Venues	<ul style="list-style-type: none"> Mature exchanges looking to add new trading products and services Emerging market exchanges developing electronic trading capabilities Focus on operational framework due to market abuse and flash crash events 	<ul style="list-style-type: none"> Need to develop trading, clearing and reporting tools, to support growth plans Need to build infrastructure supporting low latency, co-location, risk management systems Need for superior market surveillance tools, risk measures like circuit breakers, kill switches
Service Providers	<ul style="list-style-type: none"> Need to support client operations in new markets and asset classes Need to develop new delivery models to match client needs and budgets Emergence of FinTech providers in capital market 	<ul style="list-style-type: none"> Developing agile and scalable solutions supporting multi-asset capabilities Leverage the cloud to offer infrastructure and applications on demand at a reduced cost Adoption of big data, artificial intelligence and other innovative solutions in capital markets

Source: Celent

Electronification of trading is expanding beyond equities into other asset classes

The need to lower cost and the growing demand for multi-asset trading are resulting in rapid adoption of electronic trading in multiple asset classes beyond equities. The decade-long process of electronification in listed equities, futures, and options has been compressed in other asset classes by advances in technology and regulation. Electronification enables easier navigation of fragmented liquidity pools in FX, fixed income, energy, and commodities across both cash and derivatives instruments. As multi-asset trading strategies become popular, demand is growing for easier and faster connectivity, consolidated data supporting aggregate view and advanced analytics capabilities to facilitate better trading, order routing, and risk management strategies.

Figure 3 looks at the market structure and demands on infrastructure for solutions as market structures shift from bilateral to venue traded. The fragmentation of liquidity pools requires robust and rapid connectivity models and means of access to new markets — an expensive and costly but noncore skill set for many market participants.

Figure 3: Demands Driven by Market Structure Changes Across Asset Classes

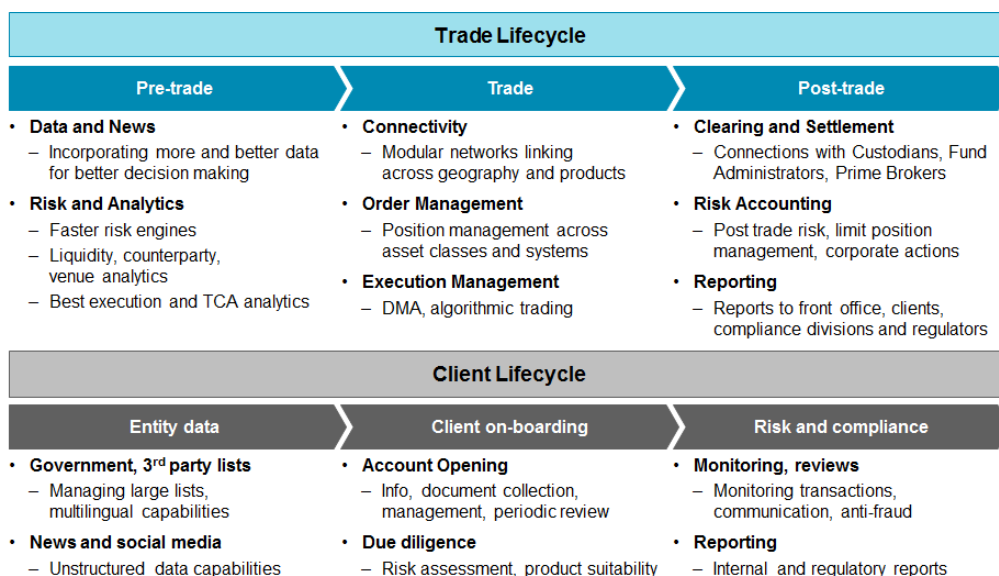
	Primary liquidity	Liquidity fragmentation	Aggregation	Electronic trading	Speed of change	Concern level
Equities	Exchange	High	Very high	Very high	Medium	Low
ETFs	Exchange	High	Very high	Very high	Medium	Low
FX	Principal	Very high	Medium	Very high	High	High
Listed Derivatives	Exchange	High	Very high	Very high	Medium	Low
Government Bonds/Rates	Principal/Exchange	High	Very high	Very high	High	High
Credit	Principal	High	Very high	Very high	High	High
OTC Derivatives	Principal	High	Very high	Very high	High	High

■ Very high
 ■ High
 ■ Medium
 ■ Low

Source: Celent

Technology has always been a driver of structural change for the capital markets. Technology is essential for building connectivity, executing and processing trades, and it helps in further adoption of electronic trading. Today new digital models are merging into and overlaid on top of existing infrastructure in a flexible manner. The move from monolithic to service-oriented architecture (SOA), to micro services, combined with more agile development and containerization, are creating rapid technology cycles. Flexible technology can improve efficiency, reduce costs, and offer superior analytics in key areas of trade lifecycle as well as client lifecycle management. However, growing complexity of operations and explosion in data universe (both structured and unstructured) present key challenges in several areas of trade and client lifecycle management, as can be seen from Figure 4.

Figure 4: Technology Challenges in Trade and Client Lifecycle Management



Source: Celent

Data is exploding. A key factor in overcoming many of today's challenges involves better and efficient management of data, including market data, reference data, and entity data, as well as unstructured emerging data sets that are providing unique insights from sources as varied as shipping mandates, to social media. The automation of the front office in FX and fixed income has created a storm of new data, and new data demands. Operations at many financial institutions have traditionally been aligned along silos of asset class, lines of businesses, or geographies. This makes sourcing, cleaning, storing, transmitting, and processing of data inefficient, limiting firms' abilities to improve efficiency and reduce cost to meet today's challenges.

A BRIEF OVERVIEW OF CLOUD MODELS

Traditionally capital market firms, particularly on the sell side, have looked to manage infrastructure and connectivity through in-house resources. But the magnitude and speed of structural changes are forcing them to look beyond to outsource operations for increased speed and flexibility. Technological maturity, changing models for application creation and deployment, speed to market, and cost pressures are driving rapid reengineering.

The cloud model has emerged as a viable alternative for solving several challenges faced by capital market firms. Adopting the cloud can not only free up significant upfront investments in technology needed for running in-house processes but also “variabilize” operating costs and make them more agile by offering ease of scalability, rapid server provisioning, testing ease, faster time to market, and better infrastructure utilisation through demand-based usage. Leveraging the cloud for infrastructure, connectivity, and even applications can easily break down existing vertical silos and enable more effective enterprise data transformation and superior analytical capabilities.

The Cloud Matures in the Capital Markets

Celent has observed strong demand for *as a Service* models for many segments of capital market participants. Combine this with enterprise virtualization, and there are numerous paths to reducing costs across cloud models.

Cloud architecture is giving a broad spectrum of market participants what they need. **Essentially, firms want to focus on core strengths while shifting the responsibility for noncore services to others.** It allows firms to rapidly add new strategies in the front office, while allowing easier access to massive data sets for reporting, or compliance. For many types of participants, having their applications outsourced has been the mode of business that makes most sense. It allows a highly scalable and easier server side, while allowing more focus on customer experience on the client side. Even the largest, most regulated firms are today, if nothing else, revising their strategy for cloud engagement.

Cloud Enabling Fintech Revolution

The ease in which new models can be tested in the cloud and the low cost of failure has put cloud into recent focus. Cloud is also enabling disruption in the capital market by providing upcoming Fintech providers a low cost yet scalable infrastructure, computing power and delivery model. At its heart, Fintech is about offering a superior and cost-effective way for accessing, processing, and analysing multitudes of data. Examples include:

- Solutions utilizing in-memory computing and machine learning to leverage the massive swell of structured and unstructured data to make predictions, and build analytics at the point of trade.
- Platforms for curating, processing, normalizing, and rapidly deploying analytics on massive data sets.
- Platforms that allow better access to execution venues and liquidity across asset classes.
- Regulatory technology (RegTech) for creating better access to global regulatory rules and data, and effective means of complying, measuring, benchmarking and reporting.

MODELS FOR DELIVERY AND DISTRIBUTION IN THE CAPITAL MARKETS

Key Research Question

1

What are the cloud deployment models in the capital markets?

The cloud journey has moved forward as financial institutions attempt to reinvent in a world of ever increasing complexity, which changes quickly and requires agility to compete effectively. There are several deployment models to choose from, such as private cloud, hybrid cloud, public cloud. While Hybrid cloud is the preferred model at present, public cloud is rapidly gaining prominence.

Capital market firms have long been adept at cost-cutting. In the early part of this century the key avenue of cost reduction was to outsource technology, and increasingly business processes, to emerging countries. Labor cost arbitrage was the key driver of cost reduction in such arrangements.

As outsourcing arrangements have matured and become commonplace, the potential to achieve further cost reduction has diminished. Financial institutions have realized they have come to look like IT behemoths running a significant amount of infrastructure and applications in-house, which leaves inadequate resources to focus on core and differentiating parts of their businesses.

The front office is no exception. Firms are balancing rapid changes in market structure, with challenges of rapidly managing, connecting, and properly implanting ever-challenging compliance, surveillance, and regulatory demands. Innovative service providers are offering end-to-end solutions for capital market firms to solve trading, compliance, and regulatory challenges in cost effective ways.

At the same time, changes in technology have brought the focus into the balance between buying infrastructure, as opposed to renting, or renting on demand. The next evolution of cost reduction efforts will rely on several key levers: a) utilize internal infrastructure in a virtualized environment; b) outsource as much of noncore infrastructure, technology, and applications to external specialist providers; and c) share the resources at a group or industry level through multi-tenancy and mutualisation, which further reduce costs for individual users. There are multiple models for delivering services. The cloud model can be the means to achieve these goals.

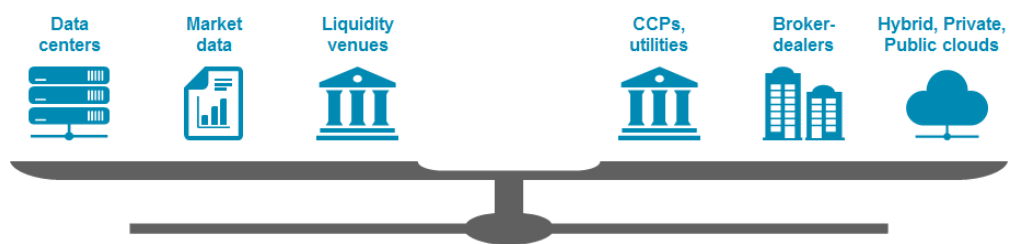
Cost is a starting point for the delivery model available to firms. Workflow, security, control, risk tolerance, and cyber-risk are key operational considerations. Likewise, the speed of creating, testing, and implementing new strategies, provisioning infrastructure, access to new asset classes, new geographies, deterministic latency, and new markets puts unique demands around location, latency, deterministic performance, and local regulation.

Evolution of the Capital Market Cloud

Participants in the capital markets have multiple needs. Those engaged on the active side of trading, whether hedge funds, prop shops, or broker-dealers, have become much more attuned to leveraging innovative approaches to solutions that solve core

problems. With cost reduction as a driver, participants have become much more accepting of outsourcing noncore activities, even those that are key to profitability.

Figure 5: The Infrastructure of the Capital Market









Source: Celent

Cloud can bring significant benefits for capital market firms, as can be seen from Figure 6.

- Typically a firm's consideration for cloud begins with cost. Using cloud allows institutions to shift CAPEX to OPEX for building operations; it also transforms fixed cost of operations into variable cost depending on firms' use of cloud resources. Furthermore, cloud enables high elasticity by allowing users to quickly scale up (or down) depending on immediate business needs. The ability to access cloud services from any place (local regulations permitting) on demand is another key consideration at this stage of evolution.
- As firms become more comfortable using the cloud, the potential of further cost savings through mutualization and sharing of cloud resources among a community (or wider public) drives the next phase conversation and adoption in a firm's cloud journey.
- As they move further up the cloud curve, the ability to monitor cloud resources utilization rate at a granular level allows them to optimize operations and further reduce costs.
- Further optimization can be achieved by developing a set of easily integratable (instead of heterogeneous) applications on the back of the cloud's standard framework and protocol. "Vendor lock in," or too much dependency on a single (cloud) vendor, may be an issue in this approach.

The cloud journey has moved forward as financial institutions attempt to reinvent in a world of ever-increasing complexity, which changes quickly, and requires agility to compete effectively. The myriad players in the capital markets have gone through the transition to multiple cloud models. Many on the buy side including hedge funds have been outsourcing as much as possible, including trading systems for years. On the other side of the coin are large broker-dealers, which are just dipping their toes into cloud models of any kind. They are, however, recognizing the additional efforts and costs of managing so much of their infrastructure on their own.

Figure 6: Key Features and Benefits of the Cloud Model

Feature	Description	Benefits
 Variable costing	Diminish CAPEX to build capacity for financial institutions	Freeing up of significant resources eases efforts to navigate tough budgetary climate
 Elasticity and scalability, on-demand	Providing cloud resources to users can be scaled up or down in any quantity at any time, on-demand	Faster time to market for new asset class, geography; easy to adjust to variable volumes
 Location independence	Financial institutions can access memory, data, network on cloud almost independently of their location	No dedicated resources needed to maintain geographical operations and look after interconnectivity across geographies
 Shared resources, cost mutualization	Cloud provider's common resources are publicly or privately shared by multiple users with dynamic assigning and reassigning of resources across users	Enables provider to achieve economies of scale and brings down cost for individual users
 Utilization efficiency	Resource usage can be monitored, controlled, and reported	Transparency in consumption and billing; Efficiency optimization by eliminating costly and inefficient processes
 Standardization and centralization	Standard framework of cloud infrastructure provides common backbone for applications that can be centrally managed and updated	Easier to integrate and streamline disparate processes and applications, ease of agility in responding to changes

Source: Celent

Next we take a brief look at the types of models evolving in the capital markets and attempt to segment the main branches of cloud evolution.

CLOUD SERVICE MODELS

Infrastructure as a Service (IaaS)

IaaS is where firms outsource key infrastructure such as data centre, network, processing power and connectivity tools to cloud providers. In the capital market context, this is particularly appealing for firms that want to provision infrastructure for their own applications. Strategically colocating servers in proximity of trading venues, and data transmission capabilities supporting very low latency can often be best provided by specialist IaaS providers, and many financial institutions particularly in tier 2 and 3 segments, are looking to avail them from the cloud.

Even firms that have the wherewithal to manage infrastructure in-house can greatly rationalize and simplify their infrastructure footprint leveraging the cloud, and improve efficiency and reduce cost in the process.

Platform as a Service (PaaS)

In the PaaS model, in addition to hardware and infrastructure, the cloud provider provides programming capabilities, tools, and APIs that financial institutions can access through the web and use to develop and run their own applications.

In the capital market this model is particularly appealing for large institutions that have to develop and maintain thousands of applications, often supporting multiple geographies and lines of businesses — such as retail and private banking, broker-dealer operations, and securities services. Many of these institutions previously were investing huge sums of money to manage everything in-house, but are now looking to outsource the infrastructure and middleware layers to cut costs, yet retain ownership of applications that need high customization.

Software as a Service (SaaS)

SaaS is the offering of fully managed infrastructure and software applications. Here the SaaS provider develops and manages the infrastructure, hardware, and middleware as well as application software, and offers the complete solution as a

service through the web to user institutions. This is a much easier and cheaper way to offer software packages, which traditionally have had to be deployed at every financial institution's premises. The SaaS provider maintains all infrastructure, operations, application development, and service.

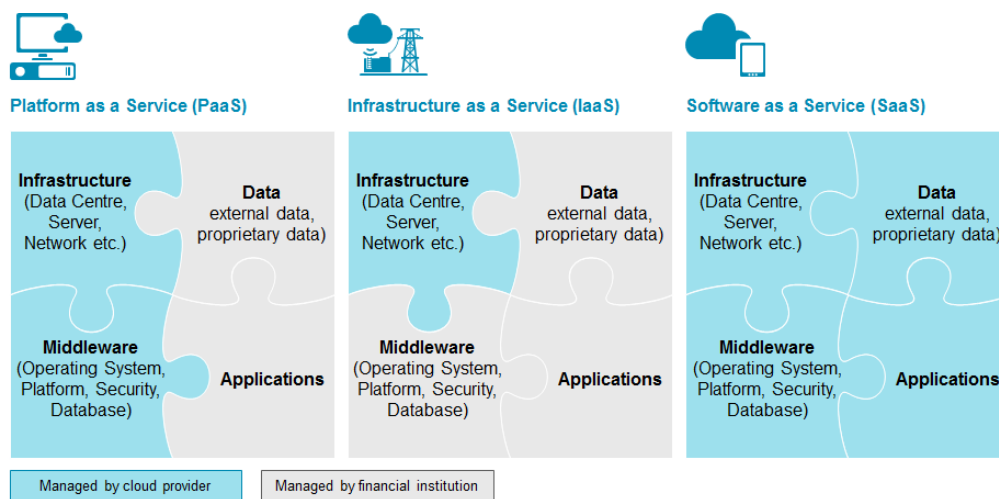
Cloud is often the de facto choice for all new software developers; even most, if not all, of the traditional solution providers in capital markets are reengineering their solutions to offer them via the cloud channel.

While some are building dedicated cloud infrastructure in this pursuit, others are forming partnerships with cloud infrastructure providers, and even other software providers with cloud capabilities to offer their own solutions via the cloud.

Further Evolution of as a Service (XaaS)

We are seeing further evolution in the as a Service (XaaS) value chain with suppliers offering other variants of this model, such as Business Process as a Service (BPaaS) offering complete business processes (not just software) as a service, Database as a Service (DBaaS) or Market Data as a Service (MDaaS), and even Artificial Intelligence capabilities as a Service (AIaaS).

Figure 7: Main Cloud Service Models



Source: Celent

CLOUD DEPLOYMENT MODELS

As noted in Figure 8 infrastructure, software and applications via the cloud can be deployed in several ways, depending mainly on a financial institution's need and willingness to maintain control and flexibility over the cloud functions as well as security and regulatory concerns.

Private Cloud

As the name suggests, private clouds are clouds set up for the use of a single financial institution, where key cloud services are offered to business users of that financial institution. Financial institutions gain high control and customizability through the private cloud, but extent of cost reduction and scalability can be limited as scaling beyond existing capacity point would require installing new hardware, thereby limiting flexibility in the process. For many institutions, much of new infrastructure is running in a virtualized environment, allowing them cloud functionality but requires maintaining data centres, hardware, and software. Legacy infrastructure is often difficult to consider for redeploying an architectural model without major costs.

Public Cloud

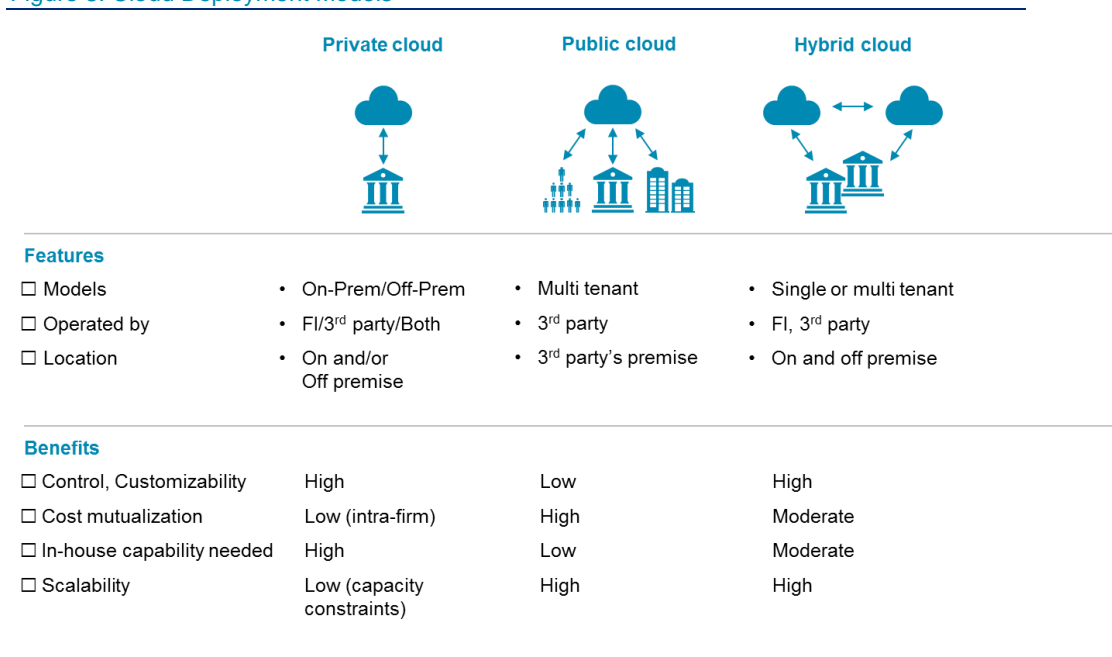
Public clouds are the next step in the evolution where cloud resources are offered to a wider public and are owned and run by third parties. The cloud-based offerings are

highly standardized since the target audience is broad and varied, but public cloud providers offer the flexibility and APIs for individual firms to build firm-specific solutions using the public cloud. Mutualized services, on-demand deployment, improved security and speed, and a growing ecosystem of solutions are all rapidly changing this space.

Hybrid Cloud

Hybrid cloud is a combination of the other models and has emerged for users whose requirements are not met by any one of them. For example, an institution concerned about putting sensitive data onto public cloud can use a private cloud to store the data and use a public cloud to run applications or manage business processes using the data. Or, firms want to build an infrastructure atop of multiple public cloud providers.

Figure 8: Cloud Deployment Models



Source: Celent

CLOUD-BASED MANAGED SERVICE

There are multiple models for hosting that are common in the capital markets. Colocation and managed colocation are two major examples. The hosted cloud is run by a third party provider offering services for one or more cloud tenants and can be on site or in a third party data centre. Institutions have their servers caged separately and have certain benefits on shared operations and power. Models might provide network engineer or system administrator support as service. Or, as is quite popular in the hedge fund space, a third party provider hosts their EMS/OMS or other systems.

As the cloud space becomes more competitive, commoditized, and economies of expertise becomes equally as important as economies of scale, we are now seeing further evolution in cloud provision where providers are looking to offer more than just cloud computing power to offer services atop cloud infrastructure. For example, in addition to offering servers, colocation, or software, the provider will be in charge of integrating them with firms' downstream systems, enabling greater customization through configurability, helping them navigate changes in business and regulatory policies and practices, and building and managing applications on top of infrastructure. These managed services can be offered to a single institution analogous to the "private cloud" model, or to a community of users. For example, with the plethora of new regulation, particularly demanding much more reporting from financial institutions, cloud providers can develop managed services that help comply with current as well as future reporting requirements. Know Your Customer (KYC)

due diligence is another area where we have seen third parties looking to provide managed services leveraging the cloud for delivery of those services.

The demand and adoption of managed services based on the cloud is likely to grow due to capital market firms' constraints to invest in in-house technology and staff, and therefore challenges in managing the cloud internally.

Industry Utilities

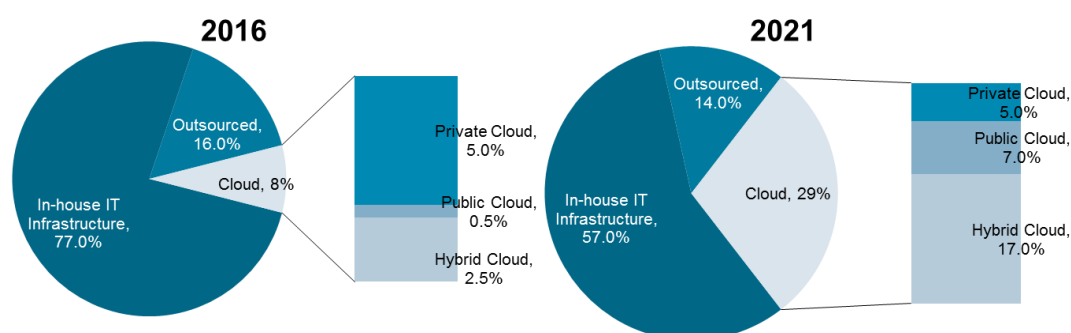
A further evolution in the managed service value chain is the emergence of the utility model, whereby a complete business process is outsourced at group or industry level. Typically a third party provider, in some cases newly formed industry consortia, build and manage the utility for a community of users or the whole industry. Specific examples include KYC utilities that function as data repositories fulfilling the industry's needs for collecting and managing KYC information and document, and regulatory reporting utilities supporting emerging regulations such as swap data reporting or MiFID. All these solutions are greatly enabled by the cloud which allows significant cost reduction and makes delivery and scalability of services extremely easy.

CLOUD ACCEPTANCE IN THE CAPITAL MARKETS

The cloud model has been around for a while now and has made headway in quite a few segments, including banking. The capital market space, usually a leader in technology adoption, is waking up to the greater possibilities of cloud. Especially the trading community within capital markets and their solution providers, driven by extreme cost and regulatory pressures, are looking at the cloud more favorably, overcoming earlier apprehensions. Front office technology, long considered a sacred ground for capital market players, is coming under scrutiny as they feel the pressure to streamline and optimize front-to-back office operations.

The openness to adopting cloud in some shape or form among capital market firms has undergone drastic change in last 12-18 months. The acceptance of various cloud models, private and public, is going through a rapid change. We are seeing capital market firms of all size rethinking their architecture. Clouds solutions are prevalent in non-core solutions, but we are seeing rapid smaller trading firms, and the buy side in general rapidly move to cloud models. Larger firms are looking to move beyond on-premise private clouds to much more flexible infrastructures. Celent sees a re-architecting of the capital market infrastructure as strategists begin building new infrastructure in cloud models. For larger firms, moving from rack and stack to lift and shift models is not as likely as building new applications in native cloud environments. Celent expects to see rapid adoption of private clouds, both on premise and off, as well a strong move to public cloud across vendors. Figure 9 below looks at growth rates for both infrastructure and compute. Public cloud will exhibit the fastest growth, growing from 0.5% of capital market budgets to 7% in 2021.

Figure 9: Rapid Adoption of Cloud Models in the Capital Markets.



Source: Celent

There is a strong secular trend among all types and sizes of capital market institutions to embrace the cloud, but current adoption levels and future considerations can vary depending on their role and size in the capital market ecosystem, as can be seen from Figure 10.

Sell side

Generally, the sell side is loath to cede control and highly regulated. They are in a situation that demands aggressive cost-cutting models. They are eager to explore solutions that build better distribution models, the migration from capital intensive to fee based models.

- Large broker-dealers and investment banks with complicated infrastructures and legacy, siloed challenges have continued to maintain their infrastructure. These firms have the resources to hire the best talent available to create a multitude of in-house solutions.

- Many firms have created private clouds for new infrastructure, allowing provisioning and demand flexibility on virtualized servers. A strong desire to cut costs has more firms exploring public cloud models as well as new models to outsource much of their infrastructure for connectivity.
- These are technologically sophisticated institutions approaching cloud from a well-considered long-term strategy, yet mindful of potential pitfalls of lock-in risks of too much dependence on cloud in their early days. Always careful about control and security aspects, they typically used in-house resources to manage cloud activities. With public cloud providers significantly upgrading their security standards in recent months, these large players are increasingly considering the public cloud to benefit from the very low cost of those modes of deployments. Therefore we at present see a hybrid approach of still keeping key resources on private cloud while leveraging the public cloud for less sensitive business applications. The first areas that the largest broker-dealers will move to public cloud environments are DevOps and testing. Decreasing fixed storage costs will be a key driver.
- These firms tend to be highly risk-averse and like to have full control of their environment, no interface with Internet, and access control. Often control and audit protocols created at corporate level of banks create a situation where there is no easy way for business within a larger bank to take different approaches. Many in the low latency community are keen on optimizing software for given hardware, as well as not allowing anyone near their computing infrastructure.
- Smaller broker-dealers and regional dealers are much more open to leveraging outsourced infrastructure and have been looking for packaged solutions that solve pain points with outsourced models for as much as possible. Innovative firms are offering access to analytics and testing in cloud environments. Often looking for platform-based solutions with modularity.
- The sell side is also seeing more opportunities for distribution of services, analytics, and products via cloud deployment.

Buy Side

Generally, the buy side is much more inclined for service-based models, acquiring technology over building in house (except few very large players) and eager to utilize hosted solutions for most systems, including their trade management systems. Many buy side players, who used to get technology support from their broker-dealers, are being left out as many broker-dealers shrink such offerings and/or focus only on large, profitable buy side clients.

- Hedge funds, active managers, and quant funds are keen on developing insights as quickly as possible, testing and implementing. The most latency-sensitive are looking for ultra-fast connectivity and models for data storage that put nothing between the hardware and operating systems of their trading infrastructure.
- Smaller buy side firms find public cloud much more appealing due to lack of resources for managing internal cloud, higher cost saving potentials, and relatively fewer concerns around privacy and security. They are also very favourable to managed service offerings because those further relieve them from having to manage even public cloud operations internally.

Market Infrastructure Providers

- Developed market infrastructure providers are at an advanced stage with many using the cloud for years for their internal operations, and some now using it for client facing activities.
- Market infrastructure players in emerging markets and asset classes (such as FX) need to be scalable and flexible in a quick time which makes cloud a worthy proposition for many. We have certainly seen very focused location based ecosystems develop around key data centre venues.
- Some of the leading market infrastructure providers have for some time been looking to commercialize their technology offerings, and have become technology

players themselves. Helping emerging market infrastructure providers through technology sales and partnerships therefore is a win-win proposition for both.

Technology Providers

- The growing demand for cloud-based solutions has made incumbent technology providers offer their software and services using the cloud.
- For upcoming fintech players, cloud is the best way to achieve scale at a very low cost and reach a wide audience in quick time.
- Increasingly we are seeing partnerships and collaborations among cloud providers, as well as between cloud and traditional technology providers, in furthering specific domain focus capabilities and taking them to the market. For example, most if not all providers of industry software packages already use the cloud as a delivery model, often in the process partnering with private and increasing public cloud providers, rather than investing in cloud infrastructure themselves.

The decision matrix for many of the cloud models and strategy is moving from IT to business. This is occurring on both sides of the user and provider fence. However, that is a complicated loop in larger institutions, with legal, compliance, IT and business all viewing their cloud decision quite differently. At the same time traditional deployed applications that are prevalent throughout the business are struggling to allow clients multiple modes of delivery. Vendors want to send applications, and more and more clients want to buy these as a service.

In fact, terminology is critical. From a vendor perspective managed services can often imply guarantees and complicated SLAs. For many providers and users of technology, there are conflicting demands for controls of the full technology stack. When one is considering infrastructure versus applications, key issues arise around the control and access to databases.

Most of the models that have developed in the capital markets began as hosted solutions. Often learning from the experience of offering single tenancy, providers learn what they can leverage across clients in the safest, most noncontroversial fashion. Whether it is services or shared templates for security masters, the best providers are offering capital market clients more and more each year.

In order to fully leverage and create smaller data centres, elements of multi-tenancy tend to evolve over time.

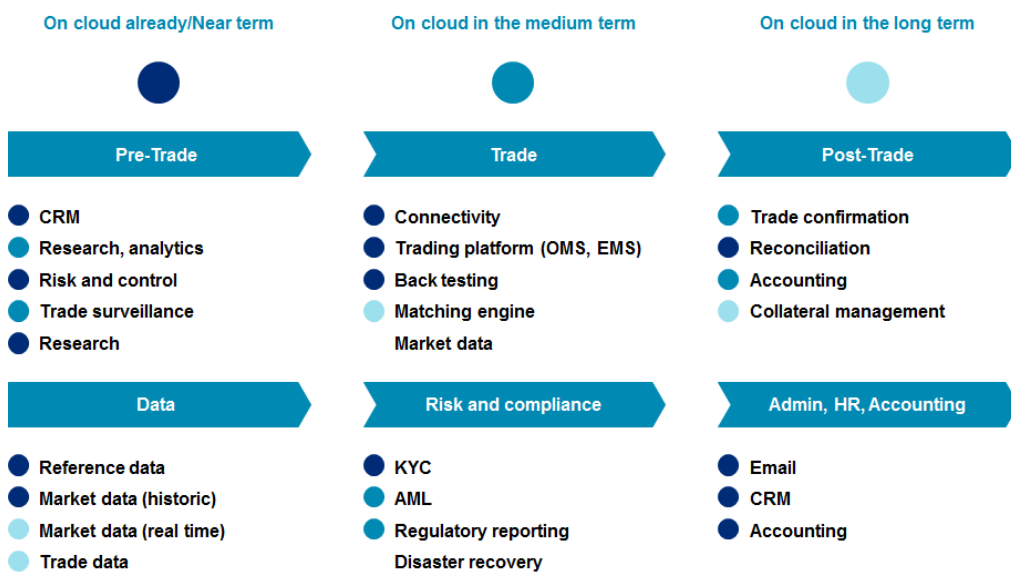
Figure 10: Cloud Adoption and Outlook within Capital Market Ecosystem

	Current level of adoption	Preference for cloud service and deployment models	Drivers for future adoption	Concerns and challenges
Broker-Dealer				
Tier 1	Low, a few early adopters, non-core systems	Mostly private cloud, IaaS, PaaS. SaaS for CRM	Cost reduction, flexibility to scale up/down	Security; legacy tech; data; inertia, organization culture
Tier 2, 3	Low, based on ad-hoc requirements	Mostly community cloud for IaaS, SaaS. Growing openness to managed cloud and services	Limited budget, expertise; scalability on demand, outsource all non-core	Security concerns, regulation
Buy-side				
Tier 1	Moderate, Generally buy-side more open to other models	Private cloud for PaaS; SaaS for point solutions	Cost reduction, outsource all non-core; self-trading models	Client concerns, data privacy, regulation
Tier 2, 3	High	IaaS, multiple models, hosted solutions for trading platforms	Limited budget, expertise; scalability on demand	Inertia due to follower, "groupthink" approach
Market Infrastructure				
Mature (market, asset class)	High for internal ops, low for client facing activities	Private cloud for IaaS, openness to public cloud for PaaS	Client demand, flexible data delivery models,	Regulation, potential commercial challenges
Emerging (market, asset class)	Moderate where local regulations permit	Primarily IaaS; growing openness to SaaS, managed services	Desire to leapfrog evolution curve, no legacy baggage; limited budget	Regulatory clarity in certain markets/Asset classes
Technology Provider				
Incumbent players	Moderate and growing	Private, IaaS for internal development, SaaS for clients	Growing demand for SaaS, XaaS, managed services	Cannibalising non-cloud offerings
Upcoming FinTech players	High	Public PaaS for internal development, SaaS for clients	Speed to market, focus on core, little capability, appetite for highly scalable models	Security and privacy issues

Source: Celent

Delving a level deeper and looking at different functions within capital market firms' operations, we think those that are noncore, non-differentiating, and do not involve client or proprietary data can easily be moved to the cloud. Thus in the trade lifecycle space, accessing commoditized data such as reference data and market data through cloud is already taking place. Firms can run and back-test algorithms, or do risk analytics using this data from the cloud. It should be noted: the latency of such data, at least at present, is of the order of a few seconds. Due to capacity limits of cloud development at present, sub second latency to support high-frequency trading type activity is still not happening. Figure 11 looks at areas in which market participants are thinking through their cloud strategy.

Figure 11: Cloud Adaptability for Capital Market Functions

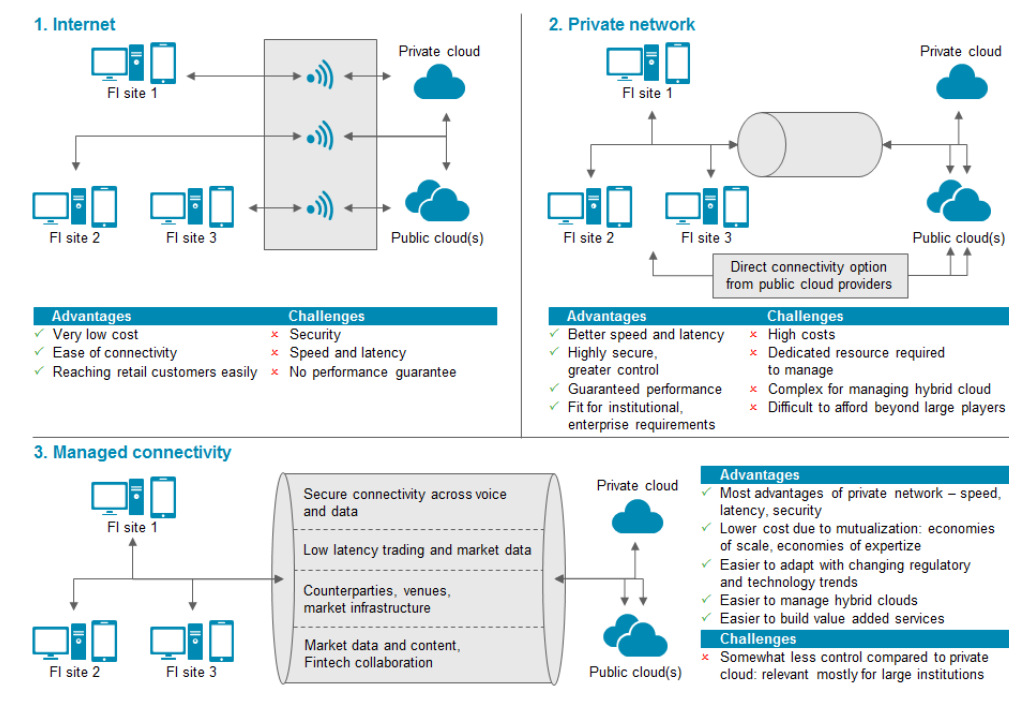


Source: Celent

REACHING THE CLOUD: CONNECTIVITY AND ACCESSABILITY

While certain models for connectivity to one’s cloud provider may work in other industries, or even on the retail side of financial services, institutional firms are looking for faster, more secure ways to connect. This is especially true in low latency fibre infrastructure, or through the air models for accessing venues, and colo sites. A key issue in planning a financial institution’s cloud strategy is connectivity — how to connect to the cloud and access cloud resources at branches, company sites, and users devices. Figure 12 exhibits several options market participants can choose from.

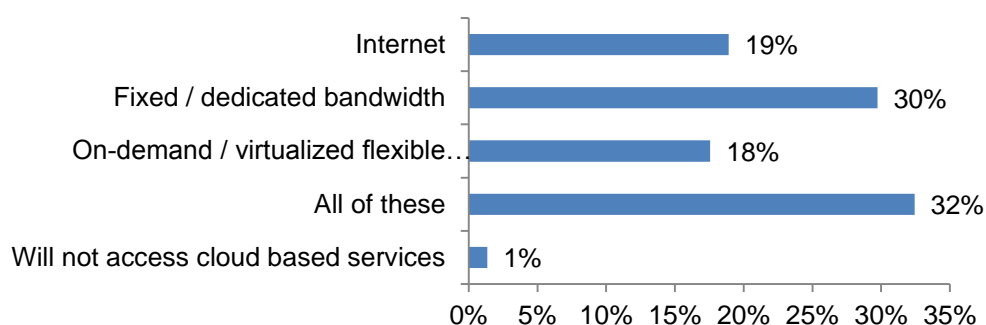
Figure 12: Connectivity Options for Accessing the Cloud



Source: Celent
FI=Financial Institution

A recent industry survey conducted by the Capital Markets division of Colt in July 2016 looked at how capital market participants see managing connectivity. Just as there is growing demand for flexibility in compute and storage in cloud solutions, there is demand for flexible infrastructure. The survey found that 1% of the respondents of the 74 capital market firms surveyed said they will not access a cloud-based solution, while almost a third (32%) are willing to consider multiple modes of connectivity (Figure 13).

Figure 13: Creating a Holistic On-Demand Capital Market



Source: Colt

INTERNET

The easiest and cheapest way to connect to the cloud is through the Internet. Many institutions, particularly smaller ones, begin their cloud journey using the Internet. This may not be the best strategy for most capital market firms because:

- The Internet is highly vulnerable when it comes to security of data sent over it. This vulnerability of public cloud is sufficient enough for many capital market firms to discard the Internet as a viable way of connecting to the cloud.
- Speed and latency are other limitations of the Internet. It is almost impossible to expect consistent speed, latency, and up-time from the Internet.

In spite of the challenges, Internet may still be viable for certain areas of capital markets, such as delivering cloud based “commoditized” solutions to retail segment. For example, a retail broker can deliver market data hosted on a cloud through the Internet to its retail clients.

PRIVATE NETWORK

To avoid the shortcomings of the Internet, private networks can be used to connect to the cloud. Here, firms use dedicated leased lines and circuits, or use virtual LANs to transmit data to and from the cloud. Capital market firms are more likely to use a dedicated private network to access the cloud for three key reasons:

- Speed and latency are greatly improved using dedicated network, as firms use dedicated and strategically located servers and data centres in this set up.
- Consistent performance can be guaranteed using private networks, and back up arrangements can be put in place in anticipation of outages and failures.
- Private networks are much more secure compared to the Internet.

Capital market firms can invest and maintain the private network in-house, but that will require high upfront investments and ongoing maintenance costs. There is an ecosystem of suppliers that can meet these needs either through provision of dedicated resources for individual institutions, or through provision of virtualized networks which are offered to multiple users, with each using it as a private network.

Notably, the public cloud providers have developed direct connectivity option to their respective clouds, so that capital market firms can enjoy the benefits of private network through availing this direct connectivity option from the provider’s resources spread across geographies and key locations. Based on an individual firm’s requirement, the cloud provider can offer dedicated space and equipment to the user, or virtualize its resource pool to meet the user’s private network requirements. The former is more expensive and less common than the latter, but both offer better performance, ease, and flexibility of using the public cloud provider’s standards and frameworks to develop and run applications on them.

MANAGED CONNECTIVITY SERVICE

We are seeing capital market participants increasingly looking to embrace the hybrid cloud model for a number of reasons:

- To keep sensitive data and applications on private cloud and use flexibility, scalability, and low cost of public cloud.
- To reduce dependence on a single cloud provider by using multiple clouds.
- To use different clouds to address different needs (e.g., location, infrastructure, application integration, and analytics capabilities).

Managing network and connectivity for each cloud can be complex and challenging for individual firms. Even when firms are using a single cloud, particularly buy side and smaller sell side firms, they are looking to outsource connectivity management as they seek to outsource as many noncore processes as possible.

To meet this demand, providers of cloud infrastructure have developed network solutions on a managed service model, whereby they enable individual firms to connect to private or public clouds. In this arrangement the providers not only offer economies of scale for infrastructure, they also bring in economies of expertise. This is becoming particularly important because traditional technology specialists often lack the skills to build and maintain solutions involving the cloud. Staying abreast with evolving requirements of public and private cloud technology can be particularly daunting for individual firms.

In addition to providing core connectivity solutions, managed service providers can offer value-added services easily by leveraging the information that resides on and flows through their networks. For example, they can easily and rapidly distribute market data, offer algo testing and analytics capabilities using the data, or offer regulatory reporting solutions. While some cloud infrastructure players may move in that direction as a natural next step in their journey, they will have to compete with existing solution providers in respective areas as the incumbents are also leveraging the cloud to deliver their solutions.

Table 1 outlines the adoption level of various connectivity options in the capital market at present and our views of future evolution. In spite of the challenges with the Internet discussed above, many capital firms still use it to access the cloud for non-differentiating functions (such as email and CRM) due to its very low cost. And the Internet's share is expected to grow marginally, mainly because we expect to see growth in adoption of the public cloud. Many firms will likely use the Internet for accessing the public cloud, at least for functions that are not high security sensitive and do not require high and consistent speed or uptime.

Currently private network is the most preferred route of accessing clouds for core capital functions, but its share is likely to shrink. Dedicated bandwidth comes with challenges of low flexibility and inefficient resource utilisation. For example, the high bandwidth needed to run heavy weekly or monthly batch processes would be rendered unutilized for most of the time, as daily operations will likely have lower requirements. The provider universe is also maturing as new managed service offerings based on demand-based resource provision and usage based pricing models emerge.

Table 1: Cloud Connectivity Preference in the Capital Markets

Model	2016	2021
Internet		
Private Network		
Managed Connectivity		

Source: Celent

○=low adoption; ●= high adoption

CAPITAL MARKET USE CASES

Key
Research
Question

2

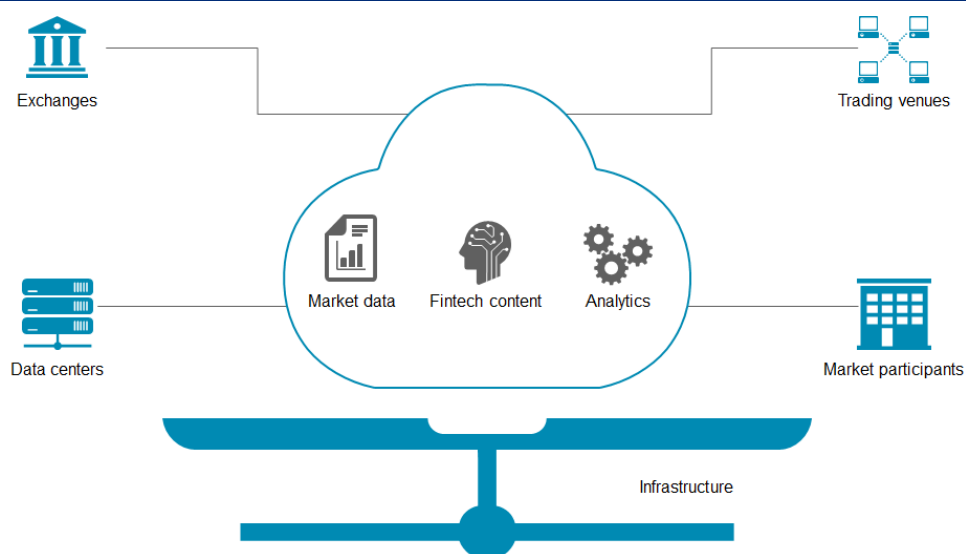
What are emerging capital market use cases?

Innovative solutions are creating a more rapid means of solving key pain points from the front to the back office. A key area of exploration is remapping market data infrastructure to cloud environments. Bringing data and computing into a single point yields tremendous insight.

In the previous chapter we discussed several areas where cloud can be adopted within capital market operations. Here, we provide three case studies analyzing in greater detail how cloud-based solutions can be adopted to address specific challenges faced by capital market firms as solutions to challenging front office regulatory challenges.

The capital market theme that is emerging is an end-to-end as-a-Service solution for a major pain point that essentially combines incumbent financial infrastructure with data, analytics, fintech content and cloud deployment.

Figure 14: Putting the Capital Market Pieces Together



Source: Celent

Capital market participants are not looking to move their existing infrastructure to the cloud. **To move a legacy infrastructure, built over years, with all its warts, and cludgy design, to a cloud environment would not make sense.** At natural transition points, when servers are decommissioned, data center contracts roll off, or new processes being developed would be a more natural point to make a transition. Especially as functionality increases, more market participants head in that direction, and prices in the cloud continue downward. Table 2 is Celent's assessment of how capital market CIOs and trading technologists are viewing their move to the cloud.

Table 2: Opportunities for Cloud Solutions in Trading and Execution Infrastructure

	2016	2021
DATA INGESTION		
DATA DISTRIBUTION		
DATA STORAGE		
ANALYTICS		
RISK ANALYTICS		
TRADING SYSTEMS		

Source: Celent

Similarly, almost all Fintech providers partner with cloud vendors, as that is perhaps the only way for these players, many of which are still at infancy or adolescence, to achieve scale quickly to become viable in the industry. For many Fintech firms and recent entrants that are providing new models for trading access, the cloud has been their birthplace. **The natural risk mitigation that a start-up receives from not investing upfront in infrastructure, long-term contracts, and hiring expensive, specialized network expertise have been a boon for innovation. Failure is cheaper, and success scales easily!** As turmoil has continued, and capital market talent leaves traditional investment bank and broker-dealer positions, we have seen more and more capital market Fintech firms building their RegTech, MarketTech, and InvestmentTech solutions in exactly this model.

TRADINGTECH AS A SERVICE

Cloud-Based Front Office Solution Set

Creating better and more transparent access to liquidity; developing efficient and intelligent platforms for trading and clearing; creating/expanding asset classes; leveraging new technologies in the cloud for access to services and applications; and pure storage plays that create more effective on-premise or outsourced infrastructure. With previously closed and proprietary opening up and platformizing, allowing direct APIs to developers to open hitherto highly closed infrastructure is evolving a new model to seamlessly manage market infrastructure or connectivity as a service.

Celent sees solutions where firms are rethinking their market data infrastructure and creating the entire distribution in cloud environments. Many of the native digital fintechs are on the retail side of the business, but we are also seeing more institutional firms leverage, in the rapidly evolving FX landscape, pricing engines and pricing distribution as a Service. As even the largest financial institutions recreate their market-making models via partnerships with technology-savvy specialized prop shops, we will see these models continue to grow.

For many, it is cost, but also the complexity in developing technology that are not core to their business. The off-the-shelf analytical tools provided in many of the cloud environments are another key driver for these models, especially as firms analyse their daily trades, fill rates, liquidity metrics, and latency metrics around fragmented liquidity. The fact is, for click traders, latency profiles in the cloud are already nearly adequate for latency-sensitive and algo traders; these tools will be EOD or for historical analysis.

REGTECH AS A SERVICE

Cloud-Based Solution to Meet Regulatory Requirements

With estimates of a half-billion pages of financial regulations being produced between 2012 and 2020, regulatory compliance and surveillance have become major pain points for all firms in the capital market. Furthermore, these regulations increase reporting and compliance obligations for all financial institutions. For firms across the spectrum, solving these issues is key; outsourced, service-based solutions are particularly important to firms without the resources or ability to manage many of the new responsibilities driven by EMIR. The buy side, in particular, is not immune. In some cases, as their regulatory burden continues to grow in the runup to MiFID II, where ARMS (Approved Reporting Mechanism) reporting will be a new requirement.

Not only do these regulations increase the volume of reported data, regulators are scrutinizing the quality of the data and require firms to adopt new standards and classifications, and provide a data audit trail. To this end, regulators want to see an audit trail of underlying data that underpins financial institutions' operational decisions around risk analytics or regulatory reporting, which means that data must be tagged with metadata to prove lineage and provenance. Some firms are working on centralization programs in order to store and scrutinize this data in a comprehensive manner as well as to bring down data costs in the long term. Many incoming regulations require the storage of this data for a minimum period of five years, so the scale of the data problem is becoming much greater.

Regulatory reporting is a key pain point, but is not a competitive differentiator. As part of a larger trend of firms looking to outsource non-competitive parts of their operations and mutualize costs through adoption of shared service, regulatory reporting is an area ripe for moving to a utility model. It is highly repetitive, standardizable, and essential for all firms, but is not a differentiator. Furthermore, investing in building this capability in-house and maintaining them on an ongoing basis is resource-intensive but could be easily reduced through adoption of a shared service or an industry utility.

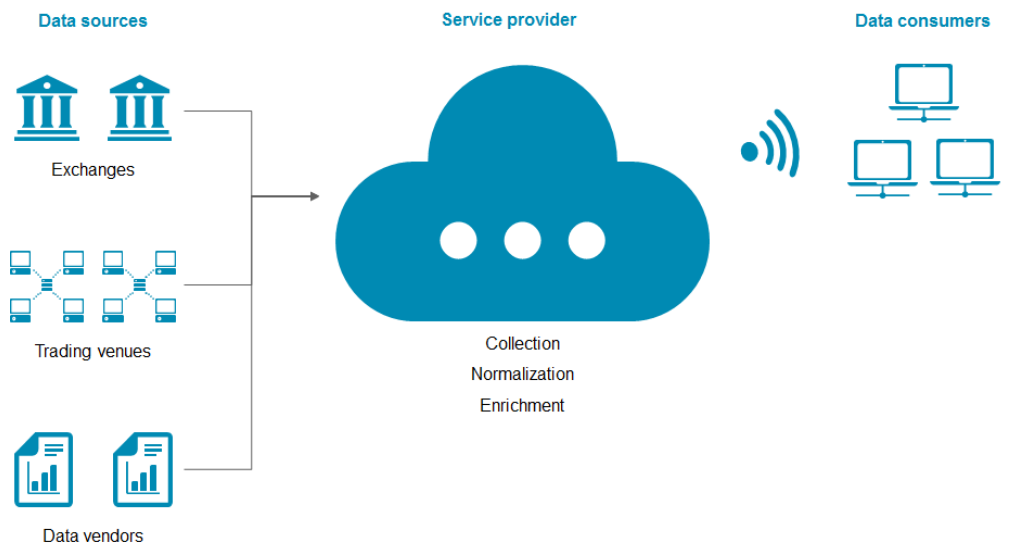
MARKET DATA AS A SERVICE

We have already seen the rapid increase of cloud solutions for market data ingestion, including directly putting L1/L2 data streams into public cloud solutions for storage and analysis purposes. Real-time and historical market data is expensive, especially for smaller firms. The competitive dynamics of market data providers have evolved in such a way that data consumers need to pay for a lot more under bundled offerings, many of which they may have no need for. More flexible delivery of market data enfranchises many types of players.

Noticing this challenge, new models are emerging that provide on-demand and the exact set of data to users that they need. Here the provider collects the universe of relevant data (such as market data or reference data) — across asset classes, markets, and venues — through direct connection to the data sources (such as exchanges and venues) or from a data vendor. This full set of data is normalized, cleansed and enriched, and hosted on the cloud.

It is then distributed to users through a portal, and according to every user's needs for specific asset classes, markets, or even time period. The client pays a la carte for the amount of data she is using. A central provider doing cleaning and enrichment of data also rids individual firms of investing in such capabilities, allowing further cost savings. The examples we have seen use the public cloud for this service and mainly target the non-latency-sensitive audience with latency of the order of seconds, but can be replicated for latency-sensitive segments with improvement in speed. This model is a great way of delivering market data in an efficient and cost-effective way. For example, a data provider that previously had to courier hard drives to deliver large volume of historical data (often decades of data needed for back-testing) can now just share a pointer on its cloud to the client for download.

Figure 15: Emerging Cloud Models for Market Data



Source: Celent

CHALLENGES IN CLOUD ADOPTION AND THE WAY FORWARD

Key
Research
Question

3

What are the key challenges for moving forward with cloud service and managed offerings?

Organizational inertia coupled with concerns around data privacy, security, and risk sharing between cloud providers and users are obstacles to cloud adoption, but the speed at which the cloud is advancing, the investment into security, and morphing regulatory conceptions are helping lower and remove the obstacles

Even though the understanding and openness to embrace the cloud are improving among capital market firms, there are still some challenges and concerns that financial institutions and their service providers must grapple with as the industry navigates this phase of industry evolution. Some of the challenges are observed in other industries as well, but stringent regulatory scrutiny on capital market firms requires them to design fool-proof solutions to overcome the challenges, which can slow down pace of adoption.

Figure 13: Key Challenges to Cloud Adoption



Source: Celent

Data Security

Dealing with data is the essential part of capital market firms' operations, therefore issues around data security is a big concern for financial institutions considering cloud adoption. This pertains to both physical security of data centers, and cybersecurity for data exchange over networks or the Internet. Since in the cloud environment data resides in a virtualized network spread across locations over which financial institutions have little control, they – particularly the large institutions – have been reluctant in the past to put sensitive data on the cloud. This has been an obstacle to adoption of public cloud so far as financial institutions have looked to use private or hybrid cloud to retain control over sensitive information.

On the connectivity side, the Internet is highly vulnerable when it comes to secure exchange of information. This is a big concern particularly for capital market firms, and they are highly averse to using the Internet for transmitting client or proprietary data. Firms with budget and resources opt for private networks, whereas others prefer to work with leased lines and managed networks from specialist providers.

Lack of Clarity over Data Storage and Transmission Laws and Regulations

A second concern around data is where it can be stored, hosted, and shared with other jurisdictions. Laws and regulations regarding information technology and cyber-rules are still developing in most countries, and few have clearly defined policies and guidelines regarding what is permissible. Some jurisdictions can be particularly strict regarding “data sovereignty,” requiring no information on national entities be hosted or shared outside its national borders.

Changes resulting from future regulations and major legal cases can be particularly onerous for early adopters that have established significant cloud operations. This uncertainty forces many institutions to take a more cautious wait and watch approach and use the cloud only for noncritical parts of their operations.

Lack of Regulatory Clarity over Risk-Liability Sharing

Similar to the case of data related issues, regulations around risk-liability sharing between cloud providers and users are still developing. The cloud model is similar to a traditional outsourcing arrangement, and as such most regulators look at liability issues involving the cloud through the same lens as outsourcing. However, many financial institutions lack adequate awareness and understanding on this issue, and lack of specific regulations around the cloud has made them reluctant to embrace it.

Among the provisions under consideration are standardized cloud computing contracts clearly spelling out service providers’ legal obligations and EU-wide certification of approved providers. The onus will be on cloud services users to determine whether their providers have implemented sufficient security measures to ensure the protection of personal data.

Customization-Standardization Trade-off

Another key reason financial institutions, particularly the larger ones, have so far looked to use private cloud is that it gives them more room for customizing their infrastructure and applications. Yet, as their cloud operations grow bigger, and they shift a significant part of their infrastructure and/or applications on a third party provided cloud, some institutions become concerned about too much dependence on the vendor. Future changes in vendor’s policies or frameworks can add to operational complexities for individual users.

Public clouds, on the other hand, offer limited flexibility for customization. While they offer tools and APIs to build and run new applications using their core platforms, the lack of comprehensive and widely accepted frameworks and discrepancies in standards among different public cloud providers can be challenging for operating cloud resources from multiple providers.

As firms go through the efforts of developing skills with a particular vendor, skills become apparent. There is nuance to understanding the primary vendor’s offerings. A multivendor solution requires considerable effort.

Organizational Culture and Inertia

Last but not least is the issue of organization culture. Putting a cloud strategy in place requires a long-term strategy, which many financial institutions are increasingly finding difficult to execute because they have to work under extreme and immediate cost pressure. Furthermore, moving away from a traditional silo-based approach is often met with resistance within the organization delaying major change initiatives. Leveraging the cloud also involves different skills and expertise compared to those needed for maintaining traditional systems. Difficulties in finding skilled people across

locations can be as difficult as overcoming internal resistance and resourcing policies and regulations.

Economics

In certain cases, depending on the applications, cloud models are more expensive than fixed internal server models. Often in analyzing a public cloud move, the economics will be favorable to an internal solution, unless their network engineers or system administrators are let go, although the math continues to move in the favor of cloud models as prices trend downwards.

Another consideration is how to optimize overall operations after moving to the cloud. Many existing systems and applications will need to be maintained, replaced, or retired after moving some parts to the cloud. Striking the right balance between optimizing costs and avoiding redundancies and yet preventing disruptions or outages can be a significant challenge.

OVERCOMING THE CHALLENGES

Many of these issues, while still daunting for individual firms, are being addressed as market participants across the board work together in consultation with regulators to find common ground and improve safety and security.

- Cloud providers, including providers of public cloud, have significantly strengthened their security features. Some participants mentioned to us they think security features of some public clouds are now stronger than those of many private clouds or on-premise systems. Few systems, whether public or publicly operated or locally installed, are completely fool-proof. The objective for financial institutions therefore should be to achieve optimal trade-off between cost-efficiency and security. One example is more advanced access controls and auditing that look at keystrokes, video monitoring, and biometric access for holistic control. The amount of investment in encryption technology (when data is at rest, when it on the move) and decryption techniques is exponentially increasing. The resources available by specialized cloud service providers will dwarf what firms can do on their own.
- Data privacy and locality concerns are being addressed as regulators see various cloud models as another outsourcing process. Providers are creating more options for data residency within national borders if that is required. European safe harbour rules often come up.
- Regulators and courts in some key countries have recently come up with clear rules around data storage and hosting. Although some are more stringent than others, this removes uncertainty and provides participants in the ecosystem clear guidelines to develop solutions for the longer term. In many cases regulators such as FINRA in the US and FCA in the UK are leveraging public clouds for their data storage. Most new models for advanced regulatory repositories are being built around public cloud infrastructure.
- Some regulators, such as those in the UK and Singapore, have also come up with specific regulations addressing risk-liability arrangements involving the cloud. Because of the rapidness of technology advancement regulators generally tend to be reactive in embracing new and innovative technology; but, there is a strong likelihood of more regulators encouraging and embracing the adoption of cloud. Some financial institutions in key markets have mentioned to us they have initiated cloud strategy immediately after local regulators came up with clear cloud guidelines.
- Participants across industries are actively collaborating, and at times creating industry bodies (such as the Open Data Center Alliance), to develop a set of common frameworks and acceptable practices. It is also becoming common for providers to adopt these frameworks and demonstrate their expertise through embracing established standards around security and control (such as SOC-1/SSAE 16). Certifications abound for cloud providers of every stripe, whether it is Soc 1&2, ISAE 3402, or SSA 19.

- Huge cost pressures are forcing many firms to overcome inertia and organizational bottlenecks, altering their attitude from “never” to “how to” embrace the cloud.
- On the economic side public clouds are getting cheaper by the day. New services are constantly evolving for the exact needs of a client. If five minutes of computing time are needed, or storage for a week, or quick retrieval, all are options that make these solutions increasingly compelling.
- By the week there are new companies emerging to sit between cloud providers and financial firms. The ecosystem is robust and incorporates start-ups and existing firms that can bring capital market specific connectivity, routing, access to venues, and colo to any type of firm.

CONCLUSION

There is a secular shift towards more flexible infrastructure. That is good because the volume of data both structured and unstructured continues to explode as new trading models are employed. Trends in digitization will accelerate, and the challenge for established technology firms and market operators will be to find the correct means of collaborating with new business models and innovative technologies.

As access to computing power becomes more flexible, firms will demand more flexibility for their bandwidth, architecture, and connectivity. Flexible computing power, with inflexible routing or connectivity does not make much sense.

Similarly, large infrastructures will be a thing of the past, but there will be a long tail. In the same way that the world's derivative infrastructure runs on technology from 45 years ago, there will be late adopters for cloud solutions for many years to come. The only question will be: Can those models survive with high fixed costs?

The exciting part of today's capital market is the pace of change in this generational shift in the nature of capital extension. Infrastructures that we consider sacrosanct will suddenly be deployed in very different fashions.

This is paving the way for the cloud model to make inroads into capital markets. Large banks are already using the cloud in various forms, and we expect to see this continue, as well as a migration of more and more non-core systems to cloud models of all types, as the desire to maintain control still makes them manage core and proprietary functions in-house or over a private cloud.

The trading community, particularly in the buy side, has traditionally had a strong desire for control over front office technology but we are seeing green shoots, particularly with smaller firms that want to focus their energy on strategy development and areas of core expertise. In other areas, such as CRM, testing, email, accounting, many are willing to use the cloud, in some cases directly the public cloud. The overwhelming cost and regulatory pressure is compelling all capital market firms to reconsider their architectural models and topology front to back office.

There are key questions and considerations for firms at various stages of their cloud journey: for example, choice of optimal service models (private, public, or hybrid cloud) or of connectivity options (private or managed networks, etc.) There is a clear trend of firms looking to move away from managing anything in-house that does not add to differentiating capabilities. The provider landscape is maturing with the emergence of new engagement models (such as managed service) beyond provision of core cloud infrastructure. High flexibility of cloud-based operations, and rapid improvements in cloud features, such as security, latency, and new engagement models, should expedite cloud adoption among core capital market firms.

While regulations play out, it is very likely that what is considered cutting-edge today will be the norm tomorrow. As cloud providers ramp up encryption, biometrics, and access control, it is likely that cloud will be the standard model in the future.

Cloud was not only a nebulous term, replete with different meanings and myriad paths to implementation; it had become a term that could put many in financial institutions' technology, legal, and compliance departments on the defensive. But that is changing rapidly. Some banks are already using the cloud for core banking operations, easing the way for adoption in their investment banking arms. The provider community is leveraging the cloud for building solutions and deploying services. The trading community, particularly in the buy side, is also shedding apprehensions of tightly guarding front office systems and looking at the cloud.

We see some of the most security-focused firms in the world move to cloud models, and we expect to see more in the capital markets. As the possibility of cloud providers becoming centres of trading, or market data, or a new ecosystem evolves, and as more participants become involved, the network effect will become profound.

Was this report useful to you? Please send any comments, questions, or suggestions for upcoming research topics to info@celent.com.

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