Independent research by

Chartis

Data Integrity and Control in Financial Services

Market Update 2018

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- Market risk
- Asset and liability management (ALM) and liquidity risk
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- Insurance risk
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The firm has brought together a leading team of analysts and advisors from the risk management and financial services industries. This team has hands-on experience of implementing and developing risk management systems and programs for Fortune 500 companies and leading consulting houses.

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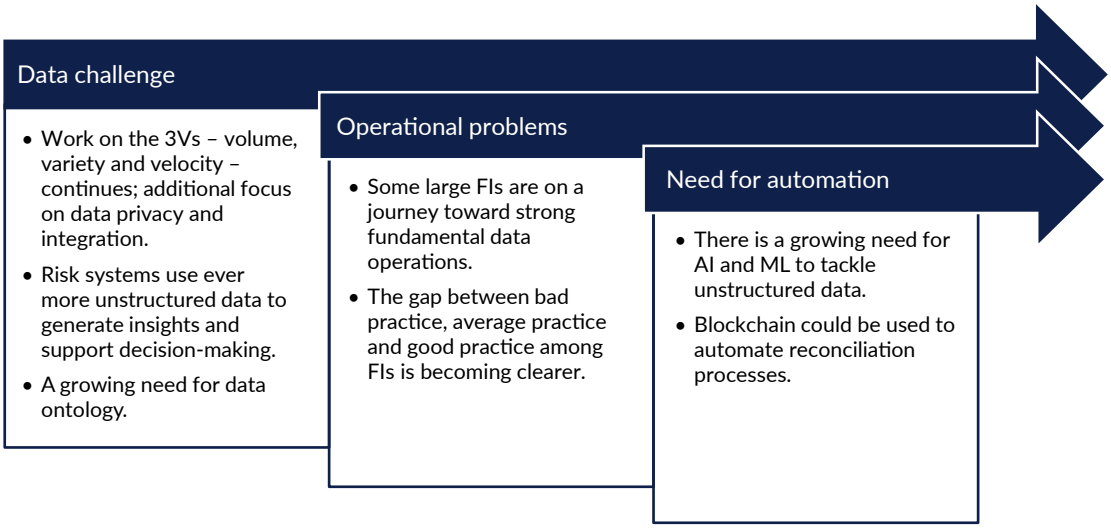
1. Executive summary

This report updates *Data Integrity and Control Solutions in Financial Services 2016*. It examines how the dynamics in this space have shifted since that report was published, and the implications for Financial Institutions (FIs) and technology vendors. This report provides key updates, and outlines our developing thesis – for our original thesis and analysis please refer to the 2016 report.

Data integrity and control 2018: key demand-side trends



FIs need data, to keep regulators and customers happy and profit margins healthy. Data needs to be in good shape so FIs, their clients, and their employees, can manage and manipulate it effectively. And even after FIs have their data's 3Vs – volume, variety and velocity – under control, privacy and integration will emerge as the big stumbling blocks to getting value out of it.

The past year has seen explosive growth in the creation and use of unstructured data, much of which has, by necessity, begun to evolve into a more structured form. For FIs, parsing unstructured data for investment decisions, for example, can consume vast amounts of IT infrastructure and cloud elasticity, and involve considerable manual intervention from staff. This trend applies to risk management too. While risk systems take advantage of ever more unstructured data to generate deeper insights to support decision-making, manual intervention, reconciliation, matching and statistical techniques are required to provide much-needed structure.

The problem is that FIs' fundamental data operations are simply not good enough. Pressured profit margins mean that focusing on Data Integrity and Control (DI&C) solutions is now essential for FIs, and will become a significant competitive differentiator in future. Paradoxically, however, the same profit pressures mean that DI&C is being pushed down FIs' list of priorities.

As the DI&C environment continues to evolve rapidly in the next few years, the gap between bad practice, average practice and good practice among FIs will become clearer. Those exhibiting best practice will exhibit 'full' DI&C – adopting a holistic approach to the discipline, with strong management and data governance processes, and a contemporary data content engineering and IT platform. In addition, ontology tools have emerged as a central feature of successful DI&C: to be used effectively in many applications, data must have consistent meaning.

FIs must also invest in the latest, most effective technologies for automation – specifically Artificial Intelligence (AI) and Machine Learning (ML). In the most successful FIs, automation will increase substantially, replacing cumbersome, recurring and often hidden manual processes. Eventually, Distributed Ledger Technologies like blockchain may even remove the need for reconciliation, one of FIs' biggest technology-related operational costs.

Very few FIs are operating at this level of DI&C today, however. So far only the largest organizations are exhibiting best practice, although even they are yet to achieve it consistently throughout their operations. Hardly surprising then that a fragmented solutions market, in which FIs stitch together a patchwork quilt of third-party, internally developed and external services to create workable solutions, has grown up around them.

Data integrity and control 2018: key supply-side trends

This fragmentation is reflected in the supply side of the market. While some vendors largely adopt a 'mix and match' approach to their solutions, others focus on a specific aspect of the DI&C cycle, be it lineage, governance or reconciliation. An important factor in this is the size of the vendor: a typical large DI&C vendor, for example, will tend not to specialize in a single DI&C category. For smaller and newer vendors, meanwhile, the DI&C environment is likely to get tougher – building use cases around data takes time and money.

Nevertheless, vendors have started to merge their DI&C criteria and go after opportunities in a common solutions space, albeit at different speeds. The result is that many vendors rely on the varied and fragmented nature of the market – and FIs' patchwork approach – to provide full solutions. But both groups will have to start thinking more holistically if they are to tap the growing opportunity this evolving market will offer.

This report uses Chartis' FinTech Quadrant™ – as part of its supply-side analysis – to explain the structure of the DI&C market. The FinTech Quadrant™ uses a comprehensive methodology that involves in-depth independent research and a clear scoring system to explain which technology solutions meet an organization's needs. The FinTech Quadrant™ does not simply describe one technology option as the best DI&C solution; rather it has a sophisticated ranking methodology to explain which solutions are best for specific buyers, depending on their implementation strategies.

This report covers the leading vendors offering DI&C solutions, including Asset Control, AxiomSL, Broadridge, Duco, FIS, Fiserv, GoldenSource, Gresham, IBM, Intellect Design, Irion, Oracle, Prometeia, Sapient, SmartStream, Wolters Kluwer, Workiva and zeb.

2. Demand-side analysis

Overview

Data is a valuable asset for FIs, but while the amount of it in the world continues to grow, and its nature continues to evolve, the effective exploitation of data remains something of an elusive goal. According to some estimates, while the volumes of data in circulation grow exponentially, large proportions of it are lying dormant and unused.

Yet in an era where digital wallets are overtaking cash, where electronic trading surpasses traditional 'hoot and holler', and where more consumers are spending their free time in virtual or augmented realities instead of the real world, we increasingly build more with 'clicks' than with 'bricks'. In that context, the quality, control and integrity of data is essential. For FIs in particular, strong DI&C is vital for the way they do business: allocating capital efficiently, generating profit and loss (P&L) statements, meeting regulators' needs, and keeping pace with competitors. Data integrity runs across the business: not only operations and risk, but also vital business decisions that combine financial accounting and customer engagement. Because these areas often rely on the same data, its quality is therefore of crucial importance to an institution's success.

Much of the groundwork for successful DI&C emerged out of the BCBS 239 standards. Published in 2013 by the Bank for International Settlements (BIS), these guidelines created a set of principles for how data and risk should be managed. Since then, however, a significant gap has emerged between regulatory requirements and market dynamics – although the BCBS 239 principles are still crucial for risk management, they no longer offer enough guidance to enable FIs to master the data at the heart of their operations.

Acknowledging this gap, in 2016 Chartis published its first *Data Integrity and Control in Financial Services* report to explore the implications for the demand and supply sides of this increasingly important sector. In it we defined 'data integrity and control' as a category of technology solutions in its own right, with a data integrity value chain for FIs comprised of six distinct elements:

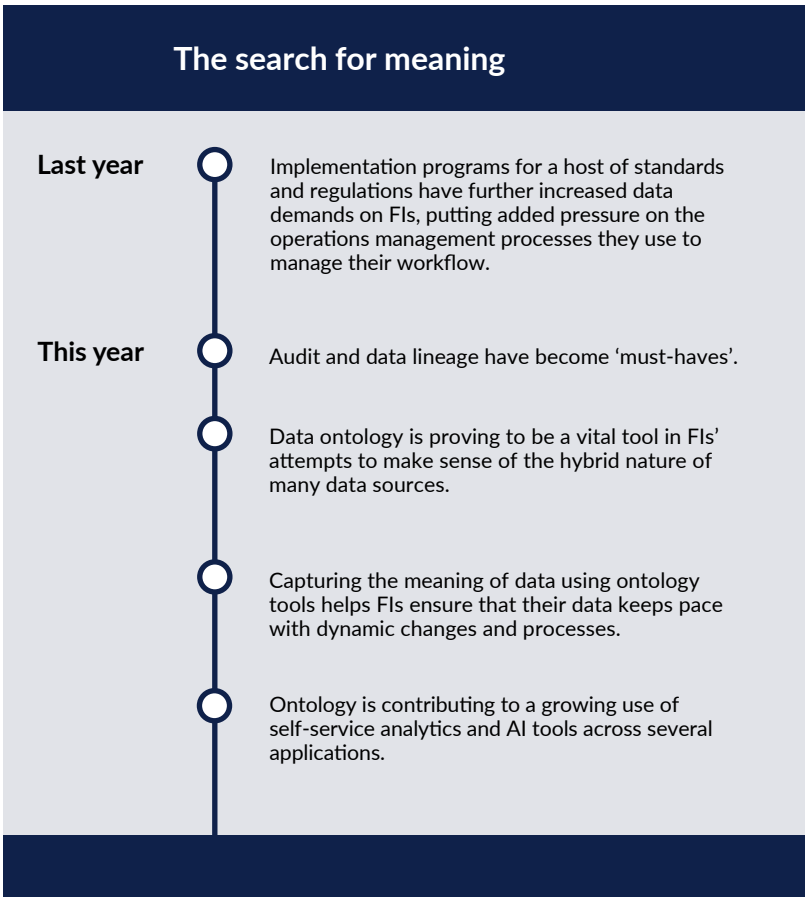
- Matching.
- Quality.
- Consistency.
- Transformation.
- Integrity.
- Distribution.

While these six elements remain central to DI&C, since the publication of our last report, a cluster of new themes and drivers have emerged.

The search for meaning

In the past year, implementation programs for a host of standards and regulations[1] have increased the data demands on FIs further, putting added pressure on the operational processes they use to manage their workflow. Audit and data lineage have now become 'must-haves', while data ontology (determining the meaning of data) is proving to be a vital tool as FIs attempt to make sense of the hybrid nature of many data sources (see Figure 1). By capturing the meaning of their data, it can be correctly classified, and FIs can ensure that the data stays relevant by keeping pace with dynamic changes and processes inside and outside the organization. Ontology has also contributed to the growing use of self-service analytics and AI tools across applications, such as data tagging and those that look to identify relationships and meaning within the data itself (identifying correlations in portfolio investment support).

Figure 1: Search for meaning in data: a brief timeline



Source: Chartis Research

New tools: transforming, analyzing, automating

A key aspect of successful DI&C is transforming unstructured data into structured data[2]. FIs can achieve this more easily with new statistical matching tools, which are becoming a vital addition to their

[1] *Such as the Current Expected Credit Loss (CECL) standard, Markets in Financial Instruments Directive II (MiFID II), International Financial Reporting Standard 9 (IFRS 9), the Fundamental Review of the Trading Book (FRTB), Payment Services Directive 2 (PSD2), the General Data Protection Regulation (GDPR), Securities and Exchange Commission (SEC) Modernization, Living Wills/Recovery and Resolution Plans (RRPs), the Comprehensive Capital Analysis and Review (CCAR), Dodd-Frank Act Stress Testing (DFAST) and European Banking Authority (EBA) Stress Testing.*

[2] *Generally, the distinction between structured and unstructured data is based on whether the data can be analyzed: in short, structured can and unstructured cannot. For more information, see Data Integrity and Control in Financial Services 2016, p.10.*

inventory. Using AI and ML tools in particular, FIs can identify more patterns and keep their data more integrated. Integrated data itself can then be fed into business analytics tools.

If data is the new gold, analytics are the tools to mine it. And as data repositories expand, organizations everywhere need more information about the best places to dig. Look in the wrong place and they could waste their resources and blunt their competitive edge. Alongside analytics to determine Return on Investment (RoI), Return on Equity (RoE) or Return on Capital (RoC), FIs must also now analyze and consider their Return on Data (RoD): knowing which bits of data can create higher returns, greater competitiveness, improved efficiency and increased client satisfaction.

In 2017 we also saw a notable, and rapid, increase in automation. Several influencing factors have boosted demand for automation among FIs: the need to protect and improve profit margins, the growth in data, heightened pressure from regulators, and the need for more efficient operations. New technology has stepped in to meet this demand – notably blockchain, with which FIs can potentially eliminate the manual reconciliation and repair of unreconciled data. The reconciliation process could eventually become redundant in fact; in the meantime, the reconciliation industry has much work to do to move away from its reliance on manual processes.

The availability of more open-source tools and high-performance databases is giving FIs even more opportunity to use new technology to address their DI&C issues. FIs now have a wide choice of technology environments in which they can store, access, process and distribute different types of data with different structures, volumes, velocities, qualities, sources and distribution targets. Although inevitably this increases the complexity and choice of the data available to FIs' systems, it also gives FIs and vendors powerful opportunities to solve more technological problems and enhance their capabilities.

A new approach

To do all this, FIs must take a more holistic, 'over the top' approach to their data, growing beyond the disciplines outlined in BCBS 239, with which they are still struggling. They must:

- Develop systems to convert unstructured into structured data.
- Look into the relationships between different types of data – just having accurate data is no longer enough.
- Address data ontology – managing the challenge of multiple, often hybrid data sources and management techniques.
- Investigate AI and ML tools for the input, processing and output stages of their data flow.
- Manage many types of data with different velocities, volumes and varieties, as well as the privacy and quality concerns around their data.
- Implement enhanced data governance processes, by extending a data-focused culture throughout the organization – ensuring that all meetings are recorded and stored centrally, for example, and exploring new possibilities that data can offer.

A rough journey

Achieving this won't be easy, however. Data and the systems to process and understand it create a complex and fragmented technology landscape. While FIs may already acknowledge the need for a holistic approach to data, many continue to manage their market, reference and reconciliation data separately, with unconnected or overlapping systems. Similarly, while some may employ tools to make unstructured data more structured, these are in parallel systems operating across different departments.

So far, the reuse of data remains more of an aspiration than a practise: a theoretical business-case argument confined to an MS Excel spreadsheet, rather than an actual deliverable or allocated resource. The coexistence of old, middle-aged and new systems[3] is increasing the technology fragmentation, sometimes enhancing the problems rather than resolving them. Paradoxically, in their eagerness to get more data, FIs are gathering it from new data sources (such as recently installed analytics systems) without having established processes to clean and manage it – which means they have to employ people to process it manually.

Data's growing importance as an ingredient for success is making companies like Alibaba, Baidu, Tencent, Microsoft, Google and Amazon ever more specialized in managing 'super data'. Not only do they derive more data, they can employ more data scientists, of higher calibre, to develop better systems to analyze this data and give it the meaning it lacks to add real business value. Increasingly they are setting the ground rules for other types of business too, such us payments, lending, investment management and crowdsourcing, and starting to challenge FIs directly. In order to compete effectively, DI&C tools are no longer just a 'nice to have' for FIs – they are becoming strategic essentials.

Most importantly, while FIs may want to invest in better, more joined-up DI&C, budget pressures and the ongoing need to achieve traditional data management best practices are hampering their attempts to combine their systems, pushing DI&C down the list of priorities. FIs' immediate business needs are being stoked by regulation, compliance, competition and new market and geopolitical changes. FIs tend to look first at reducing the cost of regulatory reporting by cutting the numbers of people they need for the job, and then by enabling data to be shared among regulatory and operational applications, risk management departments, finance and client-related activities.

The dynamics shaping DI&C tools

The following sections examine:

- The external dynamics in the market that are encouraging FIs to seek new functions and capabilities from their DI&C solutions.

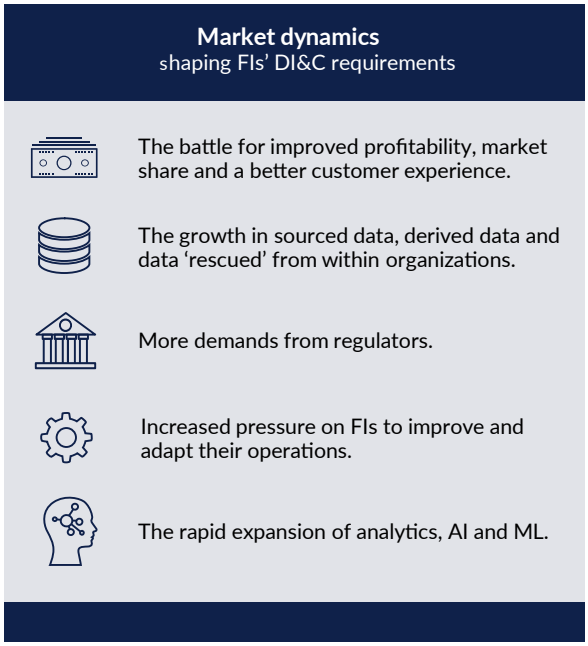
- The dynamics within FIs themselves that are helping to shape demand for specific functions in DI&C.

Market dynamics

Five external market dynamics are now shaping FIs' DI&C requirements (see Figure 2).

[3] *We define 'old' as more than seven years, 'middle-aged' as between two and seven years, and 'new' as less than two years.*

Figure 2: Market dynamics shaping DI&C tools



Source: Chartis Research

Battle for improved profitability, market share and a better customer experience

Macroeconomic shifts in the global economic and political landscape, and competition for traditional and new types of data, continue to put pressure on FIs' profit growth. Overall, despite limited rises in countries like the US and the UK, interest rates remain low. In Europe and Japan, where interest rates have been falling, the continued use of quantitative easing has dampened the performance of asset managers, pension funds and deposits. Meanwhile, political developments such as Brexit have increased uncertainty around investments. The biggest challenge, however, comes from technology, because it competes directly for budgets, and/or because it requires careful strategic choices and management decision-making.

Some profit in financial markets is migrating from investment banks to buy-side firms, information providers and exchanges and clearing houses. More buy-side clients are moving to passive investment products that demand more formal, and often very inexpensive, data management. Increasingly, the companies that are more profitable are those with data assets they can readily monetize, such as exchanges and post-trade intermediaries.

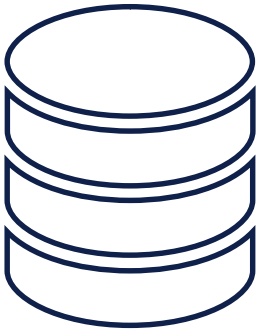
For embattled FIs, all these challenges involve data to some extent. By analyzing data they can gain vital insight into their commercial and technological environment, and seek out new tools, capabilities, products, clients and revenue streams. The overall success of a business is increasingly linked to high levels of data quality and efficient data processing.

One indication of the growing value of data is the profitability of the companies that provide it. Successful clearing houses, investment banks and exchanges now specialize in data and data provision; those that don't are working on their offerings. Information providers, buy-side firms and banks are expanding into analytics, while CEOs and CFOs at a range of firms are looking to maximize their risk-weighted returns by identifying new sources of data and better data analysis. Customers, for their part, are also becoming ever more demanding. Corporate clients expect improved data feeds and services to

help them navigate their systems, while retail clients are clamoring for ever more attractive, relevant and frictionless digital experiences. In both dimensions, monetizing data has become a new source of growth, and for many FIs the notion of RoD has become a guiding principle for achieving it.

FIs need data not only to boost their profits, but also to allocate capital and manage their liquidity. Those firms that need help collecting data may see their costs rise. Demand for third-party data sources is growing as financial markets become ever more complex and regulatory requirements multiply. Unfortunately, market data providers often fail to provide clean, consistent data, leaving FIs to bear the cost of data management. For Tier 1 FIs, which often have reconciliation and other DI&C functions in place, this can mean spending billions of dollars before they can use their data to make strategic or investment decisions and add value for their clients. Finally, as the volume and variety of data has increased (see below), so has the need for data taxonomies. So far, however, it is uncertain whether the main data suppliers will provide them, or whether taxonomies will come via consultancies and integrators that provide them as managed services – with a further impact on FIs' costs.

Data growth



Data is growing and evolving along multiple dimensions. Growth of the '3Vs' of data – volume, variety and velocity – continues, within and outside businesses, on the supply- and demand-sides of the market:

- Internal processes are becoming more complex, and involve more data needing to be transferred at faster speeds than ever before.
- Volumes of external data are also growing exponentially every day, as use of the Internet of Things[4], social media and mobile devices continues apace.

The supply of data – unstructured and semi-structured – is also increasing exponentially, from (among other things) technology, consumer platforms and new devices. Not only can this data support competitive, differentiated and metric-based decisions, it can also help FIs validate and reconcile without human intervention. Data growth is also accelerating within FIs, as they look for opportunities to grow their data so they can monetize it by using it for internal purposes, or by selling it.

New alternatives…

Many organizations now exploit so-called 'alternative data', which is usually unstructured and derived from a host of sources including logistic sensors, vehicles, satellites and media. The use of alt-data has had already a big impact on financial services (particularly among hedge funds, although also in equity and commodity trading, and lending), and will continue to grow in the next few years. Chartis will explore this increasingly important area in future research.

Data has to be accurate *and* 'smart', in that it must have meaning to help FIs make decisions, provide client services and meet their obligations to regulators, auditors and shareholders. FIs need ever more data to monitor their profits and to bolster their 'lines of defense' to ensure regulatory compliance. The growth of risk factor analysis means that investment managers are drilling down into the detail:

[4] *This phenomenon – essentially millions of web-enabled and connected devices – raises two important issues for organizations. It can act as an investment aid, deriving often counter-intuitive actionable insights from so-called 'alternative data'. And it can give organizations insights into managing their networks (of servers, data centers and so on).*

from holdings, to breakdowns of holdings, to transactions, dimensions of transactions, and finally to risk factors or drivers. Electronic trading using low-latency tools and systems is becoming a bigger and faster market. And as trading and operating processes become more complex, more data is created – and more data is needed.

Providing some structure

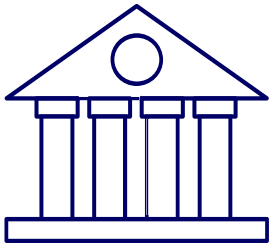
The level of work involved in organizing data depends largely on how structured the data is5. Volumes of unstructured data are still growing faster than structured data, partially due to the increased use of non-text-based data such as video and audio. Institutions are competing vigorously in their search for value in rich-media data streams. The focus has shifted from processing *Big Data*, in which the requirement was to digest the material that data streams produce, to *Fast Data*, which focuses on the timeliness of decision-making and the act of converting data into action – exemplified at its most extreme by low-latency trading.

In the past year, alongside an explosive growth in the creation and use of unstructured data, we have seen the emergence of new tools and more processing power to enable unstructured data to evolve into a more structured form. In the case of investment decisions, parsing unstructured data can consume vast amounts of IT infrastructure and cloud elasticity, and a great deal of manual editing and intervention from staff.

Various forms of unstructured data (such as bond prospectuses or loan documents) are gradually becoming more structured so they can satisfy certain business functions. These include providing warnings about potential non-compliance, providing support for investment decisions, or providing more accurate, validated structures such as those required for IFRS 9 and CECL audit disclosures.

Risk management shadows this trend. Risk systems use ever more unstructured data to measure risk, generate insight, support decision-making and reduce the amount of manual processing that staff have to do. On the other hand, manual intervention, reconciliation, matching and statistical techniques are still widely used, because they can provide a structure for data. Chartis' anecdotal research has revealed a huge increase in FIs' costs and the number of Full-Time Employees (FTEs) they use to manually analyze data and provide supervised learning support for statistical, AI and ML initiatives.

More demands from regulators



Beyond BCBS 239

Regulators are demanding more detailed, accurate and timely reporting and monitoring. Against this backdrop, for many FIs, software and service providers, DI&C is fully covered by the BCBS 239 principles. One positive development has been that the BCBS 239 requirements have been considered best practice not only in the larger organizations they were originally aimed at, but also – and more informally – throughout the rest of the financial services industry.

However, while useful, the BCBS 239 guidelines are not enough to enable FIs to reach full DI&C. BCBS 239 principles have enabled FIs to target a platform that provides accurate, validated, timely, and audited data with an established lineage that can be used within a DI&C framework. But, changing

[5] *See pp10-11 of our previous DI&C report.*

business and operational requirements (discussed in the next section), and important risk management and investment decision-making processes, require *semantic* and *ontological* approaches to data. In 'full' DI&C, 'meaning' must be embedded in the data itself to support these services with automation and AI/ML.

MiFID II has extended the principles of BCBS 239 with extra demands for comprehensiveness, timeliness and accuracy. To address MiFID II, FIs had assumed they could simply build on much of the work they had done for BCBS 239 and MiFID I, European Market Infrastructure Regulation (EMIR) and various stress tests. Unfortunately, however, MiFID II exposed the flaws in many FIs' embryonic systems, requiring them to undergo additional rewrite and overlay projects. It also revealed the need for 'full' DI&C, rather than just traditional data management that uses crudely cleaned and validated transactional data for regulatory and internal reporting.

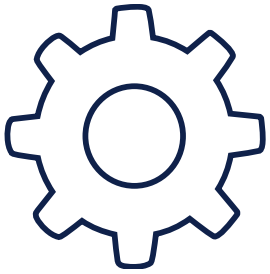
In 2017, MiFID II, IFRS 9, PSD2, GDPR, FRTB and CECL all, in different ways, affected how FIs manage their data. As programs to handle these regulations and standards were implemented, FIs' demand for data also increased. Those affected by IFRS 9 and CECL, with their accountancy and finance clients, demanded the most accurate data because they have a fiduciary responsibility to comprehensively report every interpretation and anomaly in disclosures, something that is not demanded by a regulator or risk manager. FRTB, meanwhile, requires much greater accuracy for P&L and P&L attribution in the front office and within the risk management function. This affects the amount of regulatory capital FIs must have, and their commercial performance.

This development offers a good example of how best practice in DI&C can have a positive influence on FIs' data handling and, ultimately, their financial performance. All the credit risk-related regulations and changes to accounting standards – especially IFRS 9 and CECL – increase the demand on FIs to process macroeconomic, behavioral and demographic market data, which is often unstructured. To do the necessary calculations FIs must make sense of market data, encouraging them to develop and/or buy tools to structure their data. Systems for GDPR – and in particular addressing the 'right to be forgotten' – require structured, easily identifiable data, while PSD2 is increasing the need for clear, easily transferrable data in the open banking space.

Meanwhile, for software, services and data vendors, the reuse of the regulatory reporting and compliance environments is an opportunity for new sales and 'upsell' business, especially if new regulation eases off in favor of the consolidation of regulatory initiatives that have already been launched.

Overall, recent regulations have forced FIs to store more data in an integrated and controlled way, and this has put even more pressure on their operations. Increasingly we are seeing FIs reusing the higher-quality data environment created by their regulation and compliance activities in the areas of operational risk management, operations, finance and client/customer relationship management. Nevertheless, for the most part this 'ideal state' is more of an aspiration among FIs – most of whom are still talking about it rather than achieving it. But it has to occur – ultimately FIs' overall performance will depend on how quickly they can turn theory into practice.

Increased need for better operations



Keeping the organization healthy

All these factors – the growth of data, more regulatory requirements and the need to integrate data across the risk management, operational, commercial and client-service areas of the business in increasingly complex system environments – are piling pressure onto FIs' IT and operations. Even before data volumes exploded, creating masses of unstructured data and millions of algorithmic-trading transactions, inappropriate processes and systems were a challenge for FIs, as was the complexity and volume of the data involved. Streams of unstructured data need well-functioning storage systems and hefty processing power.

In effect, operations are the 'veins' in an FI, carrying the 'blood' of data through the organization. Whenever a blockage appears the organism is at risk of 'losing consciousness' – quite simply, losing track of what is going on. Most of the recent tranche of regulations have highlighted how poor-quality data can slow, or even stop, an FI's circulation. The fact that workflow transaction processing is still not happening across the industry is problematic for the management and measurement of risk in decision-making. In short, healthy, enriched blood is not getting to the organizational brain.

Regulators set compliance timelines based on an assumption that FIs have timely workflow functions. But they have underestimated the time FIs will need to address the problem before implementing the new changes; many solutions to tackle bad workflow are still works-in-progress or short-term tactical fixes. Regulations such as PSD2 and MiFID II demand significant extensions and changes in targeted data subsets. These include long-established standardized transaction formats for trading cash and derivatives trading, such as Financial Information eXchange (FIX) and Financial products Markup Language (FpML), and the filing of formal accounts in eXtensible Business Reporting Language (XBRL). However, there is some way to go before commercial and retail lending, portfolio risk management and factor analysis become fully standardized and digitized. In the last decade, ever more formalized regulatory reporting has been regionalized and differs from jurisdiction to jurisdiction, creating many different targets and variables when it comes to systems transformation.

The end of reconciliation?

Blockchain is touted as one possible solution to some of the operational problems FIs face in this regard. Reconciliation, for example, creates huge costs for FIs, requiring advanced technology but still depending on people to execute. Blockchain can potentially reduce the number of repetitious and costly reconciliation hubs and interim data silos, which themselves breed inaccuracies, losses and data duplications. So far, however, this is happening slowly, and could take up to two decades to fully realize. For example, the reconciliation business thrives on in-house developments and software/service vendors, and any new data process has to be reconciled back to the organization.

Distributed Ledger Technology (DLT) – the broad category of technology to which blockchain belongs – still faces its own issues around volumes of transactions, prices and documents and the way it handles performance, authentication, validation and transaction updates. Nevertheless, we are seeing early-stage DLT implementations in trade finance, loan documentation, digital contracts, low-volume commodity trading in commodities such as diamonds, and client lifecycle management (CLM) in banking. There is also the large, ambitious DTCC derivatives transaction management initiative, which is acting as an important test-bed for the technology. The big upside is that if DLT/blockchain could completely

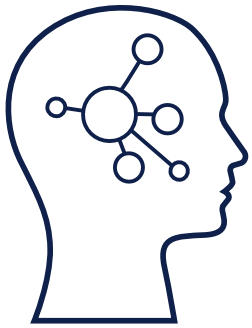
eradicate reconciliation processes, billions of US dollars would be removed from financial services industries' costs[6].

Positive shifts, but challenges remain

In the past decade, FIs' thoughts have been occupied with regulation, the fear of fines and the threat of very low margins. Slowly, however, regulation is coming under control, and has become more predictable in terms of its scope, timing and costs. Meanwhile, despite macroeconomic challenges, FIs have been able to get smarter and manage their cost-cutting better, improving their economic performance.

Despite these positive shifts, however, FIs' core data operations are not good enough to manage their normal operational and risk-management processes. A strong approach to data is vital, not only for processing Big Data or implementing regulations, but also to outperform competitors, satisfy clients and achieve high profit margins. Increasingly, success in the market is not about the slickest marketing, the best deal-making or the trendiest technology. What distinguishes the top-performing FIs in the market is their efficient operations, centred on best practices in data. What's more, this situation is unlikely to change anytime soon – unless, of course, AI has a positive impact on DI&C and operational management.

Accelerating expansion of analytics, AI and Machine Learning



The term 'Artificial Intelligence' covers a number of capabilities, including Maching Learning (ML), Robotic Process Automation (RPA), Natural Language Processing (NLP) and rules extraction. In simple terms, AI is a set of statistical processes that needs to be understood and managed in the right way to be effective. Faced with massive data burdens and regulatory requirements, FIs have turned to AI to segment their data sets and improve their analytics. AI is proving particularly effective in areas involving large numbers of documents and repetitive processes, mainly in automating legal, compliance and risk documentation.

One important consideration in using AI is the type of database that underpins it: different types of AI require different databases. Databases are growing in nature and number, and cover a range of risk management functionalities:

1. **Unstructured databases**: can process data (such as video) – including NoSQL and Hadoop – and are best suited to simple ML applications, such as regression.

2. **Array databases**: store data in grids of one, two or more dimensions, and support cluster algorithms, enabling specific data types to be arranged more efficiently. Very useful for advanced ML techniques (e.g. Deep Learning).

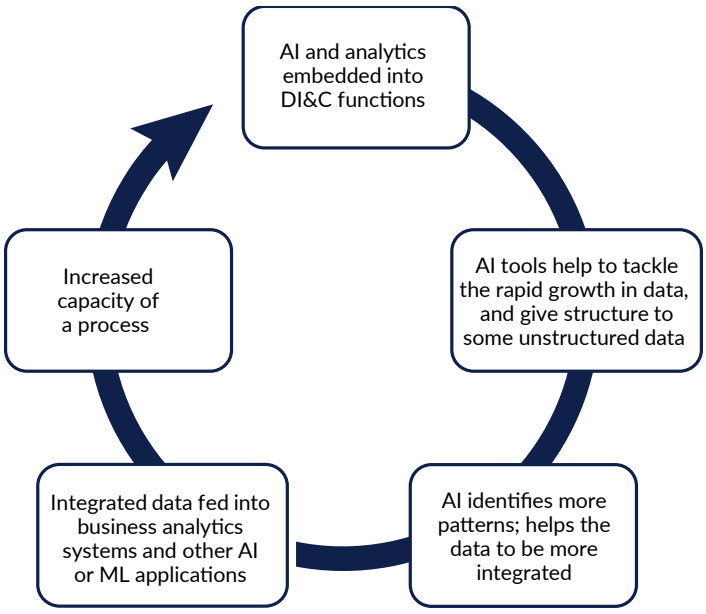
3. **Columnar databases**: store data in columns instead of rows, enable advanced AI and ML by allowing parallel processing.

4. **Graph databases**: employ graph structures for queries, underpinning advanced techniques such as graph analytics.

[6] *To read more about the influence of blockchain see Chartis' report* ***Spotlight on Blockchain in Financial Services – Time to Rein in Expectations****.*

AI and analytics are increasingly being embedded into DI&C functions. AI tools help organizations to tackle the rapid growth in data, and give structure to some unstructured data, but they themselves rely on large volumes of data to identify patterns. Being able to identify more patterns helps the data to be more integrated. This integrated data can then be fed into business analytics systems and other AI or ML applications (see Figure 3). This increases the capacity of a process, partly because an AI system can sift through more data than a human worker.

Figure 3: The data/AI cycle



Source: Chartis Research

The inevitable result of this, however, is that AI tools produce even more data. To become efficient in the face of this flood of data, the AI system needs to know what to focus on. Once again, data ontology is crucial, not only for successful AI – while more data is being produced, false positives and sloppy algorithms can be distracting – but also for effective DI&C processes. Grasping the meaning of data helps FIs keep up with dynamic changes and processes. Data with consistency and meaning can help AI tools to identify more patterns, which in turn can help to improve decision-making and risk and finance operations.

Enterprise dynamics

End-user analytics

Chartis has developed the concept of the DI&C value chain (see Figure 4), to help FIs understand their overall data environment and plan how to optimize their investments. The value chain splits the typical data flow in an organization into six 'integrity' steps, from the acquisition of data through to its final distribution.

Figure 4: The DI&C value chain

Source: Chartis Research

The steps are defined in our original report[7] – but note the following changes in this iteration:

- To the first step, 'Data reconciliation', we have added 'Updating and comparing market and reference data' and 'Checking for completeness and timeliness'.

- In the second step, 'Semantic data quality', we have altered the third bullet slightly to read 'Helping to reduce operator overload, thus moving from manual to automated systems.'

Recognizing that ETL (Extract, Transform, Load) is an activity that happens before and throughout the DI&C process, we have also added a seventh step:

- *End-user visualization and control*

    - Creating a microsystem (on an individual PC if necessary) for DI&C within the end user's environment.

    - Manipulation of data by end users.

    - Enabling end users to store, aggregate, analyze and visualize data.

FIs increasingly have to process many sources of data that have their own specific ETL end-user tools, so heads of IT are extending the ETL function throughout the organization, so it is not held centrally. ETL is no longer just the domain of IT specialists – it has been absorbed into a category of activity referred to as 'data wrangling', undertaken not necessarily just by IT staff, but by those with some IT skills, or skills in data; even business users.

By distributing the tools for data wrangling, FIs and their Chief Data Officers (CDOs) can orchestrate them through centrally determined policies and governance. End users – which can be clients, employees, partners or external agencies – are thus becoming more independent analyzers of data, using not just MS Excel but also tools that enable them to enhance the ontology of data by making various attributions in terms of structure, meaning and semantic definition. End users collect data, 'wrangle' it and use it for their specific business purposes. For this they effectively need a 'mini' DI&C framework in an End-User Computing environment.

Crucially, a data architecture has no final 'future state'. The ongoing evolution of business and data will create new challenges that will need fast fixes many years before replacement solutions become available. Companies which aim for best practices in data management will first need to achieve data maturity.

Achieving IT maturity in data integrity and control

For effective DI&C, FIs need mature data control processes and technology in place. It is rare to find mature IT systems across the whole enterprise; it tends to exist in different data domains ('puddles', 'lakes' and 'swamps') or, more likely, different business departments.

To achieve more consistent maturity across the organization, FIs must apply a data governance program. Overall data governance is a basic requirement for not just policies and procedures, but also taxonomies, ontology, data models and consistent measures, at the enterprise level.

[7] *See pp14-15.*

The reality is that governance processes often need to be implemented at a more granular level in the organization, at the level of the department, or even the sub-department involved with data engineering. But different departments (such as syndicated loans and middle-market lending) have different levels of maturity, as may their data management systems. Bringing this together requires enterprise-wide management of DI&C.

Data integrity and control: capabilities and functionality

Required functionality

Based on our demand-side analysis, we summarized FIs' required capabilities for DI&C solutions on pp21-22 of the previous report. These remain unchanged – although note that, to match the value chain, solutions must now also address the seventh step: end-user visualization and control[8].

Current functionality

Before risk solutions can be classified as DI&C offerings, they require a range of functions. In our previous report, Chartis divided these functions into the following categories: **governance; discovery; controls; audit; reporting, alerting and workflow; integration support; data insight**; and **adaptability**. Other factors include the FI's readiness to incorporate data integrity solutions, the types of data being processed, and sector-specific issues such as different requirements for data validation and analysis9. In this report, to reflect the ongoing development of DI&C solutions, we have added four additional categories: AI, Ontology, Data Security/Identity Management and Database Models.

AI

AI capabilities are becoming essential in both managing and exploiting the vast and ever-increasing swathes of available data, and are already being used in DI&C processes such as discovery. However, how AI is used depends on the type of database the data is stored in. Unstructured databases, for example, are best for simple ML, while array databases are useful for its more advanced variant. On the other hand, DI&C tools are necessary to support AI applications. To ensure it is complete enough and in a suitable format for AI applications, data needs to be properly managed.

Ontology

To be used effectively in a number of applications, data must have consistent meaning – without ontology DI&C functions are inefficient. Ontology reduces the amount of manual intervention FIs have to make, coding and building rules, and saving time and money. With time ontology will be able to develop on its own as new data contexts are discovered. Eventually systems will expose new data via ML systems and will build semantic attributions.

Data security/identity management

The GDPR will come into effect on 25 May 2018. Despite warnings of its arrival, most enterprises are behind schedule and underprepared for it. As well as mandating good data practices, GDPR will require companies to adhere to individuals' 'right to be forgotten'. However, data privacy is a complex area that will take some time to address properly. After FIs have the 3Vs of data under control, privacy

[8] *Note that in our analysis end-user visualization and control is distinct from the use of tools such as Excel in an end-user computing context.*
[9] *See pp18-20 of our previous report.*

and integration will emerge as the big stumbling blocks to getting value out of Big Data. In addition, there is the growing spectre of cyber risk, which is creating more demand for data security and good data practice.

Database models

Database models are used in different stages of database design, whether mapping relationships between data or reflecting how data is stored. Table 1 summarizes the main types of database model available.

Table 1: A brief summary of database models

Type of database model	Description
Flat	The simplest model, with the data stored in one table as a list.
Relational	Data is sorted into tables and the model addresses relationships between the tables.
Hierarchical	Data is organized into a 'tree', and each data record has a 'root'.
Network	Enables relationships between records that are linked.
Object-oriented	A collection of associated software 'objects'. (Examples include multimedia databases and hypertext databases.)
Object-relational	A hybrid that combines the relational model and the object-oriented model.
NoSQL	Types include graph databases (which are highly flexible), multi-value models (which contain lists rather than data points), and document models (which store and manage semi-structured data).
Entity-relationship	Similar to the network model; often used in database design.
Inverted file	Designed to enable fast, comprehensive text searches.
Multidimensional	This variation of the relational model is designed to enable online analytical processing.
Semi-structured	Useful for describing systems that are treated as databases but without a schema, and for interactions between databases with different schema.
Context	Incorporates other database elements as required.
Associative	Divides its data points according to whether they are independent or related to something else.

Type of database model	Description
Semantic	Incorporates information about the real-world importance and relations of data.
XML	Enables users to specify data in XML format.

Source: Chartis Research

Platform confusion

FIs' internal development teams, and several technology vendors, use a 'platform' concept, which can include data management platforms, data integrity platforms and data intelligence platforms. While there is much talk about 'platforms' in the technology industry, the term is a much used and abused one, and confusion abounds. One important clarification is that not everything that is 'as a service' constitutes a 'platform' – few 'as a service' offerings, in fact, are platforms, which can be internal or external to an organization.

Used correctly, though, a platform approach has several advantages:

- It leverages the combined capabilities of an ecosystem of individual products to drive more value than they can provide on their own.
- It enables third parties (such as ecosystem members and platform users) to build functionality (such as apps) and businesses on it. To do so they can use valuable services from the platform, but the platform itself does not have to change to support that particular functionality/business.
- It can integrate specific packages of services and distribution capabilities to cut down the amount of work and time taken to get propositions to market faster, more broadly, and with less cost.

The defining concept of a platform, and a data management platform in particular, is that it has a well-defined **abstraction layer** between the platform itself and the applications and functionality built on top of it. This makes the data more **meaningful** and **usable** for the business, providing a set of standards and services that can be used by many third parties over and over again to accomplish different goals.

A data integrity and control platform

A data management, integrity and control platform contains technology and business dimensions. The platform should be designed to enable its users to add functionality without affecting the underlying stack. Technically a platform should supply a well-defined set of standards that lay out how it should be used, and a rich (and growing) set of services that users can leverage to build their own functionality.

These tools and services should include a Software Developers' Kit (SDK) to leverage and modify or create services that operate across a choice of shared infrastructures (such as desktop, cloud and internal systems), depending on the nature of the platform. Ideally these services should also be standardized and general-purpose so that different platform users can do different things with them. At this stage in the maturity of platform content and development, however, to provide useful and meaningful data, FIs need specific platforms and ontological data. Ideally there needs to be a

top layer that is specific to financial services, using industry-standard database management and analytics components.

Platforms are powerful tools and there are many good reasons to build them. But FIs should be clear up-front about whether they should be platform *users* or platform *builders*. If an FI is looking to leverage the power of a platform, it is sometimes not entirely obvious which approach makes most sense. If the organization builds a platform, it must ensure its technical, business and organizational design are all set up to make it a success. It is not enough to have sophisticated technology and engaged staff – FIs must spread awareness and knowledge across the organization so that all staff can keep up with any new developments.

Technology trends in data integrity and control

Several broad trends have been identified in the technology underpinning DI&C, and which are shaping the landscape.

A move to the cloud

Cloud solutions are dominating the DI&C space – the importance of the cloud is something Chartis will explore further in forthcoming research[10].

AI and ML gaining momentum

Most FIs are investigating AI projects of some description, although only a few of these will succeed, in line with the necessary 'trial and error' pattern familiar in most technology adoption. There are three main reasons for this:

- The FI lacks sufficient resources.
- The FI fails to select and manage the appropriate technology, methodology and model.
- Managing, integrating and controlling the necessary data infrastructure is a complex task – the infrastructure must be secure, involving clustered hardware, and data flows must be supervised. Cloud offerings can enable FIs to automate and outsource many of their processes and ensure that their data infrastructure is always functioning.

Apache Hadoop issues

Despite Hadoop's popularity in recent years, some FIs have had problems setting it up, complaining about issues including its complexity and poor support for small files. In response, Hadoop enthusiasts argue that it is still the best tool for large data sets, and that because it will remain a core component of the enterprise stack, its problems are likely to be fixed.

Spark on the rise

In some quarters, Apache Spark has been promoted as a better and faster way to process data for Hadoop clusters than MapReduce. Despite claims that a new framework, Ray, might replace Spark,

[10] *See also the Chartis Report Spotlight on Risk as a Service.*

Spark has continued to evolve, gaining deep learning capabilities and being adapted to use specialized hardware like Graphics Processing Units (GPUs) and Field-Programmable Gate Arrays (FPGAs).

New analytics support

Graph databases are proving increasingly popular, thanks to their usefulness in specific applications involving connected data. Some FIs are using visualization tools, which are also becoming more popular, while firms that specialize in visualization are enjoying some growth. Some investment managers are even using virtual reality techniques to explore their data. Finally, as we highlighted earlier, end users in many organizations now have more control over data.

Data fabrics and data swamps

So-called 'data fabrics' enable FIs to streamline data management tasks and handle data across a variety of databases. They can also help FIs to address some of the software integration challenges with Hadoop. Because data fabrics can address some of the challenges with siloed data, we expect their use to continue well into 2018.

Data swamps, however, pose a new threat. While keeping Hadoop data lakes clean and consistent provides much work for software vendors, it's a tough battle. There is a considerable gulf between public pronouncements on the strength and quality of institutional data lakes, and the concerns of leaders over the real risk that their data lakes will be overwhelmed with ill-defined information of uncertain origin.

Conclusion

FIs need a renewed focus on DI&C – moving beyond their current data operations to a position where they can exploit data to differentiate themselves. External and internal dynamics are shaping the solutions they need, and ongoing developments in technology are influencing and driving the tools they can use. Best practice will mean adopting 'full' DI&C: a holistic approach that incorporates strong and mature IT, data governance and management, and ontology and automation. Finally, this level of engagement needs to move beyond the larger institutions if FIs are to leave their 'makeshift' solutions behind and fully and consistently embrace the potential data offers.

3. Supply-side analysis

Vendor landscape

We can categorize vendors in the DI&C space by their backgrounds and heritage, broadly classifying them as:

- Reconciliation providers.
- Application providers.
- Market and reference data management providers.
- Regulatory and transaction reporting providers.

Over time some vendors – usually the larger data management ones – have moved into other categories from their original specialties, usually because they have invested in or acquired other companies. While this ability has distinguished the performance of some vendors, for others it has created problems. In some cases their own data integration was unable to keep up with their appetite for investment, leaving them with more than one data model, or the need to develop a process to integrate their data model with new systems.

Furthermore, following acquisitions, multiple data and cross-reference schemes may be running, creating duplication, and a lack of cross-referencing that can lead to companies' own systems requiring additional internal reconciliation.

To tackle the problems with data integration, Tier 1 FIs and leading vendors are purchasing DI&C systems from established suppliers (see Figure 5). To satisfy increasingly broad requirements for DI&C they also have to integrate a large number of third-party tools and functions to manage and use hybrid database environments. Best practice for vendors may be to mirror this behavior among Tier 1 Fis, developing a mix of SQL, MongoDB and graph database environments that make use of different AI tools.

Figure 5: How FIs and vendors are tackling data integration

Source: Chartis Research

Over time, the DI&C environment is likely to get tougher for smaller and newer vendors. Building use cases around data takes time, and a vendor that has been around for 20 to 30 years has plenty of experience, even if it has not updated its technology. By contrast, vendors with excellent technology but a lack of experience often struggle to deliver added value above the technology – helping to make business and organizational changes.

In many ways, the Tier 1 banks and the leading vendors are offering a dynamic environment in which individual tools can be blocked and replaced if they fail. Similarly, by operating in the same way as the big FIs, the leading vendors put pressure on the smaller players, which may not offer much variety in their solutions.

All vendors are responding to at least some of the adjacent opportunities that exist in the market – such as AI and ML – and have started to merge their criteria and move to a common space in terms of the functionality they offer, albeit at different speeds. This is because sales of certain types of function, such as reconciliation and reference data management, tend to be greater.

Companies that don't operate in those areas have relied on other vendors to provide solutions to their shared clients. In particular areas, therefore, there is a lack of shared functionality because specific clients often rely on dominant suppliers of reconciliation and reference data management. Meanwhile, other companies in their second and third iteration don't develop reconciliation and reference data management, relying instead on clients' multivendor approach.

Many vendors[11] are reluctant to say where they are in their progress toward a 'full' DI&C solution. This may indicate that they have yet to develop a successful data model. We are currently seeing companies spending considerable sums on best-practice service but not necessarily following through with deliverables. Combining all DI&C tools into one environment is a difficult task. Some companies rely on their clients making multiple purchases from different vendors and doing the integration themselves. Only a few vendors have combined most, or nearly all, functionality into a full DI&C offering.

Categories of tools

Mixing it up

Chartis has divided DI&C tools into seven categories[12]:

- Data modeling tools.
- Data quality tools.
- Master data management.
- Data reconciliation and control.
- Data presentation and reporting.
- Extraction, Transformation, Loading (ETL).
- End-user monitoring, activity and control.

We use these categories to illustrate the variety and types of tools that a typical large vendor may develop to satisfy the different segments of the DI&C value chain. This has highlighted some interesting angles. A typical large DI&C vendor, for example, will not specialize in a single DI&C category (such as data quality). The most common approach by far is a mixture of categories, although this mostly happens by necessity and circumstance rather than conscious choice.

Vendors are still adopting this 'mix and match' approach to their solutions. Nevertheless, the gap has widened between the comprehensiveness of the offering and their competence in delivering it, and intermittent quality and incomplete functionality. This seems to be the result of focused investment based on a number of factors: a strategic appreciation of the role of data, a corporate 'data DNA', and efficient execution of solutions.

Over time, categorizing vendors according to the tools they offer becomes more and more problematic as they absorb different functions. Most vendors now use ETL, for example. Many vendors are adopting cutting-edge technology such as AI and ML or, depending on their investment philosophy, new capabilities and resources, adopting audit and data lineage simply because they cannot be in the marketplace without them. We are also seeing some vendors making use of metadata and semantics, and even developing semantic ontological models.

[11] *Note that several DI&C providers either did not respond to Chartis' request for a briefing, or declined to participate in our research.*
[12] *For more information, see pp23-25 of our previous DI&C report.*

A question of focus

Some vendors support the full lifecycle of data across the DI&C value chain, from checking and controlling the integrity of trade and transactional data (such as reconciliations), all the way through the lifecycle and progress of data elements within the organization. This includes:

- Data quality (both rule-based and statistical).
- Semantic control/mapping and management of intermediate data.
- The lineage of this intermediate data.
- Sophisticated storage and management.
- A comprehensive data model.
- Providing tools for effective data distribution and access control.

Other vendors, meanwhile, focus on a specific aspect of the DI&C lifecycle, such as reconciliation at the trade and transaction level, while others focus on lineage and governance. Equally, while some focus on reconciliation, governance and management of complex data types, others focus on relatively simple but high-volume transactions.

Application vendors, many of which have been in business for decades, have broadly split into two groups:

- Those that have established a transparent DI&C platform framework that underlies their application.
- Those that have tinkered with their application to embed aspects of data management and data quality in a non-strategic way.

Those in the second category may have done enough to survive in the past decade, with its heavy regulatory environment and sensitivity to data, offering features and functions to retain their user base and pick off undemanding clients. But going forward they are likely to face several life-threatening challenges.

Some application vendors conceal their lack of coverage in data management and DI&C by offering Software as a Service (SaaS) and managed services that conceal their internal operations by delivering outcomes and 'experiences'. However, challenges with this approach soon become clear – typically around developing 'must-have' qualities such as multi-tenancy, client data segregation, end-point cyber security flexibility of reporting, and client 'self-service'.

So far, data management solutions are weak in the area of blockchain, which is still an immature market. This is likely to change rapidly, however, as blockchain/Distributed Ledger Technology (DLT) could offer the vital building blocks needed to improve DI&C and reducing the need for reconciliation. Vendors may still be watching developments at this stage, but they are likely to become involved eventually, once the innovators have gained a foothold and shown that the technology works. The irony, however, is that the lack of DI&C applications that support the technology is creating added risk in the marketplace.

Fragmentation of offering

Despite vendors' claims that they cater to most segments of the data integrity value chain shown in Figure 4, our analysis highlights how their approach to DI&C is fragmented across different types of tools. Most vendor-bundled offerings are incomplete, and range widely in their quality and performance. As a result, financial services end users often have to put together a patchwork quilt of third-party, internally developed and external services offerings to create a workable – but potentially vulnerable – solution.

Very few vendors have created a genuine 'data intelligence platform', although some aspire to it by bringing together applications and building and integrating the relevant technology layers. Some vendors have even succeeded when projects have been led by smart clients.

Conclusion

The vendor landscape often reflects the client one: both environments are siloed and segmented, although market drivers are encouraging more integration, aggregation, optimization and data reuse. This is reflected in a shift in data management, integrity and control solutions. They used to be attached to individual functional applications and separate data tools that operate individual and focused components of data functionality. Now, however, they are becoming increasingly integrated. Gradually, in turn, these integrated solutions are evolving into platforms.

In another echo of the end-user landscape, vendors' approaches to DI&C can be fragmented, mixing up various tools or focusing on specific areas, with the size of the vendor playing an important role. Like the FIs they serve, however, vendors are responding to technology trends, with most investigating automation and some venturing into blockchain territory. And by exploring the possibilities offered by 'full' DI&C they can open up new possibilities in this vital space.

FinTech Quadrant™ for data integrity and control solutions in financial services

Figure 6 shows Chartis' view of the vendor landscape for DI&C technology solutions. The FinTech Quadrant™ is a proprietary methodology developed specifically for the financial technology marketplace. It takes into account vendors' product, technology and organizational capabilities. Appendix A sets out the generic methodology and criteria used for the FinTech Quadrant™. Specifically, we have considered the following criteria as particularly important:

- Completeness of offering:
    - Organizational maturity.
    - Governance.
    - Discovery.
    - Automation.
    - AI and Machine Learning.
    - Audit.

    - Reporting.
    - Integration support.
    - Alerting and workflow.
    - Data reconciliation tools.
    - Reference and semantic data management.
    - Support and insight for varied data types.
- Market potential:
    - Customer satisfaction.
    - Market penetration.
    - Growth strategy.
    - Financials.
    - Business model.
    - Enterprise readiness.
    - Multi-sector presence.
    - Roadmap.

As in the previous report, the 'Support for and insight into varied data types' (in the 'Completeness of offering' scoring) evaluates how well a particular vendor's tools analyze structured and unstructured data[13].

Since the last report we have also added:

- AI and Machine Learning - this is one of the key initiatives that the most successful vendors are investing in. Others are developing offerings but will not have any deliverables until 2019 at the earliest, while some vendors are postponing their solutions until even later. The most successful applications are aimed at reducing manual intervention, and identifying and automatically repairing inaccuracies and incomplete elements. Compared with manual intervention using employees, the ROI for these new tools can be compelling.

We also split 'Semantic integrity, control and reconciliation' into 'Data reconciliation tools' and 'Reference and semantic data management'. Historically both these disciplines have had dedicated vendors, necessitating separate assessments – and this dichotomy still exists. A few of these separately categorized vendors have recognized that the two disciplines are interrelated and, when

[13] *Data Integrity and Control in Financial Services 2016, p26.*

working together, can lead to a more integrated platform. Good reference data can be 'learnt' from reconciliation systems, which in turn can automate the reconciliation and repair process.

Note that the revised scope of this report, and its focus on AI/ML and ontology, meant that not all vendors we approached agreed to be briefed for our quadrant analysis. This may have been because they felt their offerings were outside the scope of our report, or because they are in the process of further developing their offerings.

Table 2 summarizes our assessment of the vendors' capabilities.

Figure 6: FinTech Quadrant™ for data integrity and control solutions in financial services

Source: Chartis Research

Table 2: Data integrity and control solutions in financial services – vendor capabilities table

Vendor	Organizational maturity	Governance	Discovery	Reporting	Automation	AI and Machine Learning capabilities	Audit and data lineage	Integration support	Alerting and workflow	Data reconciliation tools, techniques and support for varied types of data	Reference and semantic data management	Support and insight for varied data types
Asset Control	**	***	**	***	**	*	****	****	***	*	****	***
AxiomSL	***	***	***	****	***	**	****	***	***	*	**	****
Broadridge	**	**	*	****	**	**	****	***	****	***	***	**
Duco	*	*	**	****	**	**	**	**	*	****	*	**
FIS	***	**	**	****	****	**	****	**	****	****	**	***
Fiserv	**	***	*	***	**	*	***	***	**	****	**	***
GoldenSource	****	***	**	**	**	*	****	**	***	*	****	****
Gresham	**	**	***	***	***	**	****	***	***	****	**	****
IBM	****	****	**	****	****	****	****	****	****	*	**	****
Intellect Design	**	**	**	****	**	*	****	**	***	**	**	***
Irion	**	***	***	****	***	*	****	**	***	*	**	***
Oracle	***	****	***	****	**	**	****	***	****	**	***	****
Prometeia	***	**	**	***	**	****	****	**	****	***	***	**

Vendor	Organizational maturity	Governance	Discovery	Reporting	Automation	AI and Machine Learning capabilities	Audit and data lineage	Integration support	Alerting and workflow	Data reconciliation tools, techniques and support for varied types of data	Reference and semantic data management	Support and insight for varied data types
Sapient	**	***	**	*	**	**	***	***	**	*	**	**
SmartStream	***	***	****	**	**	*	****	**	***	****	****	**
Wolters Kluwer	**	**	***	***	**	*	****	***	***	*	*	***
Workiva	**	**	**	****	***	*	****	***	**	*	**	****
zeb	**	***	**	***	***	*	***	***	***	**	**	****

Source: Chartis Research

4. Appendix A: FinTech Quadrant™ methodology

Chartis is a research and advisory firm that provides technology and business advice to the global financial services industry. Chartis provides independent market intelligence regarding market dynamics, regulatory trends, technology trends, best practices, competitive landscapes, market sizes, expenditure priorities, and mergers and acquisitions. Chartis's FinTech Quadrant™ reports are written by experienced analysts with hands-on experience of selecting, developing, and implementing financial technology solutions for a variety of international companies in a range of industries including banking, insurance and capital markets.

Chartis's research clients include leading financial services firms and Fortune 500 companies, leading consulting firms and financial technology vendors. The FinTech vendors that are evaluated in the FinTech Quadrant™ reports can be Chartis clients or firms with whom Chartis has no relationship. Chartis evaluates all FinTech vendors using consistent and objective criteria, regardless of whether or not they are a Chartis client.

Where possible, FinTech vendors are given the opportunity to correct factual errors prior to publication, but cannot influence Chartis's opinion. FinTech vendors cannot purchase or influence positive exposure.

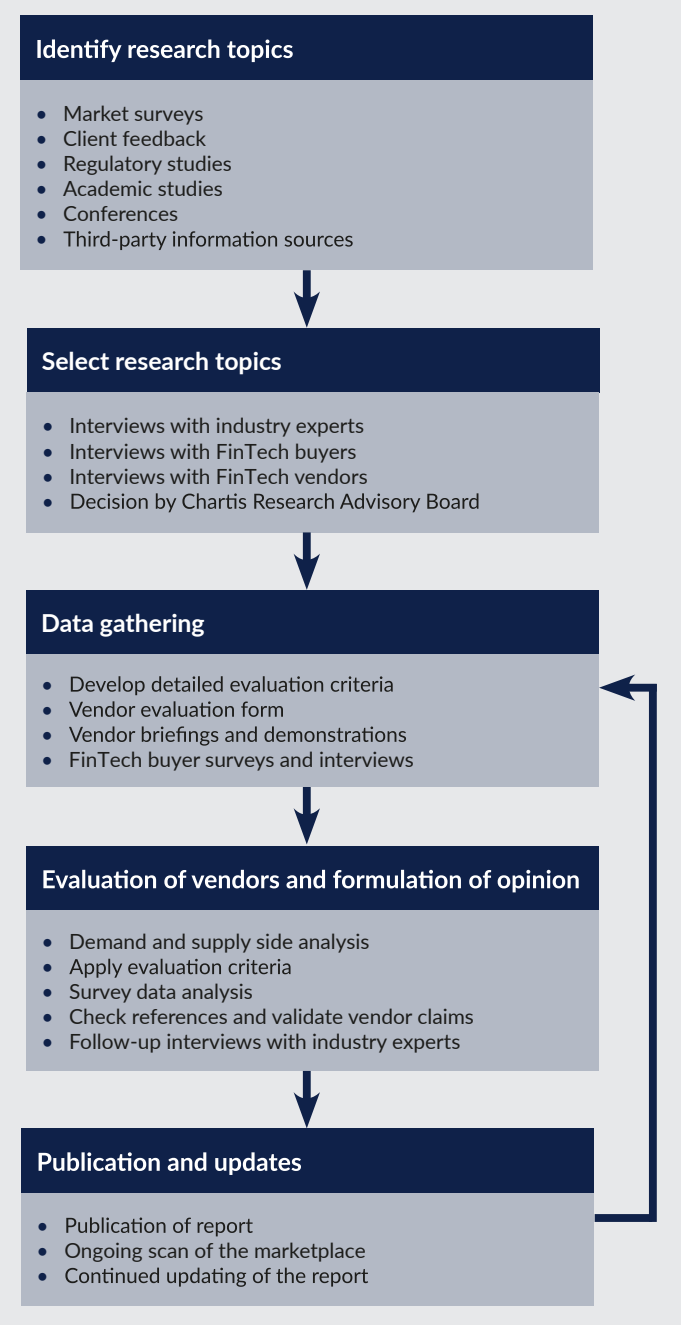
Inclusion in the FinTech Quadrant™

Chartis seeks to include FinTech vendors that have a significant presence in a given target market. The significance may be due to market penetration (e.g. large client base) or innovative solutions. Chartis does not give preference to its own clients and does not request compensation for inclusion in a FinTech Quadrant™ report. Chartis utilizes detailed and domain-specific 'vendor evaluation forms' and briefing sessions to collect information about each vendor. If a vendor chooses not to respond to a Chartis vendor evaluation form, Chartis may still include the vendor in the report. Should this happen, Chartis will base its opinion on direct data collated from FinTech buyers and users, and from publicly available sources.

Research process

The findings and analyses in the FinTech Quadrant™ reports reflect our analysts' considered opinions, along with research into market trends, participants, expenditure patterns, and best practices. The research lifecycle usually takes several months, and the analysis is validated through several phases of independent verification. Figure 7, below, describes the research process.

Figure 7: FinTech Quadrant™ research process



Source: Chartis Research

Chartis typically uses a combination of sources to gather market intelligence. These include (but are not limited to):

- **Chartis vendor evaluation forms.** A detailed set of questions covering functional and non-functional aspects of vendor solutions, as well as organizational and market factors. Chartis's vendor evaluation forms are based on practitioner level expertise and input from real-life risk technology projects, implementations, and requirements analysis.

- **Risk technology user surveys.** As part of its ongoing research cycle, Chartis systematically surveys risk technology users and buyers, eliciting feedback on various risk technology vendors, satisfaction levels, and preferences.

- **Interviews with subject matter experts.** Once a research domain has been selected, Chartis undertakes comprehensive interviews and briefing sessions with leading industry experts, academics, and consultants on the specific domain to provide deep insight into market trends, vendor solutions, and evaluation criteria.

- **Customer reference checks.** These are telephone and/or email checks with named customers of selected vendors to validate strengths and weaknesses, and to assess post-sales satisfaction levels.

- **Vendor briefing sessions.** These are face-to-face and/or web-based briefings and product demonstrations by risk technology vendors. During these sessions, Chartis experts ask in depth, challenging questions to establish the real strengths and weaknesses of each vendor.

- **Other third-party sources.** sources In addition to the above, Chartis uses other third-party sources of information such as conferences, academic and regulatory studies, and collaboration with leading consulting firms and industry associations.

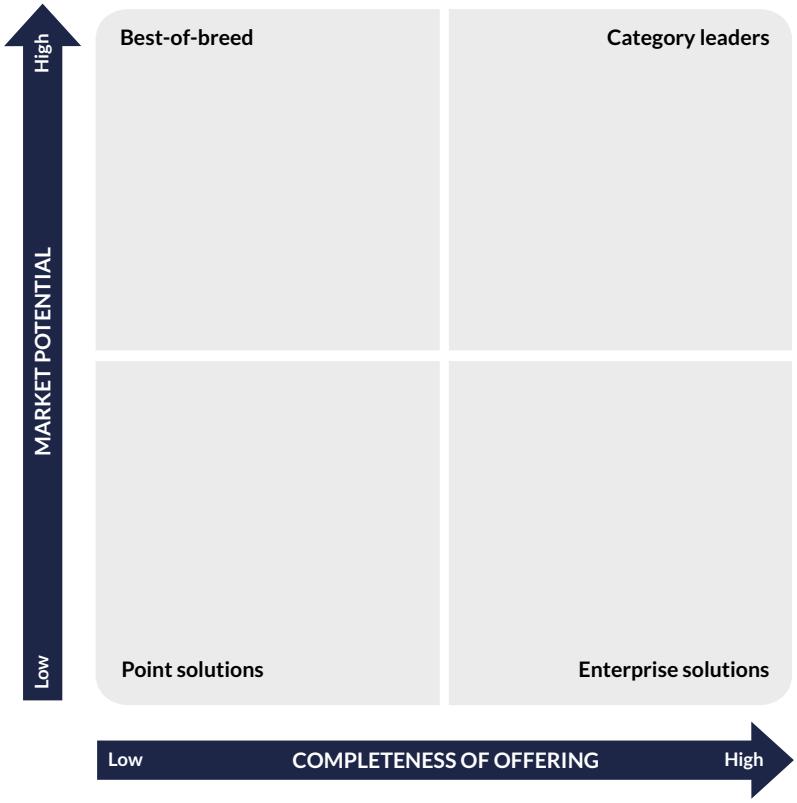
Evaluation criteria

The FinTech Quadrant™ (see Figure 8) evaluates vendors on two key dimensions:

1. Completeness of offering

2. Market potential

Figure 8: FinTech Quadrant™



Source: Chartis Research

The generic evaluation criteria for each dimension are set out below. In addition to these generic criteria, Chartis utilizes domain-specific criteria relevant to each individual risk, which are available on request. This ensures total transparency in our methodology and allows readers to fully appreciate the rationale for our analysis.

Completeness of offering

- **Depth of functionality.** The level of sophistication and amount of detailed features in the software product (e.g. advanced risk models, detailed and flexible workflow, domain-specific content). Aspects assessed include: innovative functionality, practical relevance of features, user-friendliness, flexibility, and embedded intellectual property. High scores are given to those firms that achieve an appropriate balance between sophistication and user-friendliness. In addition, functionality linking risk to performance is given a positive score.

- **Breadth of functionality.** The spectrum of requirements covered as part of an enterprise risk management system. This will vary for each subject area, but special attention will be given to functionality covering regulatory requirements, multiple risk classes, multiple asset classes, multiple business lines, and multiple user types (e.g. risk analyst, business manager, CRO, CFO, Compliance Officer). Functionality within risk management systems and integration between front-office (customer-facing) and middle/back office (compliance, supervisory, and governance) risk management systems are also considered.

- **Data management and technology infrastructure.** The ability of risk management systems to interact with other systems and handle large volumes of data is considered to be very important. Data quality is often cited as a critical success factor and ease of data access, data integration, data storage, and data movement capabilities are all important factors. Particular attention is given to the use of modern data management technologies, architectures, and delivery methods relevant to risk management (e.g. in-memory databases, complex event processing, component-based architectures, cloud technology, software-as-a-service). Performance, scalability, security, and data governance are also important factors.

- **Risk analytics.** The computational power of the core system, the ability to analyze large amounts of complex data in a timely manner (where relevant in real time), and the ability to improve analytical performance are all important factors. Particular attention is given to the difference between 'risk' analytics and standard 'business' analytics. Risk analysis requires such capabilities as non-linear calculations, predictive modeling, simulations, scenario analysis, etc.

- **Reporting and presentation layer.** The ability to present information in a timely manner, the quality and flexibility of reporting tools, and ease of use are important for all risk management systems. Particular attention is given to the ability to do ad-hoc 'on-the-fly' queries (e.g. what-if-analysis), as well as the range of 'out-of-the-box' risk reports and dashboards.

Market potential

- **Market penetration.** Both volume (i.e. number of customers) and value (i.e. average deal size) are considered important. Also, rates of growth relative to sector growth rates are evaluated.

- **Brand.** Brand awareness, reputation, and the ability to leverage current market position to expand horizontally (with new offerings) or vertically (into new sectors) are evaluated.

- **Momentum.** Performance over the previous 12 months is evaluated, including financial performance, new product releases, quantity and quality of contract wins, and market expansion moves.

- **Innovation.** New ideas, functionality, and technologies to solve specific risk management problems are evaluated. Developing new products is only the first step in generating success. Speed to market, positioning, and translation into incremental revenues are critical success factors for exploitation of the new product. Chartis also evaluates business model or organizational innovation (i.e. not just product innovation).

- **Customer satisfaction.** Feedback from customers regarding after-sales support and service (e.g. training and ease of implementation), value for money (e.g. price to functionality ratio) and product updates (e.g. speed and process for keeping up to date with regulatory changes) is evaluated.

- **Sales execution.** The size and quality of sales force, sales distribution channels, global presence, focus on risk management, messaging, and positioning are all important factors.

- **Implementation and support.** Important factors include size and quality of implementation team, approach to software implementation, and post-sales support and training. Particular attention is given to 'rapid' implementation methodologies and 'packaged' services offerings.

- **Thought-leadership.** Business insight and understanding, new thinking, formulation and execution of best practices, and intellectual rigor are considered important by end users.

- **Financial strength and stability.** Revenue growth, profitability, sustainability, and financial backing (e.g. the ratio of license to consulting revenues) is considered as key to scalability of the business model for risk technology vendors.

Quadrant descriptions

Point solutions

- Point Solutions providers focus on a small number of component technology capabilities, meeting a critical need in the risk technology market by solving specific risk management problems with domain-specific software applications and technologies.

- They are often strong engines for innovation, as their deep focus on a relatively narrow area generates thought leadership and intellectual capital.

- By growing their enterprise functionality and utilizing integrated data management, analytics and BI capabilities, vendors in the Point Solutions category can expand their completeness of offering, market potential and market share.

Best-of-breed

- Best-of-Breed providers have best-in-class point solutions and the ability to capture significant market share in their chosen markets.

- They are often distinguished by a growing client base, superior sales and marketing execution, and a clear strategy for sustainable, profitable growth. High performers also have a demonstrable track record of R&D investment, together with specific product or 'go-to-market' capabilities needed to deliver a competitive advantage.

- Focused functionality will often see Best-of-Breed providers packaged together as part of a comprehensive enterprise risk technology architecture, co-existing with other solutions.

Enterprise solutions

- Enterprise Solutions providers typically offer risk management technology platforms, combining functionally-rich risk applications with comprehensive data management, analytics and BI.

- A key differentiator in this category is the openness and flexibility of the technology architecture and a 'toolkit' approach to risk analytics and reporting, which attracts larger clients.

- Enterprise Solutions are typically supported with comprehensive infrastructure and service capabilities, and best-in-class technology delivery. They also combine risk management content, data and software to provide an integrated 'one-stop-shop' for buyers.

Category leaders

- Category Leaders combine depth and breadth of functionality, technology and content with the required organizational characteristics to capture significant share in their market.

- Category Leaders demonstrate a clear strategy for sustainable, profitable growth, matched with best-in-class solutions and the range and diversity of offerings, sector coverage and financial strength to absorb demand volatility in specific industry sectors or geographic regions.

- Category Leaders will typically benefit from strong brand awareness, global reach and strong alliance strategies with leading consulting firms and systems integrators.

5. How to use research and services from Chartis

IIn addition to our flagship industry reports, Chartis offers customized information and consulting services. Our in-depth knowledge of the financial technology market and best practice allows us to provide high-quality and cost-effective advice to our clients. If you found this report informative and useful, you may be interested in the following services from Chartis.

For FinTech buyers

If you are purchasing a FinTech solution, Chartis's vendor selection service is designed to help you find the most appropriate solution for your needs.

We monitor the market to identify the strengths and weaknesses of the different FinTech solutions, and track the post-sales performance of companies selling and implementing these systems. Our market intelligence includes key decision criteria such as total cost of ownership) comparisons and customer satisfaction ratings.

Our research and advisory services cover a range of FinTech topics such as trading systems, collateral management, risk management, data aggregation, analytics and business intelligence.

Our vendor selection services include:

- Buy vs. build decision support
- Business and functional requirements gathering
- Identification of suitable implementation partners
- Review of vendor proposals
- Assessment of vendor presentations and demonstrations
- Definition and execution of Proof-of-Concept (PoC) projects
- Due diligence activities

For FinTech vendors

Strategy

Chartis can provide specific strategy advice for FinTech vendors and innovators, with a special focus on growth strategy, product direction, go-to-market plans, and more. Some of our specific offerings include:

- Market analysis, including market segmentation, market demands, buyer needs, and competitive forces
- Strategy sessions focused on aligning product and company direction based upon analyst data, research, and market intelligence
- Advice on go-to-market positioning, messaging, and lead generation
- Advice on pricing strategy, alliance strategy, and licensing/pricing models

Thought leadership

FinTech vendors can also engage Chartis to provide thought leadership on industry trends in the form of in-person speeches and webinars, as well as custom research and thought-leadership reports. Target audiences and objectives range from internal teams to customer and user conferences. Some recent examples include:

- Participation on a 'Panel of Experts' at a global user conference for a leading Global FinTech vendor
- Custom research and thought-leadership paper on the latest financial services regulations and implications for technology solutions
- Webinar on new FinTech solutions for customer onboarding and due diligence
- Internal education of sales team on key regulatory and business trends and engaging C-level decision makers

6. Further reading

- *Data Integrity and Control Solutions in Financial Services 2016*
- *RiskTech100® 2018*
- *Hedge Fund Risk Management Technology 2018*
- *IFRS 9 Technology Solutions: Market Update 2017*
- *Spotlight: quantifying cyber risk in financial institutions*
- *Spotlight on Risk as a Service*

For all these reports see ***www.chartis-research.com***.