

# Mitigating IT Risk for Financial Risk Analytics

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May, 2014

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## Executive Summary

*Financial Risk Analytics has evolved beyond a secondary regulatory and cost-focused perspective, to become a core part of businesses. Today, Risk Analytics provides a competitive edge by enabling businesses to efficiently use capital and manage risk exposures with higher confidence to make better informed and timelier business decisions. Hence CEOs increasingly rely on their CFOs and their Chief Risk Officers (CROs) for strategic advice and active risk management.*

*Risk Analytics using simulation-based tools provides a powerful, flexible and accurate way of assessing credit, market and liquidity risks. Simulation techniques can effectively handle a wide range of market conditions, complex portfolios comprised of a variety of instruments including derivatives that involve collateral, margins and counter-party agreements.*

*Many firms view IT infrastructure investments for Risk Analytics as a competitive differentiator critical to promoting enterprise-wide sharing of risk information with holistic risk governance. But IT is also a source of risk - lack of adequate security, performance and disaster recovery must be mitigated.*

*IBM Algorithmics provides sophisticated analyses of different economic scenarios that help firms better quantify risk for a single department or firm-wide across a common set of market scenarios. With Algorithmics, firms have a better handle on their financial exposures, market and credit risks before they finalize transactions. Assessing intraday risks with greater confidence can help boost a firm's profitability and growth.*

*The Mark-to-Future (MtF) methodology in IBM Algorithmics enables firms to fully simulate portfolio values over all instrument types across all scenarios and time steps to quantify risks with considerable precision. But with ever larger portfolios and scenarios, exponential growth of data, and more stringent regulations, MtF simulation requires a high-performance parallel computing infrastructure to eliminate performance bottlenecks in both batch and real-time calculations. But this further drives up IT risk due to manageability and complexity.*

*To get timely and trusted insights from Risk Analytics while minimizing IT risk and improving time-to-value, IBM is delivering an **Application Ready Solution for Algorithmics**. This integrated offering, anchored on a validated scalable high-performance clustered reference architecture, delivers the timely risk insights firms need to lower Tier 1 capital.*

*Firms should consider deploying this IBM Application Ready Solution for Algorithmics to achieve active and scalable risk management by distributing the computational demands of advanced risk analytics across a dynamic grid computing environment. With this Application Ready Solution, enterprises that deploy risk management can move from reactively measuring risk to actively managing risk based on timely insights drawn from more accurate analyses. This solution also lowers the total cost of ownership, improves time-to-value and mitigates IT deployment and management risks.*

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## Managing Enterprise Risk End-to-End is Crucial

Businesses today are under intense pressure to cut costs yet improve the quality, accuracy and confidence of risk assessment. Increasingly firms, particularly in the financial sector, must adhere to an avalanche of stringent and complex regulatory requirements. Regulators now require tighter supervision of model risk management and are carefully dissecting failures from inadequately managing operational risk.

Besides traditional quantitative risks such as credit, market and liquidity risks; qualitative risks such as operational, reputation and strategic business risks are increasingly becoming important<sup>1</sup>. Consequently, CEOs increasingly rely on their CFOs and their Chief Risk Officers (CROs) for strategic advice and active risk management<sup>2</sup> to gain a competitive edge.

In the past, many firms analyzed risk in silos or using ad-hoc approaches without structured governance processes. But now, with recent Basel III, Solvency II and Dodd Frank regulations aimed at stabilizing financial markets after the global financial crisis, firms have strong incentives to improve compliance in order to reduce capital requirements and reserves.

But these new regulations place increased demands on risk managers to prove compliance through rigorous analytic requirements, procedures and models. The level of sophistication of risk models used varies widely from relatively simple spreadsheet tools to complex mathematical models that can scale to thousands of economic scenarios and instruments.

## Standardized Simulation-based Methods Quantify Risk Better

Many legacy risk systems –often ad-hoc and in silos - use approaches that cannot scale to handle the increased volume and frequency of analyses now demanded by regulators. The need to consistently apply accurate risk insights in making timely decisions throughout the enterprise is driving firms to improve risk governance, standardize risk frameworks, consolidate risk systems, and share infrastructure and combine insights.

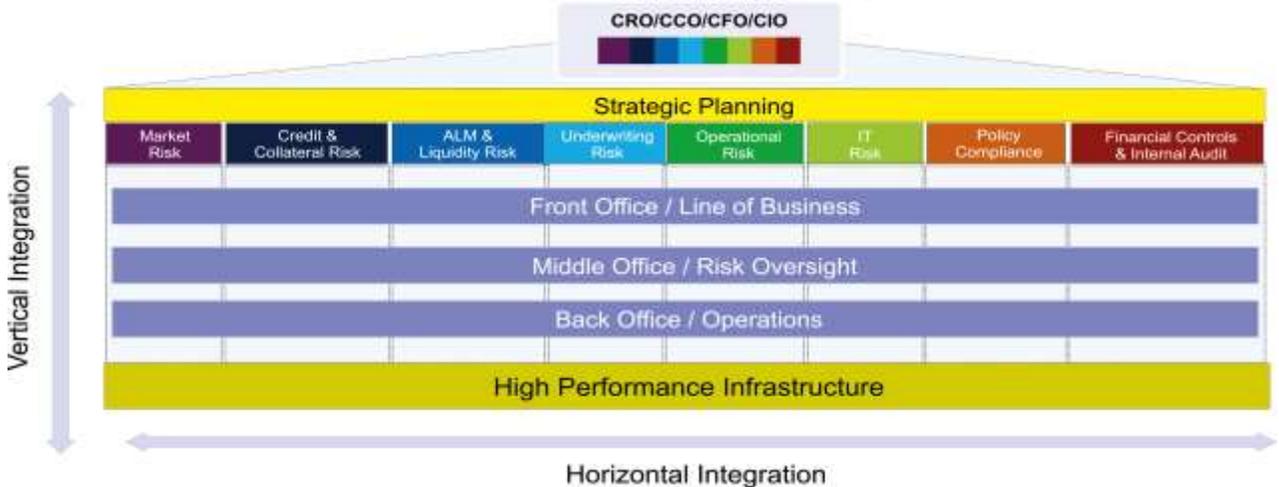


Figure 1: Better Outcomes with Vertical and Horizontal Integration of Risk<sup>3</sup>

<sup>1</sup> Chartis, "The Risk Enabled Enterprise – Global Survey Results and Two Year Agenda", 2013, <http://public.dhe.ibm.com/common/ssi/ecm/en/yt103273usen/YTL03273USEN.PDF>

<sup>2</sup> Pushing the frontiers: CFO insights from the IBM Global C-suite Study, 2014, <http://public.dhe.ibm.com/common/ssi/ecm/en/gbe03590usen/GBE03590USEN.PDF>

<sup>3</sup> Michael Zerbs, IBM Banking Summit 2013, [https://www-950.ibm.com/events/www/grp/grp004.nsf/vLookupPDFs/Risk%20and%20Capital%20Management%20-%20Deriving%20Incremental%20Value/\\$file/Risk%20and%20Capital%20Management%20-%20Deriving%20Incremental%20Value.pdf](https://www-950.ibm.com/events/www/grp/grp004.nsf/vLookupPDFs/Risk%20and%20Capital%20Management%20-%20Deriving%20Incremental%20Value/$file/Risk%20and%20Capital%20Management%20-%20Deriving%20Incremental%20Value.pdf)

*Accurate active risk management crucial for competitive edge*

*Standardized simulation frameworks with consolidated systems improve risk assessments*

More than 2/3<sup>rd</sup> of losses sustained by financial firms between 2008 and 2011 were due to Credit Value Adjustment (CVA) mismatches<sup>4</sup> rather than actual defaults. Hence, many leading firms are empowering their traders with investments in real-time risk analytics for better trading outcomes; extending their risk management operations from traditional end-of-day Value-at-Risk (VaR) reporting in the middle office to decision support in the front office.

In order to empower the front office, these firms need an active vertically and horizontally integrated enterprise risk management strategy that relies on having an up-to-date aggregate view of exposures firm-wide. This includes accurate valuations and risk measurements—reflecting CVAs of portfolios and new transactions. Pioneering banks are investing in systems that more accurately assess CVA<sup>5</sup>, and integrate CVA into pre-deal pricing and structuring to support future growth by freeing up more capital and minimizing earnings volatility.

Simulation-based tools provide a powerful, flexible, consistent and accurate way of assessing credit, market and liquidity risks and CVAs. These techniques can effectively handle a wide range of market conditions, complex portfolios comprised of a variety of instruments including derivatives that involve collateral, margins and counter-party agreements, all within a standardized framework that promotes enterprise-wide sharing and consistency.

The Mark to Future (MtF) methodology<sup>6</sup> in IBM Algorithmics is designed to be this standard framework for simulation-based risk management, including market, credit and liquidity risks. MtF enables firms to fully simulate portfolio values over all instrument types across all scenarios and time steps to quantify risks with considerable precision.

## IBM Algorithmics' Integrated Risk Management Solution Suite

[IBM Algorithmics](#) provides solutions for market, credit and liquidity risk, as well as collateral and capital management. Its customer list includes more than 300 global clients in over 30 countries, including 70 of the world's top banks.<sup>7</sup> Key solutions include:

- **Market Risk** provides a scalable integrated risk platform to measure, manage and control capital market exposures across asset and liability functions
- **Credit and Capital** delivers real-time access to accurate, integrated credit data, enabling regulatory compliance, enhanced decision making and improved financial performance
- **Collateral and Management** provides timely access to accurate collateral related data, reducing operational risk and increasing business opportunities
- **ALM (Asset Liability Management) and Liquidity Risk** provides a simulation based framework to handle sophisticated products, address regulatory requirements and support advanced calculations such as stochastic scenarios

Predictions of market, credit and liquidity risks are based on the MtF methodology – a cornerstone intellectual property and foundational computational kernel in Algorithmics that requires a high performance computing (HPC) infrastructure.

<sup>4</sup> <http://www.shearman.com/~media/Files/NewsInsights/Publications/2013/11/BaselIIIIFrameworkTheCreditValuationAdjustmentCVA-ChargeforOTCDerivativeTradesFlAFR111113.pdf>

<sup>5</sup> Algorithmics, "Credit Value Adjustment:and the changing environment for pricing and managing counterparty risk", December 2009, <http://www.cvacentral.com/sites/default/files/Algo-WP1209-CVASurvey.pdf>

<sup>6</sup> Dr. Philip Symes, "Algorithmics Mark-to-Future", <http://www.philipsymes.com/finance/algorithmicsmtf.pdf>

<sup>7</sup> [http://www.investinontario.com/en/Pages/OS\\_financialservices\\_success\\_stories\\_ict.aspx](http://www.investinontario.com/en/Pages/OS_financialservices_success_stories_ict.aspx)

*Pioneering firms investing in real-time front office Credit Value Adjustments (CVA) capabilities for competitive edge*

*Algorithmics' MtF standard framework promotes collaboration, consistency and accuracy for risk management including CVA*

*Algorithmics provides solutions for integrated market, credit and liquidity risks*

## Why MtF Requires High-Performance Infrastructure?

To calculate counterparty risk exposures under Basel 3, banks may choose a standardized method or an internal model method (IMM) approach. While more complex, IMM can help banks qualify for default risk capital savings. IBM Algorithmics supports IMM through its Mark-to-Future (MtF) portfolio valuation methodology (Figure 2), which is based on a risk and reward framework<sup>8</sup> where scenarios are the drivers of uncertainty. This methodology can capture implied relationships between various risk factors. Credit, market and liquidity risks can be integrated in one framework. Monte Carlo simulations of instrument valuations are run through time and across numerous possible scenarios.

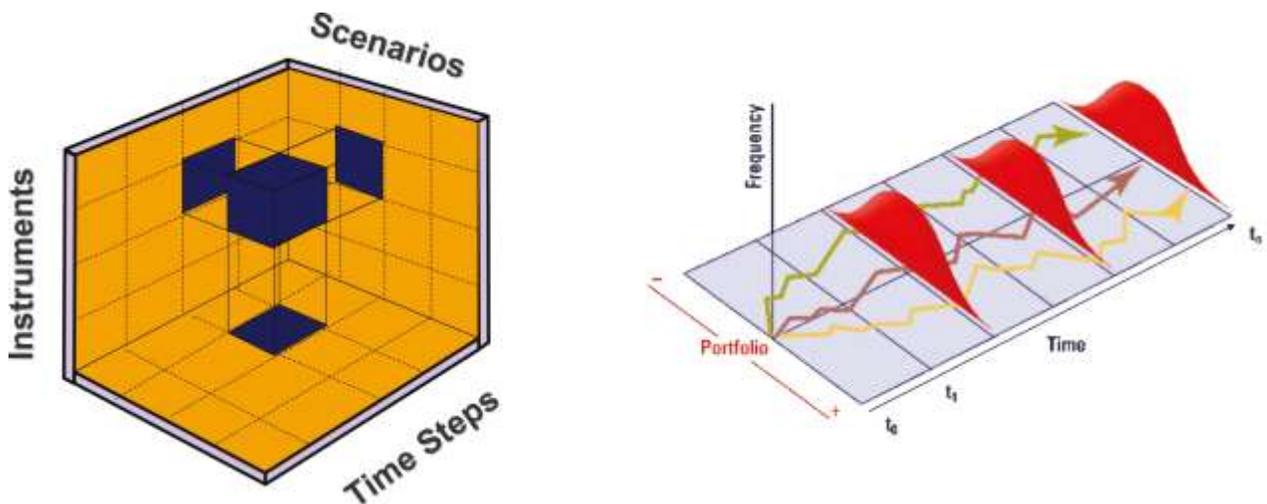


Figure 2: MtF Cube and Computing Forward in Time<sup>9</sup>

Valuations calculated across all relevant scenarios are then aggregated to compute a wide array of risk measures and statistics. This methodology is highly flexible and takes advantage of distributed processing throughout the analytic process. But with much larger portfolios and scenarios, exponential growth of data, more real-time risk analytics and stricter regulations, the IT infrastructure must be able handle compute and data intensive workloads.

## Flexible, Agile, High Performance Infrastructure More Crucial Now

Risk analytics is being integrated deeper and is becoming more pervasive across the enterprise. For example, firms are extending their risk management operations from traditional end-of-day reporting in the middle office with a few users, to decision support in the front office with a much larger cadre of traders. Further, interactive reports that are required to support trading decisions must be available in near real-time<sup>10</sup>. This implies that the IT infrastructure must support a combination of large-scale compute and data-intensive analytics with real-time batch workloads. It must be flexible, agile and high-performance for compute and data.

<sup>8</sup> Ron S. Dembo, et. al., "Mark to Future: A Framework for Measuring Risk and Reward", <http://public.dhe.ibm.com/common/ssi/ecm/en/vt03132usen/YTL03132USEN.PDF>

<sup>9</sup> Oleksandr Romanko, "Mathematics at Algorithmics", [http://studc.cms.math.ca/events/2011/CMSWinter2011Toronto/files/panel/Romanko\\_Math\\_at\\_Algo\\_CMS\\_Dec2011.pdf](http://studc.cms.math.ca/events/2011/CMSWinter2011Toronto/files/panel/Romanko_Math_at_Algo_CMS_Dec2011.pdf)

<sup>10</sup> Neil Bartlett, "Risk Management Data Meets Moore's Law", <http://public.dhe.ibm.com/common/ssi/ecm/en/vt03162usen/YTL03162USEN.PDF>

*MtF 3D Risk-reward method standardizes calculations but is compute and data intensive*

*Infrastructure must be agile, flexible and high-performance to support large-scale compute and real-time batch workloads*

Following the 2007 global credit crisis, many financial firms began managing counterparty credit risk (CCR) better by using CVA<sup>11</sup>. But this is a complex challenge for a trading desk to quantify and manage because of its cross-asset and credit contingent nature. It also significantly drives up performance requirements. CVA doubles the revaluation of all derivative transactions over a few thousand Monte Carlo scenarios and a hundred or so time steps. Worse, to hedge the profit/loss swings associated with CVA changes, it's crucial to understand the sensitivity of CVA changes to all relevant market and credit risk factors. This may require that the entire Monte Carlo simulation to run not just a few times but rather hundreds of times per nightly batch run. Although there are numerical techniques that can speed up this process, the computational requirements are still dramatically increased.

In order to deal with these emerging risk management challenges, firms are refreshing their systems and deploying specialized accelerators such as GP-GPUs when necessary. Without overloading networks or letting costs go out of control, enterprises are deploying innovative high-performance parallel infrastructure solutions that right-size compute and right-place storage resources based on the importance and time-criticality of each analytic job. This helps accelerate business results and deliver fully simulated near-real-time risk assessments.

### IBM Technical Computing Solutions for Risk Analytics

IBM offers a wide array of leading [technical computing and big data solutions](#) including high-performance systems, clusters, HPC clouds, and pre-integrated big data solutions. Featured systems include: IBM System x [high-performance](#) servers, [IBM Flex System](#) and [IBM System Storage](#). Key technical computing software includes powerful and intuitive workload and resource management software from [IBM Platform Computing](#), [IBM Elastic Storage based on IBM General Parallel File System \(GPFS\) technology](#) – a high-performance shared-disk and clustered file system. Additional offerings include [IBM DB2](#) database software that offers industry leading performance, scale, and reliability; middleware and business partner applications and service providers with deep proven expertise in the financial services industry. Additionally, IBM has a worldwide technical staff of domain experts to collaborate with clients and prospects to migrate and optimize Algorithmics on IBM systems and software to solve their largest and most challenging risk analytics problems.

#### Key benefits of some unique IBM solution components include:

- **IBM System x servers and IBM NeXtScale:** These servers deliver flexibility in a high-density footprint. They provide highly reliable, high-performance and flexible platforms that can scale quickly and inexpensively. Financial firms can cost-effectively perform risk simulations for their largest trading counterparties in just a few minutes. This gives them the compute power they need to execute “what-if” risk profiles in milliseconds for pre-deal analysis on the trading room floor or run time-critical, end-of-quarter, large-scale asset-liability risk analytics for insurance applications.

Additionally, the **IBM Flex System** is a fully integrated infrastructure platform that combines no-compromise system design with built-in expertise and are integrated into complete, optimized solutions. This fully integrated infrastructure platform supports a mix of compute, storage, and networking resources. It is simple to acquire and deploy quickly and can automatically adapt to changing operating conditions. Financial firms

<sup>11</sup> IBM White Paper, “Toward active management of counterparty credit risk with CVA”, <http://public.dhe.ibm.com/common/ssi/ecm/en/vtw03216usen/YTW03216USEN.PDF>

*CVA drives up compute and data needs by orders of magnitude*

*Firms investing more in high-performance infrastructure*

*IBM offers high-performance infrastructure with servers, storage with workload, resource and data management software*

*IBM Elastic Storage delivers high performance, availability and business continuity*

can accelerate time-to-value and mitigate IT deployment and management risks with the built-in broad patterns of expertise and proven guidelines in systems management, applications, and hardware maintenance.

- IBM Elastic Storage:** It is an enterprise-grade parallel file system, fully POSIX compliant (so no need to pre-load data), delivering very high performance with no single point of failure and maintaining business continuity. Each compute node gets fast parallel read/write access to a common file system to accelerate the job. IBM Elastic Storage dramatically improves simulation performance by avoiding filer “hot spots” common in network file sharing (NFS) or Server Message Block (SMB) file-sharing implementations. Fast parallel file system access is critical to speed up aggregation steps in Algorithmics and also helps improve query performance.

This technology also provides efficient block-level data replication between multiple clusters in the same data center or in a remote center. Current data sets that are replicated between centers not only ensure business continuity if one center is unavailable, but also provide additional capacity to help meet periods of peak demand.

- Platform Symphony:** It is a reliable, efficient and easy-to-use enterprise-grade grid management solution with fail-over capabilities, supporting multiple job streams within Algorithmics and many other concurrent applications. This helps organizations share infrastructure across a growing set of applications, reducing total cost of ownership (TCO). Symphony is ideal for scalable system environments where consolidation can greatly increase resource utilization. It also improves performance and efficiency with sub-millisecond latency and minimal wait time between job steps in the workflow.

Symphony’s scheduling model enables it to immediately accept and complete urgent, shorter-duration workloads, preempting less-critical applications. This provides traders exceptional agility to reevaluate risks based on changing market conditions by borrowing resources as necessary. Agility and speed are further enhanced by Symphony’s ability to allocate resources dynamically at run time.

The following case studies leverage many of these solution components including [IBM Platform Symphony](#), [IBM GPFS](#) and [IBM System x servers](#) and is the basis of the IBM Application Ready Solution for Algorithmics and the associated [reference architecture](#).

## Case Studies: Agile High-Performance Scalable Risk Analytics

Many global Algorithmics clients benefit from IBM’s broad portfolio of technical computing infrastructure solutions that boost performance, utilization and efficiency; lowering total cost of acquisition and ownership (TCA and TCO). Often fewer servers are required to satisfy business and capacity requirements, translating to lower operating costs for facilities, electricity and labor while mitigating IT risks. Here are some real life deployments:

### Major European Bank

<b>Challenges</b>	<ul style="list-style-type: none"> <li>To comply with Basel III, this bank had to run more exhaustive risk analyses with IBM Algorithmics within a tight allotted time.</li> <li>Large Algorithmics’ MtF simulations created bottlenecks with the bank’s NFS based file system, further delaying timelines.</li> </ul>
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*Platform Symphony low latency scheduler offers significant unique performance advantages for large-scale risk analytics*

*IBM Technical Computing solutions boost performance, utilization and efficiency; lowering total cost of acquisition and ownership*

*Far better performance, capacity and availability for risk analytics with GPFS on IBM System x and Storage*

<b>Solution</b>	<ul style="list-style-type: none"> <li>• An IBM System x iDataPlex with about 1200 x86 cores and IBM Storage with IBM GPFS to solve compute and data bottlenecks.</li> <li>• GPFS provided an independent path between compute nodes and storage to speed up data management.</li> <li>• The GPFS environment was architected for availability with mirrored data volumes to a second site for business continuity.</li> </ul>
<b>Benefits</b>	<ul style="list-style-type: none"> <li>• Dramatic reductions in aggregation time by replacing the current file system with GPFS and increasing the data transfer speeds from compute hosts (MtF output) to shared storage.</li> <li>• The bank has full report on its risk exposures on time every day with low risk of failure.</li> <li>• Up to 10x improvement in raw file system I/O and 2x increase in scenario modeling capacity.</li> </ul>

### A Global Insurer

<b>Challenges</b>	<ul style="list-style-type: none"> <li>• This insurer offers products such as pensions and annuities and needed a risk system that enables its analysts to accurately model risk to determine the right asset mix/investment level to meet profit/loss and liabilities goals and reserve sufficient capital for risk and Solvency 2 requirements.</li> <li>• Needed a system that was robust, scalable, and fast and be free of compute and data bottlenecks that often slow Monte Carlo simulations. Simulations can involve up to: 150 time steps, 100,000 scenarios, 750 risk drivers, etc.</li> </ul>
<b>Solution</b>	<ul style="list-style-type: none"> <li>• IBM Platform Symphony grid management and GPFS software running on about 1100 x86 cores. Matlab, an IBM Business Partner was used to develop models.</li> </ul>
<b>Benefits</b>	<ul style="list-style-type: none"> <li>• Very agile and scalable risk system, enabling analysts with on-demand capabilities for rapidly developing, testing, and deploying risk models.</li> <li>• Easily processes large scale simulations including workloads and data volumes created by Algorithmics MtF calculations.</li> <li>• Significantly improved overall system efficiency through effective sharing of critical IT resources.</li> <li>• Gained needed capacity without adding hardware</li> </ul>

### Major Asian Bank

<b>Challenges</b>	<ul style="list-style-type: none"> <li>• Liquidity exposure calculations with Algorithmics on a dedicated cluster took 100 hours to analyze 150,000 records.</li> </ul>
<b>Solution</b>	<ul style="list-style-type: none"> <li>• IBM Platform Symphony grid management software and services.</li> </ul>
<b>Benefits</b>	<ul style="list-style-type: none"> <li>• Reduced calculation times by 90% to 10 hours</li> <li>• Expanded access to 6 times the amount of compute capacity through resource sharing, resulting in performance improvement for multiple applications.</li> </ul>

*Very agile and scalable system for rapid development, test and deployment of risk analytics with Platform Symphony and GPFS*

*Enhanced performance and capacity for liquidity risk with Platform Symphony and GPFS*

As clients increasingly deploy complex IT infrastructure for today's risk analytics, they are looking to mitigate IT risk and improve time-to-value and manageability. To address these needs, IBM is delivering an **Application Ready Solution for Algorithmics**.

## The IBM Application Ready Solution for Algorithmics

This integrated offering, anchored on a validated scalable high-performance clustered reference architecture, delivers timely risk insights and mitigates IT deployment and management risks.

**Unique Business Value:** We believe that this IBM solution is well-optimized for these time-critical risk analytics workflows because the solution is:

- **Workload Optimized.** Each solution component is optimized to handle its individual tasks very effectively with excellent performance and reliability.
- **Seamless.** Solution components complement each other, making the workflow seamless and fast.
- **Conformant with Common Open Industry Standards.** These IBM components support common open-source industry standards, making solution deployments simpler.
- **Supported End-to-End.** Customers get the benefit of end-to-end IBM support and services for the IBM components and overall solution

**Solution Description:** This solution provides an expertly designed and tightly integrated architecture for easily deploying and managing an optimized enterprise-wide risk management infrastructure based on IBM Algorithmics AlgoOne (sold separately). It is a collection of IBM software and hardware components such as IBM Platform Cluster Manager, IBM Platform Symphony, and IBM Elastic Storage, with a choice of IBM Flex System blade servers or IBM NeXtScale Systems for larger, scale-out deployments.

The IBM Application Ready Solution for Algorithmics solution consists of:

- **Complete cluster:** A comprehensive, tightly integrated cluster designed for ease of procurement, deployment, and operation. It includes required components for a risk analytics cluster including recommended servers, network adapters, storage, operating system, management software, and runtime libraries.
- **Application optimized configuration:** The reference architecture and recommended configurations have been carefully designed to accelerate risk calculations and data management, ease workload and resource management. This helps reduce total cost of ownership and IT risks. IBM also provides install scripts to quickly deploy the infrastructure, enabling users to become productive more quickly.
- **Advanced technology for performance and robustness:** The hardware and software components in the cluster are customizable to allow the best performance or the best price/performance ratio.
- **Commercial, solution-level support:** The IBM clusters are pre-integrated, tested and supported as a complete solution.

*Optimized and tuned for seamless execution of risk analytics workflows*

*Supported end-to-end and conforms to open industry standards*

*Complete, integrated risk management infrastructure solution, based on "best practices" reference architecture.*

*Mitigates IT deployment & manageability risks for Algorithmics AlgoOne*

All these components work together to provide a flexible, high-performance infrastructure for market, credit and liquidity risk, as well as collateral and capital management. Together, this is a comprehensive solution for building risk management systems. It can also be regarded as an on-premise framework for building dynamic risk systems. Individual solution components are easily expandable through product add-ons or by adding additional on-premise or off-premise compute nodes to meet client specific needs.

The IBM Application Ready Solution for Algorithmics provides customers with a solid foundation for building a risk management system that takes an integrated enterprise-wide approach, and can efficiently evolve to help meet compliance requirements. Figure 3 depicts the high-level solution architecture.

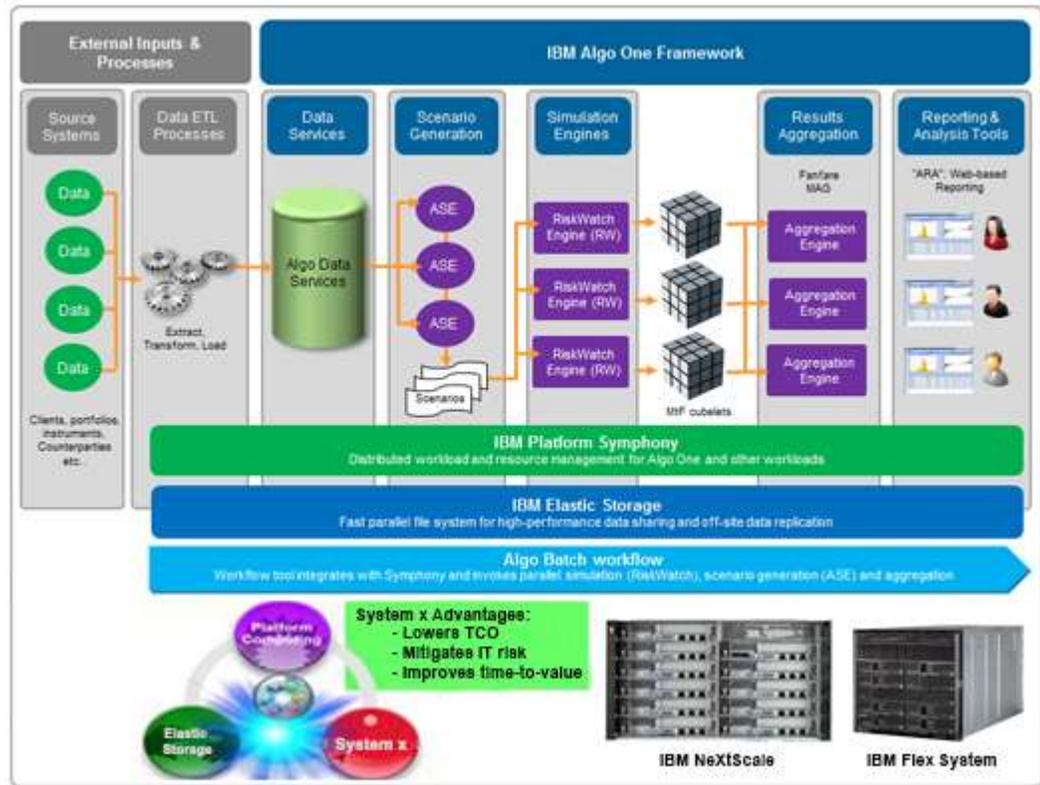


Figure 3: Architecture of IBM Application Ready Solution for Algorithmics (source: IBM)

*Improves time to value to deploy risk management on-premise or in the cloud*

*Accelerates risk analytics and time-to-value while lowering TCO and IT risks*

## Conclusions

Active risk management requires state-of-art high-performance and agile risk systems that are capable of analyzing data from multiple sources, and delivering timely results and insights. The data, models, analytics and IT systems need to be tightly coupled in order to deliver such intelligence “real time”. The entire system, end-to-end, must be tuned and optimized to support the workloads characteristic of active risk management.

Most firms lack the time, money and/or expertise to build an active risk management system from scratch. Instead, many firms are now choosing to buy integrated solutions optimized to support active risk management across the enterprise. These solutions offer the potential of accelerating risk analytics and time-to-value while lowering TCO and IT risks.

Firms considering deploying an integrated solution for risk analytics should seriously consider the **IBM Application Ready Solution for Algorithmics** for the following reasons:

- Over 300 firms in over 30 countries, including 70 of the world's top banks use Algorithmics
- Many firms already benefit by accelerating risk analytics to get timely insights using one or more of the included IBM infrastructure solution components – System x servers, IBM Elastic Storage and Platform Symphony
- IBM provides a validated [reference architecture](#) that improves time-to-value while mitigating IT deployment and manageability risks and lowering TCO, all with commercial solution-level support.

## For More Information

For more information on IBM Technical Computing solutions for financial analytics and IBM Algorithmics, please contact your IBM representative or visit:

[www.ibm.com/systems/technicalcomputing/industry/finance.html](http://www.ibm.com/systems/technicalcomputing/industry/finance.html)

[www.ibm.com/software/analytics/algorithmics/](http://www.ibm.com/software/analytics/algorithmics/)

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