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# White Paper

## The Importance of Continuous Intelligence on the Future of Full-stack System Management

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# Introduction

Enterprises of all sizes are facing an information technology crisis. Ironically, this crisis comes at a time when the power of IT has never been stronger, thus presenting both an opportunity and a challenge. The opportunity centers on IT's ability and to create new business models and better address customer needs, while the challenge lies in its role as a disruptive force to established enterprises that underestimate the power and speed of IT-fueled change. Cases in point: Who would have thought it was possible to build a multi-billion dollar transportation business overnight that doesn't own any vehicles, or a retail sales business with no stores, or a hospitality business with no properties? While these represent the extreme examples, the message is clear: Enterprises must rethink how they consume IT or risk being consumed by it.

Accelerating IT's growth in power, responsibility, and disruption is the market acceptance of cloud infrastructures, both pure cloud and hybrid. In fact, one could argue that the cloud has ushered in a defining IT moment through its transformational impact on IT infrastructures and new software-as-a-service applications, resulting in new business, economic, architectural, performance, reliability, and management models. It also presents new ways to architect, produce, and consume IT. For example, architectural benefits include a service orientation, better separation of concerns, microservices, immutable infrastructure, and real-time operations. Production benefits of the cloud include agility, faster time to market, dynamic scalability, and the opportunity to continuously deploy and innovate. And consumption benefits include compelling economics, the availability of a wide and growing variety of differentiated services, and a friction-free path to adoption.

In response, enterprises are reevaluating fundamental principles regarding how they should build, buy, outsource, and integrate IT assets and systems because cloud-inspired models necessitate careful evaluation. The key is to determine where these cloud models can enable IT to help evolve corporate strategy. In addition, IT leaders will need to address the growing complexity and dynamic nature inherent in a cloud IT infrastructure given its roots in services and continuous change. For example, cloud's capability to scale to meet IT service demands via instantaneous provisioning is a major asset to IT. Additionally, cloud-native development and deployment enables the continuous delivery of new and improved application capabilities at a much faster pace—days and weeks as opposed to months and years.

The overall increase in infrastructure flexibility and responsiveness due to the cloud is forging a new dynamic form of IT , in which new approaches to managing, troubleshooting, and monitoring systems and applications are now required. IT leaders will need complete, real-time visibility and proactive awareness across their entire applications infrastructure—a type of intelligence, if you will, that is continuous. A continuous intelligence capability enables us to rethink and significantly improve how we address system management, which is the subject explored in this white paper.

# The Full-stack System Management Reference Model

To explore the impact of continuous intelligence on systems management, we're introducing a reference model to provide a contextual vision of the future management of applications and systems to better frame strategic decision making and IT transformation opportunities and challenges. This is a full-stack system management reference model because it can be applied to the full stack starting at the bare metal and spanning all the way up to microservices. This means that the reference model applies to the infrastructural layer, virtualization layer, applications, and microservices. This full-stack system management reference model is divided into four key components of system management strategy. While some management tools today fall outside this reference model, we are beginning to see vendors provide support for more of the capabilities that are defined within this model.

### The Growth of IT Complexity and Operational Data

IT evolution is commonly characterized by a search for better ways to address abstraction and the separation of concerns. While the principles of abstraction and separation of concerns appear to be at odds with each other, they provide a natural tension that keeps IT in equilibrium. The result has been the development of higher level architectures and products that embrace a more distributed IT system composition. These new architectures and products support encapsulation and polymorphism while simultaneously leveraging a more highly distributed approach to configuration that drives agility and flexibility. The overall effect to the infrastructure is greater productivity, quality, performance, and complexity. So, which one of these attributes doesn't belong with the others? Complexity is the price we pay for these other benefits. Complexity and the desire to achieve higher levels of productivity, quality, and performance are therefore the root causes behind why system management must evolve.

Full-stack system management has always depended upon measurements as the foundation for setting management policy and as the trigger for actions. This relationship will persist and intensify as the industry moves forward. Devices, run-times, applications, and even components will provide a continuous flow of data to enable an understanding of health, state transitions, and activities. The implication is that the volume, variety, and velocity of management data is dramatically increasing. Despite the "cost," this is desirable from a system management perspective because the volume, variety, and velocity of IT activities relative to the mission of the business are likewise increasing. There is no longer tolerance for performance and availability issues. IT is now mission-critical to the business. Therefore, the "cost" to the business of not being able to proactively manage the business effectively does not even compare to the cost of continuous data collection.

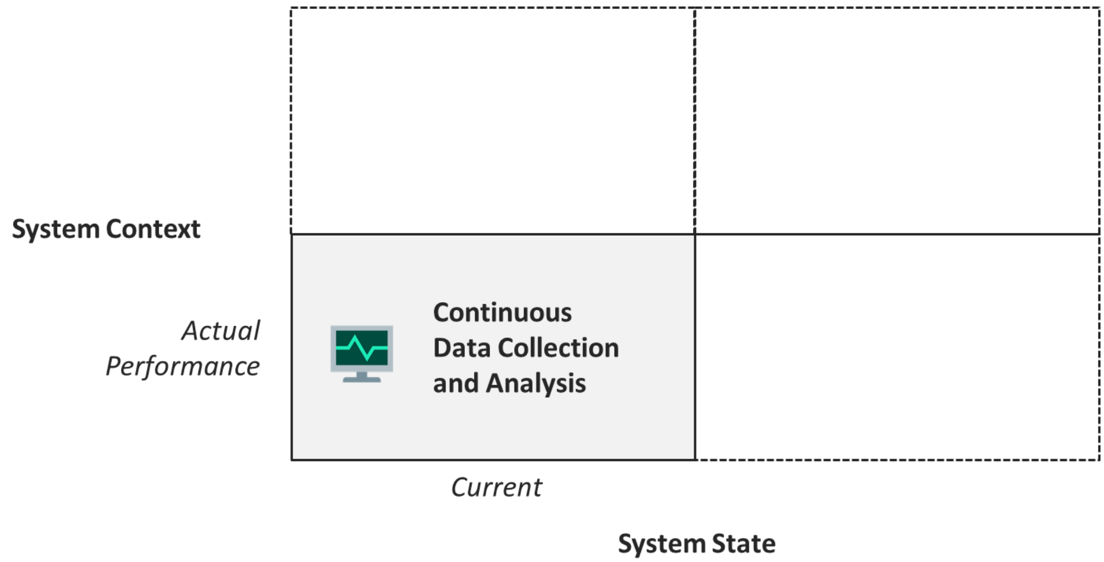
## Continuous Real-time Data Collection and Analysis: The Foundation of Continuous Intelligence

Existing approaches for system monitoring and application performance management are no longer sufficient to provide the complete view into the volume, variety, and velocity of data being generated across the full stack, from bare metal to microservices. What developers and IT managers gain in focus for performance KPIs, IT loses in breadth and depth with respect to the way the velocity of change affects the entire system as a whole and the unknowable gaps that inevitably occur between application updates, usage rates, system availability, and performance.

The foundation of continuous intelligence is continuous real-time data collection, which provides real-time visibility into the operational state of IT assets. Assets are physical (devices) or virtual (run-times, applications, containers, components, and the cloud). Advanced analytics are then applied to drive business and operational insights to improve or optimize system operation.

Figure 1 shows where continuous data collection is positioned and how it helps organizations to understand the actual performance of the current system state.

*Figure 1. System Management Reference Model: Continuous Data Collection*




*Source: Enterprise Strategy Group, 2015.*

Real-time and continuous data sources encompass many different types of content. Logs represent a readily available source of event and transaction data. Real-time access to log data is necessary to eliminate latency and support real-time analytics and proactive system management. To simplify data collection, applications and run-time systems should be developed and deployed so that key event and operational data is being collected by the logs.

A challenge of continuous real-time data collection is the volume of data that is accumulated. Pattern recognition and anomaly detection techniques and compression can be very effective at reducing the data footprint without materially impacting the fidelity of the underlying signal. Another challenge in continuous data collection where assets reside outside of the data center is security. All data moving into or outside of the data center must adhere to established security and authentication models to ensure it cannot be compromised. Consequently, the implementation of a security model must be able to address appropriate PCI requirements. These challenges suggest that multi-tenant, cloud-based services for real-time data collection and analytics have a disproportionate advantage to address the volume, elasticity, and security needs of cloud and hybrid applications because of their inherent ability to efficiently store and scale data as needed. Single-instance cloud solutions fall short due to their elasticity limitations. Since the volume, variety, and velocity of data change continues to grow, obtaining a multi-tenant, cloud-based IT analytics solution that maximizes data storage and scaling flexibility is paramount to ensure operational efficiency. Therefore, enterprises should look for services that have these attributes.

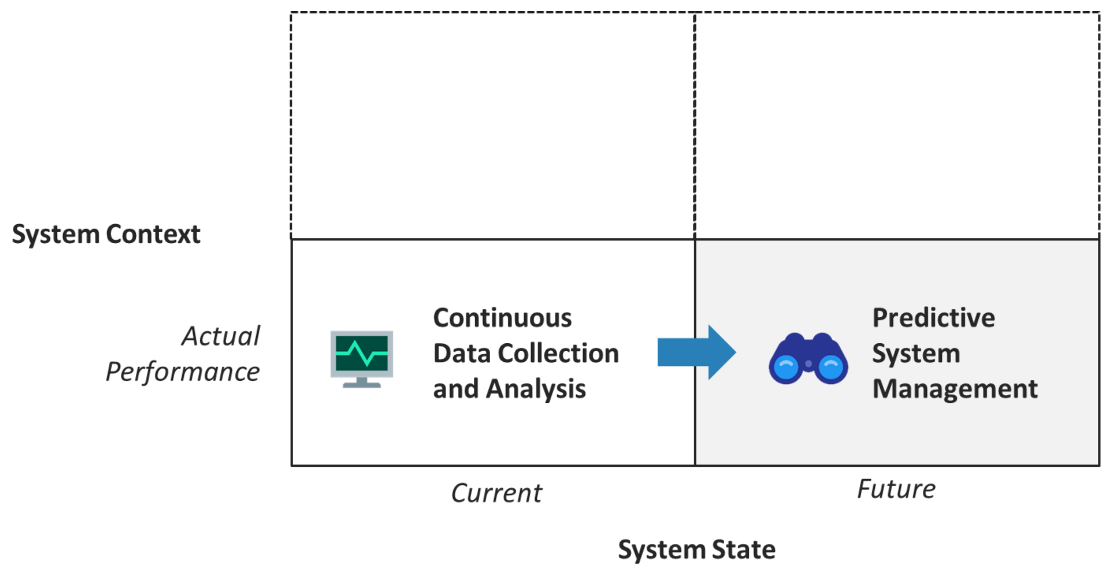
In addition to flexible storage and scalability capabilities, cloud-based solutions that can provide advanced analytics are becoming increasingly warranted. Continuous real-time data collection makes all log data available for conventional monitoring and real-time analytics. But given the volume, variety, and velocity of machine data, depending on conventional search queries to understand the root causes of a failure is like searching for a needle in a hayfield. Solutions that leverage machine-learning analytics dramatically reduce the time to identify key patterns and anomalies that often decrease mean time to investigate/respond from days to hours or minutes.

Also, access to all log data in real time provides an opportunity to use analytics to correlate data in several ways. First, correlation across historical data has the potential to identify other measures that are a better leading indicator of an issue. This means more lead time in understanding an issue and a larger window to remediate the issue before it is a problem. Second, forensic analysis can be based on more data, which will allow better understanding of the problem and next best actions. Finally, multi-tenant, cloud-based third-party support of these activities can leverage the knowledge of the community to improve the management of individual enterprise community members. So continuous real-time data collection and a wide variety of analytical techniques to address search, filtering, segmentation, conditional logic, algorithmic transformation, and correlation form the foundation of the system management reference model.

## Predictive System Management

Predictive system management (PSM) includes a variety of techniques that leverage historical data, relationships, and performance patterns to predict future behavior. Historical data is critical to the development of predictive models. The model is trained by selecting those use cases where failures have occurred and analyzing the data prior to the failure to craft a pattern that can predict a failure with a particular degree of accuracy. The success of this approach is dependent upon the richness of the data and skill in leveraging the analytics in developing effective patterns. PSM is therefore predicated on continuous data collection and analysis though advanced analytics. Figure 2 shows the relationship of PSM to continuous data collection.

*Figure 2. System Management Reference Model: Predictive System Management*



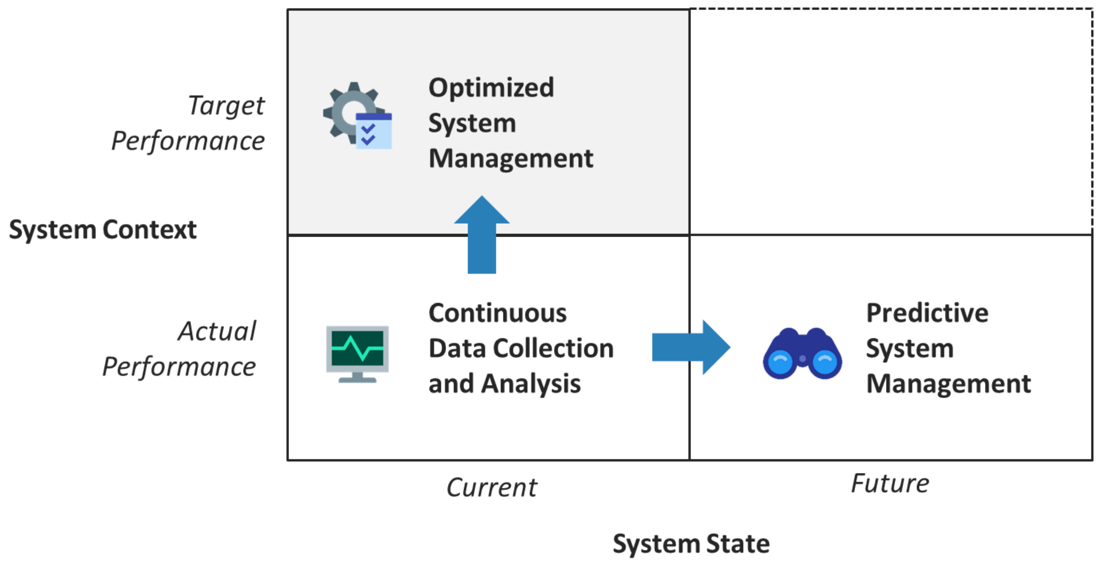

*Source: Enterprise Strategy Group, 2015.*

The utility of PSM is that it enables an enterprise to transition from reactive to proactive in its approach to full-stack system management. This is a far more desirable and defensible position for IT to align with. An effective proactive approach to system management is able to spot unusual behavior and take corrective action before failures occur. While PSM is a great approach to protecting the enterprise from well understood failures at any layer of the stack, it also enables an enterprise to extend its system management capabilities beyond conventional monitoring and alerting. There is a strong relationship between continuous data collection and analysis, and PSM. Detailed continuous data supports the development of better patterns and real-time data streams enable the enterprise to leverage these patterns in production systems to identify issues before they result in failures. Therefore, PSM is not feasible without continuous real-time data collection.

## Optimized System Management

Optimized system management (OSM) is a way to extract the highest utility from a system given specific goals subject to specific constraints. Optimization is therefore very different from prediction but the two techniques complement each other. PSM is forward-looking, and typically focused around ensuring availability whereas OSM is geared toward maximizing performance or achieving the most with what you currently have. Figure 3 shows the relationship of OSM to continuous data collection and analysis and PSM.

*Figure 3. System Management Reference Model: Optimized System Management*




*Source: Enterprise Strategy Group, 2015.*

The most significant difference expressed in Figure 3 is the positioning of OSM in the upper half of the full-stack system reference model. OSM introduces a new requirement that involves defining system objectives or goals. These goals require an enterprise to set priorities, which means an enterprise must make decisions regarding the metrics of IT operation that it considers most important. Goals typically include minimizing cost, maximizing performance, or minimizing asset utilization. Optimization seeks to find the best use of assets that enables the maximization or minimization of the objective function (goal). An important dimension of optimization is the role of constraints. Constraints provide boundaries that limit how far a particular independent variable can move in search of an optimized outcome. This also helps ground optimization in reality because resources are always limited in the short run. Because OSM leverages the relationship between performance goals and actual performance, it is most effective at addressing issues higher up the stack where tradeoffs exist between cost, utilization, and performance.

Optimization, like prediction, leverages well vetted analytic techniques. Optimization is a very powerful capability but must be approached with respect. This is because optimization is simply a mathematical technique and necessitates that you frame your goals and constraints effectively in order to achieve desired results. Complex optimization scenarios require operations research experience to ensure that the optimization models do not create too little or too much churn. Too little churn indicates that an environment is not well optimized. Too much churn signifies an environment that is optimized too tightly and is therefore brittle and unable to absorb normal operating variances.

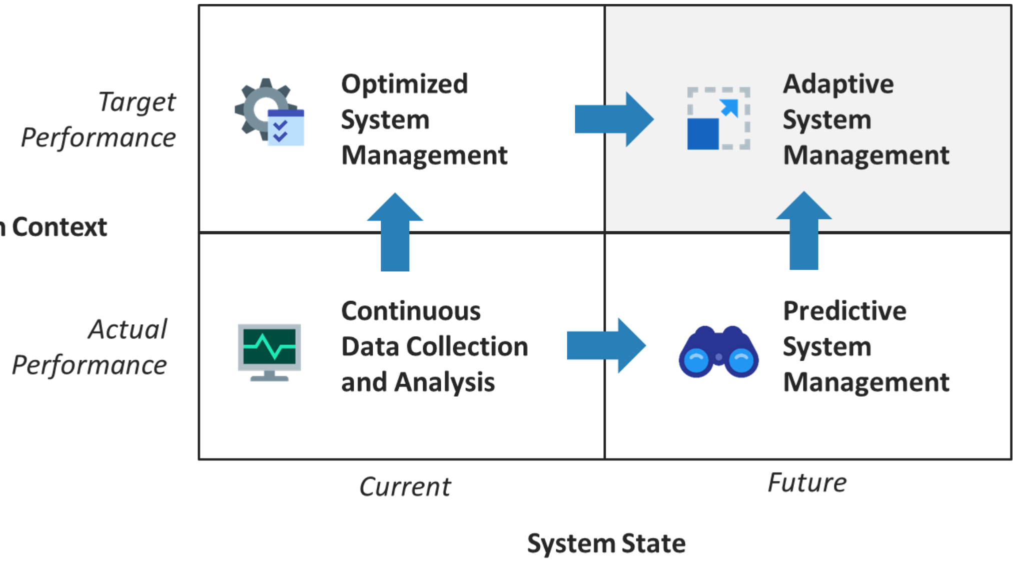
Optimization does represent a more challenging activity to master than PSM, but the potential benefits to the enterprise are commensurately higher. Given the importance of IT operations and the profound impact that optimization can have on these ongoing operations, enterprises must approach OSM carefully. The best approach is to consult with optimization experts to understand what is necessary from an implementation perspective as well as the risks and benefits associated with optimization.

The need to rebalance or optimize is typically triggered when the differences between target and actual KPIs become too great. These differences can either be based on thresholds or predictive analytics. Continuous real-time data collection and analysis is therefore critical to both understanding when to optimize but also how to fine-tune the optimization so that it is most effective.

## Adaptive System Management

Adaptive system management (ASM) combines elements of PSM and OSM and leverages feedback based on decisions being made by these models to understand the effectiveness of system management models in use and recommend ways to improve these models. ASM is especially helpful in setting strategy when faced with a changing environment. ASM represents the cutting edge of what is possible in system management. Figure 4 positions adaptive system management in the upper right hand quadrant of the system management reference model. Successful experience with PSM and OSM are prerequisites before embarking on an ASM path.

*Figure 4. System Management Reference Model: Adaptive System Management*




*Source: Enterprise Strategy Group, 2015.*

ASM depends upon the ability to understand a change to the IT operational environment and the ability to measure the impact of this change. Measuring the impact of this change is usually accomplished through an economic model because of its utility in expressing complex changes in a normalized way. Changes to the IT operational environment can include rebalancing the environment as a result of optimization or proactive and reactive changes made to the environment as a result of conventional or predictive actions. Experience acquired by measuring the impact of changes to the IT environment helps train the recommendation engine. The recommendation engine leverages economic model transaction data and anticipates how best to respond to environmental changes. As the accuracy and confidence in the recommendation engine grows, specific types of recommended actions can move from being merely recommended to more automated actions.

ASM today resides on the fringe of system management and use cases for ASM are hard to come by because enterprises utilizing ASM are few in number and unlikely to discuss their experience because it is perceived as an important strategic differentiator. ASM is presented here because it represents the logical unification, integration, and pinnacle of what can be achieved in system management. Therefore, we anticipate that ASM will grow in time, fueled by the cloud infrastructure and cloud application market transitions, because these transitions inherently increase the dynamic nature of IT environments, and ASM represents a systems management discipline to address these new requirements. Because ASM is focused around change, continuous real-time data collection and analysis through advanced analytics are prerequisites for engaging in ASM. Enterprises interested in pursuing ASM should also have deep experience in PSM and OSM and have in-house operations research expertise available to guide the development and implementation of what today will be a highly customized solution.

### Achieving Continuous Intelligence

Continuous intelligence is a term that defines the collective capabilities that characterize this system management reference mode. Continuous intelligence is achieved in phases and begins with continuous real-time data collection because it is common to all of the analytic techniques described in each of the quadrants of the model. Many enterprises will find that the core benefits of continuous intelligence can be achieved with just real-time data collection and analysis. This is because the dramatically expanded scope and real-time access to application and system data provide a significantly improved basis for system management. While the addition of PSM, OSM, and ASM can extend the value proposition of continuous intelligence, the incremental addition of these capabilities is subject to the law of diminishing returns. However, this full-stack system management model is an important reference for understanding the future direction of system management and evaluating system management tools.

Enterprises that should consider full-stack system management tools that support continuous intelligence have any combination of the following characteristics:

- An interest in exploiting the benefits of cloud computing
- A growing adoption of modern application architectures (microservices)
- The desire to support the continuous integration and delivery of applications
- The need to support a growing heterogeneous collection of edge devices
- Concerns regarding how to manage and secure a mushrooming IT environment

## The Bigger Truth

The cloud presents new ways to architect, produce, and consume IT. The existing preference of large enterprises for private and hybrid cloud delivery models is transforming all aspects of IT, including development, deployment, and operations. The business models and technology models associated with the cloud are sufficiently different that enterprises that fail to determine how modern IT solutions can transform their business will be left behind. At the core of business transformation is the ability to support continuous integration (CI) and continuous deployments (CD). Endemic to CI/CD is the concept of immutable infrastructure that can be instantiated or destroyed in seconds. These requirements set the bar regarding agility and time to market. At scale, CI/CD necessitates high levels of automation. Consequently, the continuous nature of IT operational changes can only be managed through a system that relies on continuous real-time data collection, analysis, and proactive management.

Continuous real-time data collection, analysis through advanced analytics, and proactive system management are what characterize continuous intelligence. The actionable insights of continuous intelligence are driven by advanced analytics that enable proactive solutions to common availability and performance concerns. The system management reference model described in this white paper builds on the principles of continuous intelligence and charts the path forward for the system management market. The union of continuous intelligence and the system management reference model together deliver the following:

- **A faster time to visibility**. Continuous real-time data collection provides a higher volume, variety, and velocity of data, which provides the foundation for real-time analytics and insight.
- **A faster time to resolution**. Predictive system management provides a proactive approach to IT management, which enables many types of IT issues to be identified before they result in asset failures.
- **A faster time to productivity**. Optimized system management relies on a proven quantitative methodology that provides a way to align capacity with demand subject to the goals and constraints of the enterprise.
- **A faster time to transformation**. Predictive, optimized, and adaptive system management all have forward-looking proactive capabilities that are focused on future states and/or future performance targets. Proactive system management is the appropriate lens for evaluating and decisioning specific to system transformation focused around adopting new technology models while addressing system availability and performance concerns.

Continuous intelligence is a path forward in the system management domain. Continuous intelligence brings together the best that real-time, advanced analytics has to offer by leveraging continuous real-time data to proactively support the evaluation of IT asset availability and performance within a highly secure environment. This approach reflects and is aligned with today's modern architecture for application development and deployment, which includes microservices and immutable infrastructure. The full-stack system management reference model described here sets an agenda for system management that emphasizes security, continuous visibility, performance, and availability, all of which can be bound together through economic policy-based governance. Vendors that adopt and deliver on this agenda will become the new market leaders in system management.

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