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Optimize IT and
reduce costs

Increase application
assurance and uptime

Automate root
cause analysis

Resolve (FixStream)
Special Edition

Sameer Padhye
Bishnu Nayak
Enzo Signore

About Resolve (recently acquired FixStream)

Resolve recently acquired FixStream, adding robust AIOps capabilities to our automation ecosystem. Designed to address increasing IT complexity, the platform includes agentless discovery and automated dependency mapping, advanced event correlation, and predictive analytics that proactively identify and prevent issues.

Combining AI-driven insights with intelligent automations, Resolve offers a closed-loop of discovery, analysis, detection, prediction, and automation. Our goal is to fuel agile, autonomous IT operations with a long-term vision of delivering on the promise of “self-healing IT.” Learn more at <https://resolve.io>



AIOps

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**by Sameer Padhye,
Bishnu Nayak and
Enzo Signore**

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AIOps For Dummies®, FixStream Special Edition

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Introduction

Artificial intelligence for IT operations (AIOps) is the next generation of IT operations analytics (ITOA). Its value is in helping organizations address IT challenges on a number of fronts, including the following:

- » The increasing complexity and dynamic nature of IT architectures
- » Digital business transformation
- » Siloed IT operations
- » Exponential data growth

So, what's the difference between AIOps and ITOA?

AIOps is a major shift from traditional ITOA platforms. As the precursor to AIOps evolution, ITOA focuses on data collection and unification for historical data analysis across domains and resolves problems with observational data. AIOps leverages big data and machine learning techniques to deliver proactive and predictive insights into problems and recommends — and automates — remedial actions. AIOps helps businesses with proactive planning and identification of business-impacting issues before they occur.

AIOps solutions can address these challenges. They enable enterprises to unify and modernize IT operations. And they allow enterprises to make the most of their existing infrastructure investments.

In this book, you learn how AIOps can transform your IT operations.

Foolish Assumptions

A wise person once said that most assumptions have outlived their usefulness, but we assume a few things nonetheless!

Mainly, we assume that you're an IT operations professional or enterprise architect responsible for IT infrastructure, applications,

and business processes. As such, this book is written for technical readers with some knowledge of topics such as IT operations, infrastructure, applications, big data, and machine learning.

If any of these assumptions describes you, then this book is for you! If none of these assumptions describes you, keep reading anyway. It's a great book and when you finish reading it, you'll know a few things about AIOps!

Icons Used in This Book

Throughout this book, we occasionally use special icons to call attention to important information. Here's what to expect:



REMEMBER

The Remember icon points out information you should commit to your nonvolatile memory, your gray matter, or your noggin — along with anniversaries and birthdays!



TECHNICAL
STUFF

You won't find a map of the human genome here, but if you seek to attain the seventh level of NERD-vana, perk up! Anything marked with the Technical Stuff icon explains the jargon beneath the jargon!



TIP

Tips are appreciated, never expected — and we sure hope you'll appreciate these tips. The Tip icon points out useful nuggets of information.



WARNING

These alerts point out the stuff your mother warned you about (well, probably not), but they do offer practical advice to help you avoid potentially costly or frustrating mistakes.

Beyond the Book

There's only so much we can cover in 48 short pages, so if you find yourself at the end of this book, thinking, "Where can I learn more?," just go to www.fixstream.com.

IN THIS CHAPTER

- » Understanding how complexity and frequent changes limit visibility
- » Assessing the cost of downtime in the digital enterprise
- » Missing the big picture because of siloed operations
- » Staying afloat in a deluge of data

Chapter 1

Recognizing IT Operations Challenges

Modern IT operations challenges render traditional, domain-centric monitoring and IT operations management systems inadequate. Such systems can't correlate the onslaught of data that various IT domains create, and they're unable to provide the insights that IT operations teams need to proactively manage their environments. In this chapter, you learn how these challenges impact IT operations.

Increasingly Complex and Dynamic IT Architectures

To increase business agility, IT organizations are deploying dynamic, modern IT architectures enabled by virtualization technologies. That includes containers, elastic clouds, microservices, and virtual machines. Consider the following:

- » According to a September 2017 report by Cloud Foundry Foundation, at least a quarter of businesses had adopted containers by late 2017.

- » 451 Research's "Cloud-Enabling Technologies Market Monitor" report found that the application container market was worth \$762 million in 2016 and is expected to balloon to \$2.7 billion by 2022.
- » The use of cloud platforms is also on the rise, as more businesses migrate more applications to the cloud. A recent Intel Security report predicted that 80 percent of all IT budgets would be committed to cloud solutions by July 2018.

The agility these architectures and technologies enable is important for businesses. It helps them adjust to the fluctuating demands of millions of digital customers around the globe.

However, that often comes at the cost of decreased visibility. That's because application workloads and flows are now abstracted from their physical infrastructure. And that creates new challenges in pinpointing potential issues.



REMEMBER

Without end-to-end correlated data, adoption of these key technologies can be risky and cumbersome. IT staff will be unable to effectively map current workloads to these new environments, and they'll struggle to manage their performance and uptime.

Digital Business Transformation

Enterprises across the globe are leveraging digital technology to transform their businesses. Such efforts aim to provide better experiences to their prospects, customers, suppliers, and internal stakeholders.

To succeed as digital companies, businesses need to rethink their entire IT stack and operational strategy. And they need to ground these efforts with business-first considerations.

That should include how they think about application and infrastructure uptime as well.

A recent study by Digital Enterprise Journal (DEJ) found that enterprises incur an average cost of \$300,000 per outage. That's if no revenue is at stake. If the outage impacts revenues, organizations

lose an average of \$72,000 per minute. That means companies lose a whopping \$5.6 million per outage!



WARNING

Modern enterprises that don't make application assurance and uptime a top objective could face catastrophic damage to their revenues and reputation.

Siloed IT Operations

Research by DEJ suggests that 41 percent of enterprises use ten or more tools for IT performance monitoring; 70 percent use more than six. And you need even more tools to manage a hybrid cloud environment, including solutions to monitor workloads running in Amazon Web Services (AWS), Microsoft Azure, and multi-cloud environments.

Domain-centric tools provide a deep view into a specific domain, but they lack the ability to provide a correlated, end-to-end view across domains (see Figure 1-1).

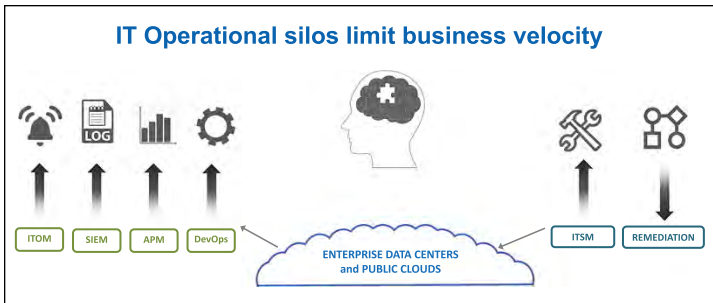


FIGURE 1-1: IT operational silos limit business velocity.

That's a problem because cross-domain data collection, correlation, and visibility are key. They can enable you to track transaction problems like failed e-commerce orders to infrastructure issues like a network problem, for example.

But siloed management tools prevent most organizations from making these important connections. As a result, most enterprises suffer longer mean time to repair (MTTR) leading to unhappy customers. Additionally, CIOs and heads of IT operations can't respond to business needs timely and proactively.



TIP

According to DEJ, MTTR averages 4.2 hours and wastes precious resources. Businesses employ an average of 5.8 full-time equivalent (FTE) employees to address each incident. In 15 percent of cases, that FTE figure is as high as 11.

The drain on human resources and finger pointing occurs as IT team members struggle to manually correlate data — often lots of data. Solving a critical business problem often entails using thousands of data points. Imagine how complex it becomes when IT must analyze thousands or millions of data points.

Exponential Uncorrelated Data Growth

Indeed, millions of data points are now flowing to the IT operations team in real time. This data deluge will only accelerate as adoption of containers, microservices, and virtualization grows.

According to DEJ, in the last 12 months, enterprises collected 88 percent more data than the prior year. Containers alone generate 18 times more data than traditional IT environments.

There are automated ways to collect and process this massive amount of data from an individual domain, but domain-specific teams then need to manually correlate it — and 79 percent of organizations report that adding more IT staff to address this problem is not an effective strategy, according to DEJ. This is not only time consuming but also prone to incorrect interpretation and results, requiring skilled resources from different domains, thus leading to a very long diagnostic process for root cause identification.

To address these challenges, organizations need a new class of technology to modernize the IT operations process with powerful correlation, analytics, and visualization capabilities. This technology needs to be able to

- » **Correlate** millions of data points across all IT domains.
- » **Analyze** data to detect patterns using machine learning.
- » **Visualize** information so that organizations can easily see what's happening and gain powerful insights.

IT organizations need AIOps.

- » Defining AIOps
- » Delivering business value with AIOps
- » Deconstructing the building blocks of an AIOps architecture

Chapter 2

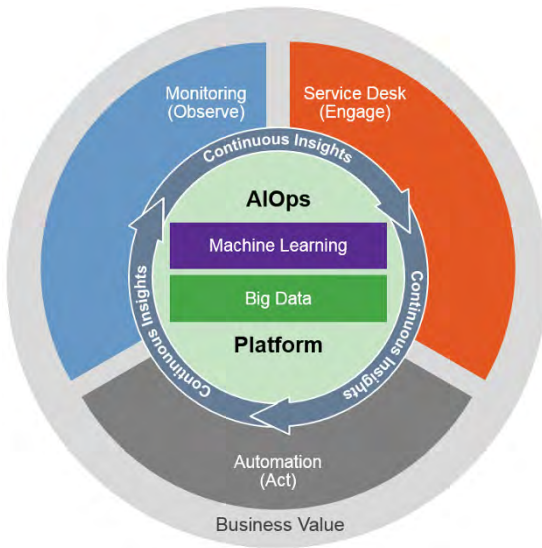
Modernizing IT Operations with Artificial Intelligence

In this chapter, you learn all about AIOps: what it is, how it delivers value, and how it works.

AIOps Defined

Gartner recognizes AIOps as a new strategic IT segment (see Figure 2-1):

Artificial intelligence for IT operations (AIOps) platforms are software systems that combine big data and AI [artificial intelligence] and machine learning functionality to enhance and partially replace a broad range of IT operations processes and tasks, including availability and performance monitoring, event correlation and analysis, IT service management, and automation.



Source: Gartner, March 2016

FIGURE 2-1: Gartner's visualization of the AIOps platform.

The general process by which AIOps platforms and solutions operate includes three basic steps: observe, engage, and act.

Observe

An AIOps platform first needs to observe the nature of data and its behavior. That involves collecting information through data discovery.

AIOps data discovery needs to support big data scale. That way, it can address the volume of data from different IT domains and sources. Those sources may include legacy infrastructure or new container, hybrid cloud, or virtualized environment elements.

Whatever the data or source, speed is key to the observation part of the process. So, the data must be collected in near real time to detect patterns. Performance- and health-related information is collected from hundreds of sources — using an agentless or agent-based model. Successful AIOps platforms leverage a combination of mechanisms to collect data from a multi-domain and multi-vendor environment. That environment may include an array of containers, hypervisors, network and storage solutions, public cloud, and other technologies and architectures.

A successful AIOps platform also combines the power of big data and machine learning with domain knowledge to identify data relationships and history to solve this complex problem.

Engage

An AIOps platform provides orchestration across key IT operations domains — most important, IT service management (ITSM).

ITSM activities, such as asset management, change management, and incident management, have traditionally been manual, and they're typically heavily dependent upon the configuration management database (CMDB). The problem with legacy CMDBs is that they're highly unreliable for environments involving frequent change.

The AIOps platform provides analytics and input to make ITSM tasks more automated and reliable. For example, AIOps can update CMDBs using its knowledge of the environment, state, and changes. The AIOps platform's ability to observe hybrid environments on an end-to-end basis provides this power. This ensures CMDB data is relevant and reliable and allows for automation and faster and more accurate incident management. The automation also minimizes risks that might otherwise happen due to human error. Finally, pattern recognition allows businesses to see and address problems before they affect the end-user experience.

Data discovery in the AIOps platform is done using an algorithmic approach. A successful discovery is accomplished by combining domain knowledge of the IT environment with efficient data processing algorithms to process data observed from entities in multi-vendor and multi-domain environments. The discovery algorithm should have the capabilities to discover meaningful data from infrastructure and application entities supporting critical business functions — for example service information, configuration data, relationship information across domains including topology data, hierarchical relationships between entities, and more (for example, virtual machine to hypervisor relationships).

Act

Automation or closed loop functions is the nirvana of AIOps platform.

Of course, automating critical IT operations using machine learning is new territory for most organizations, and IT leadership will need to get comfortable with it before they fully embrace automation. But new state-of-the-art automation — which uses advanced human inputs and machine learning — is maturing, and organizations can employ it today to do both simple and more complex jobs.

For example, they can employ automation to clean log files to free up space, and they can use it to restart an application. Automation also can change application traffic policy on a router if AIOps sees the need.

How and Where AIOps Delivers Value

Enterprises that have deployed AIOps solutions have experienced transformational benefits. They include revenue growth, better customer retention, improved customer experience, lower costs, and enhanced performance.

Their operational teams have been able to:

» **Increase end-to-end business application assurance and uptime.**

- Manage an integrated set of business and operational metrics.
- Predict and prevent outages.
- Dramatically reduce mean-time-to-detect (MTTD) and mean-time-to-repair (MTTR).
- Lower the number of IT full-time equivalents (FTEs) dedicated to troubleshooting.
- Decrease operational noise and alerts.

» **Optimize IT and reduce IT costs.**

- Replace older, silo-focused IT monitoring tools.
- Auto-discover complex, heterogeneous topologies.
- Gain visibility into the hybrid IT environment.
- Accelerate migration to the hybrid cloud.

- Expedite the adoption of hyper-convergence and microservices architecture.
- Reduce risk in consolidating and migrating data centers.

» **Free up resources to enable IT operations to become a proactive source of innovation.**

- Automate and reduce the cost of audits and compliance.
- Simplify IT processes.
- Break down silos across their IT teams.
- Enable less experienced staff to become more productive, faster.

What the AIOps Architecture Looks Like

An AIOps solution includes the following functional blocks (see Figure 2-2):

- » **Open data ingestion:** An AIOps platform collects data of all types from various sources. This may include operational insights such as faults, logs, performance metrics, log alerts, tickets, and more. The ability to ingest data from the most diverse data sources is critical because it allows for an accurate, real-time view of all the moving parts across hybrid IT environments.
- » **Auto-discovery:** Given the very dynamic nature of modern IT environments, businesses need an auto-discovery process that automatically collects data across all infrastructure and application domains — including on-premises, virtualized, and cloud deployments. Auto-discovery also identifies all infrastructure devices, the running applications, and the resulting business transactions.
- » **Correlation:** Next, the AIOps platform correlates this data in a contextual form. It needs to determine the relationships between infrastructure elements, between an application and its infrastructure, and between the business transactions and the applications.

- » **Visualization:** When the end-to-end correlation process is completed, data need to be presented in an easy-to-use format. And that's what visualization is all about. Visualization is important because it allows IT operations to quickly pinpoint issues and take corrective actions. Every solution includes a dashboard of some type. Yet an estimated 71 percent of organizations say data is not actionable. That's why AIOps is important. It provides a new generation of visualization that makes data actionable.
- » **Machine learning:** Finding the root cause of a problem is key. But it's even more critical to determine recurring patterns and predict likely future events. AIOps solutions use supervised and unsupervised machine learning to determine patterns of events in a time series. They also detect anomalies from expected behaviors and thresholds and predict outages and performance issues.
- » **Automation:** Automation is a key component of AIOps because it delivers the end return on investment (ROI) to the customer. It does so by automating human IT operations tasks, reducing significant operating expenses (OPEX), and expediting innovation. It also reduces MTTR and can improve customer satisfaction.

AIOps enables IT operations to modernize existing processes. It allows IT operations to make progress versus traditional IT operations analytics (ITOA) strategies, abandon old, reactive processes, and become proactive by predicting issues and preventing outages.

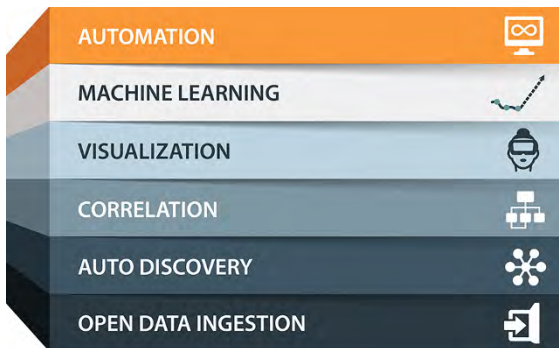


FIGURE 2-2: The building blocks of an AIOps architecture.

IN THIS CHAPTER

- » Getting a complete picture of your infrastructure
- » Ensuring application uptime and performance
- » Going beyond infrastructure and application discovery and insights

Chapter 3

Understanding AIOps Capabilities

In this chapter, you learn about current infrastructure and application discovery and insight challenges, and how AIOps capabilities address these challenges.

Infrastructure Discovery and Insights

We live in a world that is massively distributed, disparate, and diverse.

In different cultures, there are many different people speaking many different languages. If you can interact with these individuals in their language, you can learn a lot, and the broader knowledge and insights can significantly benefit people, as well as businesses, around the world.

Enterprise networks are worlds of their own, and in some ways, they mirror this larger disparate world.

Enterprise hybrid IT data centers contain lots of entities across network, compute, and storage supplied by different technology vendors. The vendors that supply these technologies have their own cultures, syntaxes, and languages to manage and interact with other entities in the IT environment.

But if you can interact with these distributed entities in a normalized way and understand how they relate to one another, you can derive a deeper understanding into the end-to-end environment. That understanding helps enterprises manage their IT environments optimally and profitably.

The point is that we live in a diverse world, and when we collect information about different entities around the world from different sources, we gain greater understanding. An AIOps platform helps businesses improve their IT operations by understanding their application and IT infrastructure resources.

AIOps technology can

- »» Collect data from disparate IT entities and siloed systems
- »» Correlate and analyze the flood of data from different sources
- »» Present that information in a way that makes it quick and easy for businesses to understand and gain value from it

But before data is correlated and visualized, it needs to be collected from millions of disparate data sources. One of the key challenges IT organizations face is the complexity associated with discovering disparate entities in a hybrid IT environment. Environments are quickly changing as digital service deployments adopt newer technologies such as virtualization, hybrid cloud, containers, microservices, and more.

The traditional discovery tools and mechanisms provided by legacy IT operations analytics (ITOA) vendors lack the agility, reliability, and completeness in keeping up with the changes that take place across a multi-vendor, multi-domain, and multi-technology environment.

Auto-discovery is becoming a fundamental requirement for today's IT operations because troubleshooting, capacity planning, maintenance, and effective management are dependent on it.

Auto-discovery in this context describes the process of automatically fetching lots of data from many disparate sources. AIOps can do this because it knows how to communicate with the various infrastructure and application entities. Data is collected by data collectors from all kinds of entities — switches, routers, load balancers, firewalls, servers, storage devices, hypervisors, virtual machines, application entities, and more — whether physical, virtual, or logical.

Beyond auto-discovery, AIOps identifies the relationships between all the entities in a hybrid IT environment and quickly identifies the root cause of complex business-impacting issues. AIOps auto-discovery feeds discovered entities and relationships to ITSM tools to further enrich the value of the ITSM capabilities, which optimizes business processes and reduces operational cost and overhead.

AN AUTO-DISCOVERY USE CASE

Broadcom, a global semiconductor company, deployed the FixStream AIOps platform to reduce MTTR, increase visibility, and gain new insights across its worldwide data centers.

Challenge

Limited visibility of hybrid IT infrastructure and automatic discovery configuration item (CI) relationships:

- There is a lack of dynamic and complete IT infrastructure inventory information.
- Manual tracking and update of relationships between CIs in ServiceNow configuration management database (CMDB) is time-consuming and becomes quickly outdated.
- Issues with IP address and CI parameter duplication are difficult to detect and resolve due to lack of visibility.
- There is a lack of automated correlation of application services with infrastructure entities.

(continued)

(continued)

Solution

FixStream's agentless auto-discovery enables

- Discovery of tens of thousands of devices in real time
- Visibility into data center infrastructure entities and their relationships with its real-time update to changes
- Automatic and dynamic updates of CI relationships across entities in ServiceNow CMDB
- Quick detection of IP and CI parameter duplications in data centers by device type and IP address
- Discovery of application services correlated with infrastructure enable efficient migration and IT optimization.

Results

Out-of-the-box CI relationship discovery and CMDB update delivers

- Reduction of IT costs via resource optimization
- More powerful ServiceNow IT service management capabilities with automated out-of-the-box CI relationship ingestion
- More efficient IT auditing and compliance with the use of relationship mapping
- Better clarity into infrastructure landscapes and their relationships for faster ticket verification and root-cause analysis
- Dynamic topology maps for all global data centers with real-time updates



REMEMBER

ITOA solutions and domain-centric tools are no longer enough — IT operations needs to gain deep insights into their distributed multi-vendor, multi-domain, and multi-technology IT infrastructure to meet their challenging business objectives — and auto-discovery, data correlation, and analytics driven by algorithms powered by machine learning is critical.

Application Discovery and Insights

In virtualized or containerized hybrid IT environments, managing business applications can be challenging:

- » What virtual entities are these applications running on?
- » Can you track the application flows across a hybrid cloud topology?
- » Can you quickly determine if the problem is with the application or in the supporting infrastructure?

These are key questions that application and business operations staff need to answer to effectively guarantee the uptime and performance of mission-critical business applications and processes. To do so, these teams need to rely on smart application discovery capabilities that can keep up with the very dynamic nature of hybrid IT.

To manage business transactions' key performance indicators (KPIs) and to guarantee business process service-level agreements (SLAs), enterprises also need powerful full-stack analytics. These analytics need to automatically map business transactions (such as orders, invoices, and so on) to their application services (web server, application server, databases, and so on) and to the supporting infrastructure (compute, network, and storage).

This must be done in real time across distributed, hybrid IT environments. Only when data and events across the hybrid stack are fully correlated and mapped can applications and business operations teams effectively manage and guarantee the performance of mission-critical processes. Without it, they will be forced to engage in extensive and complex troubleshooting exercises to triangulate hundreds of thousands, if not millions, of data points. The time required to do so can negatively impact the uptime and performance of key processes like e-commerce, order to cash, and others.

MAKING CONNECTIONS: THE VALUE OF DATA CORRELATION

The app economy is upon us, and businesses of all stripes are moving to address it. In this age of digital transformation, businesses rely on applications to serve customers and improve operations.

Businesses need to rapidly introduce new applications and adopt new technologies to become more agile, efficient, and responsive.

As part of these efforts, businesses are employing cloud-based solutions, software-centric and microservices architectures, and virtualization and containers. But these new architectures and technologies are creating challenges of their own.

In the past, each application lived on its own dedicated server, and ensuring the desired performance level was relatively simple.

In today's highly distributed world, however, that's simply no longer the case. Here's why:

- Some business applications today live in public clouds and enterprises tend to have no, or very limited, visibility into those clouds. Other businesses take advantage of more distributed hybrid cloud models consisting of on-premises, public, and private clouds but also suffer from limited or incomplete visibility across their distributed, hybrid environment.
- Applications increasingly run on virtual machines rather than physical servers, which adds more complexity.
- Containers often exist alongside, or within, virtual machines (VMs). The use of containers — and the number of containers themselves — is quickly proliferating enterprise IT environments.

All of this makes for a very dynamic — and complex — environment. Because this environment is very different from what came before, the application performance tools created a decade or so ago no longer apply. Tools that only consider the application — and not the underlying infrastructure — fall short.

Organizations need new solutions that can address what's happening with applications and networks today. These tools must collect and correlate information about the application itself and about the underlying infrastructure.

This should include data about application server performance, events, logs, transactions, and more. The compute, network, and storage resources involved in application delivery also need to be figured into the equation.

Only with this full complement and correlation of data can organizations understand what's happening with their applications. This is important to ensure that applications perform as expected to yield the desired business results.

Intelligent data correlation data puts new insight at the fingertips of businesses and allows you to do a lot of really amazing, time-saving, and income-impacting things. For example, you can trim application troubleshooting efforts from weeks, months, or days down to minutes.

Leveraging Machine Learning

Machine learning techniques must be leveraged to deliver solutions for IT operations, and AIOps platforms are built on this foundational concept. AIOps platforms leverage the power of machine learning to detect relationships across entities and process millions of events to detect patterns and sequences to identify business-level issues.

AIOps platforms combine the power of discovery, correlation, and machine learning to provide meaningful insights to IT operations teams. This capability improves productivity and reduces operational cost. For example, if you're upgrading a router, you need to know the dependent infrastructure entities and application impacts. Or maybe you need to detect a repeating pattern across an application stack to take proactive action to address the underlying issue or predict business outages before they happen, based on sequences of repeating events with a business impact. These are some examples of use cases where machine learning algorithms can provide AI capabilities to automate operations activities. As hybrid IT environments are becoming extremely dynamic and heterogeneous with dynamic workloads distributed across private data centers and public clouds, machine learning and AI techniques are the only solutions that can get a handle on the day-to-day IT operations activities. Without AI and machine learning, business innovation and digital transformation will slow down and negatively impact the business.

IN THIS CHAPTER

- » Gathering data in hybrid IT environments
- » Visualizing data to improve root cause analysis
- » Getting complete visibility in virtualized environments

Chapter 4

Getting Started with AIOps

In this chapter, you learn how to enable data collection in hybrid IT environments, perform day-to-day troubleshooting and operations management, and gain end-to-end visibility in virtualized and cloud environments using AIOps.

Collecting Unstructured Data from Hybrid IT

Businesses, which are increasingly reliant on connected applications, need to get a handle on data collection from heterogeneous and hybrid IT environments. They can do that by correlating, analyzing, visualizing, and acting on an array of data.

That's the only way organizations can avoid failure, optimize networks, and ensure application — and business — success. An AIOps solution that implements a scalable and efficient data collection mechanism can address these hybrid IT challenges.

Presenting Data to Enable Faster Troubleshooting/Trendspotting

AIOps correlates data about applications and underlying infrastructure using artificial intelligence (AI) techniques and makes predictive analysis and efficient root cause analysis possible. Now the question becomes: What's the best way to present that data?



REMEMBER

Data correlation, analytics, and visualization are the keys to AIOps.

Presenting data, for example, in a spreadsheet, can be time-consuming to analyze and can make it difficult to understand what story the data is telling. Alternatively, presenting data visually makes it easy and intuitive to see what's happening in complex cloud and data center environments and the applications they support.

With visualization, you can see in a minute what would otherwise take hours or days to discern. AIOps techniques are used to algorithmically process and correlate event data for business applications and infrastructure in order to make the troubleshooting process much faster. This is really important when your team is scrambling to fix an issue, for example, that's preventing customers from making purchases on your website, and it can be a real lifesaver when managers, executives, and/or customers are pushing you to quickly find a solution to their application issues.



TIP

A recent survey of 1,000 workers at U.K. and U.S. businesses conducted by Prysm, Inc., found that 86 percent of companies benefit from faster decision making through data visualization. The same study showed that 80 percent of organizations report more accurate decision making with visualization. Another recent study conducted by SAS, CIO Marketplace, and IDG Research suggests that companies that adopted data visualization saw a 77 percent improvement in decision making as a result.

The point is that data visualization helps tell a story. Visualization means you don't have to do a lot of analysis and interpretation. Instead, you can simply see what's happening, decide what to do about it, and act.

Research illustrates the importance of visualization in understanding. This makes sense considering how we're built. Seventy

percent of all our sensory receptors are in our eyes, 50 percent of our brain is dedicated to visual processing, and 90 percent of information transmitted by the brain is visual.

The Social Science Research Network reports that 65 percent of people are visual learners. 3M research indicates people process visuals 60,000 times faster than text, and visual aids can improve learning by up to 400 percent.

So, how does data visualization work in AIOps? It's somewhat akin to Google Maps.

Google Maps lets you select your view of the world. You can zoom in and out, and maneuver around, and view all possible paths to your destination — as well as related data such as traffic information, construction areas, weather conditions, and gas stations along the way.

AIOps visualization is a lot like that. But rather than roads and gas stations, it shows the topology of data centers along with network, storage, and compute resources and the applications they support.

An AIOps platform provides a real-time view of the connections between public and/or private data centers and the resources within them. It shows applications-related operational data like events, tickets, and more, and which resources your applications are using. And, like the Google Maps real-time accident location feature, it highlights trouble spots in your environment so that you can pinpoint problems very quickly.

Importantly, AIOps doesn't just show data — it presents data in a contextual view, so you only see what's relevant to the application or business process you're managing.

Google Maps visualizes only the accidents and bottlenecks along a particular journey — like Denver to Detroit. AIOps likewise presents data in an application-centric way so you can pinpoint what you want to see for that specific application. In this way, you won't be inundated with irrelevant data that slows analysis and delays decision making.



Legacy tools present only isolated aspects of the larger application, cloud, and data center picture. AIOps visualization removes the blinders that have blocked organizations from having full visibility. It offers a complete and real-time view of what's happening with your applications and environments.

Increasing Operational Efficiency in Virtualized Environments

Many enterprises today use multiple virtualization solutions in their on-premises and cloud environments, requiring expertise in different technologies to support day-to-day operations and ensure that critical business functions meet service-level agreement (SLA) requirements.

AIOps is built on big data technologies that correlate cross-domain, cross-vendor entities in context with business application, device group, and other operational contexts specific to enterprises. AIOps is intended to benefit infrastructure, application, and business operations teams, with a single converged platform built from the ground up, unlike legacy solutions built using various tools.

Look for the following capabilities delivered by an AIOps platform:



- » **Auto-discovery:** Know what you don't know in a timely manner. One of the biggest challenges in a virtualized environment is knowing and understanding the application and infrastructure resources due to dynamic design concepts such as vMotion and workload auto-scaling. AIOps auto-discovers the virtual infrastructure (virtual machines, hypervisors, virtual switches, virtual networks, and so on), as well as application service entities deployed and dependent on those entities — and keeps them up to date. Thus, you get a reliable, dynamic inventory which becomes the foundational building block for operations activities.

- » **Topology:** Know how things are connected and the dependencies and relationships between them. Think of the days when people used folded paper maps or a road atlas to get from point A to point B, and how technology has evolved since then. Google Maps navigates to your destination using real-time global positioning system (GPS) data to give you precise turn-by-turn directions, getting you to your destination quickly and reliably. The traditional way of managing your network topology with a static Visio diagram simply doesn't work in a highly dynamic, virtualized environment where things change constantly.
- » **Application discovery and mapping:** Know the locality of your critical business services. Dependency mapping between application services and virtual machines/networks requires you to keep up with frequent changes and dynamic mapping of applications to compute, network, and storage resources. AIOps accomplishes this by periodically discovering application service instances and flows, and mapping them to the virtual machines, switches, and networks to which they are associated, while keeping the dependencies up to date. Maps are computed algorithmically and dynamically, and are kept up to date by the algorithm.
- » **Dynamic heat map:** Know where your available infrastructure capacities are without manual effort. AIOps creates a flexible and dynamic heat map across all entities in a virtualized environment to represent their relative utilization with color coding using various parameters such as central processing unit (CPU), memory, and disk space. The heat map can be dynamically re-calculated based on specific user requirements, selections, and inputs — such as application, business process, device group, and others — along with workload placement and resource allocation.
- » **Data explorer:** Know the hierarchical relationship between cross-domain entities and automate the compliance reporting. The AIOps platform enriches the value of unstructured data that exists across domains in hybrid IT environments to deliver operations and business-level use cases via data exploration. Data is explored across a hierarchical dataset which allows for different use cases such as migration, maintenance, and auditing. AIOps provides an intuitive

data explorer view for users to pull auditing and compliance reports. The output is up to date and reflects the state of the environment, which is extremely reliable for auditing and compliance needs.

» **Machine learning:** Finding the root cause of a problem is key. But it's even more critical to determine recurring patterns and predict likely future events. AIOps solutions use supervised and unsupervised machine learning to determine patterns of events in a time series. They also detect anomalies from expected behaviors and thresholds and predict outages and performance issues.

AIOps provides the much needed “single-pane-of-glass” view into complex IT infrastructures that encompass fragmented and distributed multi-vendor, multi-domain technologies including legacy, virtualization, hybrid cloud, containers, microservices, and more.

IN THIS CHAPTER

- » Determining the root cause of outages and events
- » Automating capacity planning and resource optimization
- » Planning successful migrations
- » Ensuring regulatory compliance

Chapter 5

Looking at AIOps Use Cases

AI Ops combines the power of machine learning with the ability to auto-discover and correlate entities across critical layers of digital business — business, application, and infrastructure.

Artificial intelligence (AI) and machine learning are not a replacement for people. In this chapter, you learn how AI and machine learning help humans perform day-to-day IT operational tasks such as troubleshooting, capacity management and planning, migrations, and auditing and compliance.

Root-Cause Analysis of Business and Security Incidents

Machine learning can correlate and analyze data from multiple enterprise application and infrastructure domains, dealing with the volume, velocity, and varieties of data generated. It can uncover patterns to show what has occurred to aid in root-cause analysis. It can use current conditions and past learning to spot exceptions and predict the future. Machine learning can even offer suggestions on what to do in various scenarios.



REMEMBER

Machine learning enables time-series event correlation in context with applications and the business. Using correlation, machine learning can suppress events to help quickly determine the root cause of issues.

AIOps platforms leverage machine learning to deliver AI capabilities for IT operations. Here are some interesting use cases:

- »» Dynamic thresholding is the foundation of the anomaly detection algorithm because it helps understand patterns driven by business trends. For example, certain business events at specific hours of the day, days of the week, or weeks of the year, such as holiday seasons, drive specific patterns in the infrastructure usage. Therefore, setting static thresholds to generate alerts for infrastructure usage can cause false positives. Dynamic thresholding sets dynamic thresholds that are time-based. For example, it may be normal for the processor (CPU) utilization of a virtual machine to reach 90 percent utilization on a busy Monday morning, but it never reaches more than 30 percent on Sunday evenings. So, the anomaly detection algorithm takes these observations and recommendations for thresholds into account while flagging certain events as anomalies using upper and lower variations.
- »» A time-series sequential pattern detection algorithm can predict business outages triggered by events anywhere in the stack where business functions are deployed.
- »» Machine learning automates IT operations and can notify operations teams of potential business outages before they happen. IT teams can then set systems to trigger actions for remediation. Executing remediation scripts or integrating with other orchestration and automation tools to take actions minimizes human tasks.
- »» Proactively detecting issues and fixing such issues enables business continuity and assures customer satisfaction. In the age of digital transformation, such capabilities and AIOps solutions are an absolute must.
- »» With machine learning, IT staff can continually and completely look for traffic exceptions so IT experts can be far more effective in preventing and quickly responding to cyberattacks.



TIP

ROOT CAUSE ANALYSIS USE CASE

A leading healthcare company pinpoints the root cause of SAP business process issues in minutes using FixStream AIOps to automate root-cause analysis by auto-discovering hybrid infrastructure entities and correlating them to SAP business applications.

Challenge

The chief information officer (CIO) faces challenges in delivering required business service level agreements (SLAs) for critical SAP business processes due to the following:

- **Impaired visibility in hybrid IT:** Dynamic and up-to-date inventory of IT infrastructure entities supporting enterprise resource planning (ERP) business processes is lacking.
- **High mean-time-to-repair (MTTR):** Operational data is siloed, existing in disparate domains of the SAP ERP stack. Manual correlation is time-consuming and incomplete, and it quickly gets out-of-date. Automated correlation between business, application, and infrastructure is required.
- **Delayed order processing and failed integration between interfaces.**

Solution

FixStream's AIOps correlation, visualization, and analytics platform enables

- **Smart-auto discovery:** Smart auto-discovery of multi-domain application and infrastructure entities keeps inventory up to date. Topology mapping provides granular relationships between physical, virtual, and logical compute, storage, and network entities.
- **Dynamic application discovery and dependency mapping:** Dynamic application discovery and dependency mapping of SAP components and non-SAP applications with underlying infrastructure and an overlay of operational health and performance data collected from various sources.

(continued)

(continued)

- **Scalable and out-of-the-box integration with SAP solution manager:** Scalable integration with SAP Solution Manager for business, operations, and infrastructure metrics and time-series event correlation enables quick identification of root cause for ERP users and business key performance indicator (KPI) issues.

Results

Rapid root cause analysis, infrastructure planning, auditing, and compliance:

- Reduced MTTR for SAP ERP KPI issues from hours to minutes
- Automated auditing and compliance of IT assets for ERP
- Optimized infrastructure resource planning and workload management for all SAP ERP applications
- Increased application assurance, improved ERP system uptime, transaction uptime, and user satisfaction
- Faster value generation from IT to business, and precise business impact analysis ensures business continuity.

Resource Planning, Optimization, and Workload Management

AI and machine learning can predict when you'll run out of capacity. For example, it could signal a potential lack of storage disk volume and excessive network bandwidth use of a router. Such information helps IT experts do proactive capacity planning to better meet business needs.

It can also identify infrastructure performance bottlenecks and recommend capacity augmentation and optimization.

AIOps platforms can integrate with ticketing, configuration management databases (CMDBs), and workflow management systems to enable seamless operations across multiple disciplines.



TIP

An AIOps platform can also detect what business applications will be impacted when a capacity exhaustion prediction is made.

Migration

Migrations are a fact of life in modern IT environments. Whether you're planning a "lift-and-shift" migration of your on-premises systems and applications to a public cloud, upgrading a vendor technology from an older version to a newer version, migration to a new technology, or your virtualization software is dynamically managing resource allocation and service-level agreements (SLAs) with warm migrations, an AIOps platform can help your team maintain complete and up-to-date visibility of your applications, dependencies, and underlying infrastructure.

Audit and Compliance

Regulatory compliance is an increasingly complex, but necessary burden for enterprises in every industry around the world. Examples include the European Union's General Data Protection Regulation (GDPR), the U.S. Health Insurance Portability and Accountability Act (HIPAA), the U.S. Sarbanes-Oxley (SOX) Act Audit, Canada's Personal Information Protection and Electronic Documents Act (PIPEDA), and the Payment Card Industry Data Security Standards (PCI DSS). Internal governance requirements add to this burden.

AIOps can automate many audit and compliance functions, helping enterprises ensure that they don't run afoul of statutory requirements that may result in fines, brand reputation damage, and loss of revenue, among other consequences.



TIP

AIOps provides automation of many audit and compliance tasks without the need for human intervention. This capability reduces operational overhead while delivering more accurate and up-to-date data required for a successful audit or compliance initiative.

IN THIS CHAPTER

- » Sharing FixStream's AIOps vision
- » Empowering business and operational leaders
- » Understanding FixStream's platform architecture
- » Working together with ecosystem partners

Chapter 6

Exploring FixStream AIOps Solutions

In this chapter, you learn about FixStream's AIOps vision, platform, capabilities, and robust partner ecosystem.

Looking at the FixStream Vision

The FixStream vision and mission is to provide an AIOps platform that can help predict any issues that can impact any business applications with 80 percent to 100 percent accuracy, so that it can be remediated before actually occurring.

Machine learning can correlate and analyze data from multiple enterprise application and infrastructure domains, effectively dealing with the volume, velocity, and varieties of data generated. It can uncover patterns to show what has occurred. It can use current conditions and past learning to spot exceptions and predict the future. Machine learning can even offer suggestions on what to do in various scenarios.

Through its purpose-built machine learning platform, FixStream can notify IT operations teams of potential business outages before they happen. It also can identify infrastructure performance bottlenecks and make capacity augmentation and optimization recommendations (see Figure 6-1).

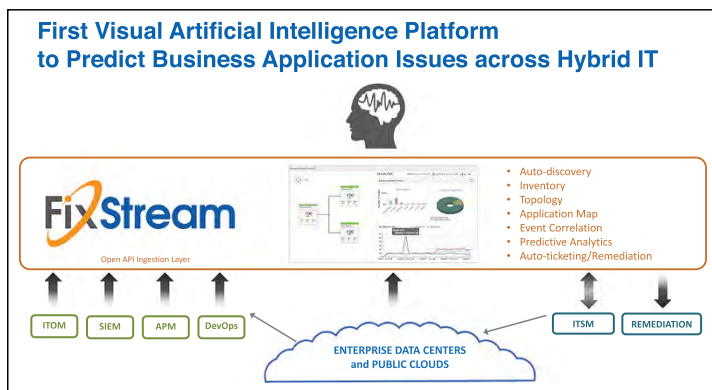


FIGURE 6-1: FixStream visual AIOps platform predicts business application issues across the entire hybrid IT stack.

Recognizing Platform Capabilities

FixStream brings business, operations, applications, and infrastructure together with platform capabilities that include the following:

- » **Time-series sequence analytics for incident prediction and visualization:** The algorithm combines machine learning power that processes millions of events in time-series with the correlation across business, application, and infrastructure to predict business-level issues before they happen. This allows customers to take proactive action to resolve the problem before it impacts the business. This significantly increases customer satisfaction, business availability and reliability, and customer retention (see Figure 6-2).



FIGURE 6-2: Time-series sequence predictive analytics.

» **Multivariate anomaly detection:** FixStream’s anomaly detection capability is based on an unsupervised machine learning algorithm that dynamically creates a baseline for multiple critical performance metrics and correlates the anomaly events for a given application or series of events, based on user-defined grouping policies. Anomalies provide analytical input for anomalous behavior, which often are an indication of bigger problems. This provides proactive identification of such behavior using historic analysis of the data in time-series.

» **Infrastructure capacity trending prediction:** A proprietary algorithm that uses time-series performance metrics data, such as disk utilization for servers, network bandwidth, and interface I/O metrics, to predict when an infrastructure device will become non-operational due to capacity exhaustion (see Figure 6-3).

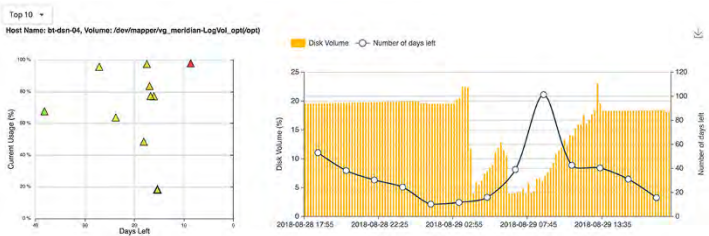


FIGURE 6-3: Infrastructure capacity trending prediction.

» **Business dashboard:** FixStream provides dashboards targeted to specific users, such as business and operational leaders. The business view allows a user to rapidly analyze all business processes (such as order to cash and e-commerce) and operational status, including the health of all transactions. The dashboard is personalized and tailored toward the roles and responsibilities of the user. Users can also design their dashboard view by selecting the appropriate widgets from the widget store, very similar to a smartphone app store experience (see Figure 6-4).



FIGURE 6-4: Business dashboard.

» **Operational dashboard:** The operational view, among many others, enables a user to visualize the operational summary at a glance, with health scores, active faults, alerts, logs and tickets, top ten, predictive volume capacity, and a geographical map of all your data centers. It can be customized through personalized widgets to visualize actionable events, network, compute and application services, overall health, and predictive algorithms.

» **Application discovery:** Automatically discovers your complex, multi-tier enterprise applications, ensuring an always accurate and complete inventory of application dependencies. It can be used to show the potential impact of changes so that you can plan transitions and migrations that won't affect the performance of business-critical applications (see Figure 6-5).

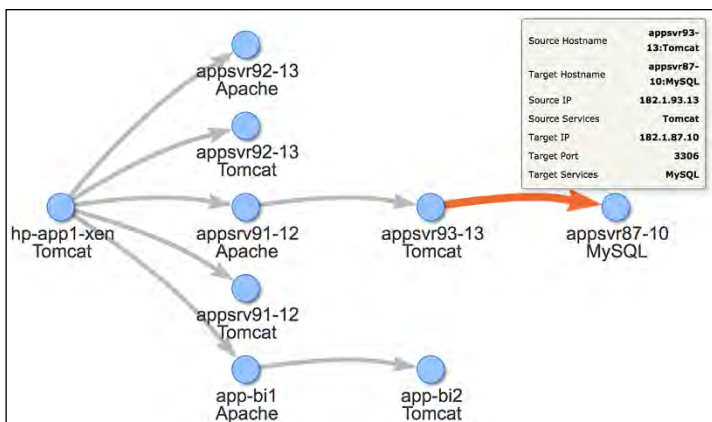


FIGURE 6-5: Application discovery.

- » **Application dependency maps:** Displays the stitching of applications to infrastructure, including application flows, and dependent physical, virtual, and logical compute, network, and storage entities, with an overlay of alerts and faults, pinpointing application-centric performance issues (see Figure 6-6).

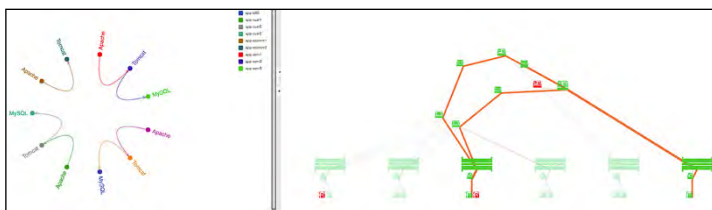


FIGURE 6-6: Application dependency maps.

- » **Business hierarchy customization:** Group applications by business function so you can focus on monitoring the health and performance of applications in any tier of your business processes.
- » **Data explorer:** Provides an intuitive data explorer view for users to pull auditing and compliance reports. It shows the hierarchical relationship between cross-domain entities and automates compliance reporting (see Figure 6-7).

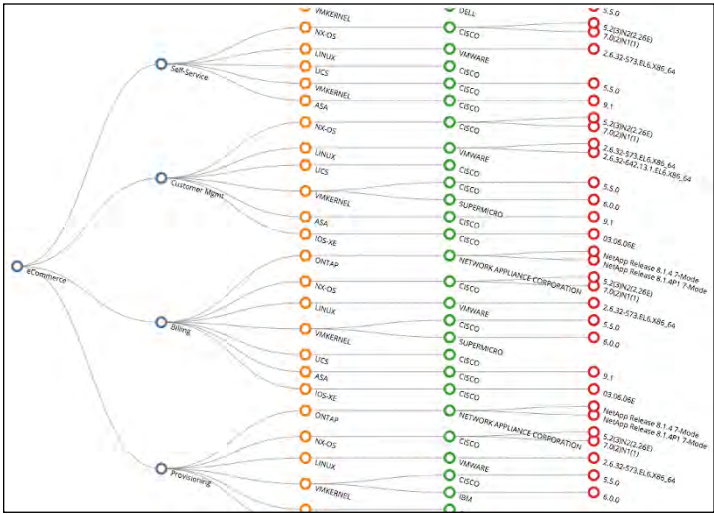


FIGURE 6-7: Data explorer.

- » **Topology view:** Dynamic view with topology analytics of physical, virtual, and logical infrastructure entities with fault, alert, and performance overlays so you can view application dependencies and explore specific application performance issues (see Figure 6-8).
- » **Inventory:** Dynamic inventory of application services and physical, virtual, and logical infrastructure resources in each data center are auto-discovered within seconds, drastically reducing the time to prepare for compliance and migrations, from weeks to minutes.

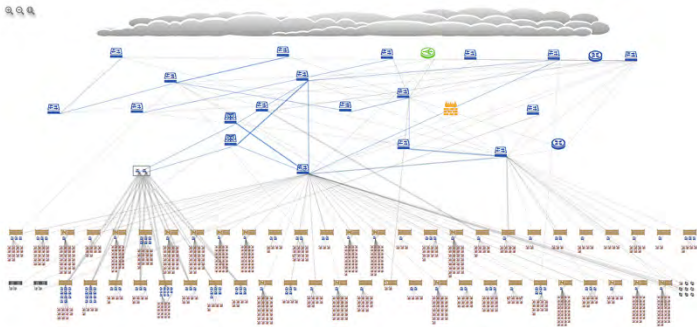


FIGURE 6-8: Topology view.



TIP

With FixStream, business leaders can now visualize

- »» All business processes and their operational status
- »» All applications within each business process and which applications are causing performance issues for that process
- »» The health of all transactions, including volume, response time, and errors, within specific applications
- »» The root cause of transaction performance issues from the services layer or infrastructure layer
- »» The global health of data centers or hybrid cloud and the infrastructure within
- »» Patterns, anomalies, and capacity trending
- »» Proof of control for various compliance requirements



TIP

FixStream also empowers operational leaders with capabilities that include

- »» Visualizing dependency details at every device level for operational management or change management
- »» Logging into devices directly from the topology map
- »» Grouping devices with certain objectives in mind, such as migration, monitoring, and change management
- »» Correlating time series events between different domains
- »» Collecting dynamic inventory information with logical and physical attributes
- »» Creating an operational overlay of all the data on topology or inventory
- »» Building dynamic topology maps
- »» Determining the capacity and utilization of assets
- »» Identifying all dependencies needed for planning, from new application launches, to migrations, to future capacity
- »» Identifying threat vectors for the entire environment, by application or device
- »» Obtaining dependency details at every entity level

Understanding the FixStream Architecture

FixStream is a disruptive artificial intelligence platform for IT operations (AIOps) that provides a business-centric view of hybrid IT environments to proactively manage, plan, and troubleshoot revenue-impacting business-critical processes in real time (see Figure 6-9).

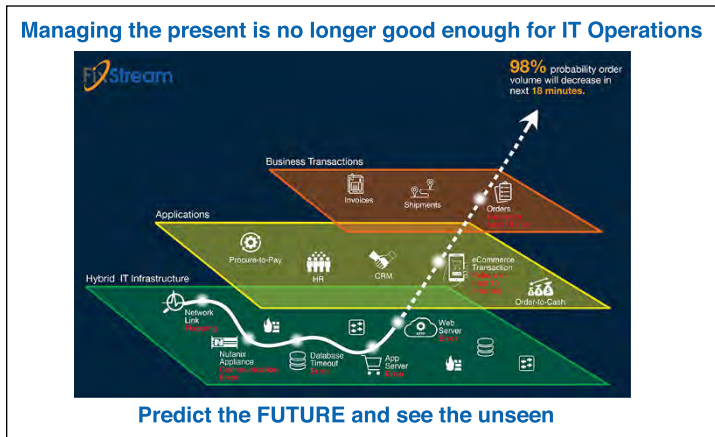


FIGURE 6-9: Managing the present is no longer good enough for IT operations.

Traditional tools provide domain-centric views with little or no event correlation, thus limiting the visibility and management of a hybrid IT environment. FixStream instead provides a single pane-of-glass view of business transactions correlated to application services and infrastructure entities (such as compute, network, and storage) that has allowed large enterprises to accelerate the delivery of new digital services and save millions of dollars by

- » Automating root cause analysis of business transaction, application, and infrastructure issues
- » Optimizing IT resources to reduce infrastructure costs
- » Accelerating adoption of hybrid cloud containers with minimal risk
- » Reducing compliance risk and audit costs

The FixStream correlation, analytics, and visualization AIOps platform uses a patented technology, called Flow2Path, to build a highly correlated set of maps including data center topology maps, application maps, and transaction maps, with operational analytics overlays. FixStream’s unique ability to integrate and correlate information in time-series data allows the operator to “go back in time” to better understand root causes and patterns leading to service issues.

The Flow2Path process begins with a data ingestion process that auto-discovers all application services, as well as all physical, virtual, and logical infrastructure entities, across each data center and cloud (see Figure 6-10). Structured and unstructured data are gathered on a cadence set by the user. Data is collected in three ways:

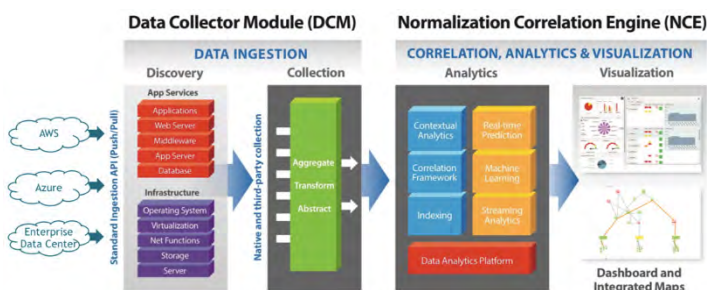


FIGURE 6-10: The FixStream architecture.

- » Agentless techniques via the FixStream Data Collector Module (DCM)
- » Built-in connectors integrated with third-party tools providing operational overlays, such as faults, alerts, logs, and tickets
- » Business transaction agents providing detailed transaction monitoring and correlation to applications

The Normalization and Correlation Engine (NCE) correlates and analyzes DCM data to create a dynamic inventory of all discovered entities with physical, virtual, and logical infrastructure entities, application services, and so on, as well as application to infrastructure maps with operational analytics overlays called iMAN (Integrated Map of Applications and Networks). These maps show the physical, virtual, and logical infrastructure, and cloud elements that an application is running on; pinpoint health

problems, performance degradation, and blind spots; and provide baselines for more advanced infrastructure optimization, performance monitoring, and machine learning capabilities.

FixStream is software only, with DCM and NCE running on a set of virtual machines; it requires no special hardware or agents. Minimal input is needed to deliver near real-time visibility through FixStream’s mapping and analytics of multi-tier applications to business process hierarchies and infrastructure.

The FixStream AIOps platform is built on an open application programming interface (API) data ingestion architecture (see Figure 6-11). The open API data ingestion layer is built on a robust set of APIs used for communication with different domain-specific tools. APIs are at the heart of the open API data ingestion architecture, which allows for data collection from the following categories of tools in a standard way:

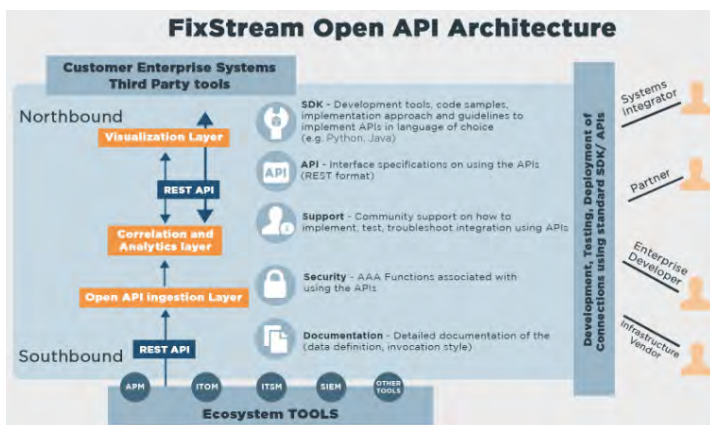


FIGURE 6-11: FixStream open API architecture.

- » **Application performance management (APM) solutions** like AppDynamics, Dynatrace, and New Relic
- » **IT operations management (ITOM) software** like Nagios and SolarWinds
- » **IT service management (ITSM) systems** like ServiceNow, Cherwell, and BMC Remedy
- » **Security information and event management (SIEM) software** such as Splunk

The ability to do open API data ingestion from an array of data sources is critical. It allows for an accurate, real-time view of all the moving parts in hybrid IT environments. This includes all applications, business transactions, and infrastructure.

FixStream has enabled this capability via connectors and south-bound APIs. Prepackaged connectors are available for many of the most popular tools in use today, and FixStream's APIs enable industry colleagues and customers to build their own connectors.



REMEMBER

FixStream's open API data ingestion is pivotal to building a community and ecosystem for enablement of data ingestion from various sources. This enables partners, customers, third-party vendors, and developers to build connectors to ingest data to FixStream and leverage the power of FixStream AIOps.

Building a Robust Ecosystem

FixStream's connector ecosystem preserves your investment in IT operations and service management tools by making it easy to bring operational and security events from your existing monitoring tools into the FixStream platform. This will enrich the correlation of faults and alerts in the context of your applications, accelerating root cause analysis across multiple domains.

To effectively correlate, visualize, and analyze very diverse IT environments, FixStream supports a broad range of prebuilt integrations with infrastructure and applications entities. These allow out of the box auto-discovery and correlation across your entire environment to get your AIOps running quickly.

For the list of supported technologies, refer to the FixStream product datasheet available at <https://fixstream.com/resources>.

Chapter 7

Ten Key Capabilities in the FixStream AIOps Platform

Empowering IT Operations to predict issues before they occur requires a modern architecture that brings big data, machine learning, and artificial intelligence (AI) techniques together. FixStream transforms IT operations via a ten-step AIOps process, out of the box:

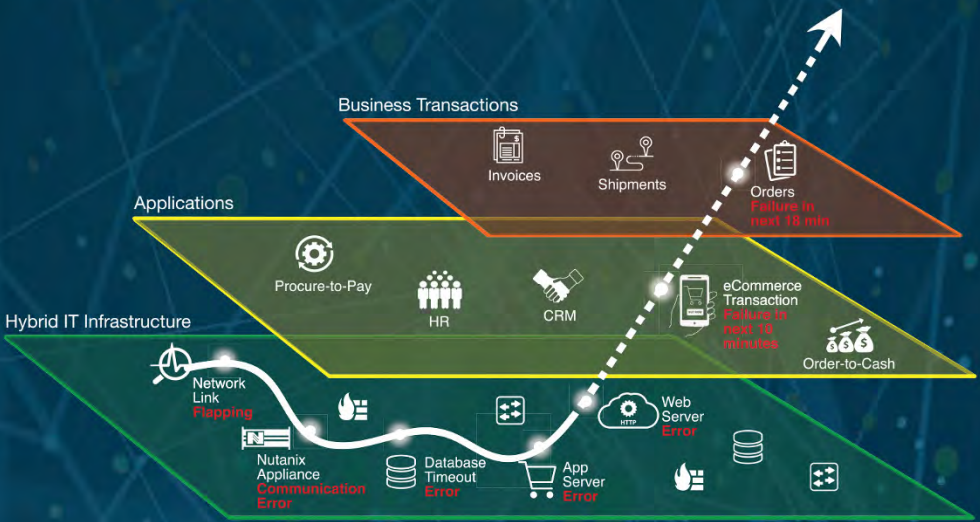
1. Auto-discovering physical, virtual, and logical entities across hybrid IT data centers, without agents
2. Capturing an accurate inventory of physical, virtual, and logical infrastructure assets requiring very detailed intelligence of vendor-specific implementation and protocol support
3. Automatically pushing the inventory data into a configuration management database (CMDB)
4. Automatically discovering application services and their flows

- 5.** Correlating all operational data for a specific application, from the transaction layer to the services and to the infrastructure layers
- 6.** Dynamically binding flows using flow analytics in a logical group that comprises a specific multi-tier application
- 7.** Mapping application flow information onto available paths
- 8.** Storing millions of events in time-series
- 9.** Identifying anomalies across all typical variables
- 10.** Detecting patterns and predicting incidents so that they can be fixed before they occur

AI PLATFORM TO PREDICT BUSINESS APPLICATION ISSUES ACROSS HYBRID IT

- Business transactions to infrastructure correlation and prediction
- Real-time correlation of millions of data points
- Enriches the value of existing IT tools
- Agentless auto-discovery
- Out-of-the-Box

98% probability order volume will decrease in next **18 minutes**.



“FixStream’s approach to infrastructure management is unique in that it addresses the user experience holistically – from the application to the infrastructure that supports it. The application of AI technologies to preemptively address user impacting issues before the user sees them is innovative, and combining such capabilities with an end-to-end management approach means that FixStream is likely to predict more faults before they can occur than other infrastructure management tools.”

Mike Jude - Research Manager, Big Data Analytics, Stratcast – Frost & Sullivan

Leverage AI to optimize your operations

Customers, technology, and new business models are driving unrelenting change through digital transformation. Mobile, cloud, and the web join enterprise data in disrupting business models that can't keep up with more connected, nimble, and well-informed customers. Enterprises are launching more and more applications designed to increase engagement with digital consumers at every touch point in the customer experience life cycle. AIOps helps businesses meet these challenge in the era of digital Darwinism.

Inside...

- Predict and prevent outages
- Dramatically reduce mean time to repair
- Decrease operational noise and alerts
- Gain end-to-end visibility
- Accelerate migration to the hybrid cloud
- Simplify IT processes
- Break down silos across IT teams

FixStream

Sameer Padhye, FixStream Founder and CEO. Prior to FixStream he served in a variety of senior management roles at Cisco Systems for twenty years. Most recently he was Senior Vice President of Services, Customer Advocacy and Service Provider Line of Business at Cisco.

Bishnu Nayak, FixStream CTO, guides FixStream's overall technology; product strategy and road map; R&D; and engagement with technology partners, enterprise, customers, and service providers. **Enzo Signore**, FixStream CMO, is responsible for the company's go-to-market strategy, positioning, branding, demand generation, and strategic alliances.

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