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APM to AIOps - Core Transformation

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ABSTRACT

Purpose: The health of the modern application ecosystem depends on many complex processes that are impossible to monitor and manage manually. A disruption to these services will cost millions and will put at risk customer loyalty and satisfaction. A few analytical solutions can scan through humungus data, detect issues over time, and proactively inform the IT Operations team about issues that might severely impact business systems.

Design/Methodology/Approach: Applying business monitoring solutions at large-scale for gaining insights is ground-breaking. Leveraging machine learning technologies, the solution will be able to analyze millions of parameters that affect business metrics over time intervals. They continuously detect anomalies, trends, and correlations and present the most relevant insights. Unlike prior generations of solutions, these new solutions excel at separating signals from noise and quickly learn and deliver critical insights.

Findings: Unlike prior generations of solutions, these new solutions excel at separating signals from noise and quickly learn and deliver critical insights. These solutions identify correlations, detect anomalies, and display potential root causes.

Originality/Value: The study brings to light the core transformation needed to migrate from the current generation APM to the Next Generation of AIOps and the various building blocks and principles that need to be taken into account while undergoing this transformation.

Paper Type: **Research Thought**

KEYWORDS Application Performance Management(APM) | Artificial Intelligence for IT Operations (AIOps) | APM Core Modernization | IT Infrastructure Monitoring (ITIM) | IT Operations Management (ITOM) | IT Service Monitoring(ITSM).

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Introduction

When performance problems do occur for the end user, the inability to monitor across the entire application delivery chain hinders the organization's ability to rapidly determine the route cause of the problem. Much time is spent trying to determine where the performance problem resides. Application delivery chains continue to cultivate in complexity. In the new world of cloud service providers and composite applications, troubleshooting application issues requires IT to chase down multiple complex request paths for an ever-growing number of applications. Lack of end-user performance insight and the inability to rapidly isolate fault domains across the application delivery chain leads to delays and high costs to resolve application performance and availability problems. IT teams time is spent majorly on debugging applications and trying to understand the root-cause of the problem. A large number of production problems could be avoided by implementing a more proactive approach to application monitoring.

As multi-tier architectures, virtualization and other new technologies grow in popularity, and data centers in turn grow more complex. As a result, IT and line-of-business professionals are hindered in attempts to ensure application performance and availability. When things go wrong, IT executives need quantitative assessments of business impact, such as "the system was unavailable to customers for 2 hours, which cost us $200,000," so they can evaluate whether the proposed fixes are worth it. Without AIOps capabilities, an I&O team would have to export data from several systems, bring it into a database or spreadsheet, and try to piece together some views of the incident's impact. Having all the data contextualized in one data lake allows IT & Operations teams to produce these estimates quickly and accurately.

Lack of Visibility and Decision Making

The application delivery chain continues to grow as enterprises continue to leverage newer technologies such as cloud services, virtualization or mobile applications help drive better efficiencies or competitive differentiation. Applications have changed and have become "composite," meaning that multiple elements are assembled for first time within the end user's browser. In fact, the average application consists of 10 separate services — each of which impacts end user experience, availability and response time. IT operations is plagued by the contrasting forces of increasing complexity on one hand and cost cutting on the other. The complexity can be defined across the three dimensions of variety, volume and velocity as:

- Rapid increase in data volumes generated by the applications and infrastructure (two-to three-fold increase per annum)
- The increasing variety of data types generated by machines and humans (for example, metrics, logs, wire data and documents)
- The increasing velocity at which data is generated as well as the increasing rate of change within IT architectures due to the adoption of cloud-native or other ephemeral architectures

A trade-off in any of these dimensions will prove costly given the insights required by a modern business. Existing monitoring tools are stressed when dealing with high volume, velocity and variety of data. More importantly, the heritage monitoring tools do not cut across different types of data for extracting criitcal insights. For example, the business needs humungas amounts of data that cuts across infrastructure and application metrics, customer sentiment data, business transaction data, sensor telemetry, and logs from various systems for additional insights. The maturity and performance the AIOps solution towards enabling multiple use-cases across IT, operations and security is the key inhibitors against a singular platform deployment.

Application performance management (APM) solutions from vendors like AppDynamics, Dynatrace, and New Relic took off in 2008 when enterprise developers ramped up the use of web services such as AJAX, JSON, and REST APIs. APM tools enable DevOps and development teams to diagnose, inefficiently performing code and reduces the time it takes to change. For IT & Operations teams, solutions such as those of Datadog, ScienceLogic, and Zenoss start at an infrastructure-centric view by uniting network data and server metrics to create a fullservice dependency map. IT & Operations professionals can then use that map to quickly identify the faulty hardware or software component that's affecting multiple downstream services.

With firms adopting DevOps practices, containerized microservices, and cloud strategies, humans can no longer manage the scale and complexity of the data that IT & Operations teams need to process to understand service performance. IT & Operations teams can't deliver the insights their business colleagues need to refine their customers' digital experiences with their current legacy toolsets.

Core Transformation

Information technology (IT) departments have used traditional APM tools for decades. Those tools use event correlation and root cause analysis to monitor IT infrastructure (web servers, application servers, CPU, memory, storage, containers, and microservices) and applications (errors, latency, configuration problems, resource contention, and bottlenecks. APM systems differ from business monitoring systems in scope and types of algorithms and models they employ. IT monitoring systems focus on a complex but highly

constrained domain. Their algorithms are tuned for the types of applications, systems, and errors these systems generate. Most monitor technical issues, but many are starting to correlate those with business processes, applications, and higher-level artifacts. In contrast, APM business monitoring systems tackle an infinite number of domains, so their algorithms must adapt to a wide variation of metric behaviors. When companies introduce new products, enter new markets, and acquire new customers, their metrics and behavior change.

In contrast AIOps platforms combine big data and machine learning functionality to support IT and operation functions through scalable ingestion and analysis of the increasing volume, variety, and velocity of data generated by IT systems. AIOps platform enables the concurrent use of multiple data sources, data collection methods, and analytical and visualization technologies. AIOps can enhance a wide range of IT operations processes, and tasks, including performance analysis, anomaly detection, event correlation, and analysis, IT service management and automation.

AIOps technology is a smart notification system than a dashboard. It's designed to continuously monitor and analyse business and doperational processes that correlate with business outcomes and provide real-time alerts of relevant correlations, trends, and anomalies, without human intervention, and with unprecedented speed and scale. And unlike prior generations of monitoring solutions, these systems excel at separating signal from noise: they quickly learn what business users consider relevant and deliver only those insights.

While dashboards measure performance against predefined or "known" metrics, business monitoring systems track all business metrics, both known and unknown. These solutions scan the dark data that exists within companies and is too voluminous to monitor and examine leveraging analytics techniques and tools. More importantly, these systems free-up data analysts to spend time interpreting, communicating, and responding to insights rather than sifting through mountains of data to locate them. Business monitoring solutions serve as an early warning system to alert business users of trends, anomalies, and glitches that might adversely affect business outcomes.

Collaboratively, the tool stacks can deliver a holistic view of all user transactions across the IT infrastructure to understand the health, availability, service impact, and end-user experience of critical applications, allowing programs to proactively diagnose and resolve problems while optimizing the performance of mission critical systems. AIOps monitors all transactions as they navigate the infrastructure and automatically links those transactions to the dependent application, network and infrastructure components to provide a view of application health, enable prioritization of incidents based on business process impact and swiftly pin-point problem areas across disparate technology silos.

AIOps assure high-value transactions, receive the highest service levels by understanding problems in business context to identify critical transactions that may be at risk, prioritize problem resolution efforts, dispatch the right resources and fix the problems that impact functionalities or key end users. Performance and availability information is presented in business terminology, providing application health metrics that can be easily understood by non-application experts and easily communicated to business users. The goal of the analytics effort is the discovery of patterns to predict incidents and to determine the root causes of abnormal system behaviors.

Transformation Methodology

AIOps platforms address the need for operations support by combining machine learning and big-data functionality to analyze the ever-increasing variety, volume and velocity of data generated in response to digital transformation initiatives. AIOps platform enables a wide range of IT operations

processes including root cause analysis, anomaly detection, event correlation etc to improve service management, monitoring, and automation tasks.

The central functions of AIOps platforms include:

- Ingesting data from multiple sources including infrastructure, networks, apps, the cloud or existing monitoring tools (for cross-domain analysis)
- Enabling data analytics using machine learning at two points:
  - Real-time analysis at the point of ingestion (streaming analytics)
  - Historical analysis of stored data
- Storing and providing access to the decision data
- Suggesting prescriptive responses to the analysis
- Initiating an action or next step based on the prescription (result of analysis)

The analytics capabilities are leveraged to discovery patterns or groups occurring in the data that are used to predict possible incidents and anomalies. These patterns are leveraged to locate the root causes of system issues and smartly drive automation to rectify them. Open-source projects enable users to assemble an AIOps platforms by integrating tools for data ingest, big data platform, Machine-Leaning, and visualization capabilities. End users can mix and match the components from multiple providers. A few enterprises actively build AIOps platforms by putting together all required layers starting with streaming to acquire data (using Prometheus, for example), followed by aggregation (using InfluxData's InfluxDB, for example) and a visualization tool (such as Grafana or Elastic Kibana).

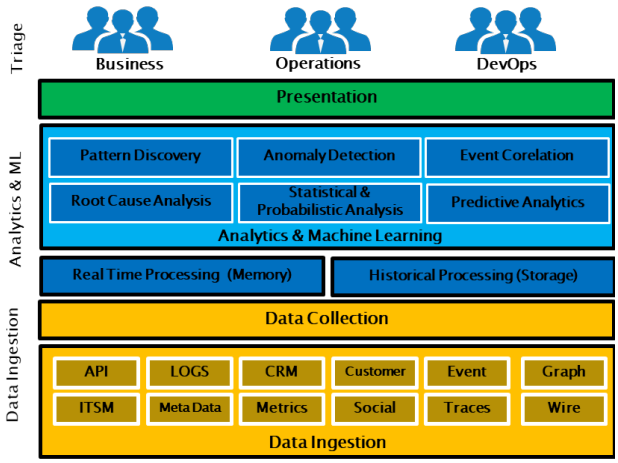

Figure 1: AIOps Architecture

Data Ingestion and Management

AIOps platforms must be able to ingest data-at-rest (historical) and data-in-motion (real-time streaming). This platforms enable data ingestion, indexing, and storage for various types of data which includes wire data, metrics, event data,, traces, document data and graphs. These solutions must also analyze data at the point of ingestion in real-time without requiring data to be saved to a database before analyses. These tools must provides a co-related analysis and insight that cut through multiple streams of historical and real-time data.

Modern IT operations aim to gain a composite visibility on IT entities, including applications, their relationships, inter-dependencies and past transformations into gain insight to the present state of the overall IT landscape. Selection of the right data source is crucial in avoiding blind spots. The progressive nature of deployment, maturity and evolving use cases requires a readiness to ingest a variety of data sources. IT & Operations teams must leverage AIOps platforms that are capable of ingesting and providing access to a wide range of historical and streaming data types.

AIOps platforms have historically focused on a single data source like logs or metrics. Unfortunately, no matter how large or frequently updated a given dataset is, the restriction to a single data type tends to limit the insights into system behavior. Modern IT systems with their modularity and dynamism — require a multi-perspective approach to gain insight into what is happening as its has been monitored.

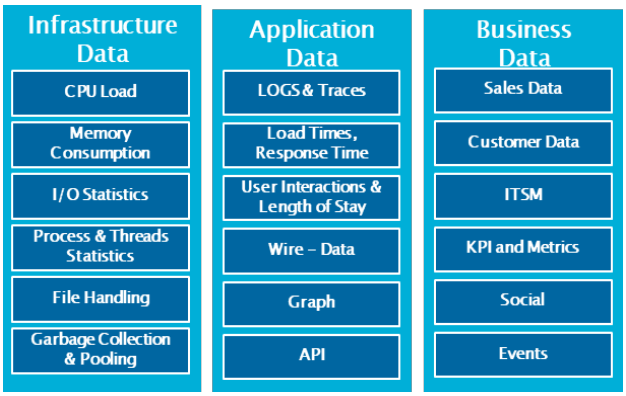

Figure 2: Data Architecture

Analytics Outcome - Machine Learning

Software solutions or appliances that enable ingestion, indexing, and persisted storage of different data types like wire data, log-data, document and metrics data. The target databases are typically poly structured or unstructured, while the stored datasets accumulate in very high volumes, update with high velocity, and are implicitly structured according into different formats. This historical data management functionality can be called "big data management." To provide value under the IT operations case, the tool must also present data in time scales perceived by a human user as real time, delivering data directly at the intersection of ingestion without requiring access to a persisted database. It must provide a coherent analysis cutting through multiple streams of real-time and historical data.

AIOps platforms enable the detection of naturally occurring seasons in data and be able to learn when this behavior is no longer anomalous. For this to be of value, the algorithm must consider whether the anomaly has an impact or not. In a large-scale deployment, there will always be anomalies, and some will matter much more than others. Transcending the mere detection of outliers, they must be correlated with potential business impact and other concurrent processes such as release management metadata tags to be fully useful and not just create more alert noise. The following types of analytical approaches are leverage to gain insights from the historical and real-time data:

Table 1: Analytics Capabilities for AIOps

Prediction Methodology	Description
Statistical, probabilistic analysis	A combination of univariate and multivariate analysis, including the use of clustering, correlation, classifying and extrapolation on metrics captured across IT entities.
Automation of pattern discovery & prediction	Discovering patterns, clusters or groups that implicitly describe correlations in historical and/or streaming data. These patterns may then be leveraged to predict incidents with varying degrees of probability.
Anomaly Detection	Using the patterns discovered by the earlier components to determine normal behavior and then to distinguish departures from that normal behavior, both univariate and multivariate. Anomaly detection should support seasonality, deciding whether behavior is anomalous within a time period called a season.
Root-Cause Determination	Pruning throught the network of correlations established by the automated pattern discovery and ingestion of graph data to define causality chains linking cause and effect.
Prescriptive Advice	Suggesting solutions to resolve an issue. These suggestions will be based on a database of historical solutions (tribal knowledge) to recurring problems or determined via crowdsourcing.

Triage & Remediation

As the technology matures, end-users will be able to leverage prescriptive advice from the platform, enabling the action stage. The steps for this are:

- Start with the Known: Recording successful solutions with tribal knowledge database. Classify problems into categories.
- Match Current with Historical: Match a problem category with a group of known solutions in the database
- Recommend: Suggest a set of solutions with probabilty
- Execute: Run solutions / ARA-Run Book. Track Resolution Effectiveness and improve the algorithm

AIOps in ITSM and DevOps

Table 2: AIOps in ITSM & DevOps

AIOps in ITSM	AIOps in DevOps
• Assisting Service Desk Agents With Assigning, Categorizing And Routing Tickets • Task Automation (For Example, Deploying Software, Handling Password Resets, Vpn Clients Updates And Reviewing Text In Email To Initiate Requests) • Strategic Insight For Identifying Change Conflicts,, Change Management, Identifying Contracts About To Expire, Determining The Best Time To Patch And Predicting Change Success, The Estate. • Leveraging Historic Data To Increase Efficiencies And Improve Agent Performance • Predictive AnalytIcs To Highlight Requests And Incidents About To Breach Sla • Leveraging Natural Language Processing - Nlp To Power Chatbots To Take Load-Off Service Desk's Team Of Priliminary Inquiries And Tasks. To Share Knowledge With End-Users And To Enable Task Automation	• It Organizations Have Also Started Exploring Aiops In A Devops Context Integrated With Application Release Automation To Assess Risk In Code And Also In Builds To Avoid Perilous Deploys. • This Requires The Ingestion Of Metadata, Including Tags From RelEase Management To Help In The Categorization And Relation Of New Functions Released. They Are Also Using Aiops To Detect Potential Security Issues. • Nlp Is Heavily Adopted In Itsm Tools, But Some Apm Vendors Have Started To Include Nlp As Part Of Their Aiops Capability. • The Aim Is To Enable A More Flexible Chatops For The Devops Teams And Offer A Better Interface To Apm Data And Automation.

Related Work

- This Paper provides an overview of state of the art in APM in industrial academic, and practice research, highlight challenges, and outlines future re-search directions.
- This paper explains a concept to extend and exploit meta information of an IT architecture documented in an Enterprise Architecture tool to support a layered monitoring approach providing correlation and traceability between monitoring data pulled out from different abstraction layers.
- This paper proposes an intelligent system that first conducts a joint time series detection to identify outliers or anomalies on the basis of statistical judgment and machine learning, and then automatically discovers those anomalous functions by the method of statistical analysis.
- This paper reviews the development of IT operation and maintenance technologies in the past two decades and introduces five abilities that a typical AIOps system requires, namely, perception, detection, location, action, and interaction.
- This work conducts an in-depth mapping study to organize and collect a number of scattered contributions to AIOps. This provides an AIOps taxonomy to create a foundation for future contributions allowing efficient comparison of AIOps addressing similar problems.
- This technical briefing, articulates real-world challenges in solutioning AIOps based the experience in Microsoft technologies. Then it recommends a roadmap of AIOps related research, and shares a few successful AIOps solutions for Microsoft products.

Conclusion and Further Work

In case a problem occurred, the goal is to isolate its root cause during problem diagnosis again manually or automatically. Manual analysis is typically conducted by employing previously mentioned data representations, e.g., by navigating from status lights, via application topologies, execution traces, component drill downs, and time series. There are also approaches to automatically detect root causes of typical performance problems, which are built into the AIOps tooling. Statistical techniques can be applied to the data to detect anomalies, which can indicate problems. Particularly time series data is leveraged to analyse and detect violations of thresholds, which are either specified manually (e.g., based on SLAs) or learned from historic baseline data. In case an anomaly is detected, alerts can be sent out to the system operators. To retain trust in automatic alerting and detection, a high classification quality in terms of recall, precision, and related measures is anticipated.

Data lakes allow you to combine all sorts of data, including machine data (such as the monitoring systems and logs that intelligent application and services monitoring - IASM tools bring together); traditional IT service management - ITSM data (change controls, tickets and asset information); and outputs from business systems like robotics process automation tools and marketing technology platforms and services. For example, AIOps can use DevOps

toolchain data to find anomalies that otherwise can go unnoticed until they affect end users. This big data platform allows you to discover service improvements that will lead to better business outcomes

The true power of AIOps, when combined with automation, is in predictive incident avoidance. Previously, capacity management tools used analytics that focused exclusively on historic infrastructure utilization. However, with modern workloads, whether private cloud, public cloud, or hybrid, the past isn't always a reliable guide to the future; AIOps capabilities allow ORGANIZATIONS to build whole systems that can scale up and down even when demand appears to have no discernable pattern to the human eye. By applying advancements in AI/machine learning to enterprise data and producing intelligent automations, I&O teams can change how their enterprises approach data management and processing and alter how using this data shapes business decisions. Software that leverages AI/ML or advanced analytics capabilties on operations and business and to provide predictive and prescriptive insights in real time. These insights produce real-time business performance KPIs, help avoid incidents altogether and allow teams to resolve incidents faster. AIOps is the next logical evolution of using data to understand how the business runs. Gone are the days of thinking of IT services performance as five 9s of success. Today, we need to measure the day- in the life journey of a digital user.

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Annexure 1

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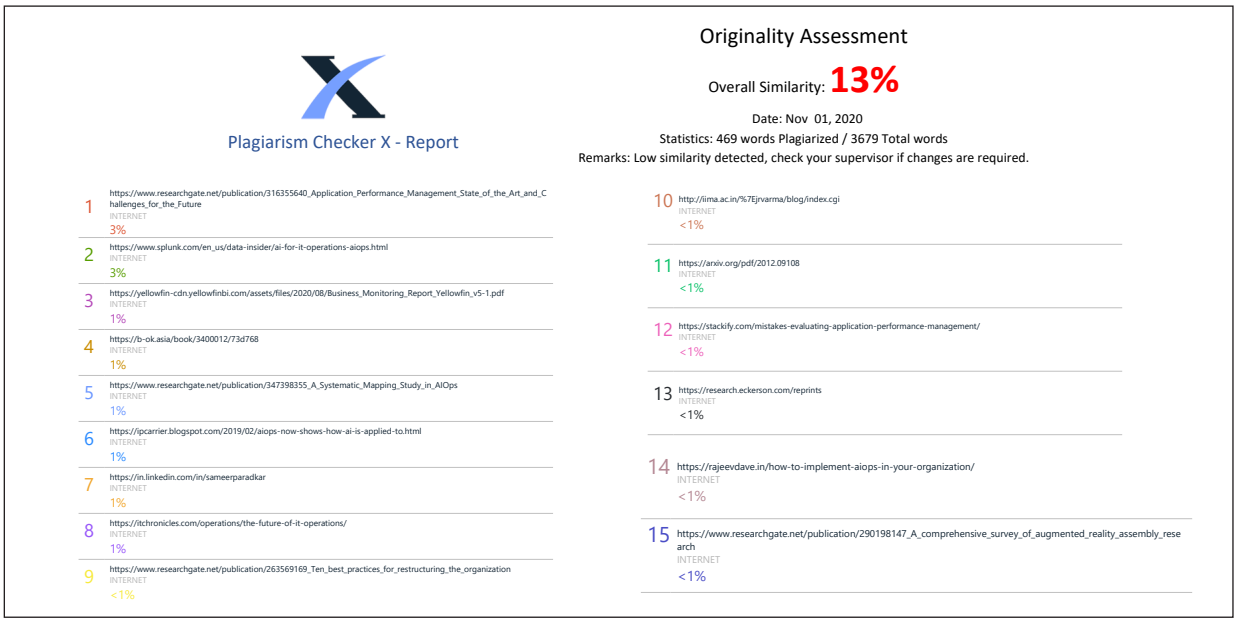

Reviewers Comment

Reviewer Comment 1: The study focuses on APM which is a core IT-operations discipline that aims to achieve an adequate level of performance. Nowadays, the success of most companies is determined by the quality of their IT services in addition to their APM. The future of performance monitoring could involve AIOps. The paper represents the ideas of the author and can be further filtered for more objective research.

Reviewer's Comment 2: The author has presented a detailed work on Application Performance Management and Artificial Intelligence for IT Operations Transformations. The work has not only focused on Artificial Intelligence for IT Operations Architecture which includes machine learning but also on the analytic capabilities. The author could go ahead with primary data collection and analyse the ground realities of the industry.

Reviewer's Comment 3: The study is qualitative nature. AIOps technology is still relatively new, the terms and concepts are relatively fluid. There is a great deal of work to be done before anyone can deliver on the promise of AIOps. The industry needs to understand the transformation. The study lacks definite objectives and can serve as a base for further refined research.

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Conflict of Interest: Author of a Paper had no conflict neither financially nor academically.

Editorial Excerpt

The article has 13% of plagiarism which is the accepted percentage as per the norms and standards of the journal for the publication. As per the editorial board's observations and blind reviewers' remarks the paper had some minor revisions which were communicated on a timely basis to the author (Sameer) and accordingly all the corrections had been incorporated as and when directed and required to do so. The comments related to this manuscript are noticeably related to the theme "**APM TO AIOps - CORE TRANSFORMATION**" both subject-wise and research-wise.The author has presented a comprehensive study on Application Performance Management and Artificial Intelligence for IT Operations Transformations. The work has not only focused on Artificial Intelligence for IT Operations Architecture which includes machine learning but also on the analytic capabilities. AIOps is already a mindset focused on prediction over reaction, answers over investigation,and actions over analysis.The study leaves behind a reason for the IT leaders should keep an eye on the rise of AIOps as a whole.Overall, the paper promises to provide a strong base for the further studies in the area. After comprehensive reviews and editorial board's remarks the manuscript has been categorised and decided to publish under "**Research Thought**" category.

Acknowledgement

The acknowledgment section is an essential part of all academic research papers. It provides appropriate recognition to all contributors for their hard work and effort taken while writing a paper. The data presented and analyzed in this paper by (Sameer) was collected first handily and wherever it has been taken the proper acknowledgment and endorsement depicts. The author is highly indebted to others who had facilitated in accomplishing the research. Last but not least endorse all reviewers and editors of GJEIS in publishing in a present issue.

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