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Datacenter Networks in the Digital Era: Necessary Advances in Network Operations

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The datacenter network is foundational to digital infrastructure. Connectivity, performance, service, and security demands are rising in line with increasing digital business requirements. Unfortunately, reliability, complexity, and resource constraints inhibit success. Heightened visibility, control, and automation are paramount.

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Written by: Mark Leary, Research Director

I. Introduction

Digital Acceleration and the Network

IDC survey results consistently indicate that top strategic business priorities for executives focus on operational efficiency, customer satisfaction, worker productivity, and business innovation.

In today's business environment, digital infrastructure (the network, datacenters, cloud services, data, applications, and security systems) must offer the most efficient and effective self-contained on-premises hardware and software systems; it has to support public cloud and communications services and the required engineering and operations IT staff in delivering these services; it should enable the best possible user experiences (for workers and customers); and it must be flexible enough to adapt to shifting business, technology, and staff requirements.

Functioning at the core of this digital infrastructure is the network. In this hyper-connected digital age, the resiliency and responsiveness of the network are prime determinants of success in operating efficiently, serving users, and driving innovation.

AT A GLANCE

KEY TAKEAWAYS

Accelerating business and technology demands — driven increasingly by AI workloads — are pushing scalability, connectivity, performance, and security requirements for datacenter networks through the roof. At the same time, budget shortfalls, staff shortages, and system/tool shortcomings restrict datacenter network engineering, operations, and evolution. IT organizations must increasingly rely on more intelligent and insightful systems that serve to bolster datacenter network service levels and capabilities, IT staff productivity and value, and, ultimately, digital business innovations and outcomes.

The Datacenter Network as Digital Lynchpin

While the use of public cloud services continues to accelerate across all industries, all company sizes, and all regions of the world, the on-premises datacenter is still viewed as a core resource and competitive differentiator in the digital business environment. Recent IDC survey-based research into advances in GenAI workloads indicates that most organizations prefer a hybrid approach — using a mix of public cloud and private datacenter resources to foster data, train models, and fuel inferencing. For larger companies, this GenAI buildout often encompasses multiple datacenters and multiple clouds.

All this planned activity around complex hybrid environments raises the bar for datacenter networks. Traffic, bandwidth, connections, and threats all rise. Configuration, integration, operation, maintenance, and enhancement become more challenging, while also more vital to be done right. Datacenter network service requirements are advancing. Datacenter network solutions and management systems must match up to these advancing requirements. Simple is better. Resilient is better. Responsive is better.

Barriers to Network Success in the Datacenter

Unfortunately, as IT organizations work to ensure their digital infrastructures deliver on their full promise in serving the business, significant challenges are presented by the network — particularly, by the datacenter network as a central connectivity resource. As networks have grown more critical, they have also grown more complex and costly to engineer and operate.

> Accelerating performance and connectivity requirements within the datacenter increase pressure on networking budgets and staff, heighten failures and slowdowns, and delay IT services and digital business initiatives. In a recent worldwide IDC survey of those in charge of datacenter networking for large enterprises, respondents indicated that network performance was one of the top impediments to rolling out GenAI for production use.

Why does the datacenter network present more challenges and an impediment to innovation? Major reasons include the following:

- Challenged Resiliency — Systems, Services, and Security

  Datacenter network demands are rising fast, resulting from new high-performance workloads (e.g., AI/ML-based), new computing infrastructure (e.g., GPUs), and intensifying hybrid cloud and multicloud interactions, which are undercutting network service levels and capabilities. Not only is the datacenter network failing to meet current service level objectives, but it is less able to serve developing service needs. A common reaction is to throw more bandwidth or connections at the problem. This is a costly approach — and one that is doomed to failure in the long term as physical limits are reached. Further complications arise from manual intervention in network engineering and operations. Not all datacenter networking staff are equally skilled and expert. And even the best can be constrained by limited toolsets and training. Analysis can be flawed. Actions can be improper. And datacenter network service suffers.

- Limited Visibility and Control

  Restrictions in visibility and control have severe implications for datacenter network engineering and operations. As management consultant Peter Drucker famously said, "You can't manage what you don't measure."

  > During times of trouble, intelligence and insights direct fast remediation. When preparing for change, intelligence and insights drive readiness. When protecting against threats, intelligence and insights detect anomalies and attacks.

  And the more detailed the intelligence is, the deeper the insights are. Management starts with measurement.

» Burdensome Operation, Integration, and Automation

Traditionally, nothing has been easy in networking. Deploying devices. Maintaining software. Managing configurations. Testing interoperability. Automating actions. Identifying problems. All require special skills and, often, specialized solutions and tools. IDC survey research indicates that most organizations have 10 or more tools focused on observability alone. The result? High costs. Low usage. Staff dissatisfaction. Service declines. And even with all those observability tools in place, organizations indicate they still struggle with coverage gaps, blind spots, and a lack of precision and predictability with automation.

> Undoubtedly, IT organizations are looking to their suppliers to make automation more robust and reliable while simplifying the deployment, operations, and evolution of their network infrastructures. Progress on the computing side of IT must be mirrored by the network.

» Rising Staff Pressures and Shortages

The networking staff is constantly presented with more technologies, more devices, more connections, more problems, and more threats. The pressure points in networking are expanding exponentially, while staff numbers are mostly stabilized. This forces IT executives to transition their current workforces — through upskilling or replacement — to being both efficient and effective with cloud-based platforms, innovative networking technologies, and AI-driven management. Unifying staff efforts across network domains (e.g., datacenter, campus, and edge) is another way of boosting staff productivity and value, but progress is slowed by specialized technologies and tools. While IT executives look to have their staffs focus more on the business and the future, owing to network complexity and criticality, the networking staff is occupied with tactical duties, such as deploying systems, adjusting configurations, and resolving problems.

» Constrained Technical and Business Innovation

Change heightens risk in networking. This is as true in the datacenter as it is in the network core, the network edge, or the networked cloud. Make a new connection. Adjust a configuration. Introduce a new policy. Add a new workload. All and more raise the risk of failure in the network. This is a mismatch with the digital business model that thrives on innovation — and even encourages failure at times. The network cannot fail, but it must be more dynamic. It must adapt readily and reliably.

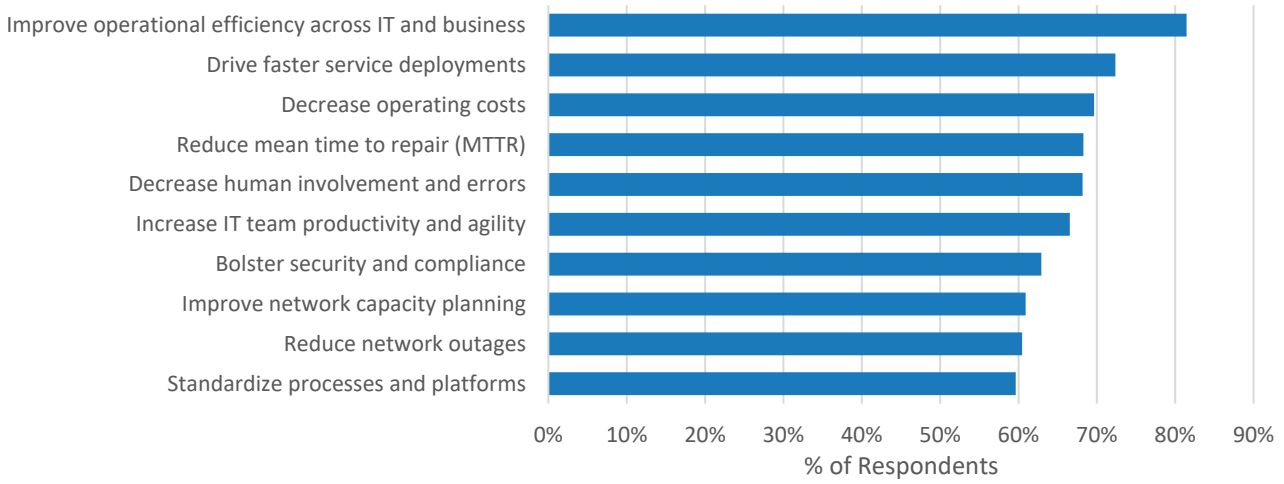
II. Trends

Given the above barriers to networking success, the need is critical for network management systems and services to support heightened intelligence and automation aimed at improving service delivery, system utilization, outage prevention, and staff productivity. IDC survey-based research indicates that network automation stands to deliver significant tactical and strategic benefits to IT and the business (see Figure 1).

FIGURE 1: ***Top Benefits of Network Automation***

Meeting Critical Tactical and Strategic Needs Within Digital Infrastructure

Q. Please rate the importance of the following network automation benefits for your organization. (% of respondents who indicated each benefit is very important or important)



Source: Worldwide State of Network Automation Study, IDC, 2024, n = 1,100

The benefits of network automation, following the front-runners of operational efficiency and service deployment speed, are fairly evenly distributed, indicating network automation's importance in evolving digital infrastructure. Network automation delivers a wide array of benefits across many key fronts.

Critical Advances in Datacenter Networking

The rapid buildup of GenAI pilot projects across all industries has certainly served to highlight future needs in datacenter networking.

The delays in converting these GenAI pilots to production rollouts and the rising concerns with network support for wide-scale GenAI deployments indicate needs that require attention today, not tomorrow. The following datacenter network trends are notable, as organizations continue to promote a hybrid public-private cloud environment and ready themselves for the further expansion of digital business and GenAI workloads:

» Platforms That Deliver Simplicity *and* Resiliency — at Scale

> In networking, complexity is the enemy. Systems integration, configuration management, performance monitoring, and problem resolution — all of these and more network tasks dramatically increase in difficulty as complexity rises.

Going forward, superior networking systems and services will offer sophisticated capabilities, while being simple to deploy, operate, and evolve. And in the datacenter, future networking solutions must scale readily and reliably, while retaining advantages in sophistication and simplicity. For many IT organizations, a platform approach to networking strikes the right balance across these often conflicting requirements. A recent IDC survey of those

overseeing datacenter networks indicated that over 60% preferred a platform approach to a collection of best-of-breed components. For these organizations, the platform provider unifies and automates the management of components, validates integration through ecosystem partnerships, and strengthens cross-platform security mechanisms.

» Observability: Detailed Intelligence, Deep Insights

Knowing the operating state of the datacenter network, associated components (e.g., physical devices, systems software, and enriched services), and connected resources is central to network service delivery now and into the future.

Comprehensive network data and full analysis of this data provide for complete visibility and control over not only the datacenter network, but also connected resources. IDC survey-based research in 2024 indicates that the past problem of limited network data is no longer an issue for most organizations. The problem now is that network data is either left unprocessed or is locked away in closed systems. Network analytics — whether focused on evaluating the present or predicting the future — is driven by available data. The more data there is, the more accurate the insights into that data are.

And it should be noted that network data and analytics not only serve the network; network data is also a vital contributor to other IT domains, including SecOps, DevOps, and platform engineering.

» Adaptive Systems and Services

The ability to adapt readily and reliably to new network demands within the datacenter network has grown in importance as new workloads and interactions arise. The buildout of GenAI models and the distribution of GenAI data are expected to dramatically increase traffic volumes and network flows within datacenters and between datacenters and cloud-based GenAI platforms. And, as the use of cloud services and multicloud environments continues to rise, exchanges and connections between private datacenters and public clouds will intensify. Datacenter network solutions that promote rapid adaptation to new connectivity, traffic management, and services demands are a match for the fast-acting and far-reaching datacenters of the future.

» Automation: Strictly Governed and Highly Dynamic

Network automation has been a tough challenge for IT organizations, systems suppliers, and service providers. Much investment has been made in building out network automation toolsets and skillsets and automating select and simplistic tasks such as device deployments, software updates, and configuration changes. While these investments have yielded positive results, they have also led to very visible failures. Enter governance over automation. Developing automation scripts, programs, or runbooks is the easy part. Assuring these automated systems will deliver their intended results is a very necessary step in network automation success. Moving beyond task automation, automation that is triggered by events or conditions or trending needs heightens network dynamics. This triggered automation assures consistent network service levels and capabilities, while also bolstering resource utilization and staff productivity.

» AI-Powered Engineering and Operations

Results from IDC's *Worldwide AI and Networking Survey, 2024* highlight the existing and developing use of AI in engineering and operating the datacenter network. Today, it is estimated that 20% of datacenter network staff tasks leverage AI for more rapid and precise execution. In two years, it is expected that this number will increase to 27%. In this same survey, respondents indicated their top targets for network-focused AI investment and innovation are network automation, threat detection, change management, and predictive analysis. When asked to cite their top expected benefits of AI advances in the datacenter network, staff productivity, business agility, and reduced downtime led the way — in that order. A more intelligent automated datacenter network and a more proactive network management approach constitute the future for most IT organizations.

III. Key Shifts in Datacenter Networking

The benefits of heightened visibility and control over the datacenter network are wide-ranging. Staff productivity, service improvements, strengthened security, cost containment, and IT/business agility all result from a coupling of detailed intelligence, deep insights, and directed automation.

The above benefits are driven by, and even further enhanced by, major shifts in underlying datacenter network management technologies and practices. These shifts represent fundamental changes in the way IT organizations engineer, operate, and evolve their network infrastructure — not just their datacenter networks.

» Conditional Control: Stateless to Stateful

Network control has always been out of sync with network conditions. Why? Existing conditions were unable to be accurately assessed — by systems or staff. Management actions were often aimed at where the network was, not where it is going. And the overall complexity of networks worked against any effort to synchronize control and conditions. By shifting from stateless to stateful control, management actions can be matched precisely with network conditions, whether existing or developing. To support stateful control, it is imperative for networking elements (e.g., hardware systems, software systems, and active services) to provide consistently detailed state information in real time in a consumable form.

» Extensible Systems: Closed to Open

Improved staff teamwork is a strategic imperative for IT executives.

> Sharing management tools and data and developing skills that cross IT domains (e.g., NetSecOps and NetDevOps expertise) represent vital shifts for IT organizations looking to break down technology silos and adopt a "better together" approach to technology projects and practices.

Using standardized systems and open source solutions (e.g., OpenTelemetry, Kubernetes, and Ansible) enables staff skills to be applied across multiple IT disciplines, enhanced collaboration among IT teams with a common knowledge base, and the use of common management tools and a single source of truth.

» Automated Operations: Passive to Active

IDC survey research indicates that almost half of IT organizations are now ready and willing to have the network take direct management action prompted by comprehensive network intelligence and insights.

This represents a dramatic change in network management. Why now? Network data collection has expanded across a full spectrum of sources (e.g., logs, polls, telemetry, and synthetic transaction). Insights (e.g., root cause analysis, anomaly detection, and predictive modeling) from all that data has heightened, bolstered by AI/ML-driven analytics engines. This combination of detailed intelligence and deep insights has instilled confidence in the resulting automated actions. Factor in the growing shortages and pressures associated with the network staff and organizations are further influenced to let the network play an active role in managing itself.

» Forward-Looking Management: Reactive to Proactive

According to IDC research focused on observability, intelligence and insights must equally serve both the reactive and the proactive management of infrastructure. This should be particularly eye-opening for networking staff, from executives to individual contributors. For too long now, networking staff time and effort have mostly been focused on keeping the network running by maintaining hardware and software, micro-managing configurations, monitoring network conditions, and diagnosing problems.

Functions that promote proactive network management (e.g., predictive analytics and triggered automation) allow the network to be more resilient and responsive via prediction, prescription, and prevention.

» Enhanced Staff Roles: Tactical to Strategic

Improving datacenter network abstraction, visibility, and control boosts service levels and capabilities and better prepares the datacenter network to be ready for anything.

Performance can be consistent. Problems can be avoided. Resources can be optimized. Costs can be contained. This more resilient and responsive network enables staff to shift time and attention away from tactical duties (e.g., detailed equipment configurations, problem resolution, system deployments, and service monitoring) to strategic roles and responsibilities focused in such areas as automation and innovation. With this shift, networking staff members have more time to develop the needed IT skills, to collaborate with IT staff from other technology disciplines, and to work on projects that would drive innovation and the business forward. From a staff management standpoint, this shift from a tactical to a strategic role also has a positive effect on staff satisfaction and retention. Increasing strategic responsibilities bolsters career development and, ultimately, earnings potential.

IV. Nokia Solution: Event-Driven Automation

Nokia Event-Driven Automation (EDA) is an infrastructure automation platform that simplifies and accelerates datacenter network monitoring and provisioning. It bolsters Day 0 design, Day 1 deployment, and Day 2+ operations across a wide

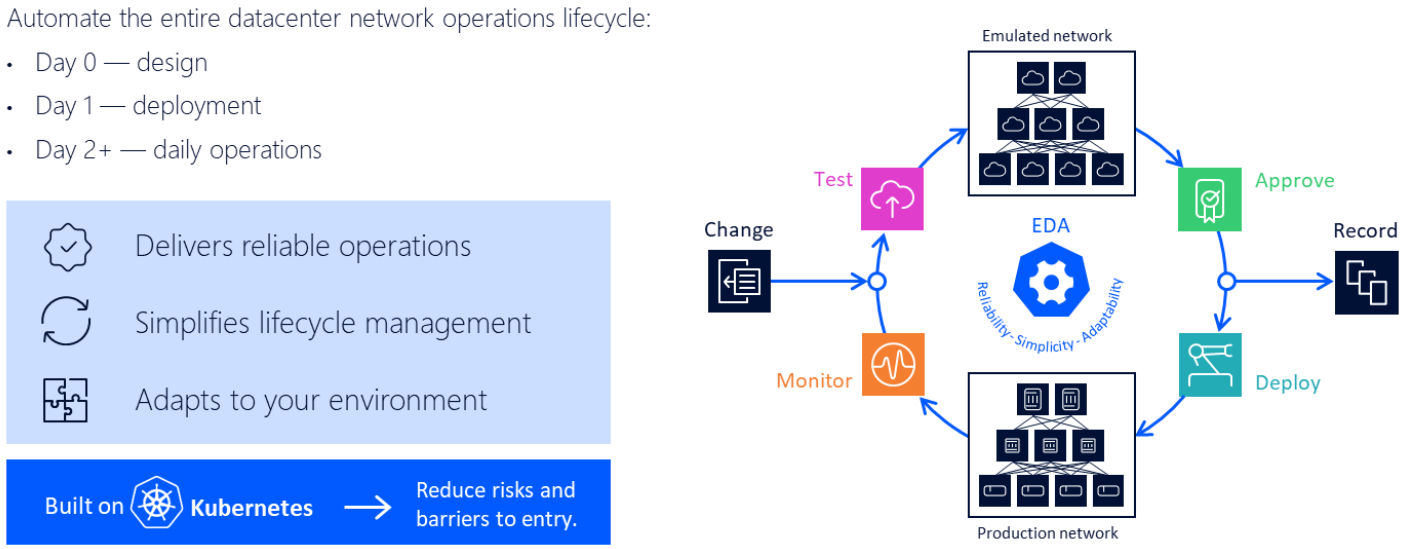
range of datacenter network environments — from small edge clouds to the largest AI fabrics. Nokia is a multinational supplier of telecommunications, information technology, and consumer electronics. The vendor serves both service providers and enterprises, worldwide, providing a broad mix of networking solutions.

Nokia Event-Driven Automation: Key Components and Capabilities

Nokia has crossed the chasm in network automation with its EDA solution. It bridges the long-standing and highly constraining gap between network observability and network automation. For too long now, network automation efforts and tools have focused on executing repetitive tasks. With EDA, Nokia has brought network automation to bear on delivering a more dynamic datacenter network (see Figure2).

FIGURE 2: ***Nokia Event-Driven Automation***

Delivering Reliable, Simplified, and Adaptable Datacenter Network Operations



Source: Nokia

The following offers a view into the key components that support Nokia's EDA solution:

- Nokia Data Center Fabric — Foundational Systems and Services

  High-performance switches and routers form the hardware base for Nokia's Data Center Fabric. Designed for modern leaf-spine deployments and based on an energy-efficient layout, the 7220 and 7250 IXR platforms deliver low latency and high capacity (up to 400/800GE) in both fixed and modular form factors. Both hardware platforms use Nokia's Service Router Linux (SR Linux) Network Operating System, providing consistent network service capabilities and management interactions across Nokia's Data Center Fabric.

- Kubernetes — Industry-Standard Orchestration and Automation

  Kubernetes is well proven and widely supported across the industry as the premier open-source orchestration and automation platform. It has a long and successful history of managing containers, virtual machines, server workloads, storage, and even AI solutions.

With EDA, Nokia has extended Kubernetes to the network, leveraging a cloud-based microservices architecture and applying key Kubernetes concepts (intent-based, declarative, event-driven, and revision control) that heighten network orchestration and automation.

Nokia also leverages Kubernetes tooling and APIs to further streamline EDA operation and integration.

» Digital Twin – Configuration Testing and Change Validation

Long established as a successful testbed in software quality assurance, the digital twin in networking is a more recent and rare capability.

Providing a virtual copy of a customer's existing network, EDA's digital twin enables testing and validation of automated actions as part of a broader CI/CD framework.

For example, when EDA's network intelligence and insights direct a certain configuration change, that change can first be applied to the digital twin to validate its intended effects — and any potential unintended consequences or unforeseen negative reactions. Given the risks associated with even the smallest of changes within any network, digital twin validation prior to execution should be considered a necessary step in network assurance.

» Network Abstraction — Ease of Use for Complex Networks

In networking, where everything seems complex, simplicity is a highly valued trait — particularly, in network management.

From evaluation to acquisition to operation to integration, Nokia has prioritized simplicity.

Intent-based networking allows operators to focus on their high-level objectives rather than on detailed implementation. App store consumption, easy set-up, and customizable UI drive rapid adoption. A unified query language, AI assistance, and low-code/no-code programming capabilities promote continually effective use. And support for Kubernetes and native APIs ease integration with other tools. Usability cannot be emphasized enough when evaluating management tools.

» Extensive Ecosystem – Ready Integrations, Reliable Interactions

Datacenters encompass a diverse set of systems, services, and vendors. Even within the datacenter network, multiple vendors, devices, and technologies form a complex web of connections and capabilities. Given Nokia's extensible EDA solution and the diversity of today's modern datacenter, support for an extensive ecosystem is a critical success factor.

Nokia's ecosystem bolsters EDA's visibility and control, while also boosting interactions with tools managing cloud platforms (e.g., VMware and RedHat), events and collaboration (e.g., MS Teams), and IT services (e.g., ServiceNow and Datadog).

And, of course, owing to the Kubernetes support within EDA, the Kubernetes toolchain offers a wealth of further possibilities to EDA.

Challenges

Nokia's EDA platform uses comprehensive network intelligence and insights to drive precise automated actions. The more intelligence there is, the deeper the insights and more precise the actions are. Increasingly, these insights and actions are to be driven by AI. Bringing AI to bear on network analytics and automation is the next challenge for all suppliers looking to deliver on the full promise of a more dynamic network infrastructure. A recent IDC worldwide survey of large enterprises indicated that network automation is the number 1 target for their AI innovation and investment aimed at network infrastructure. For Nokia specifically, a further challenge awaits in the expansion of its EDA solution beyond the datacenter. Datacenter network challenges and requirements are increasingly common to the core and the edge of networks. Even organizationally, there is increasing unification of networking staff across all network domains — wired and wireless, core and edge, datacenter and cloud. Key EDA capabilities such as conditional control, detailed observability, and active automation would all serve high-impact outcomes — not just within the datacenter, but also across the campus, edge, and cloud.

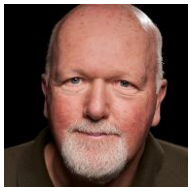
V. Conclusion

Network automation has challenged both IT organizations and technology suppliers for decades. Networks are unique, ever-shifting, and mission-critical. Task-based automation aimed at the deployment, maintenance, and adjustment of network systems and services requires strict governance to deliver intended results. And, while those results provide good gains in execution speed and staff time savings, automating manual tasks does not deliver a fail-safe and dynamic network infrastructure. Network automation that is triggered by changing conditions, specific events, or trending demands enables the network to best serve connected and highly dynamic computing systems and services, datasets, applications, and endpoints.

Combining data, analytics, and actions enables the datacenter network to be more dynamic, adapting quickly and precisely to changing conditions, developing problems, and new demands.

New workloads (e.g., GenAI) and heightened connectivity (e.g., cloud services and network edge) are pushing datacenter networks and associated IT staff and tools to breaking point. A close coupling of detailed intelligence, deep insights, and properly directed automation is necessary for IT organizations to engineer and operate a fully resilient and highly responsive datacenter network infrastructure. Combining data, analytics, and actions enables the datacenter network to be more dynamic, adapting quickly and precisely to changing conditions, developing problems, and new demands. In this hyperconnected digital business environment, such a network serving the datacenter — and all its dependent resources — is vital to both IT and business success.

About the Analyst



Mark Leary, *Research Director*

Mark's core research coverage focuses on network observability and management solutions; network automation projects and tools; and related predictive analytics, AI/ML-driven insights and actions, threat defense, and digital experiences as they apply to a resilient, dynamic, and secure network infrastructure.

MESSAGE FROM THE SPONSOR

Datacenter networks in the AI era must deliver reliable and seamless connectivity within the datacenter, as well as between datacenters, clouds, and other networking domains. Human errors continue to cause major problems, regardless of whether they are caused by vendor product design/quality issues or the mistakes of network operations staff.

Our Data Center Fabric solution adopts a quality-first approach to deliver the reliability, ease of use, and flexibility required for modern datacenter switching infrastructures. It includes highly scalable hardware platforms for AI back-end and front-end networks and an open, extensible, and resilient NOS (SR Linux).

Our goal with network operations is to reduce human error to zero. Nokia Event-Driven Automation (EDA) is a next-generation datacenter network automation platform that combines speed with reliability and simplicity. It makes network automation more trustable and easier to use, from small edge clouds to the largest datacenters.

IDC Custom Solutions

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