Independent market research and competitive analysis of next-generation business and technology solutions for service providers and vendors

HEAVY READING
WHITE PAPER

Leveling Up with Autonomous Network Operations

A Heavy Reading (now part of Omdia) white paper produced for Google Cloud

AUTHOR: JENNIFER P. CLARK, PRINCIPAL ANALYST, HEAVY READING (NOW PART OF OMDIA)

WHY AUTONOMOUS NETWORK OPERATIONS (ANOPS)?

The concept of autonomous networks marks a major shift in telecom operations—away from manual network management and toward artificial intelligence (AI)-driven, intent-based, and closed-loop automation. Heavy Reading (now part of Omdia) defines autonomous network operations (ANOps) as the ability to manage and optimize a network without manual intervention. ANOps is crucial for handling complex, large-scale, and dynamic environments such as 5G, Internet of Things (IoT), and future networks (5G standalone [SA], 6G, and beyond). Properly implemented, ANOps can deliver a network that can self-configure, enhance performance, improve efficiency, and eliminate human error. As communications service provider (CSP) networks continue their breakneck growth as measured by any metric (number of sites and devices connected, overall traffic volume, upstream traffic volume, latency-sensitive applications, etc.), a transition to ANOps becomes indispensable for reducing operational costs while improving network scalability and flexibility. The end game of ANOps is a network that can self-configure, self-heal, self-optimize, and self-protect.

WHERE ARE THE CSPS TODAY WITH ANOPS?

The TM Forum published its autonomous networks (ANs) maturity model in December 2022. This framework defines an evolutionary path for telecommunications networks to progress to full autonomy and provides a useful yardstick by which to measure CSPs' progress toward ANOps (see **Figure 1**). The model offers a structured approach for service providers to assess current capabilities and plan the journey to autonomous operations. According to the TM Forum, as of 2025, most CSPs are operating at Levels 1 or 2 of the TM Forum's AN maturity model, i.e., manual operations with some automation. However, over 60% of operators plan to reach Level 3 or higher by 2028. In 2023, 31 major CSPs and vendors, including Telefónica, Orange, China Mobile, and MTN Group, committed to achieving Level 4 ANs by 2025. These companies are adopting the TM Forum's standards to accelerate automation, focusing on intent-driven operations, closed-loop control, and self-healing capabilities.

Figure 1: TM Forum autonomous networks levels

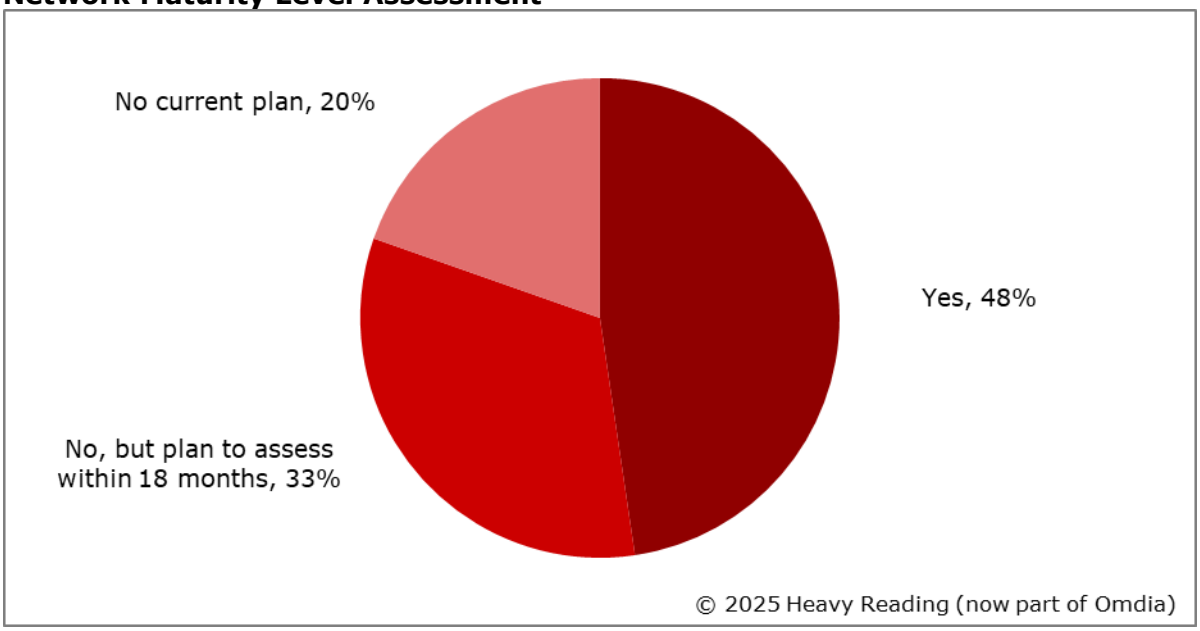
Autonomous levels	L0 Manual operation & maintenance	L1 Assisted operation & maintenance	L2 Partial autonomous networks	L3 Conditional autonomous networks	L4 High autonomous networks	L5 Full autonomous networks
Execution	P	P/S	S	S	S	S
Awareness	P	P/S	P/S	S	S	S
Analysis	P	P	P/S	P/S	S	S
Decision	P	P	P	P/S	S	S
Intent / Experience	P	P	P	P	P/S	S
Applicability	N/A	Select scenarios				All scenarios
P People (manual) S System (autonomous)						

Table 2: Autonomous Networks Levels (ANL)

Source: Heavy Reading (now part of Omdia), based on TM Forum

A 2025 Heavy Reading (now part of Omdia) survey of 106 global CSPs supports the TM Forum's findings. It revealed that almost half of the survey respondents (48%) have already participated in an Autonomous Network Maturity Level Assessment based on the L0 to L5 levels defined in **Figure 1** above. Another third plan to do so by the middle of 2026, leaving only 20% with no current plans for such an assessment (see **Figure 2**).

Figure 2: Nearly half of respondents have already participated in an Autonomous Network Maturity Level Assessment



Note: Numbers in figures throughout this report may not total 100 due to rounding.
Q: Has your organization participated in an "Autonomous Network Maturity Level Assessment"? (n=107)
Source: Heavy Reading (now part of Omdia), 2025

Omdia's *Telco Network Automation Survey* from late 2024 also concurs with the TM Forum, showing that most CSPs today are at Level 2 (partial autonomy) or are transitioning to Level 3 (conditional autonomy), as shown in **Figure 3**. At Level 2, automation typically focuses on specific network areas (e.g., RAN, transport, or core), but human operators still handle cross-domain decisions. Level 3 introduces AI and machine learning (ML) for analytics, plus policy-based orchestration for closed-loop automation in certain functions, such as network assurance, traffic optimization, and self-healing. Because these processes usually stay within separate domains, end-to-end automation and cross-domain orchestration have not yet been realized.

Figure 3: Which best describes the level of automation (per TM Forum's definition) in the following network domains within your organization?

Autonomous levels	L0 Manual operation & maintenance	L1 Assisted operation & maintenance	L2 Partial autonomous networks	L3 Conditional autonomous networks	L4 High autonomous networks	L5 Full autonomous networks	Weighted average
IP backbone	7%	17%	28%	21%	16%	12%	2.6
Optical transport network	7%	18%	25%	30%	9%	11%	2.5
Converged core	9%	26%	23%	18%	12%	12%	2.4
Fixed access network	10%	12%	29%	31%	12%	5%	2.4
Radio access network	5%	27%	27%	24%	8%	8%	2.3
Average	**8%**	**20%**	**26%**	**25%**	**11%**	**10%**	**2.4**

Note: n=61

Source: Heavy Reading (now part of Omdia), Omdia, Telco Network Automation Survey Report – 2024

As things move up to Level 4 (high autonomy), AI-driven closed loops coordinate across several domains based on high level intent. Getting to Level 4 is a step change and still a future goal for most operators. It will require investments in AI, digital twins, and cross-domain orchestration. Using these technologies, networks will be better able to respond to changes in requirements or faults in real time. Many CSPs are already planning their roadmaps to Level 4. The TM Forum has contributed significantly to their plans by publishing the Level 4 blueprint in late 2024. Achieving large-scale autonomy, however, will depend on overcoming hurdles such as outdated infrastructure, interoperability, and the need for trustworthy AI.

AI – AT THE CORNERSTONE OF ANOPS

Industry consensus points to AI and machine learning (ML) as critical enablers of ANOps among the CSPs. AI and ML provide predictive analytics for network behavior and enable anomaly detection and pattern recognition. AI also supports decision-making algorithms to power automated responses and facilitates continuous learning.

Agentic AI

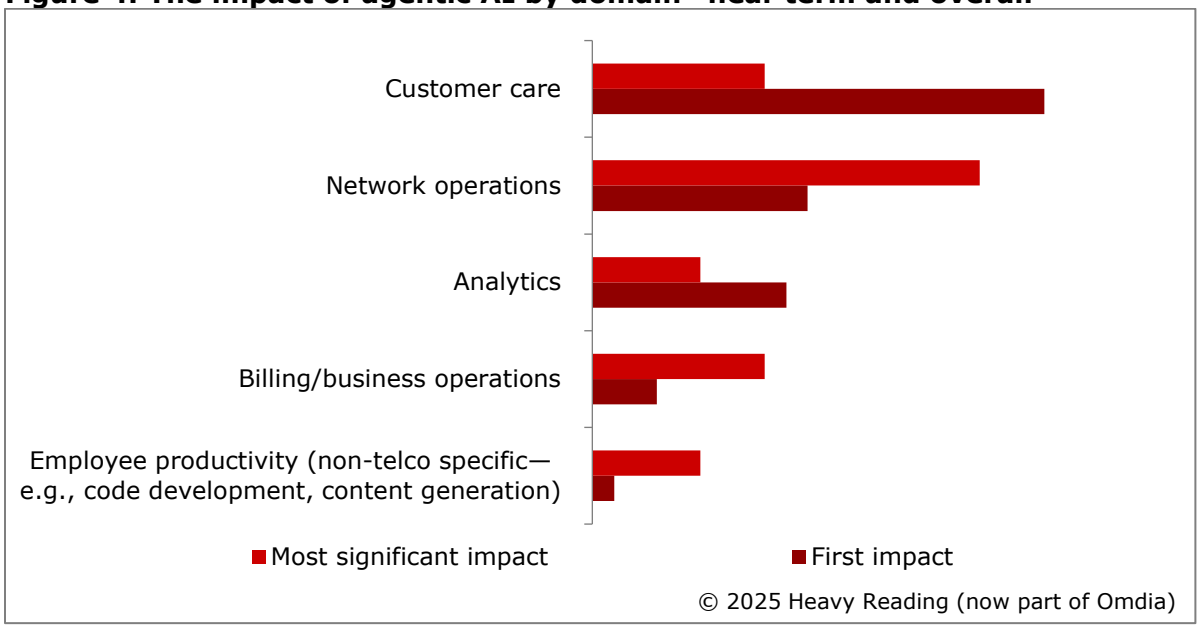
Agentic AI refers to AI systems that can act autonomously on behalf of users or organizations to achieve specific goals. This was the hot AI topic at this year's Mobile World Congress (MWC), in large part due to the role it plays in ANs, facilitating the transition from human-driven processes to intent-based, autonomous systems. Traditional AI systems typically operate within narrow domains and execute specific functions when prompted. In contrast, agentic AI systems can initiate actions without explicit instructions, coordinating complex workflows across multiple domains and over extended periods.

These attributes are particularly important for ANOps as, again, unlike traditional automation, agentic AI possesses the following advantages:

- **Defined agent space:** AI agents understand the scope and boundaries of the environment in which they operate, perceive, and act.
- **Context awareness:** AI agents understand the full context by analyzing data from networks, users, devices, and support histories.
- **Multi-agent orchestration:** Multiple AI agents collaborate dynamically to execute complex network tasks.
- **Continuous learning:** Systems improve over time through ongoing experience with network operations.

CSPs see agentic AI as mostly impacting customer care use cases in the near term, according to the Omdia survey. However, they also believe it will have *the most significant impact* overall on network operations, which includes ANOps (see **Figure 4**).

Figure 4: The impact of agentic AI by domain—near term and overall



Q: In which domain will agentic AI first make a significant impact/have the most significant impact? (n=107)
Source: Heavy Reading (now part of Omdia), 2025

AI language models

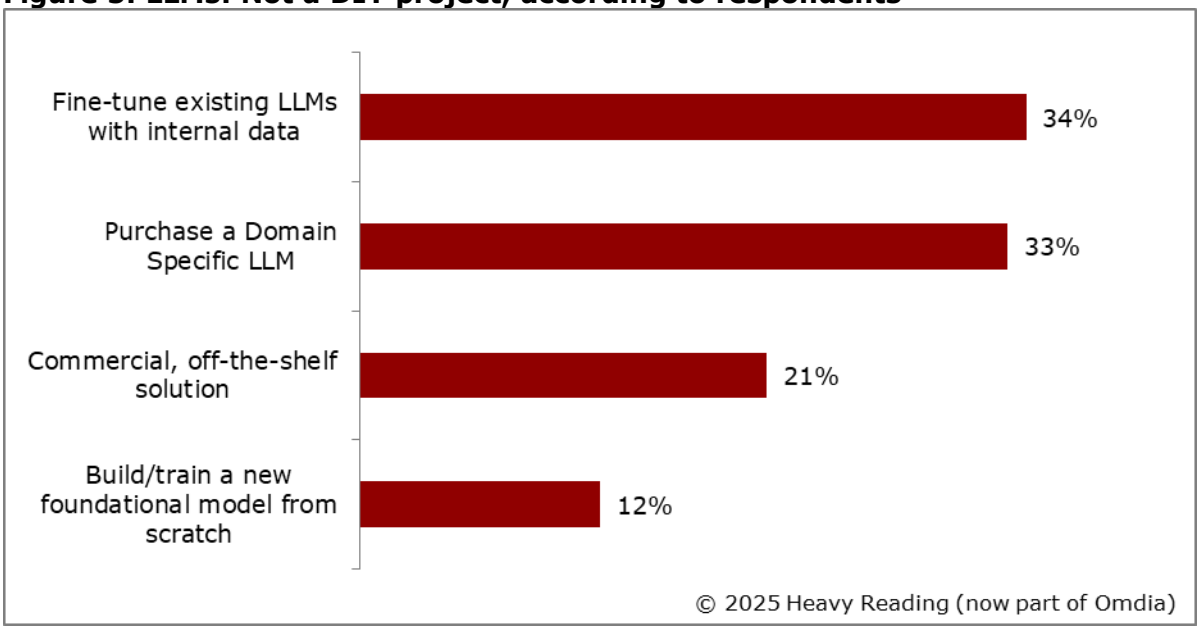
The adoption of AI relies upon the use of language models that are repositories of vast amounts of data. AI systems are trained on this data and are capable of understanding, generating, and interacting with the user's natural language. CSPs use large language models (LLMs) to automate, optimize, and enhance a wide range of processes, including customer service, net ops, process automation, and product innovation.

LLMs are typically integrated into telco-specific platforms or workflows and are often fine-tuned with proprietary data to address unique operational challenges and regulatory requirements. LLMs have billions of parameters (numerical values that the model learns during training to understand and generate text) and are trained on massive datasets, making them capable of complex tasks and nuanced language understanding. Small language models (SLMs), on the other hand, have a smaller number of parameters (ranging from millions to a few billion) and are trained on smaller or more specific datasets, making them more efficient and suitable for specific enterprises, business units, or lightweight applications.

The process of creating an LLM or SLM is a daunting task, requiring developers who are highly skilled in AI, data management, and natural language processing (NLP). Once created, the language model is a living system ingesting ever more data and refining how that data is manipulated.

Those CSPs that have already participated in an Autonomous Network Maturity Level Assessment prefer to purchase a domain-specific LLM (45%), whereas respondents from the largest CSPs prefer to fine-tune existing LLMs with internal data (42%) and have limited interest in purchasing a domain-specific LLM (15%) (see **Figure 5**). As for the CSPs that are interested in building and training a new foundational model from scratch, they do not have a specific demographic profile. Heavy Reading (now part of Omdia) wishes these outliers the best of luck.

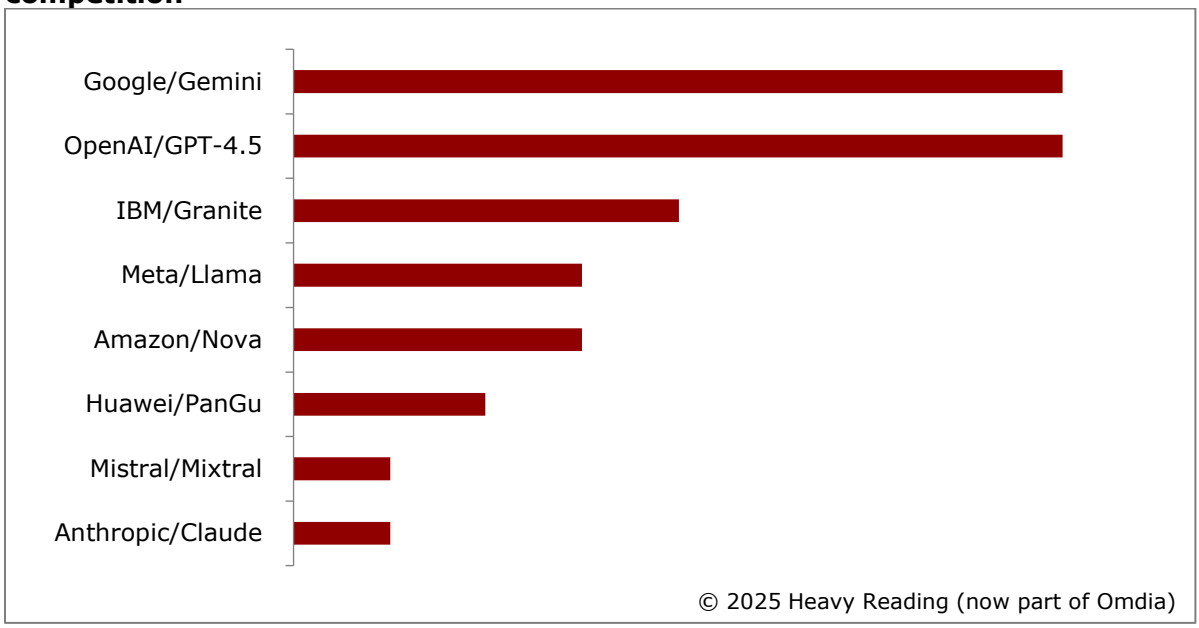
Figure 5: LLMs: Not a DIY project, according to respondents



Q: What is your organization's approach to establishing large language models (LLMs)? (n=106)
Source: Heavy Reading (now part of Omdia)

Omdia queried respondents on which LLMs they are currently using for production use cases (see **Figure 6**). Google's Gemini family of multimodal LLMs and OpenAI's GPT-4.5 emerged at the top of the list. It is fair to view these results largely as a reflection of non-telco-specific use cases because Gemini and GPT-4.5 are widely available today to both consumers and enterprises. As CSPs move further down the path of ANOps, it will be interesting to track what LLMs (or SLMs) they rely on most.

Figure 6: Google Gemini and OpenAI GPT-4.5 have a solid lead on the LLM competition



Q: Which LLMs are you using for production use cases today? (Select top two) (n=106)
Source: Heavy Reading (now part of Omdia)

More essential technologies for ANOps

AI is one technology that has had a significant impact on the implementation of ANOps. However, there are multiple other technologies that work together to enable self-managing, intelligent network systems, including the following:

- **Intent-based networking (IBN):** Although the term "intent-based networking" was coined in 2017, it is still a critical element of ANOps today. IBN enables policy-driven network management. It does so by creating an abstraction layer between business goals and technical implementation. In doing so, it is able to translate business requirements into network configurations and validate that the network behavior matches the intended outcome.
- **Network automation and orchestration:** This automates repetitive tasks and workflows, provides programmable interfaces (APIs) for network control, enables zero-touch provisioning of network devices, and coordinates complex multi-step processes across network domains.

- **Digital twin technology:** This creates virtual replicas of physical networks that, in turn, enable the simulation and testing of changes to the network before they are deployed. It also provides modeling capabilities for predictive analysis and supports "what if?" scenario planning.
- **Cloud and cloud native technology:** The microservices and containers (Kubernetes, Docker) that are part of cloud native architectures are essential for enabling flexible and scalable service deployment. Likewise, the software design philosophy that underpins cloud native, continuous integration/continuous delivery (CI/CD) of network functions is core to an agile and flexible service infrastructure. Finally, edge computing, enabling local, low latency processing and decision-making, is an integral part of CSPs' cloud native strategies.
- **A robust ANOps ecosystem:** This enables CSPs to leverage partner innovations to accelerate their own autonomous capabilities. Collaborating with integrators, hyperscalers, open source communities, and startups allows the CSPs to integrate even when reskilling and upskilling their own workforces for AI/ML and/or when automation falls short of their goals.

These technologies, along with the ongoing industry move to software-defined networking (SDN) and network functions virtualization (NFV), collectively enable networks to become increasingly autonomous, moving through progressive levels of automation toward fully autonomous operations by which networks can self-manage with minimal human intervention.

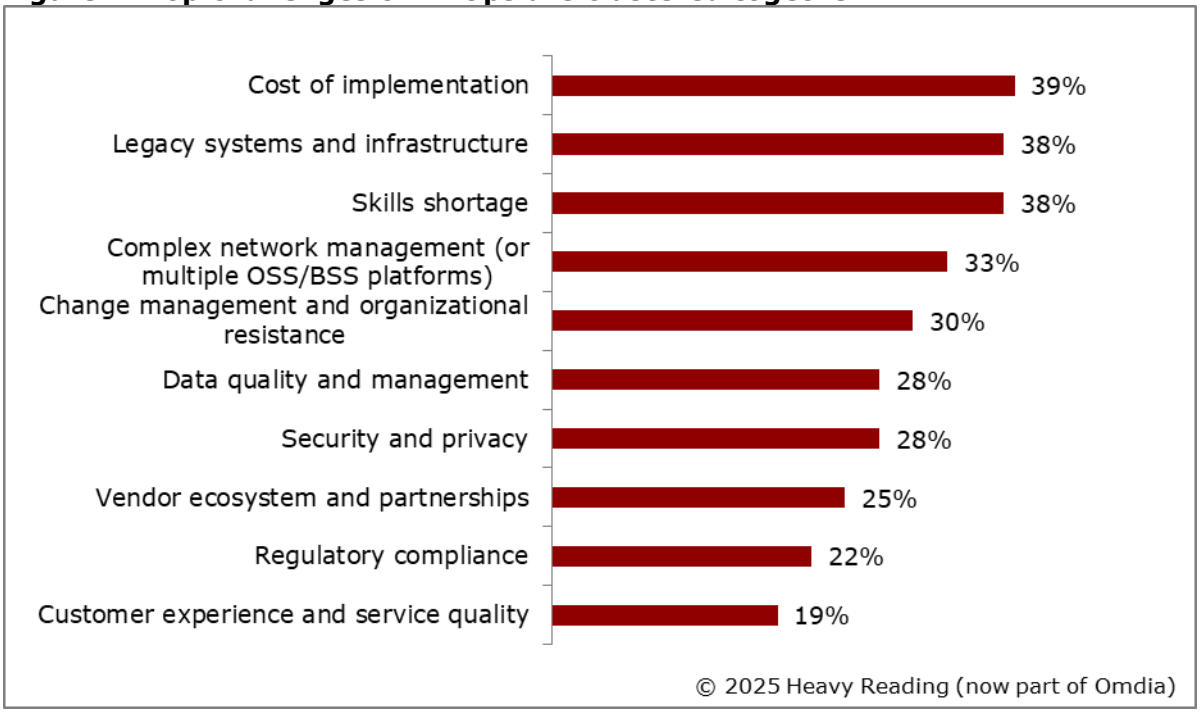
THE PATH TO ANOPS

Although the list of ANOps enabling technologies is rich, CSPs face a similarly lengthy list of challenges along the road to ANOps, as shown in **Figure 7**. However, only 20 percentage points separate what respondents said is the greatest challenge to achieving full ANOps and what they identified as the least of their challenges. In addition, even the top challenge pulled in less than 40% of respondents. The clustering of responses—and the clustering at the bottom half of the scale—suggest that CSPs are mostly trying to work through the execution of their ANOps plans. No challenge is perceived as insurmountable, but all challenges are worthy of notice:

- **Cost of implementation** claims the highest percentage of responses, with good reason. The initial investment in AI/ML platforms, orchestration tools, and skilled personnel is high, and the ROI is likely to be measured in years. Justifying the spend internally can be its own challenge.
- **Legacy systems and infrastructure** are in a dead heat with the cost of implementation. Most telcos still function with some decades-old systems that were not designed for automation or integration. Upgrading or replacing these systems can be expensive, risky, and time-consuming.
- **Skills shortage** rounds out the virtual three-way tie for ANOps challenges most likely to keep respondents up at night. Shifting to ANOps requires a cultural shift and new skills (AI, DevOps, cloud native ops). AI development alone requires highly specialized skills, including data science, ML, and advanced analytics. With these skills in short supply and competition for such talent stiff, CSPs are compelled to look outside their organizations, expanding their ecosystems to fill these skills gaps.

- **Management issues**, whether pertaining to overall network management, change management, or data management, take up the middle ground in the list of challenges. These are topics that are top of mind for CSPs as they work through the complexities of breaking down data silos, data cleansing, and either developing or purchasing AI foundational models, LLMs, SLMs, and agentic AI solutions. At the same time, CSPs are looking to reconcile the multiple operation support systems (OSS) and business support systems (BSS) they have implemented over the decades, jettison the ones they can, and improve the interoperability of the ones that remain.

Figure 7: Top challenges of ANOps are clustered together



Q: What are the major challenges facing your organization as you try to achieve fully autonomous operations? (Select top three) (n=105)
Source: Heavy Reading (now part of Omdia), 2025

At the bottom of the list of challenges are vendor ecosystem, regulatory compliance, and customer experience. This positioning is not because these characteristics are not important; rather, it is because CSPs feel they are farthest along with implementation and control over those elements. For example, all CSPs will claim that customer experience (along with operational efficiency) is at the core of every decision they make.

The implementation of ANOps comes with a set of regulatory challenges that need to be carefully addressed. CSPs have been navigating the highly complex landscape of regulatory issues for more than a century. Nevertheless, the introduction of AI and ANOps raises several concerns, notably:

- **Data privacy and protection:** CSPs must ensure that their autonomous systems comply with data privacy laws, including ensuring data anonymization, securing user consent, and allowing for data access rights.

- **Transparency and explainability:** Regulatory bodies may impose requirements for the explainability of AI models, potentially slowing automation if CSPs are unable to provide adequate transparency.
- **Security and cybersecurity compliance:** ANOps must be designed to meet stringent cybersecurity standards, ensuring that automated systems are resistant to cyberattacks, such as malicious interference with network traffic or data.

STRUCTURAL REALIGNMENT – WHERE TO START?

Many of the challenges listed in **Figure 7** have their genesis in the highly complex and siloed nature of providers' current operations. One important task in moving to ANOps is enabling the multiple overlay networks, OSS/BSS, data lakes, supply chains, industry regulations, etc., to work together in harmony. But where are CSPs motivated to start this structural realignment? Where is it likely to provide the most benefit?

Respondents clearly maintain that they will start with infrastructure—*network, IT, and cloud* (see **Figure 8**). Combining legacy fixed-line and mobile network operations will reduce duplication, cut costs, and improve agility. With the shift to SDN and commercial off-the-shelf (COTS) platforms leveraging cloud native communications, CSPs can unify and modernize their multiple overlay networks, merging core and edge networks, consolidating network operations centers (NOCs), and leveraging software-optimized, shared infrastructure.

Customer experience and support ranked second, reflecting the growing consensus that customer satisfaction and customer retention rely on seamless service across all touchpoints. This includes unified contact centers, AI-powered chat, and integrated CRM systems. Realignment allows CSPs to centralize customer data, both structured and unstructured, and enables a comprehensive and unique view of each customer.

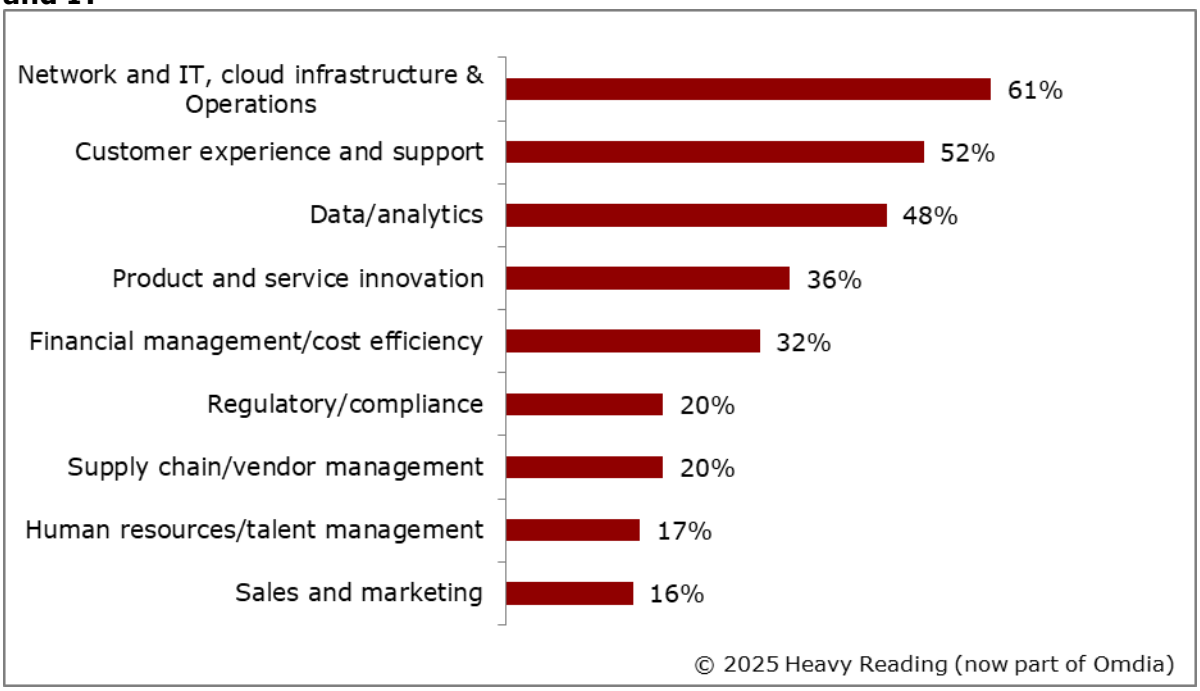
CSPs are often envied for the seemingly endless volume of information they have about the customer. However, this volume can be both a blessing and a curse. As a member of a Tier 1 CSP commented recently in a conversation with Heavy Reading (now part of Omdia), "Our strength is that we have comprehensive customer data. Our weakness is that we have 6 different versions of this data and the data silos do not communicate with each other." With this in mind, *data/analytics* makes perfect sense in ranking as the third most important area for structural realignment through

- Converged data silos such as marketing, customer service, network ops, and finance, enabling cross-functional insights (e.g., linking churn to network quality in specific areas).
- Faster, more accurate business intelligence for more effective promotions and reduced churn.
- Accelerated innovation and time-to-market by aligning data architecture and governance across units, enabling the use of standardized KPIs and data analytics.
- The ability to prototype and quickly deploy AI/ML use cases such as predictive maintenance and fraud detection.

- Enabled self-service analytics for enterprises to mount more agile responses to market needs and sharpen their competitive edge.
- Cost optimization through consolidating analytics tools, cloud infrastructure, and data management platforms, reducing redundancy and tech debt.

All remaining areas for realignment have aspects of these top three areas of focus.

Figure 8: The greatest benefit of structural realignment is expected in the network and IT



Q: Which areas will benefit most from structural realignment/convergence? (Select top three) (n=107)
Source: Heavy Reading (now part of Omdia), 2025

A deeper dive into data

Heavy Reading (now part of Omdia) research shows that CSPs believe their organizations are adept at getting data ("data identification/acquisition") and at storing data (whether on-premises, in the cloud, in the data warehouse, or in the data lake). But after that, their level of confidence falls off sharply. In all remaining areas of data readiness/management, the majority of CSPs give themselves low marks. This includes the areas of data integration, preparation, analysis, and governance. It also applies to metadata management. Briefly stated, metadata management is the organized approach to handling metadata, which is data about data. A whopping 75% of CSPs Omdia surveyed ranked their organizations between "marginal" and "poor" in this area. Only a paltry 2% gave themselves an excellent ranking. Clearly, data management is the tip of a very large iceberg when it comes to the CSP preparedness for AI in support of ANOps.

STANDING AT THE CROSSROADS OF AUTONOMOUS NETWORK OPERATIONS

Heavy Reading (now part of Omdia) research and survey results show that CSPs continue to be challenged by two overarching areas of concern with ANOps adoption. The first is data management: breaking down data silos, scrubbing data, and securing data. The second is defining an AI strategy, including the multiple technology choices they will need to make and to whom they will turn for assistance.

At the same time, CSPs are grappling with the meta-issue of the ethics of AI. These concerns start—but do not end—with issues such as privacy, bias, accountability, security, and data sovereignty. However, for the generations of CSP professionals raised on the promise (think Star Trek's Commander Data) or the threat (think the Terminator's cybernetic assassin) of sentient AIs, these concerns extend to issues of autonomy and control, moral agency, and environmental sustainability. These issues, as well, will take insight, innovation, and a global village to evaluate and address.

It is clear from this survey that CSPs, which suffered in the not too distant past from a profound not-invented-here syndrome, are intent on developing the partnerships that will accelerate their adoption of ANOps and AI, gaining the tools they need to contain operational costs, facilitate their ability to scale quickly, enhance their competitive profile, and improve customer experience. The ecosystem is key in the CSP deployment of ANOps.