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

HEAVY READING
WHITE PAPER

Plotting a Course Toward Autonomous Operations

A Heavy Reading white paper produced for Tata Consultancy Services

TATA CONSULTANCY SERVICES

AUTHOR: JENNIFER P. CLARK, PRINCIPAL ANALYST, HEAVY READING

INTRODUCTION

Heavy Reading conducted a survey in March 2025 to take the pulse of where communications service providers (CSPs) are in planning for and implementing autonomous operations (AO). Survey respondents also answered questions about additional emerging technologies that are key to implementing AO, such as artificial intelligence (AI), enhanced data management, and AI foundational models.

The survey pulled in 107 responses from global CSPs, and this report presents the highlights. Heavy Reading looks at where the CSPs are today in their efforts to leverage AO throughout the organization and where they expect to be 18 months from now. We also examine where CSPs think the impact of AO will be greatest and where barriers to AO adoption will be most keenly felt.

Heavy Reading sought to answer questions such as the following:

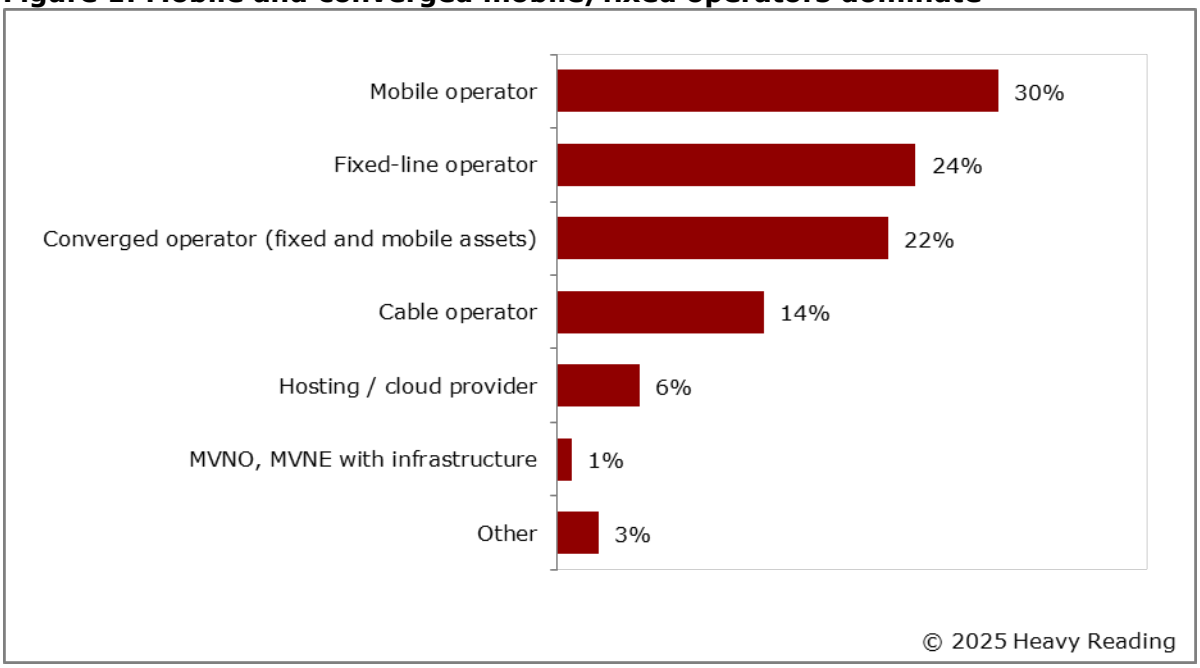
- Where in the network are the CSPs focusing their efforts as they move to AO, and how will this change during the next 18 months?
- Which emerging technologies are the enablers of AO?
- What are the main implementation challenges of AO? Cost? A shortage of skilled personnel? Or something else?
- Where are CSPs turning to for help in terms of an expanded ecosystem?
- What is their strategy for adopting a large language model (LLM) or, perhaps, a small language model (SLM)?
- How do they rate their organization when it comes to data management, an integral aspect of both AO and AI?

This survey-based report presents a snapshot of where the CSPs are with AO at the close of 1Q25 and how they are defining the partnerships, technologies, and strategic initiatives that will enable them to succeed in 2025 and beyond.

SURVEY DEMOGRAPHICS

Mobile and converged operators accounted for more than half of the survey respondent pool—52% of overall responses (see **Figure 1**). Cable and fixed-line operators made up another large wedge of the pie—38%. Hosting and cloud providers contributed just 6% of responses. The remaining 4% came from mobile virtual network operators (MVNOs) and mobile virtual network enablers (MVNEs) with infrastructure and "others."

Figure 1: Mobile and converged mobile/fixed operators dominate

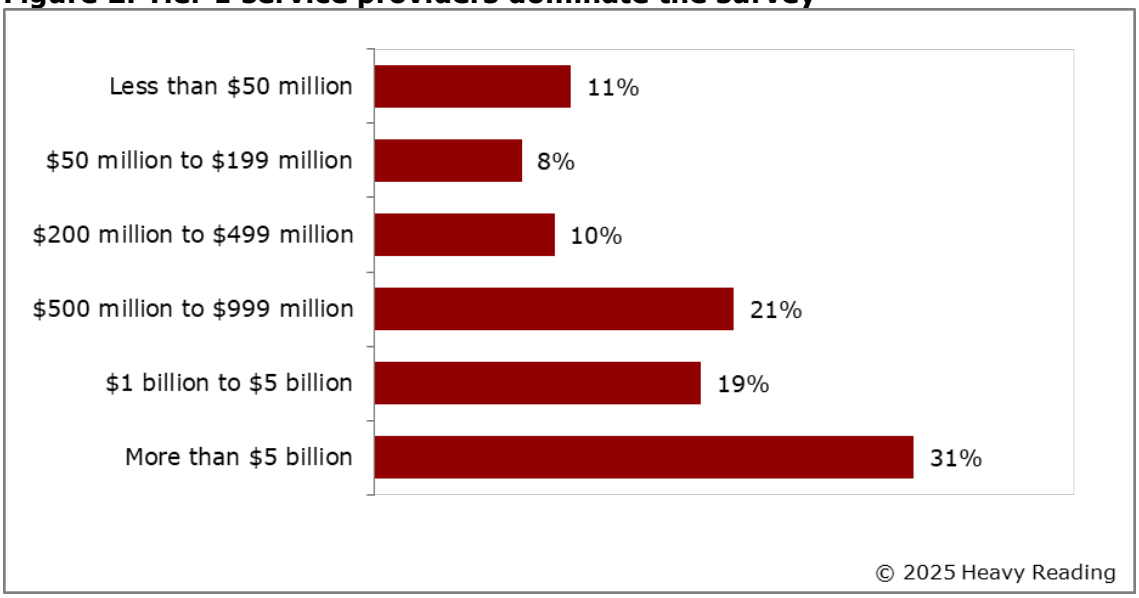


Note: Numbers in figures throughout this report may not total 100 due to rounding.
Q: What type of service provider do you work for? (n=107)
Source: Heavy Reading, 2025

Among the survey respondents, 50% represented large CSPs with annual revenue of more than $1bn (see **Figure 2**). CSPs with revenue of between $200m and $999m made up 31% of the respondent pool, and those with annual revenue of less than $200m made up the remaining 19%. Revenue dictates the capital budget available for funding the transition to emerging technologies and new operational paradigms, including 5G, edge computing, cloud native networking, and AO.

Heavy Reading research shows that over the past decade, carriers have dedicated, on average, 17–18% of their revenue to capex, a percentage they are working to lower with a transition to commercial off-the-shelf (COTS) servers and virtualized and containerized network functions. The widespread adoption of AI-enabled infrastructure may help to lower operational costs by accelerating the move to AO, including predictive maintenance and zero-touch management. However, the flip side of the coin shows that compute- and storage-intensive AI applications, which AO will rely upon, will drive both expansion and cost throughout the network, particularly at the network edge.

Figure 2: Tier 1 service providers dominate the survey

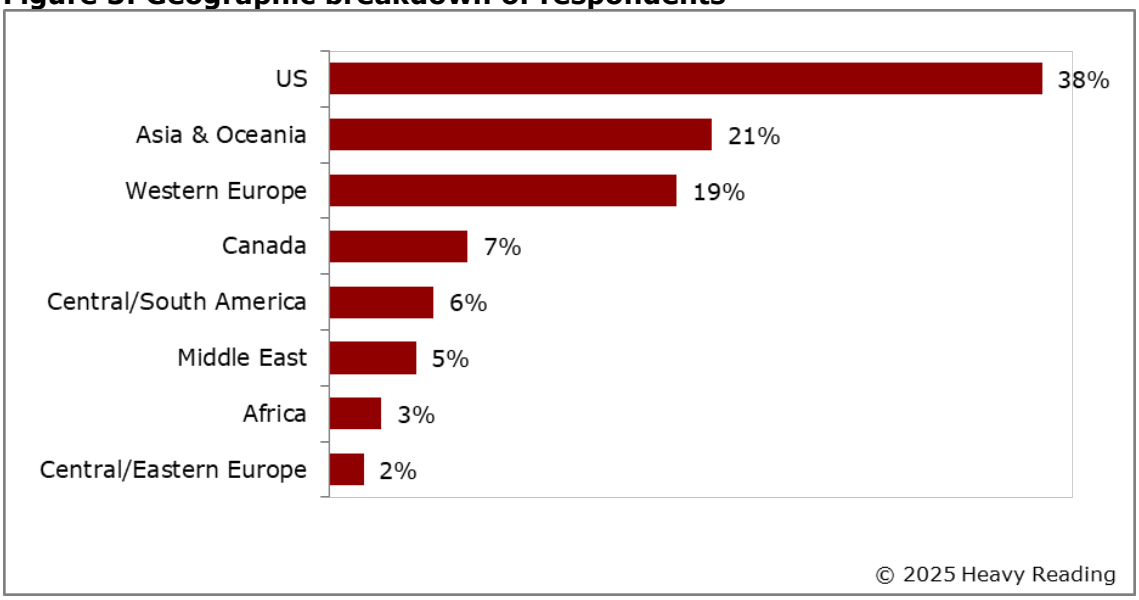


Q: What is your company's approximate annual revenue (USD)? (n=107)
Source: Heavy Reading, 2025

Regional breakdown

More than a third of the survey respondents were from the US (see **Figure 3**). Eastern and Western Europe, together with the Middle East and Africa (EMEA), accounted for a healthy 29% of respondents. The Asia & Oceania region brought in another 21% of respondents. The remaining 13% hailed from Canada, Central America, and South America (including the Caribbean).

Figure 3: Geographic breakdown of respondents

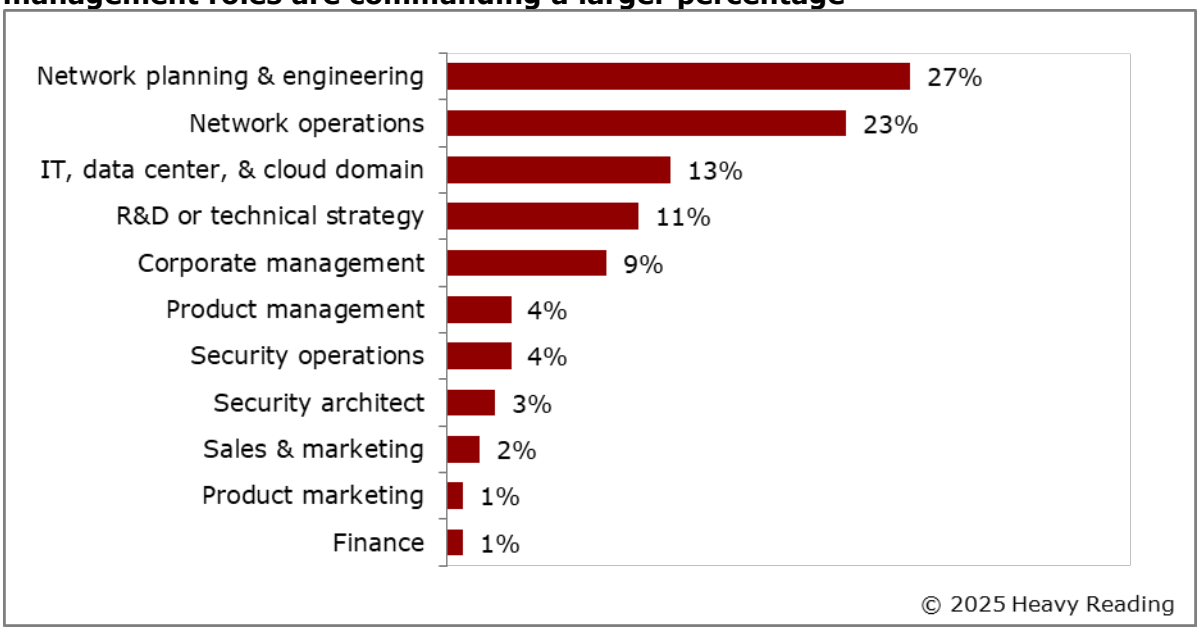


Q: In what region is your organization headquartered? (n=107)
Source: Heavy Reading, 2025

Job function

In most Heavy Reading surveys, more than half of the respondents are in technical networking roles: planning and engineering, R&D, and NetOps. In this telco AO survey, the technical networking role percentage easily clears this bar at 61% (see **Figure 4**). Management, finance, and marketing (including product management and product marketing) accounted for another 19%. Meanwhile, IT, data center, & cloud domain job functions are taking a larger role—in this case, 13%. Security operations and security architect contributed the remaining 7% to the mix.

Figure 4: Technical networking roles still dominate the survey, but IT and management roles are commanding a larger percentage



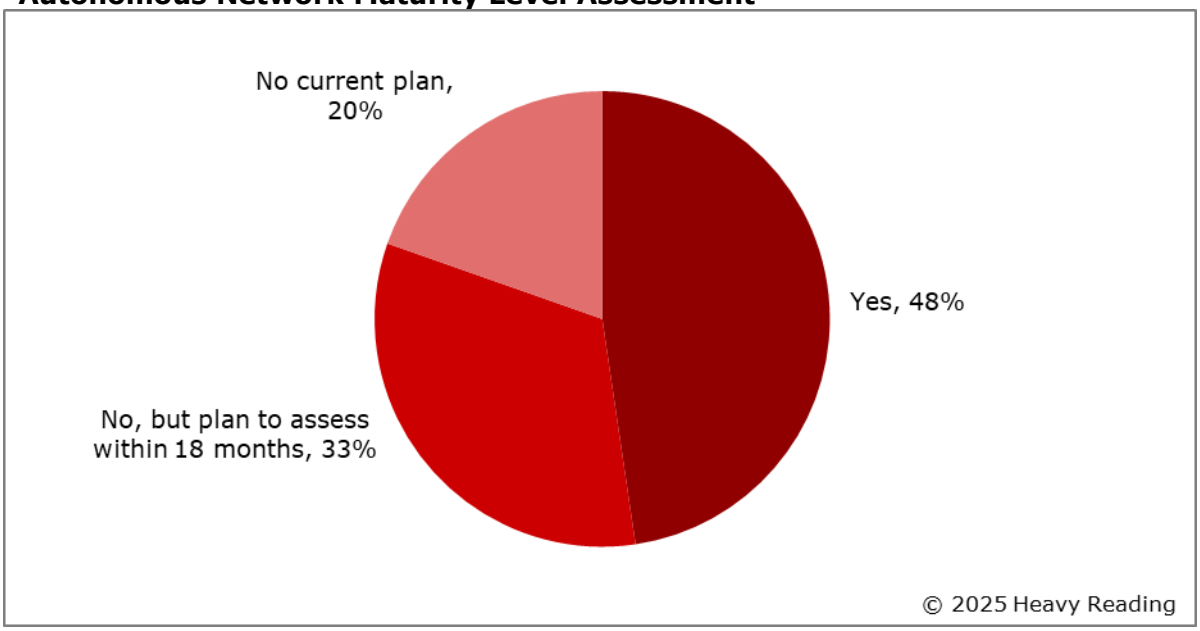
Q: What is your primary job function? (n=107)
Source: Heavy Reading, 2025

PLOTTING THE COURSE 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 autonomous networks (AN) maturity model, i.e., manual operations with some automation. However, more than 60% of operators plan to reach Level 3 or higher by 2028. In 2023, 31 major CSPs and vendors, including Telefonica, Orange, China Mobile, and MTN Group, committed to achieving Level 4 ANs by 2025. These companies are adopting TM Forum's standards to accelerate automation, focusing on intent-driven operations, closed-loop control, and self-healing capabilities. Heavy Reading's survey results support the TM Forum's findings and provide additional insights into where in the CSPs' organization the telcos are placing the greatest amount of focus from the AN perspective (see **Figures 5** and **6**).

Half of respondents (48%) have already participated in an Autonomous Network Maturity Level Assessment, and another third plan to do so by the middle of 2026, leaving only 20% with no current plans for the assessment.

Figure 5: Just shy of half of respondents have already participated in an "Autonomous Network Maturity Level Assessment"

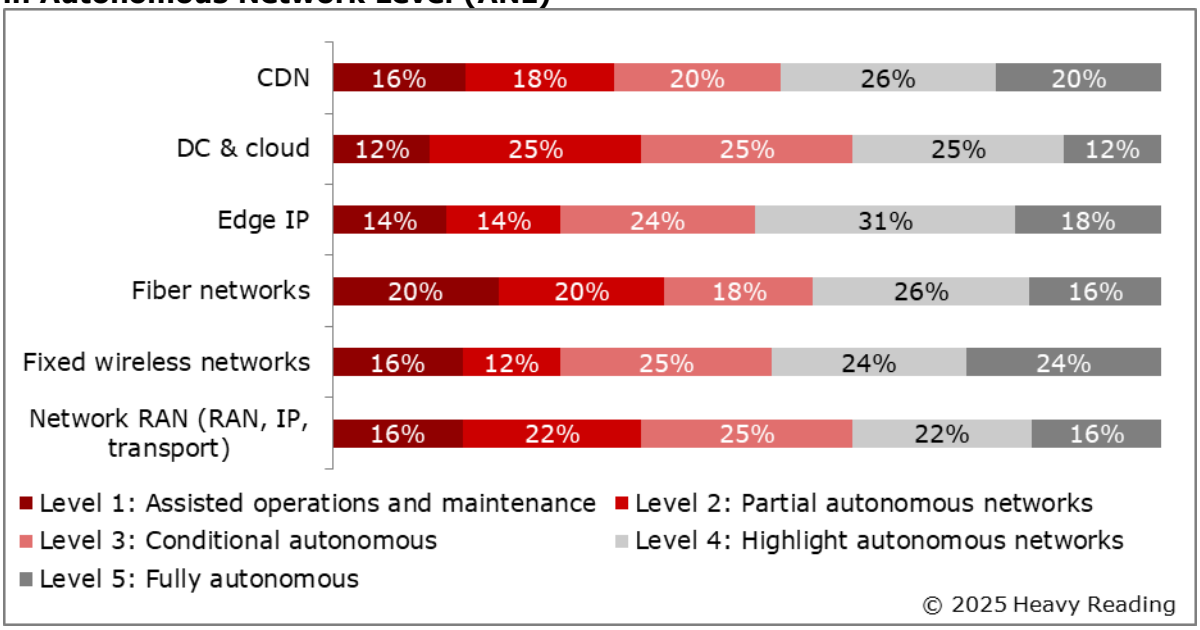


Q: Has your organization participated in an "Autonomous Network Maturity Level Assessment"? (n=107)
Source: Heavy Reading, 2025

Where in the network are the CSPs focusing their efforts as they move to AO (see **Figure 6**)? The 51 respondents that have already participated in an Autonomous Network Maturity Level Assessment state that they are currently further along in edge IP and the fixed wireless network. Just under half of these with a current maturity level assessment have achieved a Level 4 or 5 assessment for these domains. However, the remaining domains are not far behind. Data center & cloud, fiber networks, and RAN are the three domains most frequently reported by survey respondents to be at Levels 1 and 2, and even for these domains, that amounts to 20% of the overall respondent pool.

CSPs with annual revenue of more than $5bn have progressed further in terms of AN maturity level. This is not surprising, as the larger the carrier, the more imperative it is to move to AO in order to contain costs while facilitating network management and scalability. Across *all six domains* on which they were queried, at least 20% of the largest carriers claim to be at Level 5. For two of the domains, RAN and fiber networks, a third of respondents with more than $5bn in revenue state that they are at Level 5.

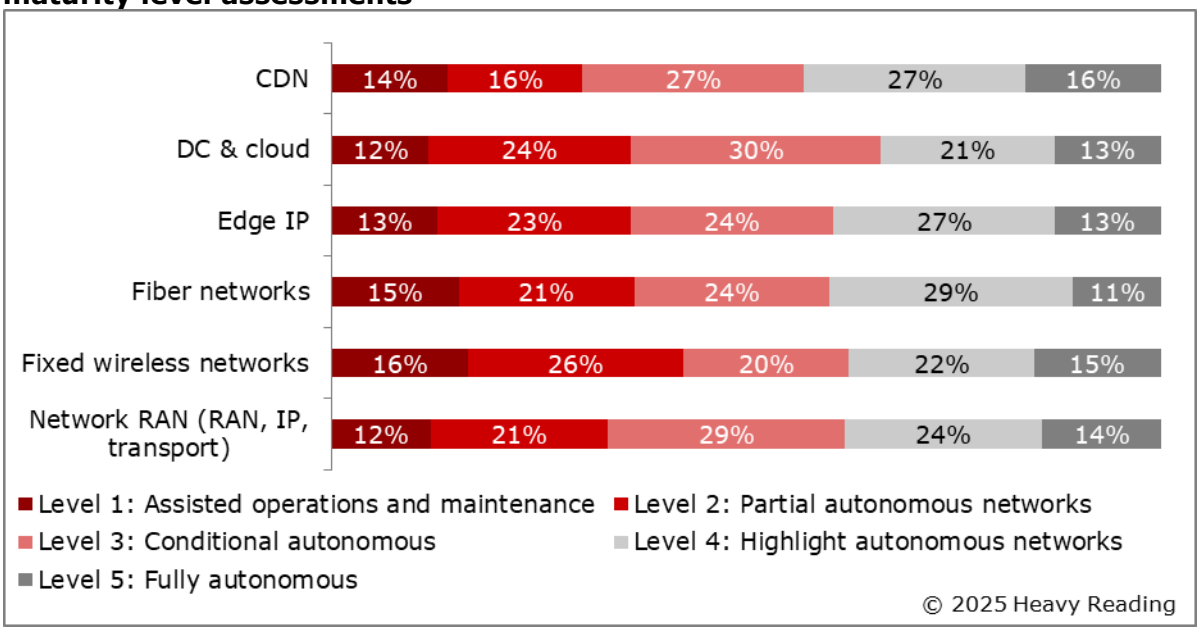
Figure 6: Data center (DC) & cloud and network RAN currently lag other domains in Autonomous Network Level (ANL)



Q: Currently, what is the TM Forum Autonomous Network Level of the following domains? (n=107)
Source: Heavy Reading, 2025

From 18 months out, the picture does not appear to have changed dramatically (see **Figure 7**). The most significant change is that 80% of survey respondents (up from 50%) expect to have participated in an Autonomous Network Maturity Level Assessment by this time. However, the difference in domain focus has all but disappeared—the rising tide of assessments will lift all domains. Looking only at respondents with annual revenue of more than $5bn, one domain that will progress in maturity level faster than the others is network RAN. Only 14% of respondents, overall, will be at Level 5 (fully autonomous) in 18 months. Looking only at the largest respondents, however, that percentage jumps to 21%.

Figure 7: Over the next 18 months, 80% of all respondents will participate in maturity level assessments



Q: In 18 months, what do you expect the TM Forum Autonomous Network Level to be for the following domains? (n=107)
Source: Heavy Reading, 2025

ENABLERS AND CHALLENGES OF AUTONOMOUS OPERATIONS

AO is crucial for handling complex, high scale, and dynamic environments such as 5G, Internet of Things (IoT), and future networks (5G standalone [SA], 6G, and beyond). Enablers of AO for telcos fall into multiple technical, organizational, and financial categories. Respondents chose to focus on technology for their top two enablers. The leading enabler, according to Heavy Reading's survey, is AI technology and tools, which pulled in 64% of respondents, 16 percentage points higher than the next most popular response. AI, along with machine learning (AI/ML), is essential for:

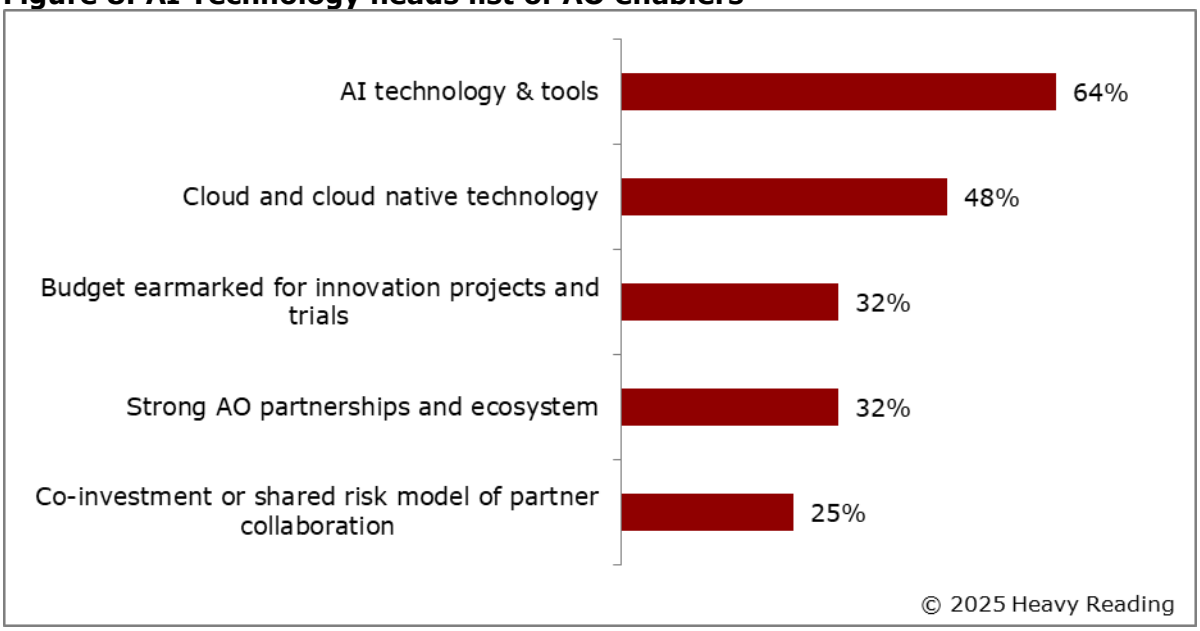
- Identifying and preventing faults before they occur through the use of ***predictive maintenance***
- Managing congestion and resource allocation with ***traffic forecasting and optimization***
- Spotting security threats or service degradation in real time via ***anomaly detection***
- Translating high level objectives into network actions with ***intent-based networking***

"Cloud and cloud native technology" was the second most popular response, and it is also technology-focused. 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—CI/CD for continuous integration and deployment 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 the CSPs' cloud native strategies. The three remaining enablers are clustered together within 7 percentage points of each other and fall into the financial and ecosystem categories. A robust AO ecosystem enables CSPs to leverage partner innovations to accelerate their own organizations' autonomous capabilities. Collaborating with integrators, hyperscalers, open source communities, and startups allows the CSPs to integrate even when reskilling and upskilling their own workforce for AI/ML and automation falls short of their goals.

The budget and shared-risk responses both pulled in at least a respectable one-quarter of respondents, indicating that, while not the topmost concern, they are a critical part of any AN plan of execution. It is interesting to note that these responses appear to be impervious to changes in demographics. They do not change, to a statistically relevant extent, when filtered by revenue, region, or status of their Autonomous Network Level (ANL).

Figure 8: AI Technology heads list of AO enablers



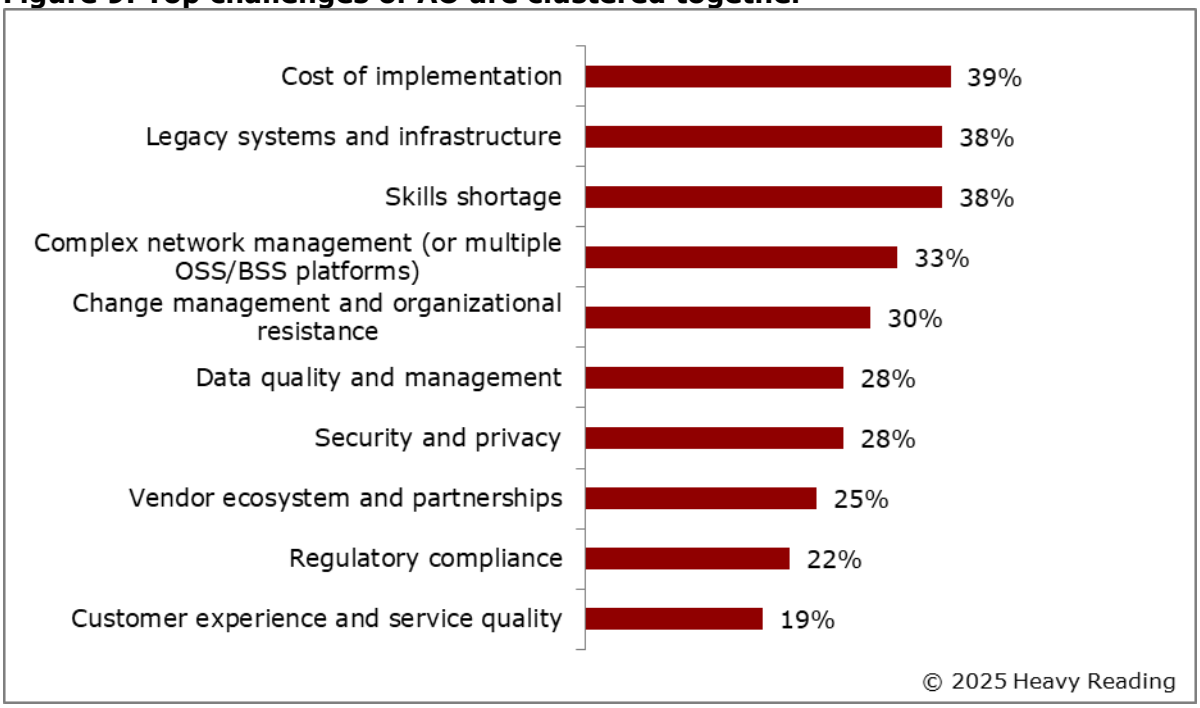
Q: Which are the main enablers of autonomous operations? (Select top two) (n=107)
Source: Heavy Reading, 2025

If the examination of the AO from enablers to barriers is flipped, there is a very different perspective from respondents. Only 20 percentage points separate what respondents see as the greatest challenge to achieving full AO 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 suggests that CSPs are mostly trying to work through the execution of their AO plans. No challenge is perceived as insurmountable, but all challenges are worthy of notice:

- **Cost of implementation** claims the highest percentage of responses, and 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 AO challenges most likely to keep respondents up at night. Shifting to AO 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 of their organization toward expanding their ecosystem 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 with CSPs as they work through the complex tasks 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, they 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 9: Top challenges of AO 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, 2025

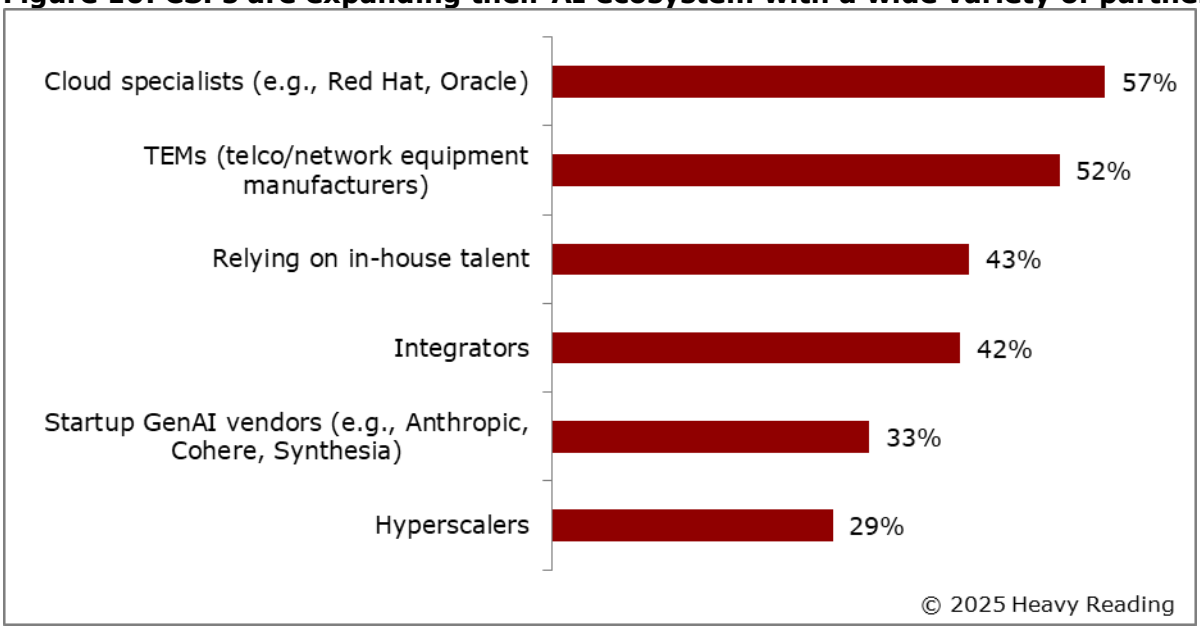
At the bottom of the list of challenges are vendor ecosystem, regulatory compliance, and customer experience. This is not because these characteristics are not important; it is because CSPs feel they are furthest along with implementation and control over those elements. For example, all CSPs will claim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

They have built or are building a robust vendor ecosystem (see **Figure 10**) in which no single category of vendor is dominant. It is, however, interesting to note that outside of the U.S., 50% of respondents are most likely to rely, along with cloud specialists (which remains number one), on integrators.

The implementation of AO comes with a set of regulatory challenges that need to be carefully addressed. The CSPs have been navigating the highly complex landscape of regulatory issues for more than a century. Nevertheless, the introduction of AI and AO 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 down automation if telcos are unable to provide adequate transparency.
- **Security and cybersecurity compliance:** AO 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.

Figure 10: CSPs are expanding their AI ecosystem with a wide variety of partners



Q: Which vendor(s) are you partnering with for AI/GenAI Solutions? (Select up to three) (n=107)
Source: Heavy Reading, 2025

STRUCTURAL REALIGNMENT—WHERE TO START?

Many of the challenges listed in **Figure 9** have their genesis in the highly complex and siloed nature of the CSPs' current operations. One of the first tasks in moving to AO is enabling the multiple overlay networks, OSS/BSS systems, data lakes, supply chains, industry regulations, etc., to work in harmony together. But where are CSPs motivated to start this structural realignment? Where is it likely to provide the most benefit?

Respondents clearly maintain that infrastructure—network, IT, and cloud—is where they will start (see **Figure 11**). Combining legacy fixed-line and mobile network operations will reduce duplication, cut costs, and improve agility. With the shift to software-defined networking (SDN) and COTS platforms leveraging cloud native communications, telcos can unify and modernize their multiple overlay networks, merging core and edge networks, consolidating network operations centers (NOCs), and leveraging software-optimized, shared infrastructure.

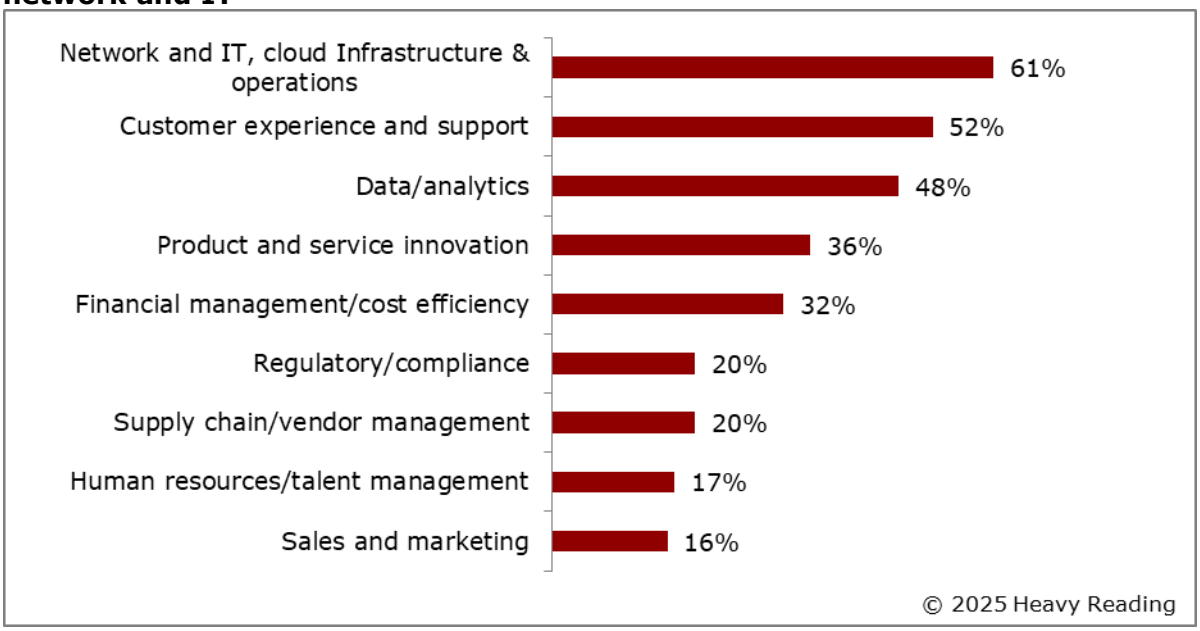
Customer experience and support ranked second, reflecting the growing consensus that customer satisfaction and customer retention rely upon seamless service across all touchpoints. This includes unified contact centers, AI-powered chat, and integrated CRM systems. Realignment allows CSPs to centralize 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 can be both a blessing and a curse. As a Tier 1 CSP commented recently in a conversation with Heavy Reading, "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 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 deploy AI/ML use cases (like predictive maintenance, fraud detection) quickly
- Enabled self-service analytics for enterprises for more agile responses to market needs and a stronger competitive edge
- Cost optimization through consolidating analytics tools, cloud infrastructure, and data management platforms, reducing redundancy and tech debt

The remaining areas for realignment all have aspects of these top three areas of focus. The gulf between the top three and the remainder listed in the exhibit is even more pronounced when only looking at the largest carriers—those with revenue of more than $1bn. For this demographic, infrastructure garners 70% of respondents; customer experience, 58%; and data/analytics, 57%. Financial management then drops to 25%.

Figure 11: The greatest benefit of structural realignment is expected in the network and IT

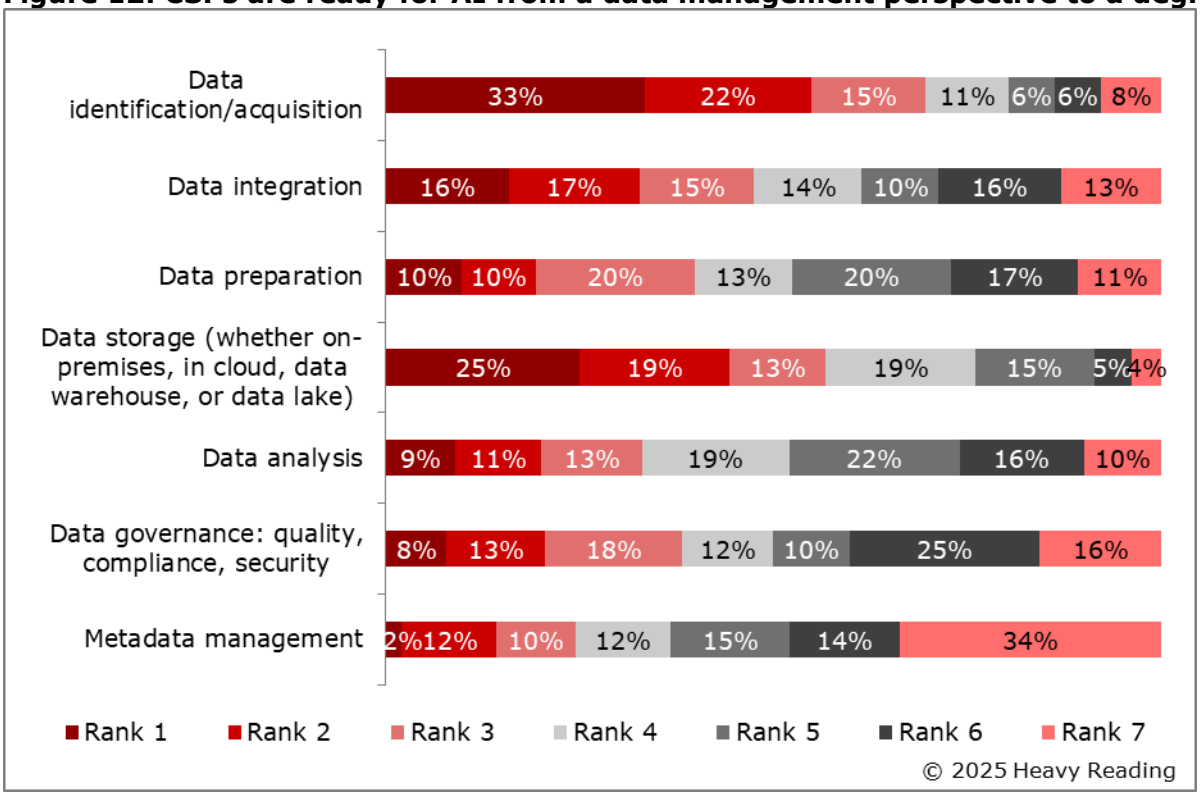


Q: Which areas will benefit most from structural realignment/convergence? (Select top three) (n=107)
Source: Heavy Reading, 2025

A deeper dive into data

Heavy Reading queried survey respondents on how they would rank their organization in terms of its preparedness for AI from a data management perspective (see **Figure 12**). The results illustrate a straightforward response: respondents believe their organizations are adept at getting data ("data identification/acquisition") and at storing data (whether on-premises, in the cloud, data warehouse, or data lake). But after that, their level of confidence falls off sharply. In all remaining areas of data readiness/management, more than 50% of the respondents ranked their organizations between Level 4 and Level 7. This includes the areas of data integration, preparation, analysis, and governance. It also applies to the lowest-ranked area—metadata management. Briefly stated, metadata management is the organized approach to handling metadata, which is data about data. A whopping 75% of respondents ranked their organizations between Level 4 and Level 7 in this area. Only a paltry 2% give themselves a No. 1 ranking. Data management is the tip of a very large iceberg when it comes to the CSPs' preparedness for AI in support of AO.

Figure 12: CSPs are ready for AI from a data management perspective to a degree



Q: How would you rank your organization in the following areas of data readiness/management today for AI? (Rank in order, where 1 = excellent and 7 = poor) (n=104)
Source: Heavy Reading, 2025

SETTING THE STAGE FOR AI

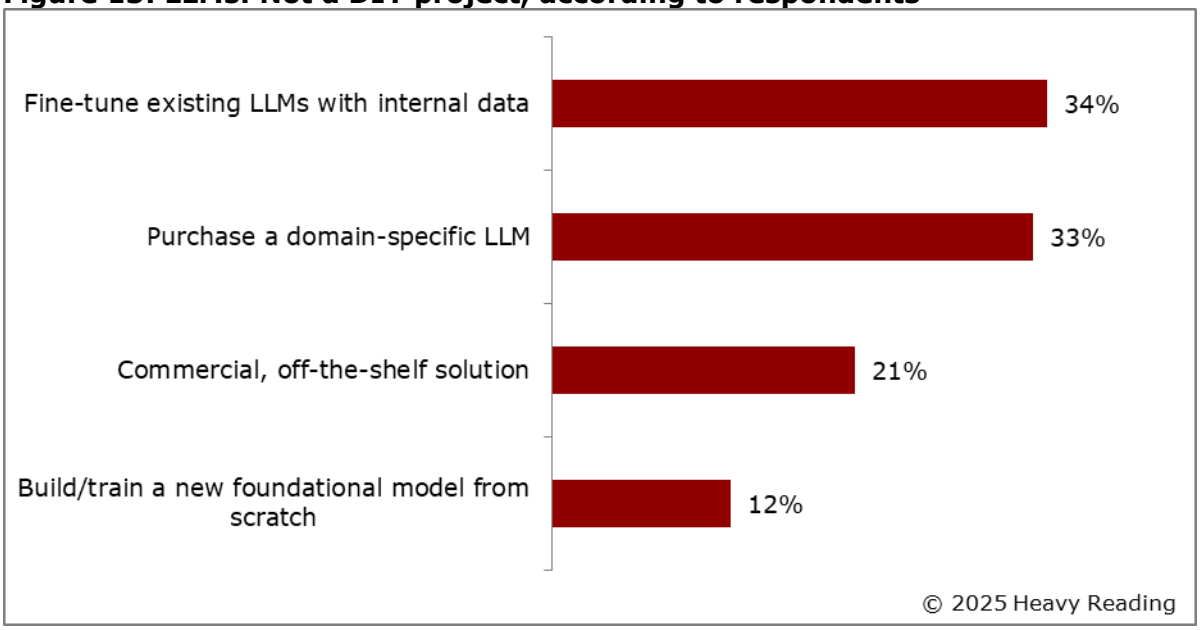
AI is a foundational element of AN operations. The adoption of AI relies upon the use of language models, which are repositories of vast amounts of data. AI systems are trained on this data and are capable of understanding, generating, and interacting with the user's natural language. CSPs use LLMs to 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.

The process of creating an LLM is a daunting task, requiring developers who are highly skilled in AI, data management, and natural language processing (NLP). Once created, the LLM 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%), while 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%). 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 wishes these outliers the best of luck.

Figure 13: LLMs: Not a DIY project, according to respondents



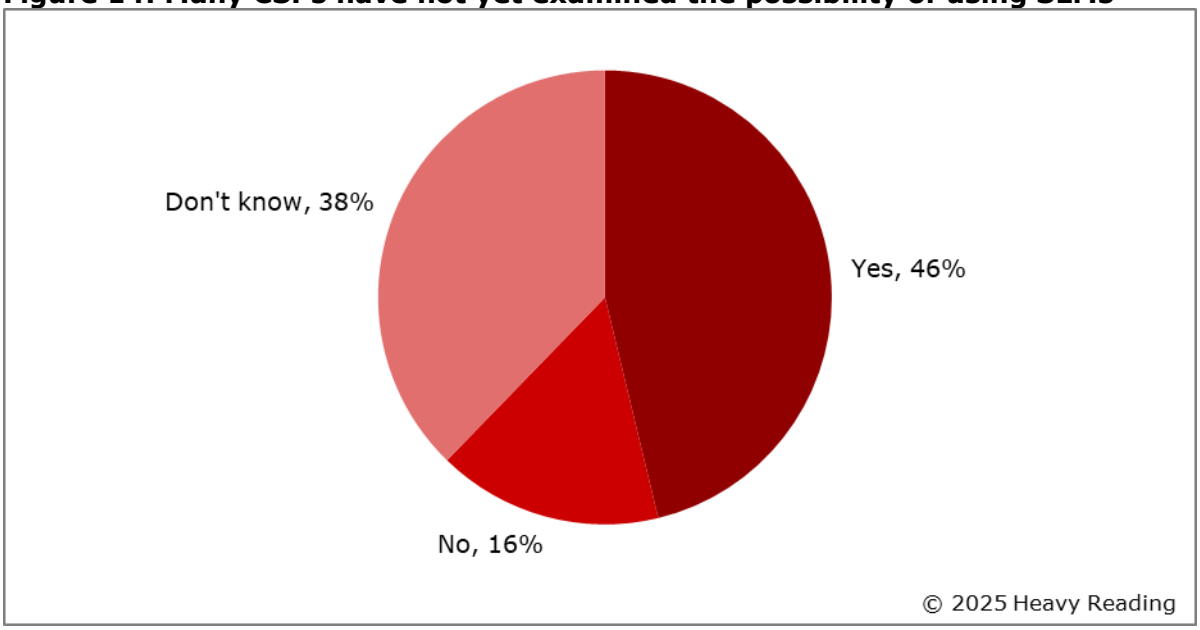
Q: What is your organization's approach to establishing large language models (LLMs)? (n=106)
Source: Heavy Reading, 2025

SLMs versus LLMs

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. 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.

More than half of the survey respondents either do not plan to use SLMs or are unsure. Contrary to expectations, the revenue bracket of the respondents does not have a significant impact on these percentages. Yet, 63% of respondents that have participated in an Autonomous Network Maturity Level Assessment are interested in using an SLM.

Figure 14: Many CSPs have not yet examined the possibility of using SLMs



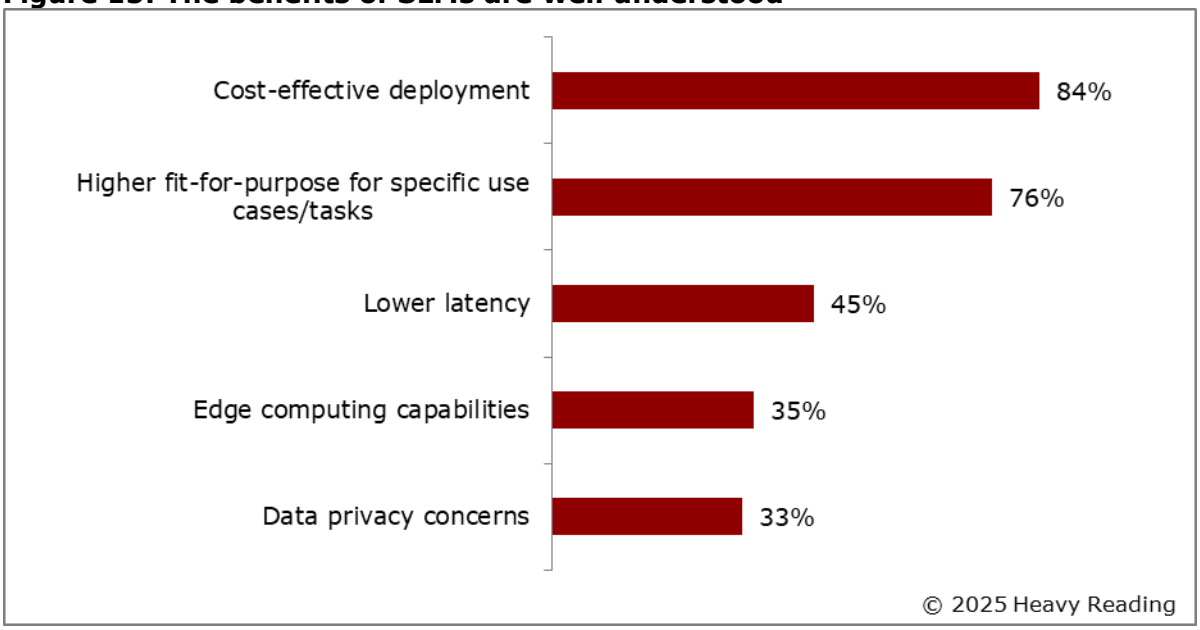
Q: Do you plan to use a small language model (SLM)? (n=106)
Source: Heavy Reading, 2025

There are many compelling reasons for using an SLM, but survey respondents are mostly driven by the lower cost (see **Figure 15**). SLMs are lightweight, and they require significantly less computational power (CPU/GPU), memory, and storage compared to LLMs. They are ideal for deployment on edge devices or in constrained on-premises environments, saving on cloud compute and endless racks of high end servers.

The second leading reason for relying on SLMs, according to survey respondents, is that they have a higher fit-for-purpose for specific use cases/tasks. A well-tuned SLM can be trained on telecom-specific tasks (e.g., troubleshooting internet outages, parsing SMS messages). These SLMs can perform just as well as LLMs when trained on narrow, domain-specific data. As CSPs adopt agentic AI, they will likely turn in greater numbers to SLMs. Agentic AI is a type of AI system that operates autonomously, adapting in real time to solve multi-step problems based on context and objectives. Telcos are likely to use agentic AI for use cases such as customer service virtual assistants, network optimization and self-healing, personalized marketing, and automated service provisioning.

Heavy Reading believes that, despite its ranking at the bottom of the list, data privacy concerns will become more of a driver for SLM adoption. The CSPs handle large volumes of sensitive user data (e.g., call records, messages, billing info). SLMs can be deployed locally, improving security, reducing the need to send sensitive data to the cloud, and helping with compliance (GDPR, HIPAA, etc.).

Figure 15: The benefits of SLMs are well understood



Q: What is the primary driver(s) to use small language models (SLM)? (Select all that apply) (n=49)
Source: Heavy Reading, 2025

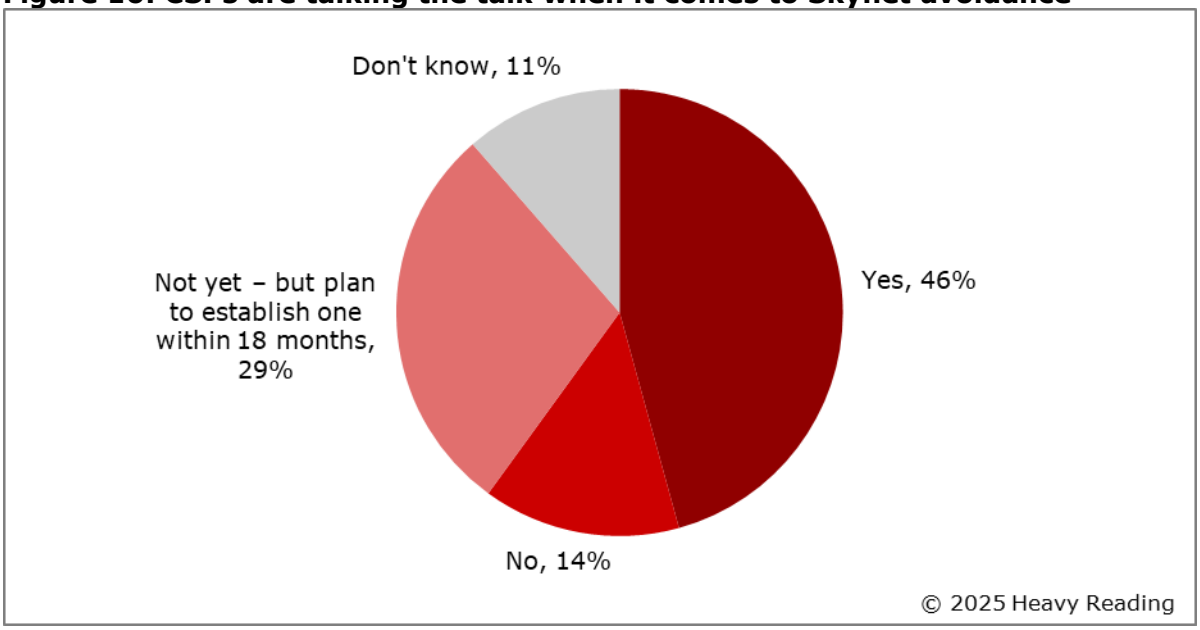
STANDING AT THE CROSSROADS OF AUTONOMOUS NETWORK OPERATIONS

Heavy Reading's survey results show that CSPs continue to be challenged by two overarching areas of concern with AO 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 where they will turn to for assistance.

It is clear from the survey results that CSPs, which once 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 AO and AI, giving them 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 to the CSP deployment of AO.

At the same time, CSPs are grappling with the meta-issue of the ethics of AI (see **Figure 16**). 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 Commander Data) or the threat (think Terminator) of sentient AIs, these concerns extend to issues of autonomy and control, job displacement, moral agency, and environmental sustainability. These issues will take insight, innovation, and a global village to evaluate and address.

Figure 16: CSPs are talking the talk when it comes to Skynet avoidance



Q: Has your organization established an AI governance model to address AI ethical considerations? (n=105)
Source: Heavy Reading, 2025

Note that this report only presents parts of the Heavy Reading survey on AO. Please reach out to the sponsor of this survey, Tata Consultancy Services (TCS), for additional survey results.