The Edge-to-Cloud Continuum

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As Research Director of the Internet of Things practice for 451 Research, a part of S&P Global Market Intelligence, Christian Renaud covers the ongoing virtualization and digitization of the physical world around us.

For 25 years prior to joining 451 Research, Christian built nationwide networks at large and small enterprises, worked with Fortune 50 companies in the systems integrator channel, built products at Cisco Systems and ran the company's New Markets and Technologies team. He has been the CEO of multiple startups, worked in venture and angel capital, and has served as an advisor to G20 and European Commission projects.

The 451 Take

The growing diversity of workloads, industries and use cases – spanning traditional application data and the emerging wave of machine data – will fundamentally shift the conversation around 'best execution venues' for workloads. This discussion will move from an 'either/or' proposition to an 'and' proposition. Analytics and business processes are increasingly leveraging data from multiple sources – from traditional business applications that may be hosted in the cloud to real-time operational data generated from machines being analyzed close to the point of data origination. This creates a powerful continuum of compute, storage and analytics from the edge to the cloud, and results in a more agile organization that enables rapid access to actionable intelligence from the factory to the field.

Edge Computing

'Edge computing' is a term that encompasses a broad array of execution venues, including devices and equipment with embedded compute, adjacent computing devices that augment compute-constrained endpoints, gateways to legacy equipment, and proximate compute resources in closets, cages and within the network operator infrastructure. Edge computing also includes hyperconverged infrastructure that integrates and virtualizes key components of IT infrastructure including storage, networking and compute.

Different organizations have different definitions for edge computing. One definition says that the edge is where data is acted on near its point of creation to generate immediate, essential value. Regardless of the definition, edge computing will become an increasingly important part of the enterprise digital strategy. Industry research suggests that the majority of data will soon be created and processed at the edge.

Given this trend, edge computing is emerging as a critical capability for organizations that:

- Must extract value from unprecedented volumes of data quickly.
- Need to reduce costs by reducing the amount of data transferred over a network.
- Are required to reduce security vulnerabilities.
- Must retain data locally for privacy reasons.

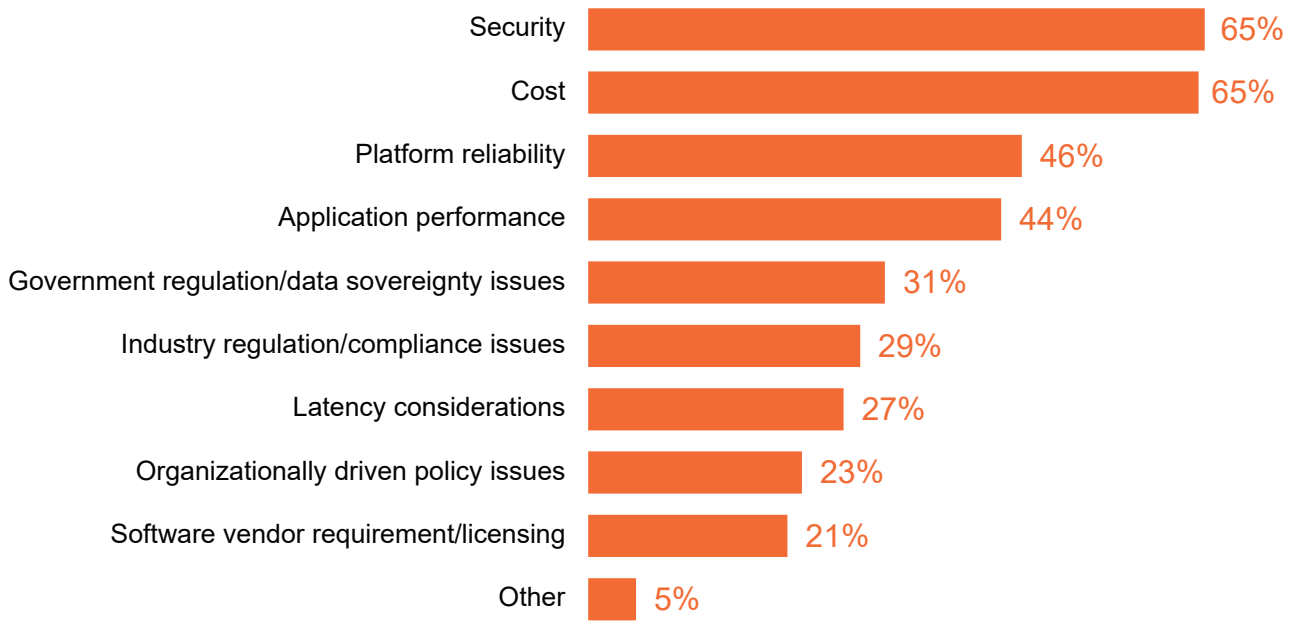
Industry leaders see a great deal of momentum for edge computing that is tied to the availability of 5G networks. They say that the combination of edge and 5G will have a profound impact on virtually all business processes and services while creating opportunities to offer new value-added business products and services. Given the scope of the opportunities, edge computing is a new imperative for organizations.

A Continuum of Compute – from Edge to Cloud

Edge computing doesn't stand alone outside of an organization's data workflows. Instead, edge computing is part of a compute continuum that spans from network-connected devices and equipment to the hybrid cloud including both public and private clouds. In this new world of IT, workloads will run wherever it makes the most sense for the business to run them. The different environments along the continuum will work together to provide the right resources for the task at hand.

On-premises and near-edge venues frequently analyze the data generated by digital transformation efforts and the connectivity of devices and machines. These workloads differ from general IT workloads in terms of best execution venue, with 55% of machine and device data initially stored and analyzed at edge locations, according to respondents to the 451 Research, Voice of the Enterprise: Internet of Things, Workloads and Key Projects 2020 survey. The selection process for the best venue for edge workloads differs slightly from those for IT workloads across cloud, hosting and managed services shown in Figure 1. Edge workload placement prioritizes additional factors such as networking connections, infrastructure resiliency and latency considerations.

Figure 1: Most Influential Factors When Determining Best Execution Venue



Q: In general, which factors are most influential when determining the best execution venue or location for your organization's workloads?
Base: All respondents (n=454)
Source: 451 Research's Voice of the Enterprise: Cloud, Hosting and Managed Services, Workloads and Key Projects 2021

Industry Considerations

Edge computing and edge-to-cloud solutions are being adopted across a wide range of industries, from healthcare and manufacturing to retail, oil and gas, and smart cities. Each industry has workloads that naturally gravitate toward a given execution venue due to application constraints or cost considerations.

Retail respondents to 451 Research's Voice of the Enterprise: Internet of Things, Workloads and Key Projects 2020 survey identified supply-and-demand-driven warehousing and fulfillment as well as responsive customer flow management as prime workloads for the cloud, whereas customer footfall and workforce utilization workloads were best performed at the edge. Healthcare respondents similarly identified data tracking across the continuum of care and outpatient monitoring as key target workloads for the cloud, while leveraging edge computing for more localized functions such as medical equipment asset tracking.

The manufacturing sector has a long history of industrial automation and optimization and has been at the cutting edge of digital transformation efforts. These efforts began with adding sensors to legacy equipment and assets that predate embedded sensors and compute. Digital augmentation is required for manufacturing organizations to perform condition-based maintenance and avoid unscheduled downtime for equipment and assembly lines. This extends further into supply chain optimization and intelligent logistics.

One growing modern manufacturing workload is 'digital twins,' which are digital models of a physical asset or process, potentially extending through the entire lifecycle of the asset, called a 'digital thread.' Digital twins are highly anticipated and valuable, with 21.9% of operational technology respondents to the 451 Research Voice of the Enterprise: Internet of Things, OT Perspective 2021 survey stating that the technology will have a high impact on their organization's operations, and over 55% anticipating a moderate impact.

The benefits of digital twins identified by survey respondents include improving data insights and application functionality, automating previously manual processes, and enabling altogether new processes. Monitoring real-time performance of assets is the highest-value use case identified by manufacturing organizations, and digital twins are a key component of this. Survey respondents that had already deployed digital twin technology within their organization proved far more likely to leverage on-premises edge private clouds than those that have yet to do so.

Considerations for Workload Placement

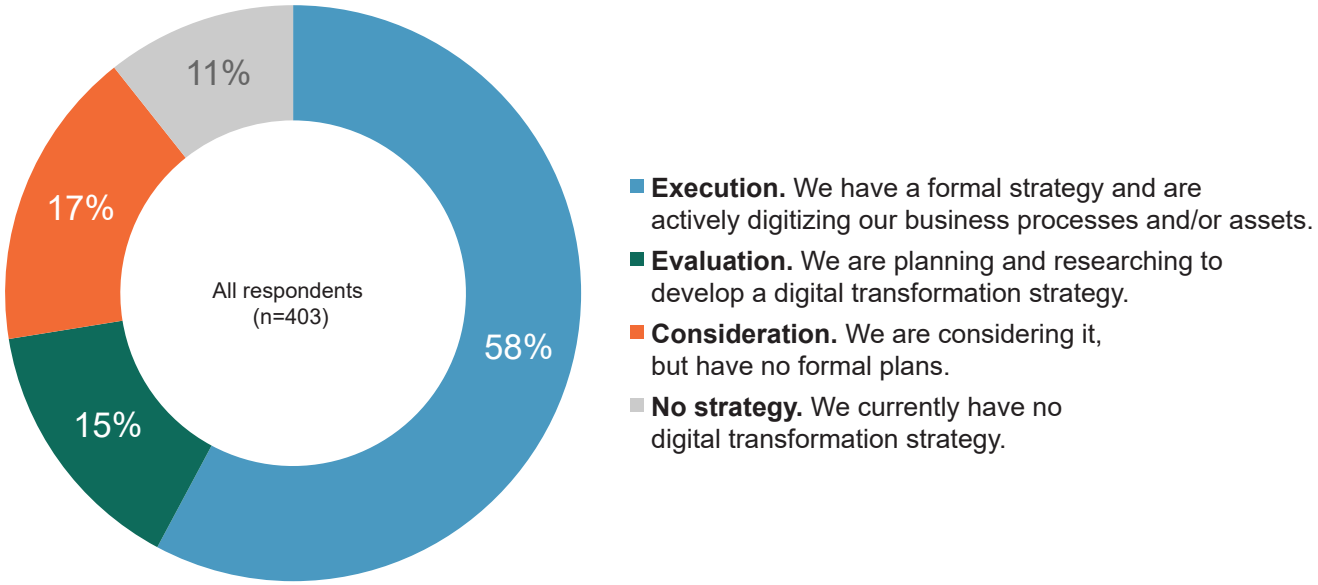
As we noted earlier, IoT workload placement should not be framed as an 'edge vs. cloud' dichotomy; rather, the two should work in tandem where it makes the most sense for the purposes of performance, security, reliability and cost. Some enterprise workloads, such as customer relationship management and enterprise resource planning systems, may be best run in a centralized datacenter, where they can easily share data with related workloads. Other workloads, such as predictive maintenance, inpatient monitoring and physical security, may be best placed at the edge to enable real-time data-driven decisions and automation.

When it comes to determining the best execution venue for workloads, organizations will consider a wide range of variables, including performance requirements, network latency, data volumes, broadband access, security issues, regulatory compliance issues, and the relative costs of edge vs. cloud deployments.

The State of Digital Transformation

Organizations across all industries are transforming their products, processes and organizational charts because they're integrating digital technologies into the fiber of their organizations. These transformations come in many forms, from instrumenting production and field equipment in order to optimize operations, safety and reliability, to fully integrating online and physical retail locations for omnichannel marketing and better logistics. Many organizations have had to accelerate their long-term digital transformation plans for various reasons. Nearly three-quarters of respondents to 451 Research's Voice of the Enterprise: Cloud, Hosting and Managed Services, Budgets and Outlook 2021 survey said they are in the active execution or evaluation stages of their own digital transformation journey, with an additional 17% in the consideration phase.

Figure 2: Digital Transformation Status



Q: Which of the following best describes the status of your organization's digital transformation strategy?

Base: All respondents (n=403)

Source: 451 Research's Voice of the Enterprise: Cloud, Hosting and Managed Services, Budgets and Outlook 2021

The selection of the best execution venue for enterprise workloads is a multivariable equation that includes considerations ranging from cost and security to application performance and data sovereignty. In a modern enterprise, there are a multitude of traditional business applications that are comparatively latency-insensitive or are required by the vendor to be hosted in their infrastructure (such as SaaS applications), as well as workloads that may be mission-critical and latency-sensitive such as factory machine control or substation communications in an electric grid, which must be colocated with the device generating the data. There are also applications at remote locations that may have limited access to inexpensive broadband. These factors all come into play on a workload-by-workload basis in venue selection. Security and cost, however, remain the most influential factors in venue selection by enterprises – even more so when the data in question is sensitive operational data.

Final Takeaways

The range of applications and workloads across industries – each with unique cost, connectivity and performance, and security characteristics – will mandate a continuum of compute and analysis at every step of the topology, from the edge to the cloud. This continuum will require new approaches to orchestration, management and security, and will result in a more agile enterprise that is able to rapidly respond to the needs of stakeholders throughout the organization. The edge-to-cloud compute continuum is a foundational component of transformation into a data-driven enterprise.

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