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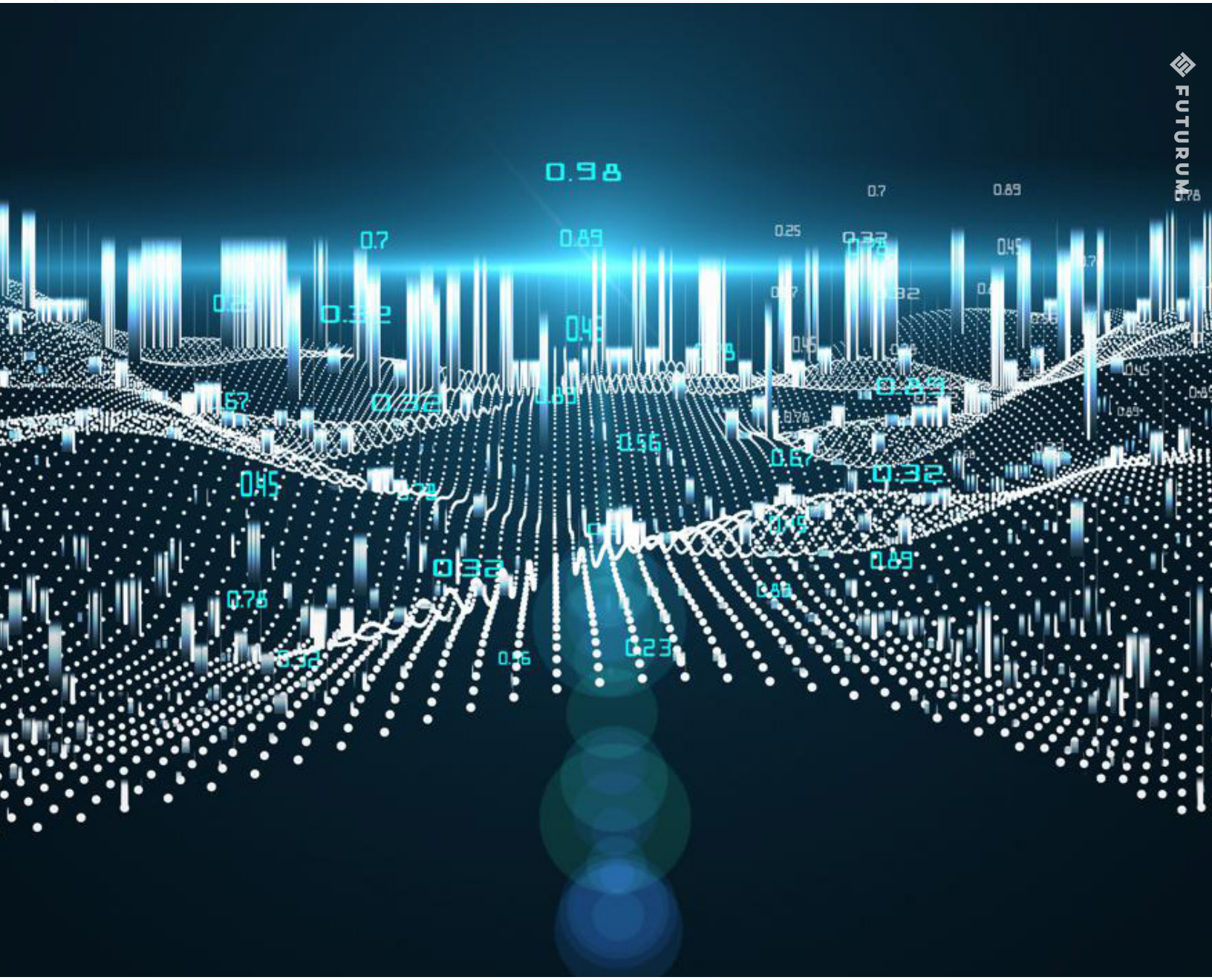

The Value of Open Source for Modern Edge Computing

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Introduction

The edge computing landscape is evolving rapidly in both the scale and diversity of use cases. The proliferation of edge devices and deployment scenarios is growing, and enterprises are facing challenges in how to securely deploy, integrate and operate infrastructure and applications at the scale that edge applications require so that operational and developer teams are not overwhelmed. This paper will explore critical use cases for edge computing, the variety of challenges in deploying edge computing at scale, the related security and operational considerations which must be implemented, and how an open source approach can help.

The edge computing market continues to grow rapidly as more organizations turn to IoT devices and adopt new applications that require real-time data processing. Conservative industry estimates outline worldwide edge technology spending will exceed $250 billion by the middle of this decade. With edge deployments, organizations can drive new value through improved opportunities with real-time data processing and leverage the power of technologies like Artificial Intelligence (AI) and machine learning.

As organizations look to deploy edge computing at scale, the need to compete and differentiate at the edge and deliver more value across the organization, requires the flexibility to bring in the best of breed domain solutions combined with the ability to drive organic innovation. Open source approaches are worthy of broad discussion and exploration to solve these critical requirements. Open source approaches ensure not only that vendor lock-in is avoided, but also that the diversity, flexibility and continuous advancements of best of breed edge technologies are used and integrated throughout the process.

Executive Summary

Edge computing is computing that takes place at or nearest to the users or near where the data is being generated– from factory floors to warehouses to industrial plants and more. This differs from traditional computing, which is often done in centralized data centers or public clouds. By placing the compute, applications, analytics, and network and storage resources closer to users and devices, organizations can offer better application experiences and act on data-driven insights, through near real-time processing and more reliable compute services.

Edge computing is focused on solving complex business problems, such as improving the pace of decision making, through leveraging data and analytics. With instrumentation and devices at the edge, new data sources become available that can provide business leaders with new insights that were previously not available. Processing data at the edge is key for near real-time decision making which has many benefits that can be felt across the organization from cost savings to improved predictive maintenance.

Companies that have a hybrid cloud operational model can extend processing capabilities to edge sites to build new services, drive more efficient operations, improve data security and regulatory compliance. Edge computing lets companies use and distribute a common pool of resources across a large number of locations for greatly improved results.

Another area where edge computing is proving to be foundational for digital transformation efforts is through enhanced end-user experiences. As the interaction with customers increasingly becomes experiential rather than transactional, forward-facing business leaders are looking to provide enhanced services to consumers and stakeholders. That's where edge developments are well-equipped to provide a platform for business innovation.

Edge computing can drive innovation in remote operations and help manage data and compliance. The edge is oftentimes where critical operations for the business occur. The ability to remotely manage and run these services is improved if the edge computing technologies being leveraged are resilient, despite limited bandwidth and connectivity. Also, and perhaps most important as threats evolve, the need to process and manage sensitive and secure data on-site while maintaining regulatory compliance is becoming even more of a C-Suite focus area. When you couple these factors with a growing shift to cloud-based computing, the need to manage any workload and any footprint across any location becomes vital for enterprises looking to fully profit from their digital transformation investments. But it is difficult to do alone.

Working with the right provider will help organizations develop a comprehensive strategy that can be the foundation of their efforts, more quickly identify and surmount challenges, integrate, launch and manage deployments, and help along the way when questions or issues arise. An open source approach helps organizations quickly realize value through edge deployments which is a requirement in today's climate.

Use Cases in Telco, Manufacturing and Utilities

The standard vendor model within telco networks is being upended as open source continues to ripple into the furthest corners of networks. Telco private networks, 5G, private 5G, MEC (multi-user edge compute), vRAN, and distributed core are driving benefits for better user experiences while providing scaling to meet burgeoning demand, greater network flexibility and improved resilience.

Manufacturing is being revolutionized with a **rapid digital transformation** across the factory floor. These disruptive trends are driving edge computing use cases that are focused on predictive maintenance, factory automation and worker safety. The benefits being seen already include dramatically increased productivity, the reduction of downtime, longer asset lifetimes and notably improved safety.

The wider energy, oil, and gas sector is undergoing rampant demand as the developing world comes online and increases its consumption. In addition, those industries are also being asked to pivot to adopt environmental, social, governance (ESG) constraints as climate concerns come to the fore. Against this backdrop **energy, oil, and gas providers are increasingly turning to edge computing**. That's because edge computing can drive efficiencies focused on process control and environmental monitoring to deliver on constraints and opportunities facing businesses today and tomorrow.

Addressing the Client Need

The needs of customers evaluating edge computing technologies as part of a wider digital transformation agenda are complex and multi-faceted, although some key factors emerge.

Security. By its very nature edge computing often means the deployment of digital technology to the furthest confines of an organization, as far from the data center as is possible. This brings a variety of new threat vectors that must be addressed by the Chief Information Security Officer (CISO) and the IT security team. Whether it is network endpoints, new sensor types or just the proliferation of edge devices, customers must be thoughtful about the requirements from a security standpoint to protect sensitive information, including PII or proprietary data. More devices mean a larger attack surface, and though each may be mini-environments, none are isolated. At some point, they will need to send data and information back to their data centers, and vice-versa. That means nodes and connections, and that creates openings for hackers to exploit. Regardless of the chosen technology layer or vendor, clients need to approach security as part of a holistic edge strategy and factor in security at every layer in the architecture from the start. To best accomplish this, all platforms must adopt a holistic DevSecOps approach.

Ease of Management. Edge computing can drive increased tensions on already typically overworked IT teams. Whether it is patching thousands of new edge devices, managing increased network traffic, or managing event logs, the burden on the core IT function will increase as edge computing gets deployed. In response, customers should be clear about finding reliable ways to manage edge

computing deployments. One particularly important requirement in this evaluation criteria is to ensure that any chosen solution has a robust and scalable approach to automation. Removing the need for IT teams to undertake repetitive tasks by automating them has many benefits, not only in operational and project resourcing, but also in the overall security of the deployed infrastructure.

Ability to Scale. Edge computing will mean an order of magnitude increase in the number of devices and endpoints that require management. To accomplish that successfully, organizations must plan for this scale including fundamental changes in the breadth and scale of IT landscapes once the project is finally deployed. Given this change, customers must examine all layers of their architecture to identify the constraints that come with any potential technology solution, but with the reality that undetected issues are compounded when scaling at the edge. By evaluating potential new problems ahead of time, companies can prevent surprise pitfalls involving Line of Business-driven use cases as any new infrastructure is deployed.

Ability to Select Common Platforms. When pursuing edge computing using open source approaches, organizations can choose a wide range of common open source platforms across their edge computing, core, and cloud requirements. By using common platforms, organizations can utilize their existing staff and skill sets more efficiently as they build out their strategies and infrastructures.

Edge Computing Challenges

To bring about edge computing successes inside organizations, the challenges of this still-evolving technology must be addressed from the start of any project. These include:

The Proliferation of Edge and IoT Devices at Scale. Managing workloads of edge and IoT devices that can number into the hundreds of thousands or more is not unheard of in edge computing environments. To handle these devices, as well as the massive data streams they can generate, organizations must facilitate easier scalability, provisioning, and infrastructure management. This complexity means that it can be difficult to manage edge computing resources and data streams centrally and at scale quickly. Consensus estimates cite "manageability" as the biggest obstacle in adopting edge computing today.

Existing Infrastructure Complexity. For organizations tasked with supporting a wide range of existing infrastructures, the introduction and integration of edge computing can be intimidating for the teams who will have to carry out the project. It can increase the skills needed by team members and the costs for implementing the strategy. For example, existing edge solutions can use a mix of heterogeneous hardware with limited footprints (e.g., in a backroom closet in a retail store or a train yard switch station), industry-specific proprietary solutions, as well as do-it-yourself code. In most cases, these various technologies have been woven together over years or decades in support of specific operational processes and may include technologies ranging from 100-year-old textile looms to modern-day robotics. Decision-makers often cite the complexity of managing multiple technologies as one of their top three challenges in deploying edge computing.

Managing the Ongoing Orchestration of Edge Computing and IoT Platforms. Deployment at scale is a serious concern and therefore customers are looking to emerging technologies such as Kubernetes open source container orchestration systems to assist with deployments. Building an edge infrastructure that supports in-house innovation and enables robust partnerships with best-of-breed third-party providers is also important. By leveraging Kubernetes and container-based microservices approaches, customers can operate at the required scale without corresponding increases in operational overheads.

Using Automation Technologies to Deploy and Manage Edge and IoT Devices. As customers seek to deploy and manage edge and IoT devices, they quickly find that they need serious help to do it. It is not a task for the meek. To make their unique IoT and edge computing challenges workable, users learn that they need an aggressively automated environment, which includes a unified automation language that can speak natively to the world out there. Such abilities to integrate across the ecosystems can enable users to tie the edge back into their data centers. And even better, a shared language between domain experts and application developers can enable cooperation on the same code, allowing them to combine their expertise. All of this combined can help make edge computing and IoT much more manageable for users and organizations.

Proper Care of Sensitive Data. Managing data at the edge means having to make decisions that protect sensitive information, including PII or proprietary data, wherever it is processed. Cyber-attacks on enterprise computing, including internet-connected devices, continue to escalate, with many breaches taking six months or more to be discovered. To address and counter these security challenges, organizations must set up stealthy controls and policies to maintain proper security postures, governance, and compliance, as they do with all their IT systems. Organizations must ensure that software is updated consistently and implement data security measures to prevent vulnerabilities.

Preventing Technology Dead-ends. Organizations need an edge computing platform that allows them to grow, change, adapt, and scale without completely re-evaluating or re-engineering their edge solutions and vendors each time their business needs change. By using open source platforms, organizations can avoid proprietary applications and platforms that lock them into specific vendor-aimed product paths. By being able to custom-build and architect their edge computing environments — where organizations directly generate value and revenue — enterprises can follow the best paths for what their projects require, instead of following what vendors mandate. Using flexible open source platforms allows enterprises to develop their own intellectual property to improve their critical business operations and offerings, giving them an advantage in highly competitive markets.

Accommodating Environmental Variability. When placed outside the central data center and closer to where data is generated, nodes will not always be in environments that are conducive to traditional architecture. Distributed nodes are not guaranteed to have reliable climate control, network access, and security. Not only must the hardware be able to tolerate these harsher environments, but also the software must be flexible enough to support power outages, network disconnects, and other work disruptions. Organizations need predictable, highly stable, resilient platforms that require minimal on-site IT maintenance and support while being easily replaceable and discoverable.

How Open Source Solves the Challenges

Customers have choices when it comes to how they deploy edge computing technologies and platforms as part of their digital transformation journeys. One of the most important decisions to be made for edge computing and other technology roll-outs will be the fundamental nature of the solution stack as it relates to the openness of the architecture.

That is where open source software code comes in. In open source, the code written and created by developers is designed to be publicly accessible by anyone who wants to see, modify, and distribute it as they see fit. Open source code is written by developers working for enterprises, educational institutions, independent developers and many others. Instead of being developed by coders inside companies, it is created in decentralized and collaborative ways, goes through peer reviews and eventual community acceptance into the open source code bases for each project. Open source software is customizable, can be more flexible, less expensive to produce and can have more longevity than its proprietary peers because it is developed by communities rather than a single author or company. The beauty of open source is that it uses the values and decentralized production model to find new ways to solve problems inside organizations and industries around the world, meaning that the best ideas win out.

The principles of open source, including collaboration, transparency, flexibility, reliability, and no vendor lock-in, translate to edge computing in a variety of ways. The first concern is the interoperability of the various solutions in the architecture. Whether it is sensors, edge nodes or core nodes, the scope of the use case will typically encompass a variety of different vendors. To ensure that all solutions in the holistic architecture interoperate effectively, open APIs will be a foundational requirement of this architecture. However, the requirements can go further and oftentimes dictate that solutions be tested to collaborate with each other.

Open source also plays important roles at the control plane or orchestration and automation layers. Containers are operationally more nimble and allow developers to implement changes faster via contained code, limiting any impact to the broader environment. Leveraging Kubernetes as a foundational enabling technology layer has benefits for edge computing deployments. In the recent past, concerns existed around three-node clusters being too heavyweight for edge use cases. This has changed, however, with lightweight nodes becoming more prevalent.

Development approaches should be also considered by customers evaluating open edge projects. Patterns like serverless, along with lightweight development frameworks, increase the reach of development teams to applications deployed at the network edge and should be actively considered as part of a DevSecOps driven evaluation framework.

Red Hat's Value Proposition

Edge computing increasingly demands a broad ecosystem of supported solutions and interactions. Open source is becoming the prevalent approach to deliver on the promise of interoperability, scale and ease of operation across both the public clouds, private data centers and edge locations. Red Hat is perfectly positioned for a variety of reasons, including the ability to leverage its diverse ecosystem of providers and software vendors, its in-house innovation and perhaps most crucially its infrastructure agnostic platforms that are focused on delivering scale, automation, innovation and security of operation.

Common Platform from Edge to Core to Cloud. This approach reduces the prevalence of mixed vendor platforms and therefore reduces the required skill sets, allows improved resource utilization and enables organizations to place applications where the business needs them most. Red Hat can support customers across public cloud, help build their own core centers, and scale out to build a modern edge computing infrastructure. As the largest enterprise open source company, Red Hat can bring together all the needed pieces of an organization's technology platform requirements to help ease and smooth the transition to edge computing.

Red Hat's open source portfolio spans everything from edge computing to private data centers that are on-premises or remote. It includes cloud computing partnerships with all major cloud vendors, including Amazon Web Services, Microsoft Azure, Google Cloud and IBM Cloud.

And the Red Hat portfolio includes a broad open source product offering lineup from Red Hat OpenShift to Red Hat Enterprise Linux (RHEL), Red Hat OpenStack, Red Hat JBoss Enterprise Application Platform, Red Hat Ansible Automation Platform, and much more. From Red Hat, organizations can get a broad, connected platform based on open source code that helps customers reduce their infrastructure complexity, simplify its management and minimize potential security threats.

Automation and Management that Scales. The need to drive robust operations is never more relevant when you also factor in the sheer breadth and scale of edge computing deployments. Red Hat has long led the market with a focus on open source-based automation tooling through the Red Hat Ansible Automation Platform to automate end-to-end tasks and processes from the data center to the edge. This can be coupled with Red Hat OpenShift to provide the Kubernetes orchestration layer and Red Hat Advanced Cluster Management (ACM) for Kubernetes that is increasingly seen as the management layer of choice for edge computing. While they both control policies in edge deployments, Red Hat OpenShift orchestrates container workloads and Red Hat Enterprise Linux runs any workload, including containers.

Used with Red Hat ACM for additional scalability, Red Hat Smart Management for predictive analytics and system management, these combined platforms give customers a robust data infrastructure, leveraging the best of event-driven architectures to process and manage the flow of sensitive data at scale. To see these critical components in action, visit the Red Hat Portfolio Architecture web page to find out how customers are building edge solutions and more using Red Hat open source software.

Extensible and Interoperable Application Environment that Adapt to Business Needs. At its core, Red Hat's software building approach is based on the adoption of modern DevSecOps processes that enable faster yet secure innovation, while also augmenting it with a robust and diverse ecosystem for best-of-breed platforms. Combined with Red Hat's extensive and robust professional services offerings, organizations can get the application platforms they need to maximize their digital and open source transformations while also getting the open source expertise they need to make their journeys easier and smoother from idea inception to final roll-out. No organization has to feel that it is diving into open source without all the help, advice and experience that is needed to make the projects successful. That is what Red Hat has been doing consistently for enterprises around the world for almost 30 years.

Red Hat and Open Source Security for Enterprises. As edge computing, IoT, containers, hybrid cloud and other technologies continue to make the data and system security landscape much more complex, Red Hat has been working hard to make its platforms more robust and protected. That means replacing or bolstering traditional perimeter-based network security using modern Zero Trust Architecture principles such as micro-segmentation, continuous user validation, and the prevention of lateral movement. Red Hat implements security systems within each layer of the application and infrastructure stack and requires authorization between people and systems – and between systems themselves – to be explicit instead of assumed, using automation and other modern processes.

Red Hat's strategy at its core is to build open source software platforms that are ready for the enterprise, while ensuring that they can be used by organizations to remain competitive, flexible, and adaptable while maintaining IT security and regulatory compliance. Through subscription models, Red Hat gives customers access to a dedicated team of experts who support our technology 24x7.

Validated Patterns Simplifying the Creation of Edge Stacks. As customers look to leverage multiple providers and suppliers and pull these together into a holistic deployment architecture, the need for templated deployment patterns is paramount. Red Hat has invested here to provide a portfolio and ecosystem approach for customers. Initially, Red Hat is focused on providing blueprints as code which enables customers to go beyond documentation and use GitOps processes to simplify deployment. The validated patterns inherent in the Red Hat approach are also highly reproducible so that scale-out is possible with consistency and that the transition from POC to production is improved. Finally, because this is open source, these patterns are open for collaboration enabling developers to suggest improvements and contribute them to the code.

Conclusions and Futurum Recommendations

As customers look to further deploy edge computing across a variety of uses cases as part of a wider digital transformation, we recommend the following:

Open Source First. Our first recommendation is to explore the open source landscape rather than vendor-specific solutions. We firmly believe that while vendor-specific solutions on the surface may seem faster to deploy, these initial benefits are overridden by downstream interconnectivity and interoperability challenges that a vendor-specific approach will drive.

Management and Automation are Critical Components. Our second major recommendation is to look at edge solutions through the lens of management and automation. As edge use cases reach maturity, one factor we observe regularly is the sheer scale of the eventual deployment. To battle this challenge, choosing a solution stack that has both built-in automation and orchestration is critical — not only from an infrastructure perspective, but also from an application life-cycle management perspective. We believe that for the benefits of an edge computing project to be fully realized customers need to think about Day Two operations as part of the overall initial design and architecture.

Cloud Deployment Should be Baked In. As customers plan for edge computing deployments, they should consider the entirety of their deployments across edge computing, cloud and private data centers to find the best single platform that gives them consistent operations from edge to core to cloud. When using Red Hat, the added benefit is that customers can get those services while also not being locked into any one cloud provider since Red Hat has relationships with all the main cloud vendors. For customers, that's the big payoff – gaining the ability to deploy edge computing in an on-premises, hybrid and public cloud model while being able to use the same tooling, orchestration, and automation layers across the infrastructure.

We believe that Red Hat is uniquely positioned to deliver on these recommendations and meet the needs of customers across a wide range of sectors. A trusted vendor partner is truly the key to success with edge computing initiatives. Working with the right provider will help organizations develop a comprehensive strategy that can be the foundation of their efforts, more quickly identify and surmount challenges, integrate, launch and manage deployments, and help along the way when questions or issues arise. Red Hat's open source approach helps organizations quickly realize value through edge deployments which is table stakes in today's climate and bears further consideration for anyone looking to move or improve at the edge.

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