

TECHNICAL VALIDATION

Design, Deploy, and Operate Kubernetes at Scale

Spectro Cloud Palette for Kubernetes

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Contents

Introduction	3
Background	3
Enterprise Strategy Group Technical Validation	5
Design (Day-0) Capabilities.....	5
Deploy (Day-1) Capabilities.....	8
Operate (Day-2) Capabilities.....	12
Conclusion	15

Introduction

This Technical Validation from TechTarget’s Enterprise Strategy Group documents the detailed evaluation of the Spectro Cloud Palette enterprise Kubernetes management platform, including its capabilities for designing (Day-0), deploying (Day-1), and operating (Day-2) Kubernetes clusters.

Background

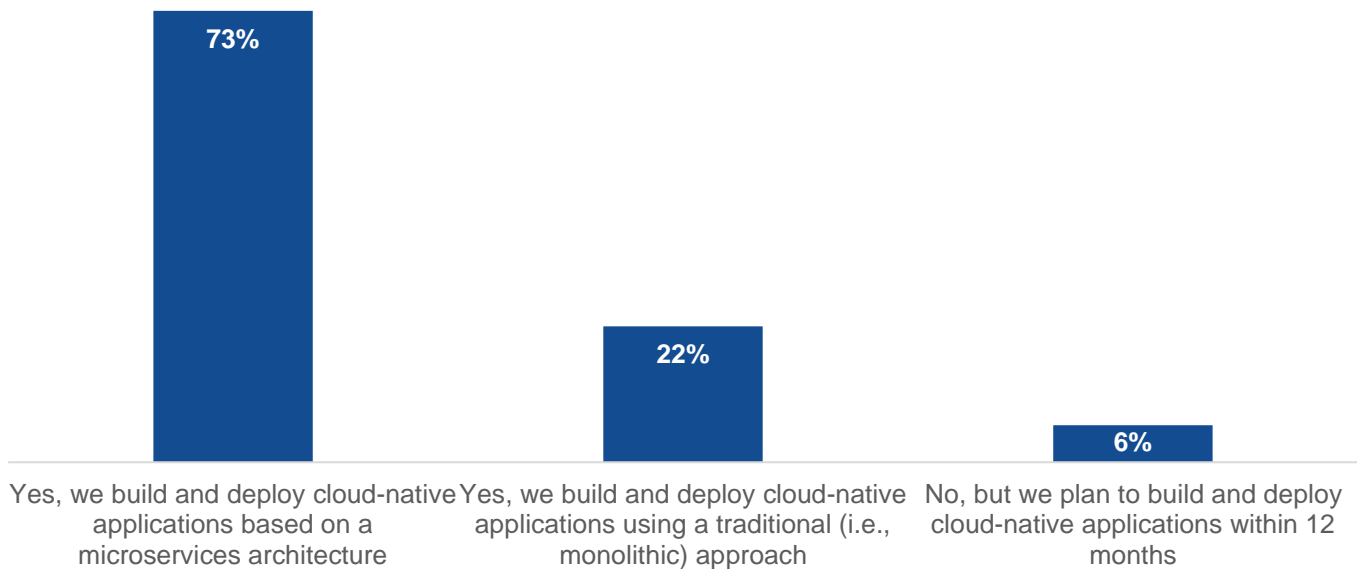
Kubernetes is an open source container orchestration solution that has emerged as the de facto infrastructure block for running applications at scale. However, Kubernetes and the cloud native ecosystem are not easy to navigate. Beyond the complexity of installing, configuring, and managing the complete lifecycle of Kubernetes and Kubernetes clusters, IT operations and platform engineering teams also need to navigate, select, deploy, and manage all the additional open source or commercial components required for applications to run (e.g., security tools, ingress, monitoring, and other integrations). This becomes more difficult when working across heterogeneous environments and as requirements change.

Enterprise Strategy Group’s research indicates that organizations are making significant progress on their application modernization journeys, with 73% of respondents currently developing cloud-native applications based on containerized microservices architectures (see Figure 1). In addition, 65% of organizations expect more than half of their production applications to be based on a containerized microservices architecture within two years.¹

To address these challenges, a solution is needed to assist in the way Kubernetes is managed in production environments in order to further bridge the gap between IT operations and DevOps teams across organizations.

Figure 1. Majority of Cloud-native Apps Are Based on Containerized Microservices Architectures

Is your organization currently developing cloud-native applications? (Percent of respondents, N=387)



Source: Enterprise Strategy Group, a division of TechTarget, Inc.

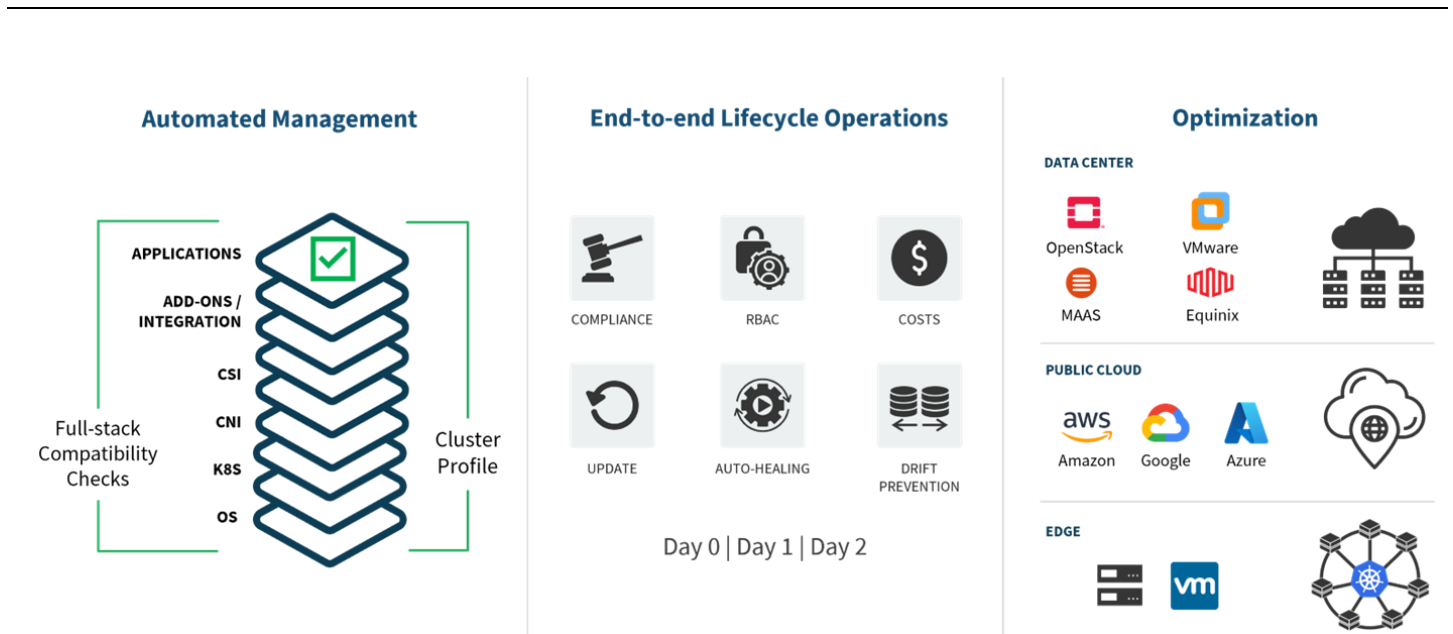
¹ Source: Enterprise Strategy Group Complete Survey Results, [Distributed Cloud Series: Cloud-native Applications](#), May 2022.

Spectro Cloud Palette Enterprise Kubernetes Management Platform Overview

Where Kubernetes provides orchestration for containerized applications, Spectro Cloud Palette provides an enterprise Kubernetes lifecycle management platform.

Spectro Cloud enables organizations to deploy and manage Kubernetes across new and existing environments, giving IT operations and platform and DevOps engineering teams control of the full Kubernetes lifecycle (see Figure 2).

Figure 2. Spectro Cloud Palette Platform Overview



Source: Enterprise Strategy Group, a division of TechTarget, Inc.

The Palette platform can deploy and manage Kubernetes clusters across multiple clouds (IaaS and managed Kubernetes services), data centers (virtualized and bare metal), and edge environments. Beyond the core Kubernetes infrastructure (Operating System, Kubernetes, networking and storage), Palette allows users to model and deploy complete “stacks,” including additional integrations that might be required (e.g., security, ingress, monitoring, CI/CD, etc.), which are managed declaratively based on extending the concept of [CNCF's Cluster API](#). Operations teams can support their developers with granular governance and enterprise-grade security via curated Kubernetes stacks and tools based on their specific needs. The Palette platform also addresses the challenges of traditional solutions, like restricted choice and scaling issues.

Palette provides the following additional key capabilities:

- Operating System (OS), Kubernetes, and add-on-agnostic approach with 50+ out-of-the-box integrations and the ability to import customer-specific technologies.
- Always-on, declarative management across all layers with two-minute reconciliation loops to avoid configuration drift and self-healing.
- Pre-deployment tests and compatibility scans across every layer.
- Decentralized architecture with at-cluster policy enforcement that enables fast zero-downtime rolling upgrades and scaling with no performance degradation.

- Out-of-the-box Role-based Access Control (RBAC), cost and quota visibility and control, monitoring, logging and alerting, compliance tests (penetration, conformance and security), scaling, backup and restore, OS patching and cert rotation.
- End-to-end zero trust access and hardened security, as well as compliance with industry standards (SOC 2 Type 2, FIPS 140-2, and ISO 27001).
- Easy integration to other technologies, such as GitOps, Infrastructure-as-Code (IaC) with Terraform, CI/CD, ITSM, SSO/Auth and notification tools.
- Flexible immutability (OS and Kubernetes distribution-agnostic) and A/B OS partitioning for zero-downtime rolling upgrades for edge locations, including air-gapped environments.
- Integrated bare-metal Kubernetes options with hybrid VM management support.
- Support for importing existing Kubernetes environments.
- Flexible consumption models (multi-tenant SaaS, dedicated SaaS, self-hosted).
- 24/7 support across all components, including third-party technologies.

Enterprise Strategy Group Technical Validation

Enterprise Strategy Group validated that the Spectro Cloud Palette enterprise Kubernetes lifecycle management platform provided comprehensive Kubernetes design (Day-0), deploy (Day-1), and operate (Day-2) capabilities.

Design (Day-0) Capabilities

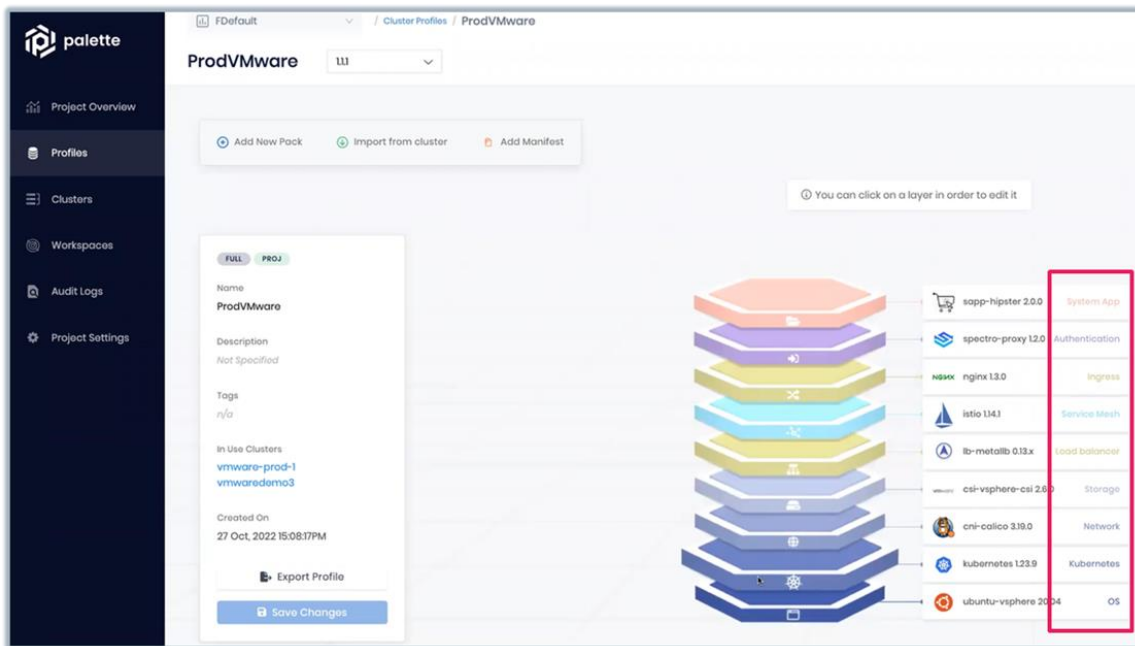
At Day-0, the design phase, organizations need to determine which OS and Kubernetes distribution to use, depending on the environment it will exist in. In addition, organizations need to determine what integrations are needed, including storage, network, load balancers, security, logging, monitoring, etc.

Spectro Cloud Palette provides the Kubernetes management capabilities to deploy Kubernetes clusters to production using a consistent, end-to-end management solution that takes into account the complete configuration of each cluster (both Kubernetes core infrastructure layers, as well as any additional integrations). The Palette orchestration engine, based on CNCF's Cluster API, gives users the ability to design and deploy repeatable cluster blueprints called "Cluster Profiles," ensuring they always remain as designed, checking the deployed state every two minutes (reconciliation loops).

Each Cluster Profile, which is like a blueprint or template, describes the entire infrastructure of a Kubernetes cluster, including the OS, Kubernetes distribution, networking, storage, load balancer, service mesh, ingress, and authentication. Palette enables users to choose from a variety of open source or proprietary solutions when building a Cluster Profile from a public repository of more than 50 technologies or to bring their own. Palette features a CNCF-conformant Kubernetes distribution called Palette eXtended Kubernetes (PXK) as an option for users.

All Cluster Profile layers are validated and tested for compatibility before they get deployed to the target environment. Figure 3 shows the Cluster Profile core layers. A cluster doesn't have to be attached to a single Cluster Profile. In addition, a single Cluster Profile can be applied to multiple clusters (e.g., reused), and a single cluster can have multiple complementary profiles applied (e.g., a set of security tools/policies can be defined in a profile and applied to all clusters distinct from the various infrastructure profiles they use).

Figure 3. Cluster Profiles

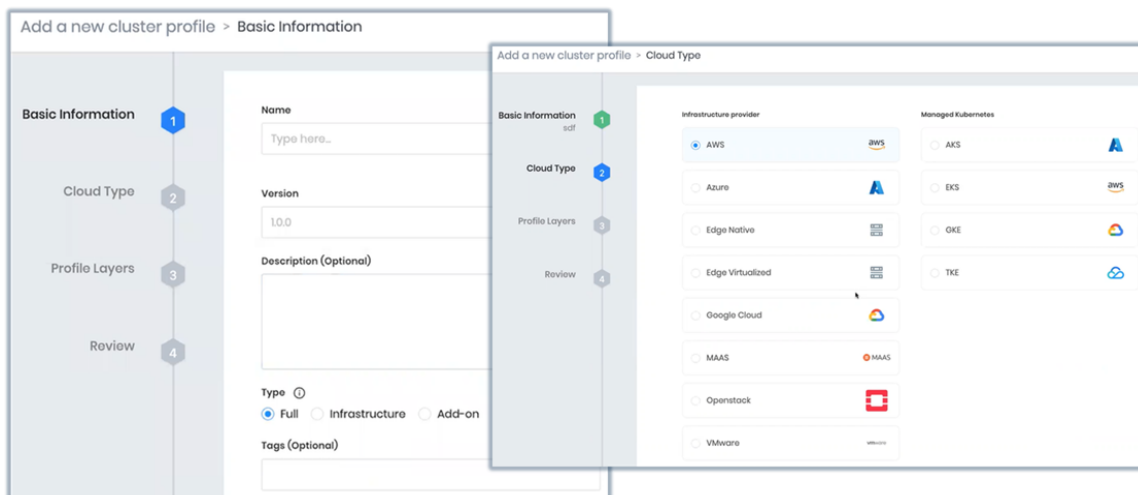


Source: Enterprise Strategy Group, a division of TechTarget, Inc.

Figure 4 shows how users can add a new Cluster Profile by following a few simple steps:

- Basic Information (Name, Version, Description, Type, Tags)
- Cloud Type (Cloud IaaS and virtualized or bare-metal data center, managed Kubernetes services)
- Profile Layers (Palette Packs, Helm Charts)
- Review

Figure 4. Adding a New Cluster Profile



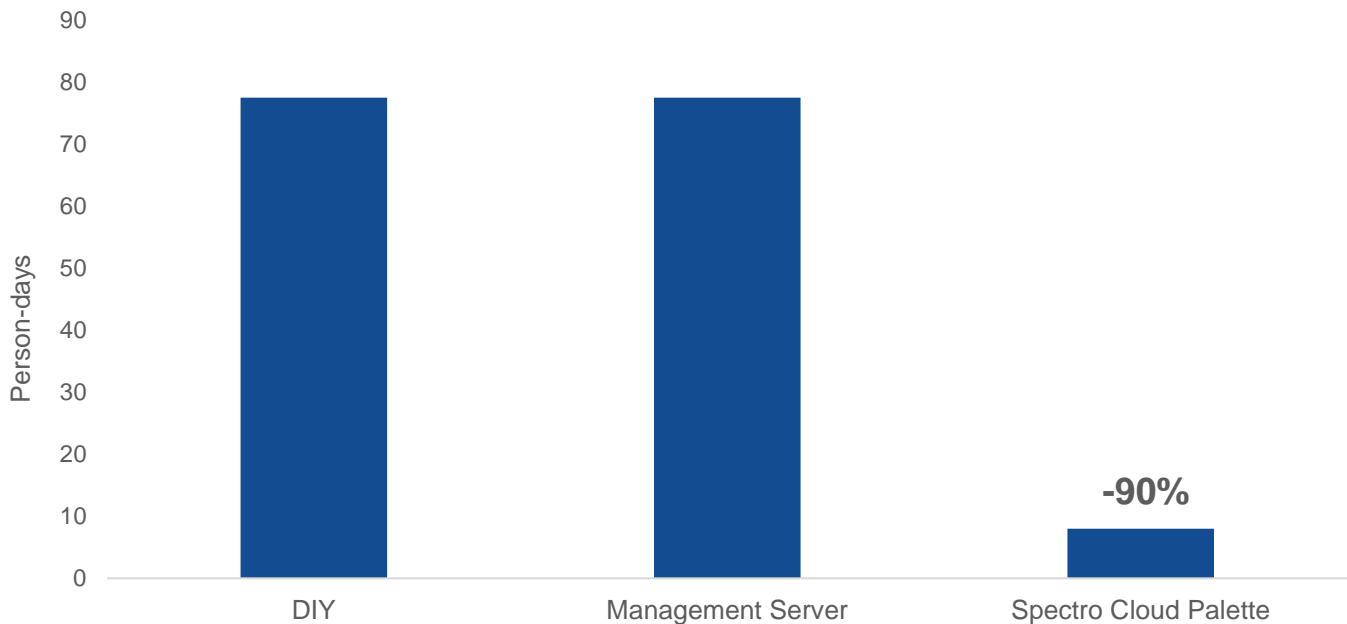
Source: Enterprise Strategy Group, a division of TechTarget, Inc.

Enterprise Strategy Group modeled the time, effort, and costs that could be expected when performing the typical tasks required to manage the complete lifecycle of a Kubernetes environment. We assumed an organization with 50 48-node clusters running three control plane nodes and 45 worker nodes per cluster. We further assumed that the organization would need to employ engineers highly skilled in Kubernetes. Through online research, we determined an average fully burdened cost of \$175K annually. We compared the Palette Kubernetes management platform to a do-it-yourself (DIY) approach and utilizing a conventional Kubernetes solution based on management servers. Our analysis covered Day-0 (the design phase), Day-1 (the deploy phase), and Day-2 (the operate phase).

Typical Day-0 activities include gathering requirements for providing production Kubernetes; defining access control policies; managing user moves, adds, connects, and disconnects; preparing security hardened golden images; researching technology integrations for each app in the stack (logging, monitoring, ingress, and service mesh, for example); and configuring single sign-on (SSO), OpenID Connect (OIDC), or Security Assertion Markup Language (SAML).

As seen in Figure 5, Palette was able to reduce the Day-0 planning and preparation time by up to 90% versus DIY or a conventional management server. Due to its centralized management platform approach and repeatability enabled by Cluster Profiles, Palette reduced or eliminated the costs associated with the time and effort spent preparing golden images, researching technology integrations, configuring identity management and sign-on when compared to both the DIY and management server approach.

Figure 5. Day-0 Planning and Preparation—The Design Phase



Source: Enterprise Strategy Group, a division of TechTarget, Inc.

Why This Matters

Day-0, the design phase, is where organizations capture the configuration and future state of their Kubernetes clusters, including the governance, tooling, and integrations needed to build upon for subsequent phases.

Enterprise Strategy Group validated that the Spectro Cloud Palette gives users the ability to build repeatable Cluster Profiles that ensure Kubernetes deployments are deployed and are maintained as desired. Palette was able to reduce the time to do Day-0 planning and preparation activities by **up to 90%** versus DIY or a conventional solution based on management servers.

The solution is able to model and validate the “full stack” of a Kubernetes cluster through Cluster Profiles, which enables operations teams to have full control of what goes into their cluster from a library of integrations, giving them the choice over ingress, monitoring, security tools, and other required elements of a cloud native stack, including the OS and Kubernetes distro.

Deploy (Day-1) Capabilities

At Day-1, the deploy phase, organizations deploy their chosen clusters into various environments such as data centers (virtualized or bare metal), public cloud, and edge. Palette provides the flexibility to deploy to all the above destinations using the same methodology based on Cluster Profiles.

Figure 6 shows the Cluster View where users can manage all their clusters across all their environments.

Figure 6. Cluster View

Type	Env	Cluster Name	Last Modified	Status	Health	Healthy Nodes	CPU	Memory
vm		vmwaredemo3	11 Dec, 2022 / 06:19 PM	Running	✓	3 / 3	0.82 CPUs / 8 CPUs	6.65 Ob / 16.69 Ob
vm		vmware-prod-1	9 Dec, 2022 / 02:02 PM	Running	✓	5 / 5	2.37 CPUs / 14 CPUs	17.95 Ob / 29.08 Ob
		demoazure1	8 Dec, 2022 / 12:34 PM	Running	✓	2 / 2	0.64 CPUs / 8 CPUs	8.72 Ob / 33.57 Ob
vm		intelopenedge2	6 Dec, 2022 / 12:04 AM	Running	✓	3 / 3	0.45 CPUs / 8 CPUs	6.94 Ob / 16.69 Ob
vm		multus-demo	6 Dec, 2022 / 12:04 AM	Running	✓	3 / 3	0.57 CPUs / 8 CPUs	5.49 Ob / 16.69 Ob
		openshift-1	28 Nov, 2022 / 10:27 AM	Running	⚠	3 / 5	0 CPUs / 0 CPUs	0 Ob / 0 Ob
vm		vmware-prod-2	21 Nov, 2022 / 11:31 AM	Running	✓	5 / 5	1.44 CPUs / 18 CPUs	14.82 Ob / 37.5 Ob

Source: Enterprise Strategy Group, a division of TechTarget, Inc.

Using the menu, users can also drill down to check the health of a cluster by viewing the following information:

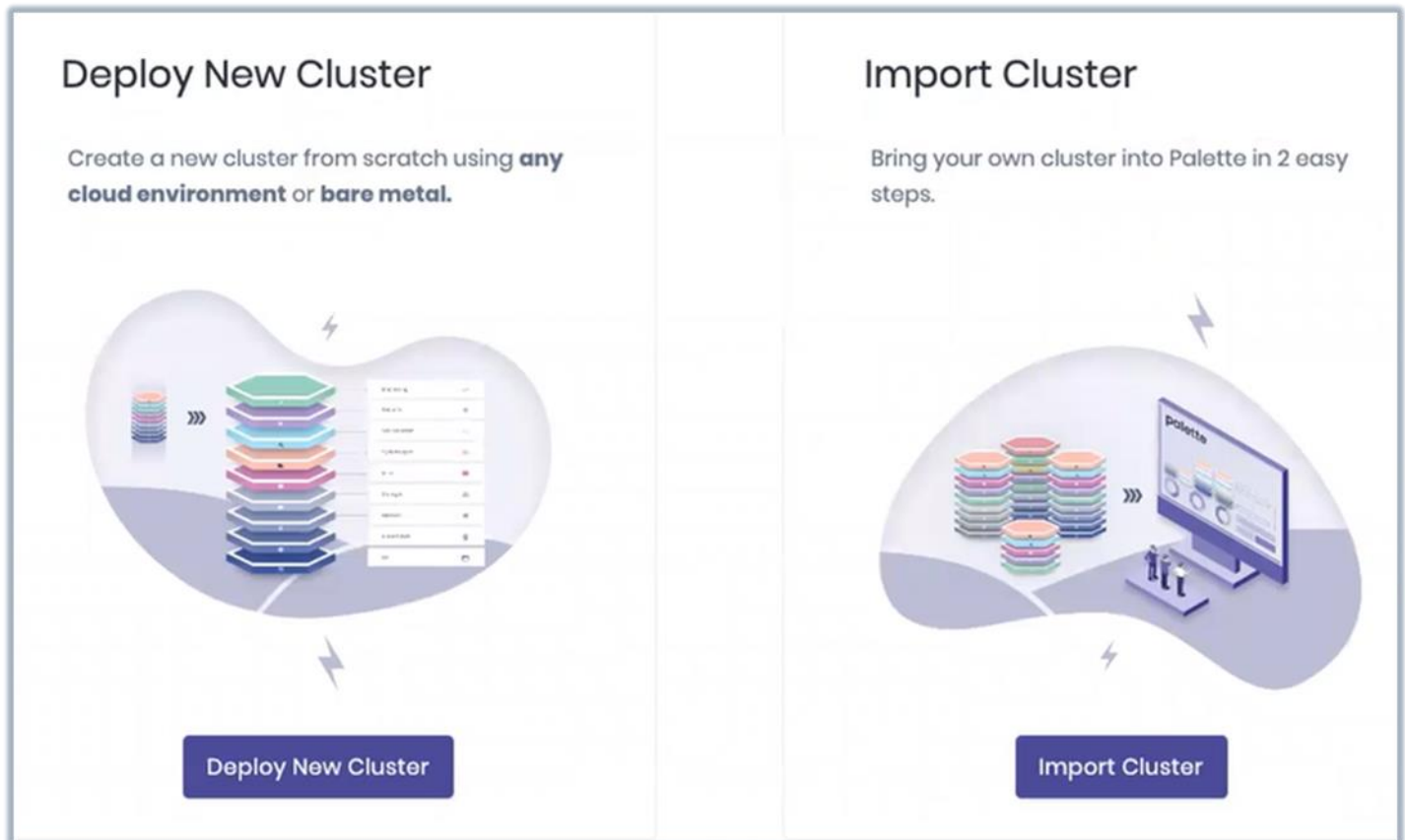
- **Overview:** real-time metrics for CPU and memory, cluster description, cluster settings, cluster status, etc.

- **Usage & costs:** estimated cost, average and maximum percent usage of CPU and memory, namespaces usage percent for CPU and memory, and costs timeline.
- **Profile:** additional layers and infrastructure layers.
- **Workloads:** namespaces, pods, deployments, daemonsets, statusfulsets, jobs, cronjobs, role bindings, and cluster role bindings.
- **Nodes:** node name, status, health, Kubernetes version, age, instance type, network, and public and private IP.
- **Events:** status, data & time, service, node name, and message.
- **Scan:** Kubernetes configuration security, penetration testing, and conformance testing.
- **Backups:** create backup and restore.

Figure 7 shows the screen used to deploy a new cluster or import a cluster. Users select the type of cluster, including the cloud type (e.g., AWS, Azure, Google Cloud, or Tencent), data center (e.g., VMware, OpenStack, or MAAS), and edge (e.g., Virtualized, Native, or VMware vCenter with credentials). Then, users step through a few screens to complete the following information: basic information (cloud type and profile layers), Cluster Profile, parameters, cluster config, nodes config, settings, and review.

Users can also import existing Kubernetes clusters into Palette for management by setting up the cluster name, cloud type (e.g., AWS, GCP, etc.), proxy/no proxy (this is optional), and the import mode (read-only mode with minimal permission or full permission mode with more management options).

Figure 7. Deploy or Import Cluster



Source: Enterprise Strategy Group, a division of TechTarget, Inc.

Palette also provides an “app mode” (Palette Dev Engine) that is targeted toward development teams that don't necessarily know Kubernetes. The app mode allows developers to quickly build applications and then deploy them onto Kubernetes clusters with unrestricted access to a Kubernetes sandbox similar to their production Kubernetes environments. This provides developers the freedom to deploy what they want, when they want, without waiting for approvals and fulfillment of internal provisioning tickets. The Palette Dev Engine can, in some cases, replace the need to configure and integrate with CI/CD tooling, although Palette also offers the latter.

As part of Palette’s Day-1 capabilities, Spectro Cloud developed a concept called “Palette Virtual Clusters,” which are clusters built on top of Loft Labs’ open source projects, vcluster and vcluster CAPI Provider. The vcluster relies on two core components: a syncer and a Kubernetes control plane to create a “virtual” Kubernetes cluster within a pre-existing host cluster. The syncer synchronizes Kubernetes resources between the API servers of the two Kubernetes control planes (host and virtual).

With Palette Virtual Clusters (see Figure 8), a cluster administrator can deploy and manage vclusters with the same enterprise-grade orchestration, cluster-wide visibility, and fine-grained role-based access control (RBAC) that Palette provides for conventional Kubernetes clusters. This solution helps improve utilization via oversubscription of clusters, which results in faster time to cluster and provides freedom of choice and flexibility for development teams.

Figure 8. Virtual Clusters

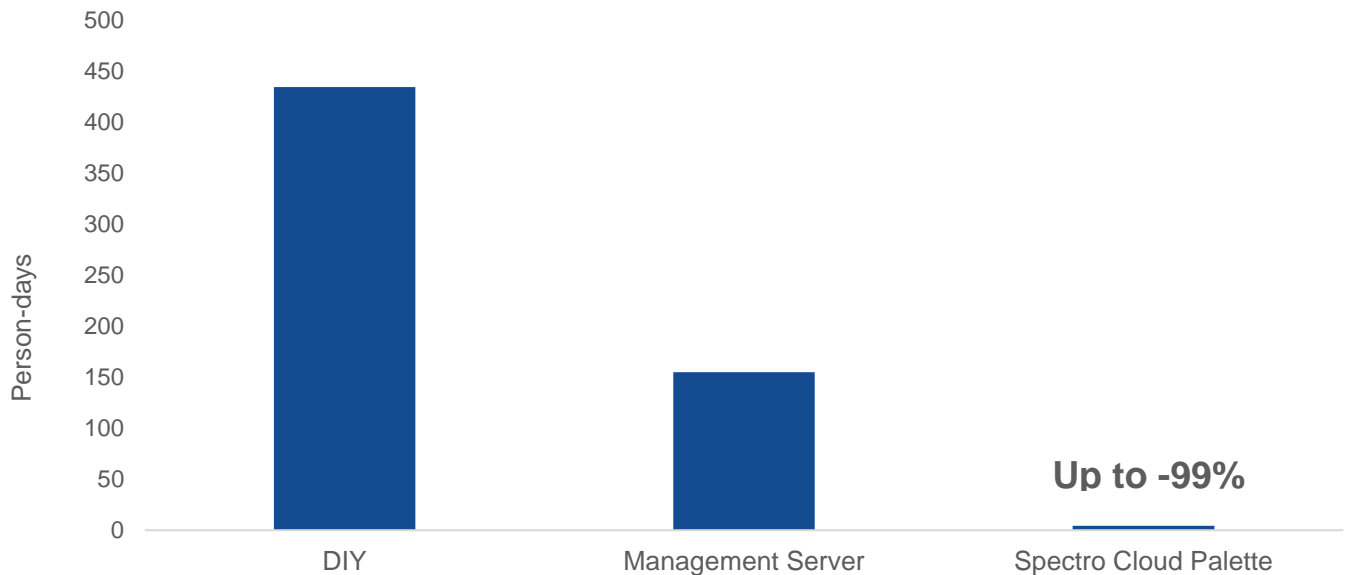
Type	Cluster Name	Cluster Group	Last Modified	Status	Health
	nestedcluster1	-	9 Nov, 2022 / 03:11 PM	Paused	✓
	sandbox-wakanda	vegas	9 Nov, 2022 / 01:47 PM	Running	✓

Source: Enterprise Strategy Group, a division of TechTarget, Inc.

For Day-1 activities, Enterprise Strategy Group used the same modeled organization and assumptions as in the Day-0 analysis.

Typical Day-1 activities include deploying a cluster to a single environment; configuring RBAC, including namespace creation, role binding creation, OIDC mapping, and service accounts; CI/CD integration; and cluster automation using Infrastructure as Code (IaC).

As seen in Figure 9, Palette was able to reduce the Day-1 deployment time by up to 97% as compared to a management server approach and up to 99% compared to a DIY approach. Overall, Palette reduced the time and effort required for all Day-1 tasks.

Figure 9. Day-1 Deployment and Release—The Deploy Phase

Source: Enterprise Strategy Group, a division of TechTarget, Inc.

We also looked at Palette's Day-1 capabilities for an edge deployment scenario (using Palette Edge). These include onboarding edge devices from power-on to in-cluster and configuring central management. In this example, the following edge assumptions were made: 100 edge locations with three nodes per site. In summary, Palette was able to reduce the Day-1 edge deployment time by up to 95% versus DIY or a conventional solution based on a management server. This result was due to both a reduction in onboarding and management set-up tasks, without taking into account reduced travel time to and from edge locations and the cost of a high-skilled engineer to perform onsite troubleshooting.

Then, we examined a Day-1 data center bare-metal deployment. For this analysis, we considered two scenarios: using an infrastructure-as-a-service (IaaS) bare-metal provider to automate provisioning or manually deploying each individual OS without an IaaS provider. In this example, we made the same assumptions as for the Day-0 and Day-1 analyses: 50 clusters, 48 nodes per cluster, with three control plane nodes and 45 worker nodes running on 12-core single-socket servers. In summary, Palette was able to reduce the Day-1 bare-metal deployment costs by up to 98% for deployment with an IaaS provider (due to out-of-the-box native integration) and by up to 88% for deployment without an IaaS provider.

Finally, we looked at Day-1 bare-metal deployment licensing, which compared Kubernetes on commercially available virtualization software versus Kubernetes on bare metal with Palette. The same bare metal assumptions were made as described above. In summary, Palette was able to reduce the Day-1 bare-metal deployment licensing costs by up to 28% versus Kubernetes on virtualized servers with a traditional management server approach. Note that this includes Palette's licensing costs.

Why This Matters

Day-1, the deploy phase, is where organizations deploy their chosen clusters into various environments.

Enterprise Strategy Group validated that the Spectro Cloud Palette platform provides the flexibility to deploy to multiple destinations, including private cloud, public cloud, edge device onboarding, and bare metal, as desired.

In addition, Palette was able to reduce the time to do Day-1 deployment activities by **up to 97%** as compared to a management server approach and **up to 99%** compared to a DIY approach, reduce the time to do Day-1 edge deployment activities by **up to 95%** versus DIY or a conventional management server approach, reduce the costs to do Day-1 bare-metal deployment activities by **up to 98%** for deployment with an IaaS provider and by **up to 88%** for deployment without an IaaS provider, and reduce the licensing costs for Day-1 bare-metal deployments by **up to 28%** versus Kubernetes on virtualized servers with a traditional management server approach.

Operate (Day-2) Capabilities

At Day-2, the operate phase, organizations need to focus on what happens once everything is deployed, including how to maintain and scale the Kubernetes infrastructure, onboard new users, ensure the health of applications, and more. In addition, organizations at this phase need to consider governance needs, visibility across deployments, utilization, monitoring across clusters, upgrades, security, configuration drift, backups, restores, etc.

Palette provides native Day-2 operations capabilities, rolling upgrades/patches, declarative enforcement, management of existing (brownfield) clusters and multi-clusters, and RBAC.

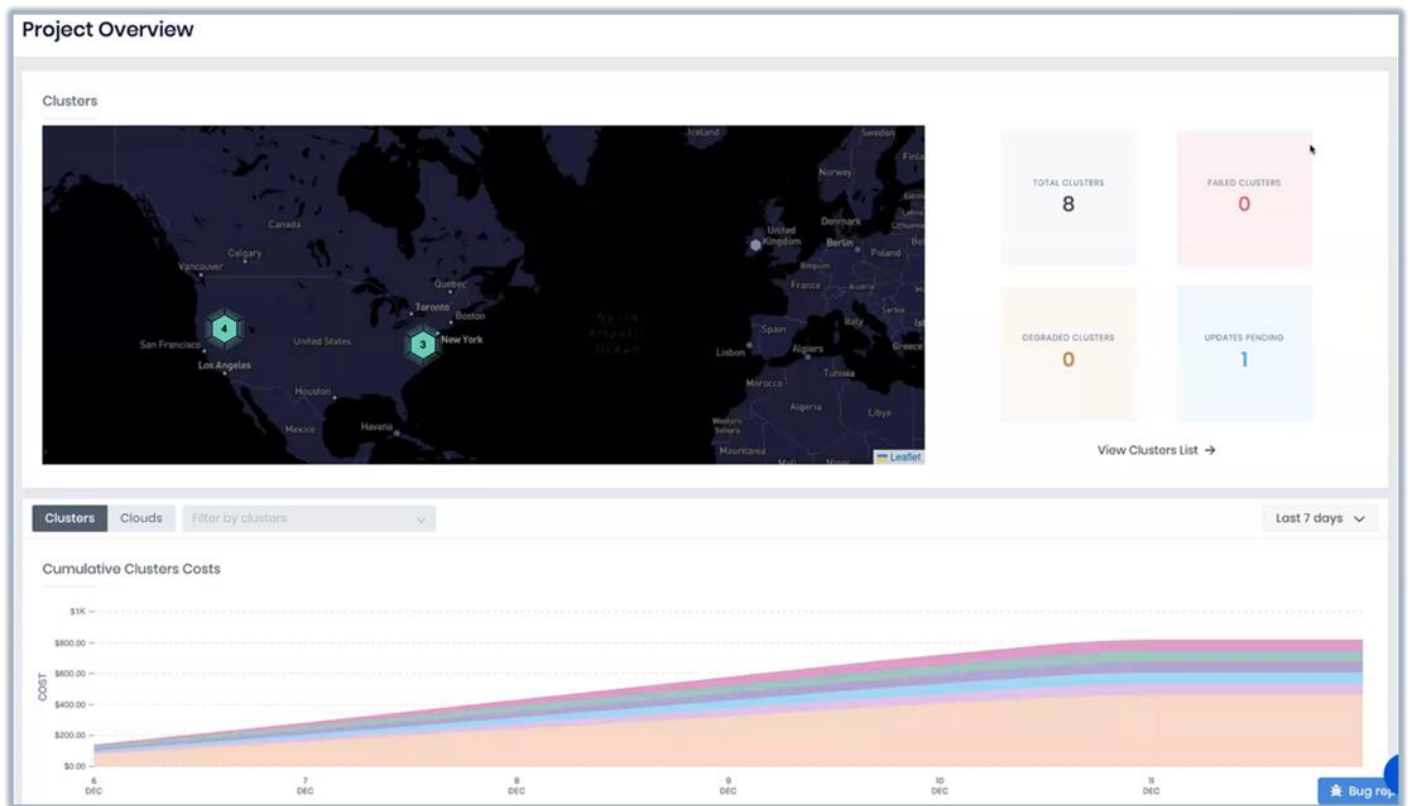
For organizations that have edge locations, Palette makes it easy to scale Kubernetes clusters with Palette Edge. The solution eliminates the need to send a field engineer to remote sites, making it easy for non-technical staff to quickly power up and onboard a new device into a managed cluster using a variety of methods, including scanning a QR code on the edge device itself, using Palette's API, through its interface, or with IaC integration.

All policy enforcement and operations happen locally, independent of the centralized management plane, resulting in no performance impact to the overall architecture. Upgrades can also be performed with zero downtime and easy rollback.

Finally, Palette Edge enables operations teams to build highly secure configurations for edge devices, including their preferred Kubernetes distribution and the underlying OS, which, once deployed, become immutable and tamperproof. This technology is provided by Spectro Cloud's sponsored Kairos.io open source project. Palette Edge features a CNCF-conformant, edge-optimized immutable Kubernetes distribution called Palette eXtended Kubernetes Edge (PXK-E) among others, such as K3s and MicroK8s.

Figure 10 shows the Palette Dashboard Project Overview, which provides visibility into all environments of the various clusters running in a project. The demo project shows eight clusters, including one that has an update. The Dashboard also shows the overall cumulative infrastructure costs (e.g., clusters and clouds) over time. Users also have visibility across the clusters deployed in different locations.

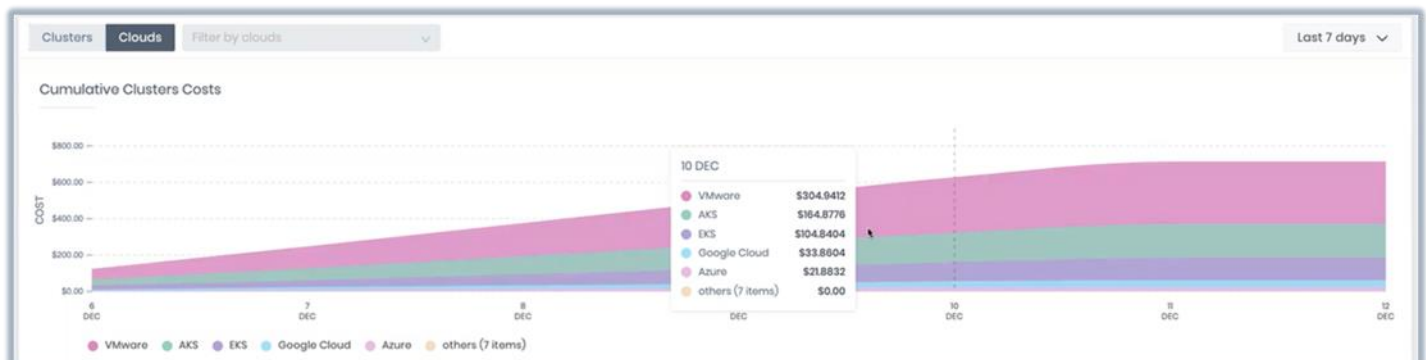
Figure 10. Dashboard Project Overview



Source: Enterprise Strategy Group, a division of TechTarget, Inc.

Figure 11 shows the Cumulative Clusters Costs screen, which displays the estimated costs across public clouds based on the instance types for each of the different nodes that are selected, including CPU, memory, and storage.

Figure 11. Cumulative Clusters Costs



Source: Enterprise Strategy Group, a division of TechTarget, Inc.

For Day-2 activities, Enterprise Strategy Group used the same modeled organization and assumptions as in the Day-0 and Day-1 analyses.

Typical Day-2 activities include updates to operating systems, Kubernetes distributions, applications, integrations, scaling (additional node pools), modifying RBAC, workload visibility, backup and restore, cert-rotations, scans (software bill of materials, penetration testing, security, and conformance), quota control, cost visibility, remote troubleshooting, monitoring, audit logs, Kubernetes distribution migration, and virtual cluster deployment.

As seen in Figure 12, Palette was able to reduce the Day-2 operations and maintenance time by up to 96% versus a conventional solution based on management servers and 97% as compared to a DIY approach. This was due to a significant reduction in the time and effort required for all Day-2 tasks, mainly remote troubleshooting and Kubernetes distribution management tasks.

Figure 12. Day-2 Maintenance—The Operate Phase



Source: Enterprise Strategy Group, a division of TechTarget, Inc.

Why This Matters

Day-2, the operate phase, is where organizations focus on maintaining and scaling their Kubernetes infrastructure, onboarding new users, ensuring the health of applications, governance, visibility across deployments, utilization, monitoring across clusters, upgrades, security, preventing configuration drift, backups, restores, etc.

Enterprise Strategy Group validated that the Spectro Cloud Palette platform manages full stack profiles with two-minute reconciliation loops to eliminate “configuration drift” and allow self-healing. The solution can patch, reconfigure, and upgrade clusters in parallel and can scale without performance degradation to thousands of clusters without the need for management servers. In addition, Palette was able to reduce the time to do Day-2 operations and maintenance activities by **up to 96%** versus a conventional solution based on management servers and by **up to 97%** as compared to a DIY approach.

Conclusion

Kubernetes is the de facto infrastructure building block for modern application development. And organizations that use Kubernetes in production are typically adding more clusters, in more locations, using multiple distributions and integrations. But configuring and running Kubernetes is not easy. Some of the key challenges for these organizations are ecosystem complexity, scale, optionality, governance, security, and support. Spectro Cloud designed Palette to help organizations through each phase of the management lifecycle, from Day-0 to Day-2.

Enterprise Strategy Group modeled and validated the time, effort, and cost to plan, deploy, and maintain Kubernetes to quantify the benefits Spectro Cloud Palette could provide for organizations deploying multiple clusters in cloud, data centers (including bare metal), or at the edge. Our analysis revealed that Palette reduces time, effort, and cost across the entire Kubernetes lifecycle compared to a DIY approach or solutions based on management servers:

- Day-0 activities – **up to 90%** less time and effort than DIY or conventional management server approaches.
- Day-1 activities – **up to 97%** less time and effort compared to a management server approach and **up to 99%** compared to a DIY approach.
- Day-1 edge deployment activities – **up to 95%** less time and effort for all edge deployment tasks.
- Day-1 bare-metal deployment activities – **up to 98%** for deployment with an IaaS provider and by **up to 88%** for deployment without an IaaS provider, along with **up to 28%** less licensing costs versus Kubernetes on virtualized servers with a traditional management server approach.
- Day-2 activities – **up to 96%** time and effort versus a conventional management server and **up to 97%** compared to a DIY approach.

If your organization is looking for a solution to design, deploy, and operate Kubernetes at scale while significantly reducing time, effort, and cost, Enterprise Strategy Group believes Spectro Cloud's Palette is worth serious consideration.

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