Cisco Cloud Infrastructure

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Cisco Cloud Infrastructure: Application, Security, and Data Center Architecture

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Cisco Cloud Infrastructure: Application, Security, and Data Center Architecture

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Warning and Disclaimer

This book is designed to provide information about Cisco Cloud Infrastructure for various Cisco Products, existing Cisco technologies in the "Data Center, Security, and Applications" domain which are available in the On-Prem environment and how the technology has evolved to fit in a Hybrid Cloud model, which facilitates the management and operation of On-Prem deployments and provides integration with Public Cloud. Every effort has been made to make this book as complete and as accurate as possible, but no warranty or fitness is implied.

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Dedications

Avinash Shukla: I would like to dedicate this book to my lil' baby girl Avira who was born during the time of writing the book, my son Aryav, my nieces Riddhi and Siddhi, my lovely wife Neelima, my sister Anubha, and my parents Kanak and Anil, for their unconditional love and support. Without their support, none of this would have been possible. I would also like to dedicate this book to one of my earliest inspirations while growing up, my beloved Bade Papa, Aravind Kumar Shukla (RIP). Lastly, I would like to thank everyone in my big extended family for their motivation and encouragement. All of you have inspired me in many ways and helped me in my professional endeavors.

Jalpa Patel: I would like to dedicate this book to my parents, Minaxi and Babubhai Patel, for their blessings and faith in me; and to Jigisha, Falguni, and Harish, for their guidance and encouragement. I also would like to dedicate this book to my brother, Hardik, and his wife, Dharmistha, who have been a great support to me throughout the complete process of writing of this book. Finally, thank you to Raj and Samaira for their love and inspiration.

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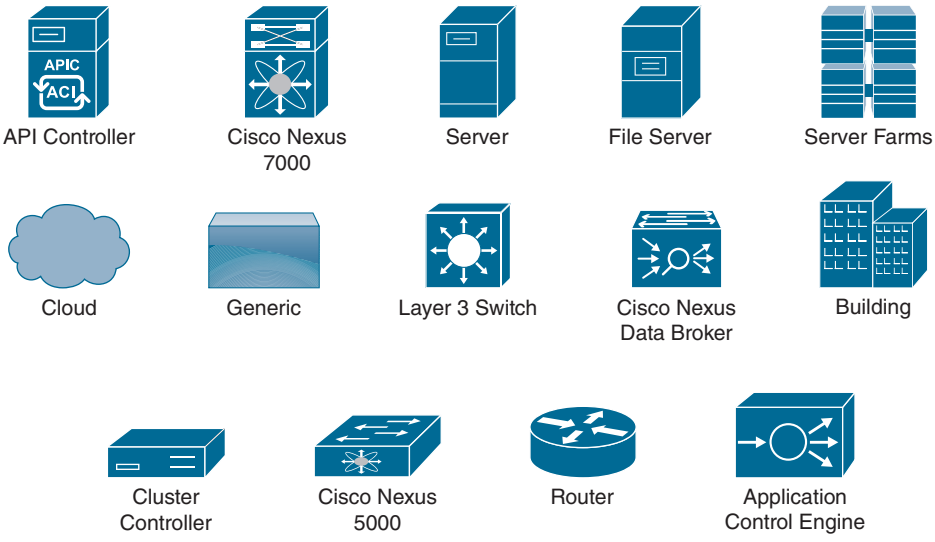

Command Syntax Conventions

The conventions used to present command syntax in this book are the same conventions used in Cisco's Command Reference. The Command Reference describes these conventions as follows:

- **Boldface** indicates commands and keywords that are entered literally as shown. In actual configuration examples and output (not general command syntax), boldface indicates commands that are manually input by the user (such as a **show** command).
- *Italics* indicate arguments for which you supply actual values.
- Vertical bars (|) separate alternative, mutually exclusive elements.
- Square brackets [ ] indicate optional elements.
- Braces { } indicate a required choice.
- Braces within brackets [{ }] indicate a required choice within an optional element.

Note This book covers multiple operating systems, and a differentiation of icons and router names indicates the appropriate OS that is being referenced. IOS and IOS XE use router names like **R1** and **R2** and are referenced by the IOS router icon. IOS XR routers will use router names like **XR1** and **XR2** are referenced by the IOS XR router icon.

Introduction

Almost every company is adopting hybrid cloud solutions as it provides decreased hosting costs, agility and scalability, and faster deployment ability and security. Using a hybrid cloud might be an investment upfront, but it will provide plenty of cost saving benefits down the road. For example, businesses that use public cloud without a hybrid might have a difficult and expensive time migrating information if they decide to make changes to their internal systems. Furthermore, because a hybrid cloud is scalable, it makes handling changes in business goals cheaper down the line. Only hybrid cloud technology can provide a blend of benefits that come from public and private servers. With a hybrid cloud, for instance, you can enjoy the scalability of a public cloud environment without forfeiting all control to a third party. In fact, with every hybrid cloud situation being different, a unique solution will have to be applied to each hybrid system in order to fulfill specific requirements. Because a hybrid cloud is designed around your organization's needs, it can be optimized with speed in mind. For example, because this system isn't entirely public, your IT staff will be able to minimize latency, which will make data transfers quicker and easier. The overall level of customization available for hybrid cloud also ensures your organization is agile enough to handle the needs of customers or clients. Not only does it connect old systems to new ones, but the hybrid cloud also allows businesses to create an overarching structure that meets the unique needs of a specific enterprise.

As we see an increasing trend in deployment of hybrid cloud with on-prem solutions, the book will be useful to both small-scale customers and large-scale data centers. It can be considered as one book for all who deal with Cisco Cloud Solutions on a daily basis. External references are provided wherever applicable, but readers are expected to be familiar with cloud-specific technologies, infrastructure concepts, networking connectivity, and security policies of the customer installation. Readers can gain knowledge about the benefits of cloud solutions, how to manage, operate, and integrate existing infrastructure in a hybrid/multicloud environment with minimum changes and leverage insights from the cloud for their business decisions.

Cisco doesn't have a public cloud offering like AWS but has many products that complement and facilitate cloud integration and use of hybrid cloud. The attempt of this book is to fill the gap where a user can find a one-stop book that details all such products and architecture and provides insights on how they can co-exist in a hybrid cloud environment.

The book helps IT professionals, CIOs, and IT managers in their decision to move into a hybrid cloud deployment vs. an on-prem deployment. It describes in detail and from a technical and business aspect the possible solutions and offerings from Cisco. The book also describes products such as the Cisco Nexus Dashboard, which facilitate the orchestration and insights about your deployment.

Last but not least, the book covers best practices and guidelines to make readers aware of known caveats prior to specific deployment, the do's and don'ts while designing complex hybrid cloud networks, how and why to design in a certain way for maximum efficiency.

Goals and Methods

CIOs and IT professionals who want to simplify their IT and networking environment are now challenged with the decision of whether to move fully into the cloud, build their own data centers, or go with hybrid solution. Making such decisions depends on a lot of factors that include the scale and complexity of their existing setup, the level of control over their own resources, security, availability of IT and networking resources, level of expertise, overall fixed and recurring costs, and so on.

As cloud is a new buzzword in industry and multiple vendors are introducing products that offer various infrastructure solutions and are challenging the existing network design, all the new technologies are getting confusing to IT professionals who are trying to move into next-generation architectures while maintaining a current setup that is generating revenue. This book will walk the reader through and provide a reference guide to understand and independently implement cloud solutions for Cisco Network, Compute, Storage, Application, and Security.

In this book we are covering Cisco Cloud Infrastructure for various Cisco Products. This book will cover existing Cisco technologies in the "Data Center, Security, and Applications" domain that are available in the on-prem environment and how the technology has evolved to fit in a hybrid cloud model that facilitates the management and operation of on-prem deployments and provides integration with public cloud. This gives you the tools to ask the right questions when you embark on the transformation of your data center into private and hybrid clouds.

Who Should Read This Book?

We see an increase in hybrid cloud adoption, which requires planning, designing, and execution strategy of on-prem and public cloud setups. In general IT professionals are divided in their areas of expertise. Individuals are spread into focus areas that overlap:

- Orchestration
- Analytics
- Cloud integration
- Virtualization
- Storage networking
- Security
- Software applications
- Automation
- DevOPs

Cisco is taking a network-centric approach to multi-cloud and hybrid deployments. Cisco has partnerships with Azure and AWS and has expanded a relationship with Google Cloud. Add in AppDynamics, which specializes in application and container management, and Cisco has the various parts to address hybrid and multi-cloud deployments. In addition, Cisco is a key hyper-converged infrastructure player and its servers and networking gear are staples in data centers. The audience of this book is the sum of all solution architects, deployment engineers, systems engineers, networking engineers, software virtualization engineers, network management engineers, sales engineers, field consultants, professional services, partner engineering, customers deploying the Cisco Cloud Solutions, and anyone who would like to know about Cisco's presence in cloud space. Also as the book touches on the business aspects of pros and cons of moving from private clouds to public clouds, IT managers and CIOs will benefit from understanding the impact of cloud solutions on the transformation of their data centers and the speed of deploying highly available applications.

How This Book Is Organized

For those who are familiar with the authors' writing style from previous books such as "Implementing Cisco HyperFlex Solutions," the authors put a big emphasis on easy reading and making the difficult look easy. The book goes through a smooth progression of the topics and a lot of the basic concepts are laid out in advance so you do not miss a beat and feel comfortable progressing through the chapters. It is recommended to go through the chapters in order to get the full benefit of the book.

Orchestration, analytics, management, security, and automation are not easy topics and are getting more complex every day. Boundaries between system administrators, networking engineers, and software engineers are getting blurred day by day and expectations are increasing to be an expert in all dimensions by a single individual.

The authors have put a lot of effort into putting you on the right track and giving you the launch pad into tackling cloud infrastructure. Their many years of experience in both the vendor and system integration track and across the different technology areas make this difficult topic sound simple. The advantages you see from this book follow:

- An easy reading style with no marketing fluff or heavy technical jargon
- Progression through the chapters from easy to advanced
- Comprehensive coverage of the topic at both a technical and business level
- First book to address Cisco cloud solutions in detail under one umbrella to bridge the technology gap between the different IT departments
- Beneficial to IT professionals trying to evaluate whether to move into the hybrid cloud solution

- Beneficial to IT management, CIO, and CTO evaluating various cloud applications
- Coverage of the latest cloud offerings by Cisco
- Discusses Automation and Orchestration solutions
- Compares and contrasts different implementations objectively and with vendor neutrality

Book Structure

The book is organized into three parts.

PART 1—Cisco Data Center Networking and Infrastructure

Chapter 1—Cisco Data Center Orchestration: This chapter talks about Cisco's data center orchestration software that uses the automation of tasks to implement processes, such as deploying new servers. Automation solutions that orchestrate data center operations enable an agile DevOps approach for continual improvements to applications running in the data center. Data center orchestration systems automate the configuration of L2-L7 network services, compute and storage for physical, virtual, and hybrid networks. New applications can be quickly deployed.

Chapter 2—Cisco Data Center Analytics and Insights: This chapter talks about Cisco's API-driven monitoring and assurance solutions that provide essential insights as well as add to an expansive and increasingly onerous toolset. These network insight solutions are bringing the ability to see the big picture, and if something goes wrong, they show exactly where to look instead of poking around and hoping to get lucky. This helps prepare companies to progressively transition from reactive to proactive and eventually predictive IT operations.

Chapter 3—Cisco Data Center Solutions for Hybrid Cloud: This chapter talks about the various hybrid cloud management platforms like ACI, UCS Director, CWOM, and Intersight that are provided by Cisco and offer flexible consumption for on-premises infrastructure in order to optimize workloads across clouds, on-premises data centers, labs, and co-location facilities for scale, performance, and agility with great value.

PART 2—Cisco Applications and Workload Management

Chapter 4—Application, Analytics, and Workload Performance Management with AppDynamics: This chapter describes Cisco's AppDynamics solution, cloud migration, and various monitoring such as Application Security Monitoring, End User monitoring and Browser monitoring. It also covers database and infrastructure visibility and cloud platforms.

Chapter 5—Management: This chapter describes the challenges that the IT teams face in managing the modern workloads and gives you various systematic Workload Management Solutions such as Intersight Workload Optimization Manager, Cisco Container Platform, and Cisco Intersight Kubernetes Service (IKS).

Chapter 6—Cisco Cloud Webex Applications: Collaboration is a key component of any IT solution and Cisco Webex provides an ideal platform for staying connected and collaborating with individuals, teams, and meetings to move projects forward faster. This chapter describes Cisco Webex Features and Cisco Webex Cloud Service Architecture in detail.

Chapter 7—Internet of Things (IoT): This chapter describes how well we can combine the Operational Technology hardware with IT and come up with amazing IoT solutions, which Cisco currently offers. These solutions can really help you get the best insights and increase efficiency.

PART 3—Cisco Cloud Security

Chapter 8— Cisco Cloud Security: This chapter talks about all the Cisco Cloud Security solutions like Cloudlock, Umbrella, Cloud Analytics, and Duo using which one can adopt the cloud with confidence and protect users, data, and applications, anywhere they are. Unlike traditional perimeter solutions, Cisco Cloud Security blocks threats over all ports and protocols for comprehensive coverage. Cisco Cloud Security also uses API-based integrations so that the existing security investments can be amplified.

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Chapter 5

Management

Cisco has been working for over three years to bring the industry-leading Application Resource Management (ARM) capability to Cisco customers. It started with Cisco Workload Optimization Manager (CWOM). CWOM is powered by Turbonomic, and it enables Cisco customers to continuously resource applications to perform at the lowest cost while adhering to policies irrespective of where the application is hosted (that is, on the premises or in the cloud, containers, or VMs). In January 2020, Cisco announced Intersight Workload Optimizer (IWO), which is the integration of CWOM and Intersight. With IWO, application and infrastructure teams can now speak the same language to ensure that applications are automatically and continuously resourced to perform.

Alongside the Intersight Workload Optimizer, Cisco offers Intersight Kubernetes Service (IKS), which is a fully curated, lightweight container management platform for delivering multicloud production-grade upstream Kubernetes. It simplifies the process of provisioning, securing, scaling, and managing virtualized Kubernetes clusters by providing end-to-end automation, including the integration of networking, load balancers, native dashboards, and storage provider interfaces.

This chapter will cover the following topics:

- IT challenges and workload management solutions
- Intersight Workload Optimization Manager
- Cisco Container Platform
- Cisco Intersight Kubernetes Service

IT Challenges and Workload Management Solutions

Managing application resources in a dynamic, hybrid cloud world is increasingly complex, and IT teams are struggling. With application components running on the premises and in public clouds, end users can suffer outages or experience slow application performance because IT teams simply lack visibility to see how things are connected and how to manage their dynamic environment at scale.

With more people accessing your business through a digital experience, application performance is more critical than ever. Managing workload placement and resources across your ever-changing IT environment is a complex, time-consuming task that has big implications on user experience and costs.

Cisco Intersight Workload Optimizer (CWOM) discovers how all the parts of your hybrid world are connected and then automates these day-to-day operations for you. Supporting more than 50 common platforms and public clouds, it provides real-time, full-stack visibility across your applications and infrastructure. Now you can harness the power of data to continuously monitor supply and demand, match workloads and resources in the most efficient way, and ensure that governance rules are always enforced. The result? Better application performance, reduced cost, faster troubleshooting, and more peace of mind.

Business Impact

Unchecked complexity can result in the following:

- **Underutilized on-premises infrastructure:** To ensure application performance, IT teams often allocate resources modeled to peak-load estimates and/or set conservative utilization limits.
- **Public cloud overprovisioning and cost overruns:** When planning and placing workloads in public clouds, IT teams routinely overprovision computing instance sizes as a hedge to ensure application performance.
- **Wasted time:** IT teams end up chasing alerts and meeting in war rooms to unravel problems instead of supporting innovation.

Figure 5-1 illustrates why managing hybrid cloud resources to ensure application performance and control costs is a complex problem.

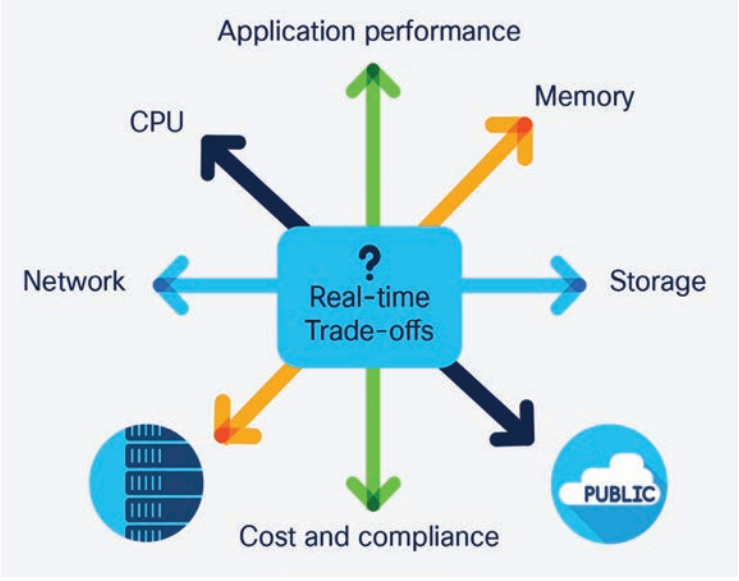

Figure 5-1 *Hybrid cloud resources for ensuring performance and cost*

The following are some of the challenges of workload management in a hybrid cloud:

- Siloed teams with different toolsets managing different layers of the stack and multiple types of resources
- Flying blind without a unified view of the complex interdependencies between layers of infrastructure and applications across on-premises and public cloud environments
- Separating the signal from the noise and prioritizing the constant flow of alerts coming from separate tools
- Lack of visibility into underutilized capacity in public clouds and cost overruns from unmanaged spikes in utilization

To deal with all this complexity, the only choice is to automate resource management and workload placement operations. But how? To optimize effectively, you need a way to collect and track streams of telemetry data from dozens, hundreds, perhaps thousands of sources. You need a way to correlate and continuously analyze all of this data to understand how everything fits together and what's important, as well as how to decide what to do from moment to moment as things continue to change. New tooling is required to connect all the dots and give you the insight you need to stay ahead of demand, stay ahead of problems, and respond to new projects with confidence. What if you could create a unified view of your environment and continuously ensure that applications get the resources they need to perform, all while increasing efficiency and lowering costs?

Cisco Intersight Workload Optimizer

Cisco Intersight Workload Optimizer is a real-time decision engine that ensures the health of applications across your on-premises and public cloud environments while lowering costs. The intelligent software continuously analyzes workload demand, resource consumption, resource costs, and policy constraints to determine an optimal balance. Cisco IWO is an artificial intelligence for IT operations (AIOps) toolset that makes recommendations for operators and can trigger workload placement and resource allocations in your data center and the public cloud, thus fully automating real-time optimization.

With Cisco IWO, infrastructure and operations teams are armed with visibility, insights, and actions that ensure service level agreements (SLAs) are met while improving the bottom line. Also, application and DevOps teams get comprehensive situational awareness so they can deliver high-performing and continuously available applications.

Benefits of using Cisco Intersight Workload Optimizer:

- Radically simplify application resource management with a single tool that dynamically optimizes resources in real time to ensure application performance.
- Continuously optimize critical IT resources, resulting in more efficient use of existing infrastructure and lower operational costs on the premises and in the cloud.
- Take the guesswork out of planning for the future with the ability to quickly model what-if scenarios based on the real-time environment.

Figure 5-2 illustrates how IWO ensures application performance with continuous visibility, deep insights, and informed actions.

Figure 5-2 *Application performance with continuous visibility, deep insights, and informed actions*

CWOM-to-IWO Migration

In June 2019, Turbonomic and CWOM became inaugural members of the Integration Partner Program (IPP), which takes the technology partnership to another level by helping joint customers maximize the value of their AppDynamics and CWOM investment. The extended integration and partnership delivers on the vision of AIOps, where software is making dynamic resourcing decisions and automating actions to ensure that applications are always performing, enabling positive business outcomes and improved user experiences. Organizations across the world are investing heavily in developing new applications and innovating faster to deliver better, more simplified user experiences. The partnership and the combination of AppDynamics and CWOM ensure that applications are architected and written well and are continuously resourced for performance.

As a full-stack, real-time decision engine, Intersight Workload Optimizer revolutionizes how teams manage application resources across their multicloud landscape, significantly simplifying operations. It delivers unprecedented levels of visibility, insights, and automated actions, as customers look to prevent application performance issues.

Figure 5-3 provides a very high-level view of IWO application management.

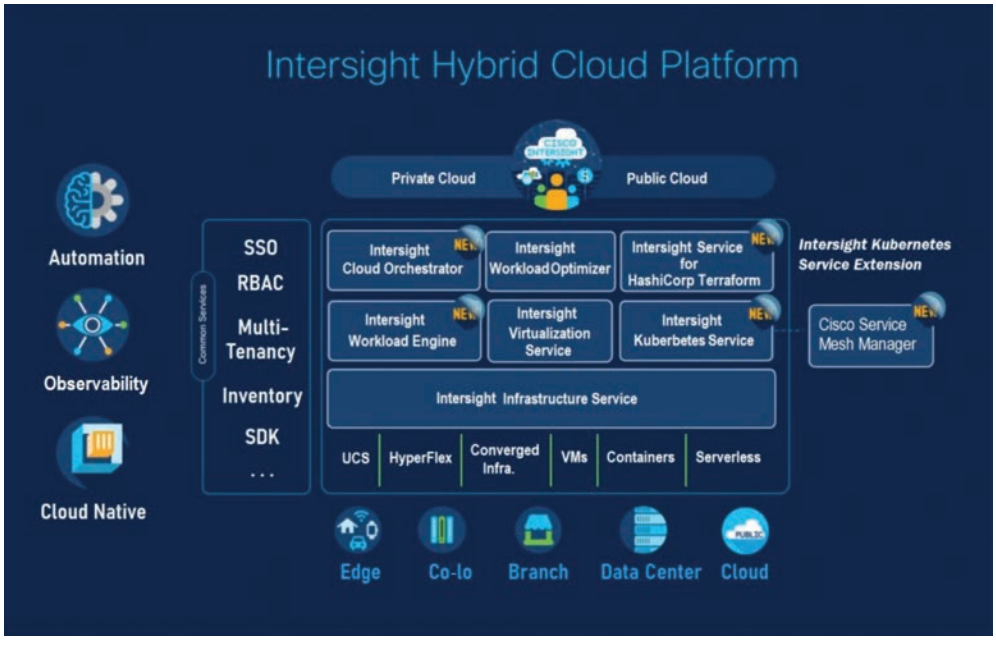

Figure 5-3 *Very high-level view of IWO application management*

Simply put, IWO provides the following customer benefits:

- It bridges the gap between application and IT teams to ensure application performance.

- It eliminates application resourcing as a source of application delay, meaning applications can perform and continuously deliver services.
- It helps IT departments stop overspending and delivers a modern application hosting platform to end users.
- It enables high-value application and IT teams to focus on strategy and innovation without jeopardizing applications.

IWO expands Intersight capabilities. All in one place, Intersight customers can manage the health of the infrastructure and how well that infrastructure is utilized to ensure application performance. Additionally, Intersight customers can monitor and manage application resources on third-party infrastructure, public cloud, and container environments.

Optimize Hybrid Cloud Infrastructure with IWO

Application resource management is a top-down, application-driven approach that continuously analyzes applications' resource needs and generates fully automatable actions to ensure applications always get what they need to perform. It runs 24/7/365 and scales with the largest, most complex environments.

To perform application resource management, Intersight Workload Optimizer represents your environment holistically as a supply chain of resource buyers and sellers, all working together to meet application demand. By empowering buyers (VMs, instances, containers, and services) with a budget to seek the resources that applications need to perform and empowering sellers to price their available resources (CPU, memory, storage, network) based on utilization in real time, IWO keeps your environment within the desired state, with operating conditions that achieve the following conflicting goals at the same time:

- **Ensured application performance:** Prevent bottlenecks, upsize containers/VMs, prioritize workload, and reduce storage latency
- **Efficient use of resources:** Consolidate workloads to reduce infrastructure usage to the minimum, downsize containers, prevent sprawl, and use the most economical cloud offerings

IWO is a containerized, microservices-architected application running in a Kubernetes environment (or within a VM) on your network or a public cloud VPC (Virtual Private Cloud). You assign services running on your network to be IWO targets. IWO discovers the entities (physical devices, virtual components, and software components) that each target manages and then performs analysis, anticipates risks to performance or efficiency, and recommends actions you can take to avoid problems before they occur.

Intelligent, proactive workload optimization simplifies and automates operations. With many tools, the focus is on monitoring and alerting users after a problem has occurred. Cisco IWO is a proactive tool that is designed to avoid application performance issues in the first place. It continuously analyzes workload performance, costs, and compliance

rules and makes recommendations on what specific actions to take to avoid issues before they happen, thus radically simplifying and improving day-to-day operations.

While some tools provide visibility into applications or visibility into an individual tier of physical or virtual infrastructure, Cisco IWO bridges all these layers with a single tool. It creates a dynamic dependency graph that visualizes the connections between application elements and infrastructure throughout the layers of the stack, all the way down to component resources within servers, networking, and storage. Figure 5-4 shows how Cisco IWO analyzes telemetry data across your hybrid cloud environment to optimize resources and reduce cost.

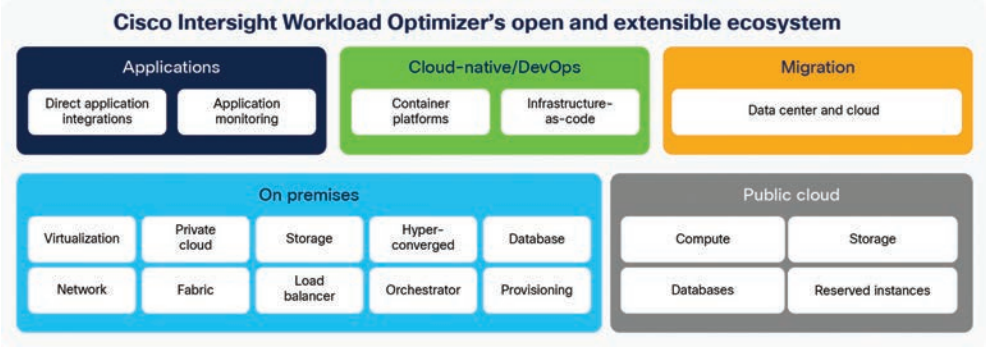

Figure 5-4 *Cisco IWO analyzes telemetry data across your hybrid cloud environment to optimize resources and reduce cost*

Cisco IWO can optimize workloads in any infrastructure, any environment, and any cloud, and it works with the industry's top platforms, including VMware vSphere, Microsoft Hyper-V, Citrix XenServer, and OpenStack. It automatically manages compute, storage, and network resources across these platforms, both on the premises and in the cloud. It analyzes telemetry data from a broad ecosystem of data center and cloud technologies, with agentless support for over 50 targets across a range of hypervisors, compute platforms (including Cisco UCS and HyperFlex), container platforms, public clouds, and more. Cisco IWO correlates these telemetry sources into a holistic view to deliver intelligent recommendations and trigger actions, including where to place workloads and how to size and scale resources.

Cisco Intersight is a cloud operations platform that delivers intelligent visualization, optimization, and orchestration for applications and infrastructure across public cloud and on-premises environments. It provides an essential control point for customers to get more value from hybrid cloud investments.

The Cisco IWO service extends these capabilities with hybrid cloud application resource management and support for a broad third-party ecosystem. With this powerful solution, you can have confidence that your applications have continuous access to the IT resources they need to perform, at the lowest cost, whether they reside on the premises or in a public cloud.

The combination of Cisco IWO and AppDynamics can break down siloes between IT teams. This integration provides a single source of truth for application and infrastructure teams to work together more effectively, avoiding finger pointing and late-night war rooms.

AppDynamics discovers and maps your business application topology and how it uses IT resources. Cisco IWO correlates this data with your infrastructure stacks to create a dynamic dependency graph of your hybrid IT environment. It analyzes supply and demand and drives workload placement and resource allocation actions in your IT environment to help ensure that application components get the computing, storage, and network resources they need. Together, these intelligent tools replace sizing guesswork with real-time analytics and modeling so that you know how much infrastructure is needed to allow your applications and business to keep pace with demand.

If you have workloads running on the premises and in public clouds, your IT teams need to make complex, on-going decisions about where to locate workloads and how to size resources in order to ensure performance and minimize cost.

Figuring out what workloads should run where is nearly impossible if you lack clear visibility into available resources and associated costs. And for workloads that run in the cloud, how do you determine what cloud instance or tier is the best fit at the lowest cost? Cloud costs can become volatile, and you can get lost in a myriad of sizing, placement, and pricing decisions that can have very expensive consequences. Cisco IWO can help in the following ways:

- Manage resource allocation and workload placement in all your infrastructure environments, giving you full-stack visibility in a single pane of glass for supply and demand across your combined on-premises and cloud estate.
- Optimize cloud costs with automated selection of instances, reserved instances (RIs), relational databases, and storage tiers based on workload consumption and optimal costs.
- Dynamically scale, delete, and purchase the right cloud resources to ensure performance at the lowest cost.
- Extend on-premises resources by continuously optimizing workload placement and cutting overprovisioning based on utilization trends.
- De-risk migrations to and from the cloud with a data-driven scenario modeling engine.

In increasingly competitive markets, more organizations are adopting containerized deployment options to deliver business-differentiating applications quickly. Kubernetes has become the de facto standard for container orchestration and helps to build, deliver, and scale applications faster. For IT teams, Kubernetes has introduced new layers of complexity with interdependencies and fluctuating demand that make it nearly impossible to effectively manage modern IT at scale.

Cisco IWO simplifies Kubernetes deployments and optimizes performance and cost in real time for on-going operations in the following ways:

- **Container rightsizing:** Scale container limits/requests up or down based on application demand.
- **Pod "move"/rescheduling:** Reschedule pods while maintaining service availability to avoid resource fragmentation and/or contention on the node.
- **Cluster scaling:** When Cisco IWO sees that pods have too little (or too much) capacity in a cluster, it will give the recommendation to spin up another node (or to suspend nodes).
- **Container planning:** Model what-if scenarios based on your real-time environment. With a few clicks, you can determine how much headroom you have in your clusters or simulate adding or removing Kubernetes pods.

How Intersight Workload Optimizer Works

To keep your infrastructure in the desired state, IWO performs application resource management. This is an ongoing process that solves the problem of ensuring application performance while simultaneously achieving the most efficient use of resources and respecting environment constraints to comply to business rules. This is not a simple problem to solve. Application resource management has to consider many different resources and how they are used in relation to each other, in addition to numerous control points for each resource. As you grow your infrastructure, the factors for each decision increase exponentially. On top of that, the environment is constantly changing—to stay in the desired state, you are constantly trying to hit a moving target. To perform application resource management, IWO models the environment as a market made up of buyers and sellers. These buyers and sellers make up a supply chain that represents tiers of entities in your inventory. This supply chain represents the flow of resources from the data center, through the physical tiers of your environment, into the virtual tier and out to the cloud. By managing relationships between these buyers and sellers, IWO provides closed-loop management of resources, from the data center through to the application.

IWO uses virtual currency to give a budget to buyers and assign cost to resources. This virtual currency assigns value across all tiers of your environment, making it possible to compare the cost of application transactions with the cost of space on a disk or physical space in a data center. The price that a seller charges for a resource changes according to the seller's supply. As demand increases, prices increase. As prices change, buyers and sellers react. Buyers are free to look for other sellers that offer a better price, and sellers can duplicate themselves (open new storefronts) to meet increasing demand. IWO uses its Economic Scheduling Engine to analyze the market and make these decisions. The effect is an invisible hand that dynamically guides your IT infrastructure to the optimal use of resources. To get the most out of IWO, you should understand how it models your environment, the kind of analysis it performs, and the desired state it works to achieve. Figure 5-5 illustrates the desired state graph for infrastructure management.

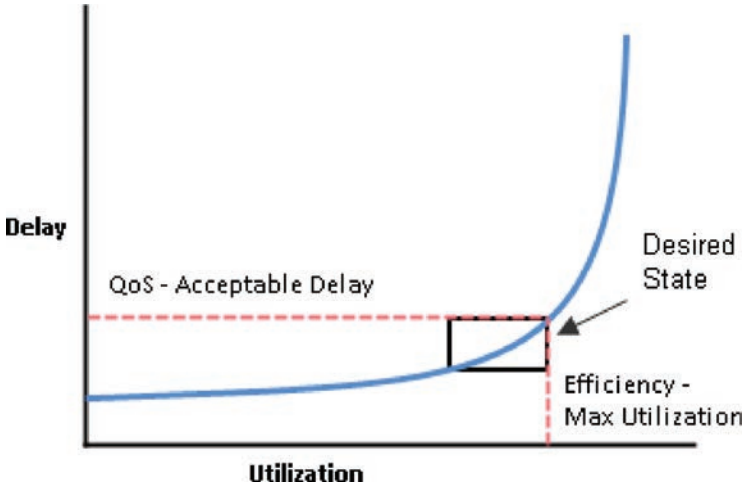

Figure 5-5 *Desired state graph for infrastructure management*

The goal of application resource management is to ensure performance while maintaining efficient use of resources. When performance and efficiency are both maintained, the environment is in the desired state. You can measure performance as a function of delay, where zero delay gives the ideal quality of service (QoS) for a given service. Efficient use of resources is a function of utilization, where 100% utilization of a resource is the ideal for the most efficient utilization.

If you plot delay and utilization, the result is a curve that shows a correlation between utilization and delay. Up to a point, as you increase utilization, the increase in delay is slight. There comes a point on the curve where a slight increase in utilization results in an unacceptable increase in delay. On the other hand, there is a point in the curve where a reduction in utilization doesn't yield a meaningful increase in QoS. The desired state lies within these points on the curve.

You could set a threshold to post an alert whenever the upper limit is crossed. In that case, you would never react to a problem until delay has already become unacceptable. To avoid that late reaction, you could set the threshold to post an alert before the upper limit is crossed. In that case, you guarantee QoS at the cost of over-provisioning—you increase operating costs and never achieve efficient utilization.

Instead of responding after a threshold is crossed, IWO analyzes the operating conditions and constantly recommends actions to keep the entire environment within the desired state. If you execute these actions (or let IWO execute them for you), the environment will maintain operating conditions that ensure performance for your customers, while ensuring the lowest possible cost thanks to efficient utilization of your resources.

Understanding the Market and Virtual Currency

To perform application resource management, IWO models the environment as a market and then uses market analysis to manage resource supply and demand. For example,

bottlenecks form when local workload demand exceeds the local capacity—in other words, when demand exceeds supply. By modeling the environment as a market, IWO can use economic solutions to efficiently redistribute the demand or increase the supply.

IWO uses two sets of abstraction to model the environment:

- **Modeling the physical and virtual IT stack as a service supply chain:** The supply chain models your environment as a set of managed entities. These include applications, VMs, hosts, storage, containers, availability zones (cloud), and data centers. Every entity is a buyer, a seller, or both. A host machine buys physical space, power, and cooling from a data center. The host sells resources such as CPU cycles and memory to VMs. In turn, VMs buy host services and then sell their resources (VMem and VCPU) to containers, which then sell resources to applications.
- **Using virtual currency to represent delay or QoS degradation, and to manage the supply and demand of services along the modeled supply chain:** The system uses virtual currency to value these buy/sell transactions. Each managed entity has a running budget. The entity adds to its budget by providing resources to consumers, and the entity draws from its budget to pay for the resources it consumes. The price of a resource is driven by its utilization—the more demand for a resource, the higher its price.

Figure 5-6 illustrates the IWO abstraction model.

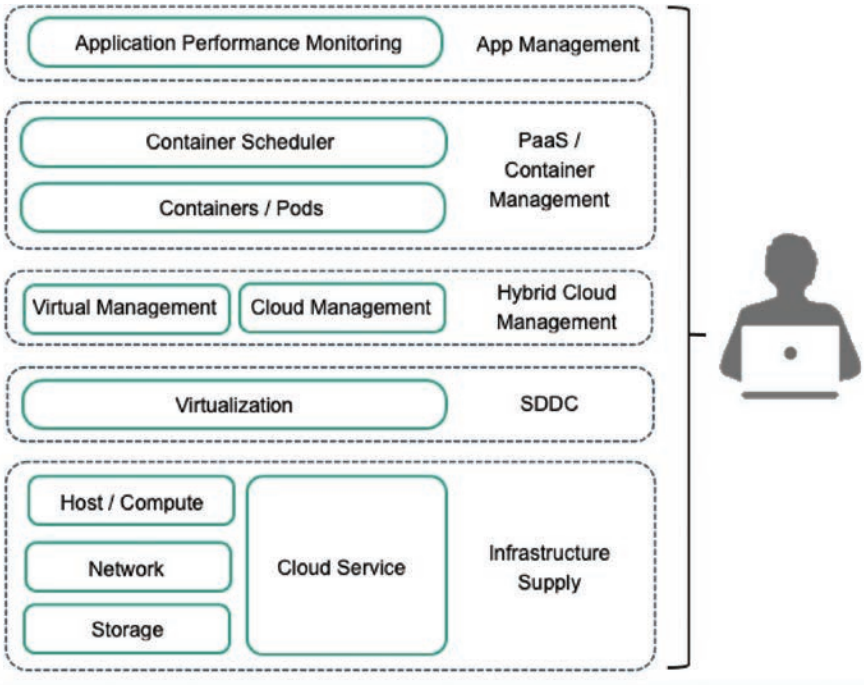

Figure 5-6 *IWO abstraction model*

These abstractions open the whole spectrum of the environment to a single mode of analysis—market analysis. Resources and services can be priced to reflect changes in supply and demand, and pricing can drive resource allocation decisions. For example, a bottleneck (excess demand over supply) results in rising prices for the given resource. Applications competing for the same resource can lower their costs by shifting their workloads to other resource suppliers. As a result, utilization for that resource evens out across the environment and the bottleneck is resolved.

Risk Index

Intersight Workload Optimizer tracks prices for resources in terms of the Risk Index (RI). The higher this index for a resource, the more heavily the resource is utilized, the greater the delay for consumers of that resource, and the greater the risk to your QoS. IWO constantly works to keep the RI within acceptable bounds.

You can think of the RI as the cost for a resource, and IWO works to keep the cost at a competitive level. This is not simply a matter of responding to threshold conditions. IWO analyzes the full range of buyer/seller relationships, and each buyer constantly seeks out the most economical transaction available.

This last point is crucial to understanding IWO. The virtual environment is dynamic, with constant changes to workload that correspond with the varying requests your customers make of your applications and services. By examining each buyer/seller relationship, IWO arrives at the optimal workload distribution for the current state of the environment. In this way, it constantly drives your environment toward the desired state.

Understanding Intersight Workload Optimizer Supply Chain

Intersight Workload Optimizer models your environment as a market of buyers and sellers. It discovers different types of entities in your environment via the targets you have added, and it then maps these entities to the supply chain to manage the workloads they support. For example, for a hypervisor target, IWO discovers VMs, the hosts and datastores that provide resources to the VMs, and the applications that use VM resources. For a Kubernetes target, it discovers services, namespaces, containers, container pods, and nodes. The entities in your environment form a chain of supply and demand, where some entities provide resources while others consume the supplied resources. IWO stitches these entities together, for example, by connecting the discovered Kubernetes nodes with the discovered VMs in vCenter.

Supply Chain Terminology

Cisco introduces specific terms to express IT resources and utilization in relation to supply and demand. The terms shown in Table 5-1 are largely intuitive, but you should understand how they relate to the issues and activities that are common for IT management.

Table 5-1 *The Supply Chain Terminologies Used in IWO*

Term	Definition
Commodity	This is the basic building block of IWO supply and demand. All the resources that IWO monitors are commodities. For example, the CPU capacity and memory that a host can provide are commodities. IWO can also represent clusters and segments as commodities. When the user interface (UI) shows "commodities," it's showing the resources a service provides. When the interface shows "commodities bought," it's showing what that service consumes.
Composed of	This refers to the resources or commodities that make up the given service. For example, in the UI you might see that a certain VM is *composed of* commodities, such as one or more physical CPUs, an Ethernet interface, and physical memory. Contrast "composed of" with "consumes," where consumption refers to the commodities the VM has bought. Also contrast "composed of" with the commodities a service offers for sale. A host might include four CPUs in its composition, but it offers CPU cycles as a single commodity.
Consumes	This refers to the services and commodities a service has bought. A service *consumes* other commodities. For example, a VM consumes the commodities offered by a host, and an application consumes commodities from one or more VMs. In the UI, you can explore the services that provide the commodities the current service consumes.
Entity	This refers to a buyer or seller in the market. For example, a VM or a datastores is an entity.
Environment	This refers to the totality of data center, network, host, storage, VM, and application resources that you are monitoring.
Inventory	This is the list of all entities in your environment.
Risk Index	This is a measure of the risk to quality of service (QoS) that a consumer will experience. The higher the Risk Index (RI) on a provider, the more risk to QoS for any consumer of that provider's services. For example, a host provides resources to one or more VMs. The higher the RI on the provider, the more likely that the VMs will experience QoS degradation. In most cases, for optimal operation, the RI on a provider should not go into double digits.

Working with Intersight Workload Optimizer

The public cloud provides compute, storage, and other resources on demand. By adding an AWS Billing Target (AWS) or Microsoft Enterprise Agreement (Azure) to use custom pricing and discover reserved instances, you enable IWO to use that richer pricing information to calculate workload size and RI coverage for your Azure environment. You can run all of your infrastructure on a public cloud, or you can set up a hybrid environment where you burst workload to the public cloud as needed. IWO can analyze the performance of applications running on the public cloud and then provision more instances as demand requires. For a hybrid environment, IWO can provision copies of your application VMs on the public cloud to satisfy spikes in demand, and as demand falls off, it can suspend those VMs if they're no longer needed. With public cloud targets, you can use IWO to perform the following tasks:

- Scale VMs and databases
- Change storage tiers
- Purchase VM reservations
- Locate the most efficient workload placement within the hybrid environment while ensuring performance
- Detect unused storage volumes

Claiming AWS Targets

For IWO to manage an AWS account, you provide the credentials via the Access Key that you use to access that account. (For information about getting an Access Key for an AWS account, see the Amazon Web Services documentation.)

To add an AWS target, specify the following:

- **Custom Target Name**: The display name that will be used to identify the target in the Target List. This is for display in the UI only; it does not need to match any internal name.
- **Access Key**: Provide the Access Key for the account you want to manage.
- **Access Key Secret**: Provide the Access Key Secret for the account you want to manage.

Claiming Azure Targets

Microsoft Azure is Microsoft's infrastructure platform for the public cloud. You gain access to this infrastructure through a service principal target. To specify an Azure target, you provide the credentials for the subscription and IWO discovers the resources available to you through that service principal. Through Azure service principal targets, IWO automatically discovers the subscriptions to which the service principal has been granted

access in the Azure portal. This, in turn, creates a derived target for each subscription that inherits the authorization provided by the service principal (for example, contributor). You cannot directly modify a derived target, but IWO validates the target and discovers its inventory as it does with any other target.

To claim an Azure service principal target, you must meet the following requirements:

- Set up your Azure service principal subscription to grant IWO the access it needs. To set up the Azure subscription, you must access the Administrator or Co-Administrator Azure Portal (portal.azure.com). Note that this access is only required for the initial setup. IWO does not require this access for regular operation.
- Claim the target with the credentials that result from the subscription setup (Tenant ID, Client ID, and so on).
- Azure Resource Manager Intersight Workload Optimizer requires the Azure Resource Manager deployment and management service. This provides the management layer that IWO uses to discover and manage entities in your Azure environment.

Cisco Container Platform

Setting up, deploying, and managing multiple containers for multiple micro-sized services gets tedious—and difficult to manage across multiple public and private clouds. IT Ops has wound up doing much of this extra work, which makes it difficult for them to stay on top of the countless other tasks they're already charged with performing. If containers are going to truly be useful at scale, we have to find a way to make them easier to manage.

The following are the requirements in managing container environments:

- The ability to easily manage multiple clusters
- Simple installation and maintenance
- Networking and security consistency
- Seamless application deployment, both on the premises and in public clouds
- Persistent storage

That's where Cisco Container Platform (CCP) comes in, which is a fully curated, lightweight container management platform for production-grade environments, powered by Kubernetes, and delivered with Cisco enterprise-class support. It reduces the complexity of configuring, deploying, securing, scaling, and managing containers via automation, coupled with Cisco's best practices for security and networking. CCP is built with an open architecture using open source components, so you're not locked in to any single vendor. It works across both on-premises and public cloud environments. And because it's optimized with Cisco HyperFlex, this preconfigured, integrated solution sets up in minutes.

The following are the benefits of CCP:

- **Reduced risk:** CCP is a full-stack solution built and tested on Cisco HyperFlex and ACI Networking, with Cisco providing automated updates and enterprise-class support for the entire stack. CCP is built to handle production workloads.
- **Greater efficiency:** CCP provides your IT Ops team with a turnkey, preconfigured solution that automates repetitive tasks and removes pressure on them to update people, processes, and skill sets in-house. It provides developers with flexibility and speed to be innovative and respond to market requirements more quickly.
- **Remarkable flexibility:** CCP gives you choices when it comes to deployment—from hyperconverged infrastructure to VMs and bare metal. Also, because it's based on open source components, you're free from vendor lock-in.

Figure 5-7 provides a holistic overview of CCP.

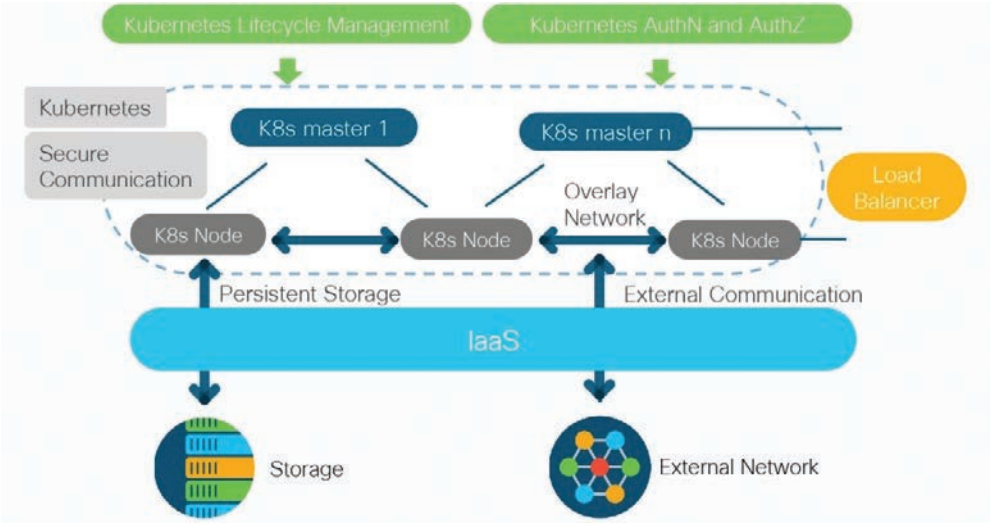

Figure 5-7 *Holistic overview of CCP*

Cisco Container Platform ushers all of the tangible benefits of container orchestration into the technology domain of the enterprise. Based on upstream Kubernetes, CCP presents a UI for self-service deployment and management of container clusters. These clusters consume private cloud resources based on established authentication profiles, which can be bound to existing RBAC models. The advantage to disparate organizational teams is the flexibility to consistently and efficiently deploy clusters into IaaS resources, a feat not easily accomplished and scaled when utilizing script-based frameworks. Teams can discriminately manage their cluster resources, including responding to conditions requiring a scale-out or scale-in event, without fear of disrupting another team's assets.

CCP boasts an innately open architecture composed of well-established open source components—a framework embraced by DevOps teams aiming their innovation toward cloud-neutral work streams.

CCP deploys easily into an existing infrastructure, whether it be of a virtual or bare-metal nature, to become the turnkey container management platform in the enterprise. CCP incorporates ubiquitous monitoring and policy-based security and provides essential services such as load balancing and logging. The platform can provide applications an extension into network management, application performance monitoring, analytics, and logging. CCP offers an API layer that is compatible with Google Cloud Platform and Google Kubernetes Engine, so transitioning applications potentially from the private cloud to the public cloud fits perfectly into orchestration schemes. The case could be made for containerized workloads residing in the private cloud on CCP to consume services brokered by Google Cloud Platform, and vice versa. For environments with a Cisco Application Centric Infrastructure (ACI), Contiv, a CCP component, will secure the containers in a logical policy-based context. Those environments with Cisco HyperFlex (HX) can leverage the inherent benefits provided by HX storage and provide persistent volumes to the containers in the form of FlexVolumes. CCP normalizes the operational experience of managing a Kubernetes environment by providing a curated production quality solution integrated with best-of-breed open source projects. Figure 5-8 illustrates the CCP feature set.

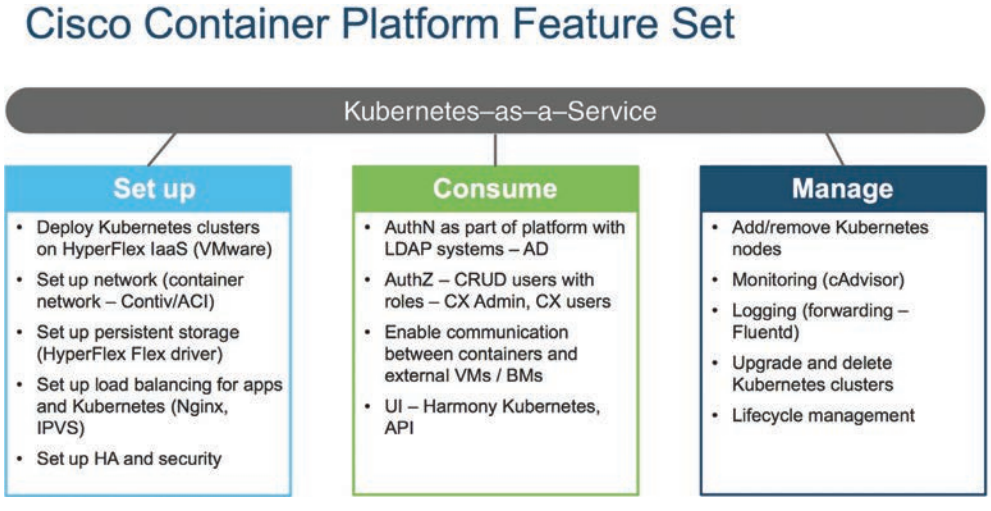

Figure 5-8 *CCP feature set*

The following are some CCP use cases:

- **Simple GUI-driven menu system to deploy clusters:** You don't have to know the technical details of Kubernetes to deploy a cluster. Just fill in the questions, and CCP will do the work.

- **The ability to deploy Kubernetes clusters in air-gapped sites:** CCP tenant images contain all the necessary binaries and don't need Internet access to function.
- **Choice of networking solutions:** Use Cisco's ACI plug-in, an industry standard Calico network, or if scaling is your priority, choose Contiv with VPP. All work seamlessly with CCP.
- **Automated monthly updates:** Bug fixes, feature enhancements, and CVE remedies are pushed automatically every month—not only for Kubernetes, but also for the underlying operating system (OS).
- **Built-in visibility and monitoring:** CCP lets you see what's going on inside clusters to stay on top of usage patterns and address potential problems before they negatively impact the business.
- **Preconfigured persistent volume storage:** Dynamic provisioning using HyperFlex storage as the default. No additional drivers need to be installed. Just set it and forget it.
- **Deploy EKS clusters using CCP control plane:** CCP allows you to use a single pane of glass for deploying on-premises and Amazon clusters, plus it leverages Amazon Authentication for both.
- **Pre-integrated Istio:** It's ready to deploy and use without additional administration.

Cisco Container Platform Architecture Overview

At the bottom of the stack is Level 1, the Networking layer, which can consist of Nexus switches, Application Policy Infrastructure Controllers (APICs), and Fabric Interconnects (FIs).

Level 2 is the Compute layer, which consists of HyperFlex, UCS, or third-party servers that provide virtualized compute resources through VMware and distributed storage resources.

Level 3 is the Hypervisor layer, which is implemented using HyperFlex or VMware.

Level 4 consists of the CCP control plane and data plane (or tenant clusters). In Figure 5-9, the left side shows the CCP control plane, which runs on four control-plane VMs, and the right side shows the tenant clusters. These tenant clusters are preconfigured to support persistent volumes using the vSphere Cloud Provider and Container Storage Interface (CSI) plug-in. Figure 5-9 provides an overview of the CCP architecture.

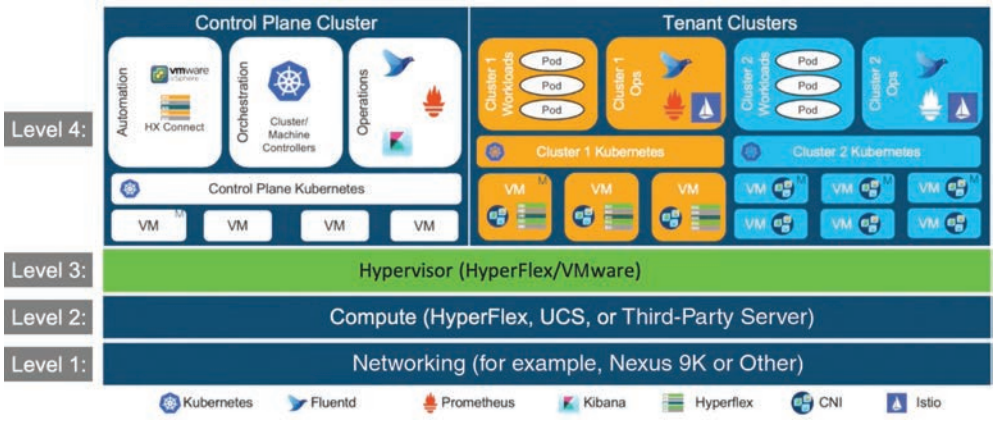

Figure 5-9 *Container Platform Architecture Overview*

Components of Cisco Container Platform

Table 5-2 lists the components of CCP.

Table 5-2 *Components of CCP*

Function	Component
Operating System	Ubuntu
Orchestration	Kubernetes
IaaS	vSphere
Infrastructure	HyperFlex, UCS
Container Network Interface (CNI)	ACI, Contiv, Calico
SDN	ACI
Container Storage	HyperFlex Container Storage Interface (CSI) plug-in
Load Balancing	NGINX, Envoy
Service Mesh	Istio, Envoy
Monitoring	Prometheus, Grafana
Logging	Elasticsearch, Fluentd, and Kibana (EFK) stack
Container Runtime	Docker CE

Sample Deployment Topology

This section describes a sample deployment topology of the CCP and illustrates the network topology requirements at a conceptual level.

In this case, it is expected that the vSphere-based cluster is set up, provisioned, and fully functional for virtualization and virtual machine (VM) functionality before any installation of CCP. You can refer to the standard VMware documentation for details on vSphere installation. Figure 5-10 provides an example of a vSphere cluster on which CCP is to be deployed.

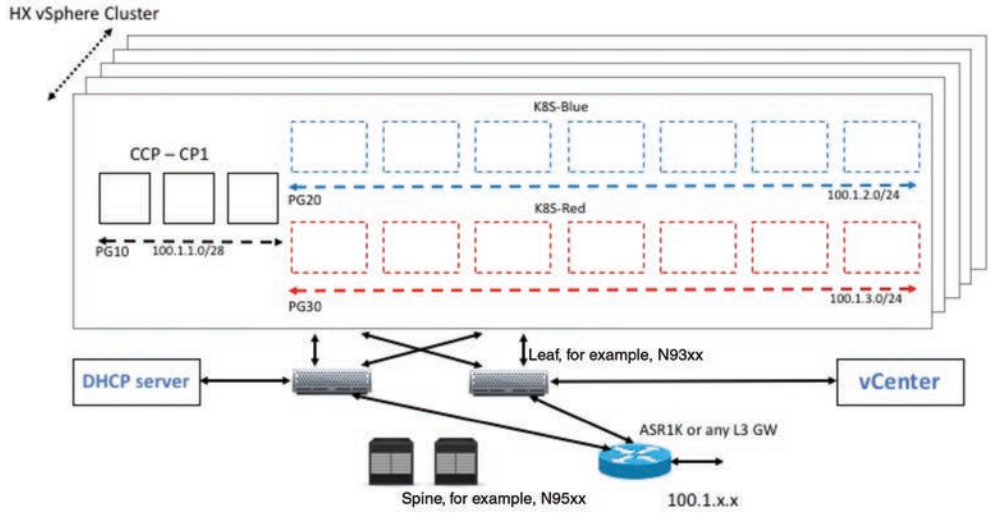

Figure 5-10 *vSphere cluster on which CCP is to be deployed*

Once the vSphere cluster is ready to provision VMs, the admin then provisions one or more VMware port groups (for example, PG10, PG20, and PG30 in the figure) on which virtual machines will subsequently be provisioned as container cluster nodes. Basic L2 switching with VMware vswitch functionality can be used to implement these port groups. IP subnets should be set aside for use on these port groups, and the VLANs used to implement these port groups should be terminated on an external L3 gateway (such as the ASR1K shown in the figure). The control-plane cluster and tenant-plane Kubernetes clusters of CCP can then be provisioned on these port groups.

All provisioned Kubernetes clusters may choose to use a single shared port group, or separate port groups may be provisioned (one per Kubernetes cluster), depending on the isolation needs of the deployment. Layer 3 network isolation may be used between these different port groups as long as the following conditions are met:

- There is L3 IP address connectivity among the port group that is used for the control-plane cluster and the tenant cluster port groups
- The IP address of the vCenter server is accessible from the control-plane cluster
- A DHCP server is provisioned for assigning IP addresses to the installer and upgrade VMs, and it must be accessible from the control-plane port group cluster of the cluster

The simplest functional topology would be to use a single shared port group for all clusters with a single IP subnet to be used to assign IP addresses for all container cluster VMs. This IP subnet can be used to assign one IP per cluster VM and up to four virtual IP addresses per Kubernetes cluster, but would not be used to assign individual Kubernetes pod IP addresses. Hence, a reasonable capacity planning estimate for the size of this IP subnet is as follows:

(The expected total number of container cluster VMs across all clusters) + 3 × (the total number of expected Kubernetes clusters)

Administering Clusters on vSphere

You can create, upgrade, modify, or delete vSphere on-premises Kubernetes clusters using the CCP web interface. CCP supports v2 and v3 clusters on vSphere. The v2 clusters use a single master node for their control plane, whereas the v3 clusters can use one or three master nodes for their control plane. The multimaster approach of v3 clusters is the preferred cluster type, as this approach ensures high availability for the control plane. The following steps show you how to administer clusters on vSphere:

Step 1. In the left pane, click **Clusters** and then click the **vSphere** tab.

Step 2. Click **NEW CLUSTER**.

Step 3. In the **BASIC INFORMATION** screen:

- **a.** From the **INFRASTRUCTURE PROVIDER** drop-down list, choose the provider related to your Kubernetes cluster.

  For more information, see **Adding vSphere Provider Profile**.

- **b.** In the **KUBERNETES CLUSTER NAME** field, enter a name for your Kubernetes tenant cluster.

- **c.** In the **DESCRIPTION** field, enter a description for your cluster.

- **d.** In the **KUBERNETES VERSION** drop-down list, choose the version of Kubernetes that you want to use for creating the cluster.

- **e.** If you are using ACI, specify the ACI profile.

  For more information, see **Adding ACI Profile**.

- **f.** Click **NEXT**.

Step 4. In the **PROVIDER SETTINGS** screen:

- **a.** From the **DATA CENTER** drop-down list, choose the data center that you want to use.

- **b.** From the **CLUSTERS** drop-down list, choose a cluster.

Note Ensure that DRS and HA are enabled on the cluster that you choose. For more information on enabling DRS and HA on clusters, see *Cisco Container Platform Installation Guide*.

c. From the **DATASTORE** drop-down list, choose a datastore.

Note Ensure that the datastore is accessible to the hosts in the cluster.

d. From the **VM TEMPLATE** drop-down list, choose a VM template.

e. From the **NETWORK** drop-down list, choose a network.

Note Ensure that you select a subnet with an adequate number of free IP addresses. For more information, see **Managing Networks**. The selected network must have access to vCenter.

For v2 clusters that use HyperFlex systems:

- The selected network must have access to the HypexFlex Connect server to support HyperFlex Storage Provisioners.
- For HyperFlex Local Network, select **k8-priv-iscsivm-network** to enable HyperFlex Storage Provisioners.

f. From the **RESOURCE POOL** drop-down list, choose a resource pool.

g. Click **NEXT**.

Step 5. In the **NODE CONFIGURATION** screen:

a. From the **GPU TYPE** drop-down list, choose a GPU type.

Note GPU configuration applies only if you have GPUs in your HyperFlex cluster.

b. For v3 clusters, under **MASTER**, choose the number of master nodes as well as their VCPU and memory configurations.

Note You may skip this step for v2 clusters. You can configure the number of master nodes only for v3 clusters.

c. Under **WORKER**, choose the number of worker nodes as well as their VCPU and memory configurations.

d. In the **SSH USER** field, enter the SSH username.

e. In the **SSH KEY** field, enter the SSH public key that you want to use for creating the cluster.

Note Ensure that you use the Ed25519 or ECDSA format for the public key. Because RSA and DSA are less-secure formats, Cisco prevents the use of these formats.

f. In the **ROUTABLE CIDR** field, enter the IP addresses for the pod subnet in the CIDR notation.

g. From the **SUBNET** drop-down list, choose the subnet that you want to use for this cluster.

h. In the **POD CIDR** field, enter the IP addresses for the pod subnet in the CIDR notation.

i. In the **DOCKER HTTP PROXY** field, enter a proxy for the Docker.

j. In the **DOCKER HTTPS PROXY** field, enter an HTTPS proxy for the Docker.

k. In the **DOCKER BRIDGE IP** field, enter a valid CIDR to override the default Docker bridge.

Note If you want to install the HX-CSI add-on, ensure that you set the CIDR network prefix of the **DOCKER BRIDGE IP** field to **/24**.

l. Under **DOCKER NO PROXY**, click **ADD NO PROXY** and then specify a comma-separated list of hosts that you want to exclude from proxying.

m. In the **VM USERNAME** field, enter the VM username that you want to use as the login for the VM.

n. Under **NTP POOLS**, click **ADD POOL** to add a pool.

o. Under **NTP SERVERS**, click **ADD SERVER** to add an NTP server.

p. Under **ROOT CA REGISTRIES**, click **ADD REGISTRY** to add a root CA certificate to allow tenant clusters to securely connect to additional services.

q. Under **INSECURE REGISTRIES**, click **ADD REGISTRY** to add Docker registries created with unsigned certificates.

r. For v2 clusters, under **ISTIO**, use the toggle button to enable or disable Istio.

s. Click **NEXT**.

Step 6. For v2 clusters, to integrate Harbor with CCP:

> **Note** Harbor is currently not available for v3 clusters.

a. In the **Harbor Registry** screen, click the toggle button to enable Harbor.

b. In the **PASSWORD** field, enter a password for the Harbor server administrator.

c. In the **REGISTRY** field, enter the size of the registry in gigabits.

d. Click NEXT.

Step 7. In the **Summary** screen, verify the configuration and then click **FINISH**.

Administering Amazon EKS Clusters Using CCP Control Plane

Before you begin, make sure you have done the following:

- Added your Amazon provider profile.
- Added the required AMI files to your account.
- Created an AWS IAM role for the CCP usage to create AWS EKS clusters.

Here is the procedure for administering Amazon EKS clusters using the CCP control plane:

Step 1. In the left pane, click **Clusters** and then click the **AWS** tab.

Step 2. Click **NEW CLUSTER**.

Step 3. In the **Basic Information** screen, enter the following information:

a. From the **INFRASTUCTURE PROVIDER** drop-down list, choose the provider related to the appropriate Amazon account.

b. From the **AWS REGION** drop-down list, choose an appropriate AWS region.

> **Note** Not all regions support EKS. Ensure that you select a supported region. Currently, CCP supports the ap-northeast-1, ap-northeast-2, ap-southeast-1, ap-southeast-2, eu-central-1, eu-north-1, eu-west-1, eu-west-2, eu-west-3, us-east-1, us-east-2, and us-west-2 regions.

c. In the **KUBERNETES CLUSTER NAME** field, enter a name for your cluster.

d. Click NEXT.

Step 4. In the **Node Configuration** screen, specify the following information:

a. From the **INSTANCE TYPE** drop-down list, choose an instance type for your cluster.

b. From the **MACHINE IMAGE** drop-down list, choose an appropriate CCP Amazon Machine Image (AMI) file.

c. In the **WORKER COUNT** field, enter an appropriate number of worker nodes.

d. In the **SSH PUBLIC KEY** drop-down field, choose an appropriate authentication key.

This field is optional. It is needed if you want to ssh to the worker nodes for troubleshooting purposes. Ensure that you use the Ed25519 or ECDSA format for the public key.

Note Because RSA and DSA are less-secure formats, Cisco prevents the use of these formats.

e. In the **IAM ACCESS ROLE ARN** field, enter the Amazon Resource Name (ARN) information.

Note By default, the AWS credentials specified at the time of Amazon EKS cluster creation (that is, the credentials configured in the Infrastructure Provider) are mapped to the Kubernetes cluster-admin ClusterRole. A default ClusterRoleBinding binds the credentials to the system:masters group, thereby granting superuser access to the holders of the IAM identity. The **IAM ACCESS ROLE ARN** field allows you to specify the ARN of an additional AWS IAM role or IAM user who is also granted administrative control of the cluster.

f. Click **NEXT**.

Step 5. In the **VPC Configuration** screen, specify the following information:

a. In the **SUBNET CIDR** field, enter a value of the overall subnet CIDR for your cluster.

b. In the **PUBLIC SUBNET CIDR** field, enter values for your cluster on separate lines.

c. In the **PRIVATE SUBNET CIDR** field, enter values for your cluster on separate lines.

Step 6. In the **Summary** screen, review the cluster information and then click **FINISH**.

Cluster creation can take up to 20 minutes. You can monitor the cluster creation status on the **Clusters** screen.

Note If you receive the "Could not get token: AccessDenied" error message, this indicates that the AWS account is not a trusted entity for the Role ARN.

Licensing and Updates

You need to configure Cisco Smart Software Licensing on the Cisco Smart Software Manager (Cisco SSM) to easily procure, deploy, and manage licenses for your CCP instance. The number of licenses required depends on the number of VMs necessary for your deployment scenario.

Cisco SSM enables you to manage your Cisco Smart Software Licenses from one centralized website. With Cisco SSM, you can organize and view your licenses in groups called "virtual accounts." You can also use Cisco SSM to transfer the licenses between virtual accounts, as needed.

You can access Cisco SSM from the Cisco Software Central home page, under the Smart Licensing area. CCP is initially available for a 90-day evaluation period, after which you need to register the product.

Connected Model

In a connected deployment model, the license usage information is directly sent over the Internet or through an HTTP proxy server to Cisco SSM.

For a higher degree of security, you can opt to use a partially connected deployment model, where the license usage information is sent from CCP to a locally installed VM-based satellite server (Cisco SSM satellite). Cisco SSM satellite synchronizes with Cisco SSM on a daily basis.

Registering CCP Using a Registration Token

You need to register your CCP instance with Cisco SSM or Cisco SSM satellite before the 90-day evaluation period expires. The following is the procedure for registering CCP using a registration token, and Figure 5-11 shows the workflow for this procedure.

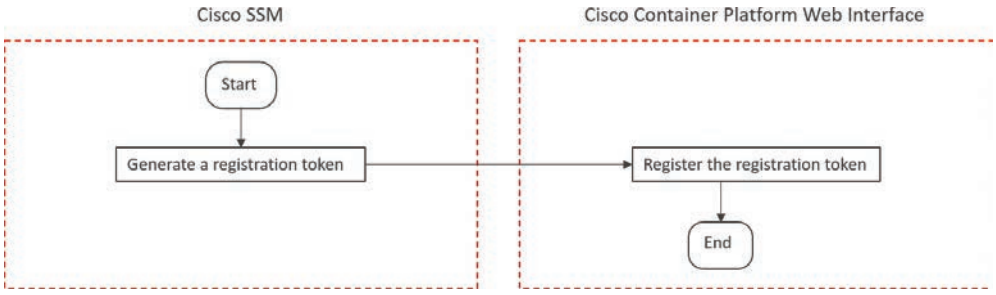

Figure 5-11 *Registering CCP using a registration token*

Step 1. Perform these steps on Cisco SSM or Cisco SSM satellite to generate a registration token:

a. Go to **Inventory** > *Choose Your Virtual Account* > **General** and then click **New Token**.

b. If you want to enable higher levels of encryption for the products registered using the registration token, check the **Allow Export-Controlled functionality on the products registered with this token** check box.

Note This option is available only if you are compliant with the Export-Controlled functionality.

c. Download or copy the token.

Step 2. Perform these steps in the CCP web interface to register the registration token and complete the license registration process:

a. In the left pane, click **Licensing**.

b. In the license notification, click **Register**.

The Smart Software Licensing Product Registration dialog box appears.

c. In the **Product Instance Registration Token** field, enter, copy and paste, or upload the registration token that you generated in Step 1.

d. Click **REGISTER** to complete the registration process.

Upgrading Cisco Container Platform

Upgrading CCP and upgrading tenant clusters are independent operations. You must upgrade CCP to allow tenant clusters to upgrade. Specifically, tenant clusters cannot be upgraded to a higher version than the control plane. For example, if the control plane is at version 1.10, the tenant cluster cannot be upgraded to the 1.11 version.

Upgrading CCP is a three-step process:

You can update the size of a single IP address pool during an upgrade. However, we recommend that you plan ahead for the free IP address requirement by ensuring that the free IP addresses are available in the control-plane cluster prior to the upgrade.

If you are upgrading from a CCP version, you must do the following:

- Ensure that at least five IP addresses are available (3.1.x or earlier).
- Ensure that at least three IP addresses are available (3.2 or later).
- Upgrade the CCP tenant base VM.
- Deploy/upgrade the VM.
- Upgrade the CCP control plane.

To get the latest step-by-step upgrade procedure, you can refer to the CCP upgrade guide.

Cisco Intersight Kubernetes Service

Cisco Intersight Kubernetes Service (IKS) effectively expands CCP's functionality to benefit from Intersight's native infrastructure management capabilities, further simplifying building and managing Kubernetes environments. IKS is a SaaS offering, taking away the hassle of installing, hosting, and managing a container management solution. For organizations with specific requirements, it also offers two additional deployment options (with a virtual appliance). So, let's take a look at how IKS can make our lives easier. Figure 5-12 provides an overview of Intersight Cloud management.

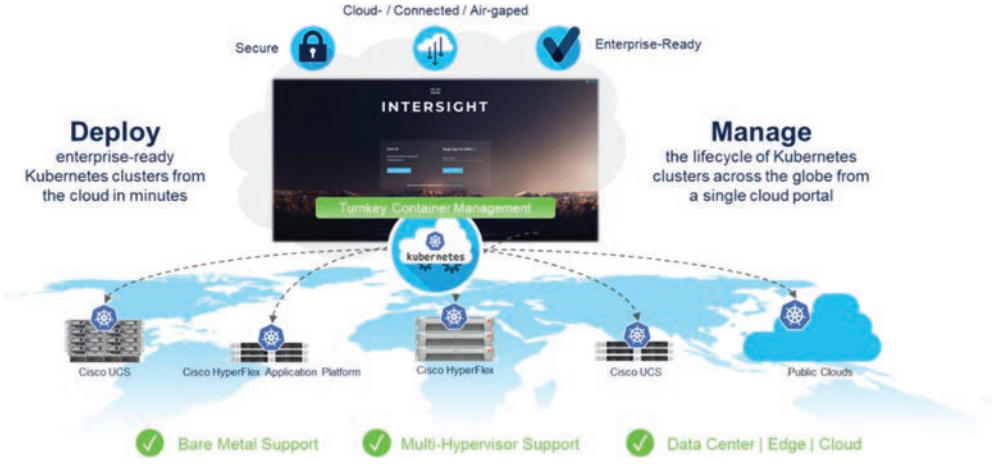

Figure 5-12 *Intersight Cloud management*

Benefits of IKS

The following are the benefits of using IKS:

- Simplify Kubernetes Day 0 to Day N operations and increase application agility with a turnkey SaaS platform that makes it easy to deploy and manage clusters across data centers, the edge, and public clouds.
- Reduce risk, lower cost, improve governance, and take multicloud control on a security-hardened platform, with enhanced availability, native integrations with AWS, Azure, and Google Cloud, and end-to-end industry-leading Cisco TAC support.
- Get more value from your investments with a flexible, extensible Kubernetes platform that supports multiple delivery options, hypervisors, storage, and bare-metal configurations.
- Automate and simplify with self-service built-in add-ons and optimizations such as AI/ML frameworks, service mesh, networking, monitoring, logging, and persistent object storage.

Common Use Case

A good example comes from the retail sector: an IT admin needs to quickly create and configure hundreds of edge locations for the company's retail branches to perform AI/ML processing and a few core ones in privately owned or co-located data centers. The reason it makes sense for processing or storing large chunks of data at the edge is the cost of shipping the data back to the core DC or to a public cloud (and latency to a certain extent).

Creating those Kubernetes clusters would require firmware upgrades as well as OS and hypervisor installations before the IT admin can even get to the container layer. With Cisco Intersight providing a comprehensive, common orchestration and management layer—from server and fabric management to hyperconverged infrastructure management to Kubernetes—creating a container environment from scratch can be literally done with just a few clicks. Figure 5-13 illustrates a high-level architecture of IKS.

IT admins can use either the IKS GUI or its APIs, or they can integrate with an Infrastructure as Code plan (such as HashiCorp's Terraform) to quickly deploy a Kubernetes environment on a variety of platforms—VMware ESXi hypervisors or Cisco HyperFlex—thus enabling significant savings and efficiency without the need of virtualization.

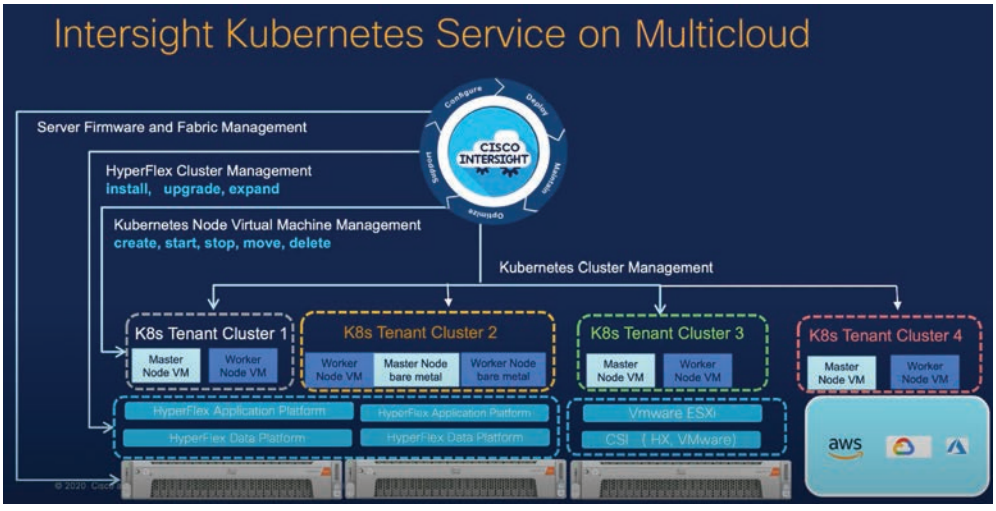

Figure 5-13 *Architecture of IKS*

Deploying Consistent, Production-Grade Kubernetes Anywhere

Few open source projects have been as widely and rapidly adopted as Kubernetes (K8s), the de facto container orchestration platform. With Kubernetes, development teams can deploy, manage, and scale their containerized applications with ease, making innovations more accessible to their continuous delivery pipelines. However, Kubernetes comes with operational challenges, because it requires time and technical expertise to install and configure. Multiple open source packages need to be combined on top of a heterogeneous infrastructure, across on-premises data centers, edge locations, and, of course, public clouds. Installing Kubernetes and the different software components required, creating clusters, configuring storage, networking, and security, optimizing for AI/ML, and other manual tasks can slow down the pace of development and can result in teams spending hours debugging. In addition, maintaining all these moving parts (for example, upgrading, updating, and patching critical security bugs) requires ongoing significant human capital investment.

The solution? Cisco Intersight Kubernetes Service (IKS), a turnkey SaaS solution for managing consistent, production-grade Kubernetes anywhere.

How It Works

Cisco Intersight Kubernetes Service (IKS) is a fully curated, lightweight container management platform for delivering multicloud, production-grade, upstream Kubernetes. Part of the modular SaaS Cisco Intersight offerings (with an air-gapped on-premises option also available), IKS simplifies the process of provisioning, securing, scaling, and managing

virtualized or bare-metal Kubernetes clusters by providing end-to-end automation, including the integration of networking, load balancers, native dashboards, and storage provider interfaces. It also works with all the popular public cloud–managed K8s offerings, integrating with common identity access with AWS Elastic Kubernetes Service (EKS), Azure Kubernetes Service (AKS) and Google Cloud Google Kubernetes Engine (GKE). IKS is ideal for AI/ML development and data scientists looking for delivering GPU-enabled clusters, and Kubeflow support with a few clicks. It also offers enhanced availability features, such as multimaster (tenant) and self-healing (operator model).

IKS is easy to install in minutes and can be deployed on top of VMware ESXi hypervisors, Cisco HyperFlex Application Platform (HXAP) hypervisors, and/or directly on Cisco HyperFlex Application Platform bare-metal servers, enabling significant savings and efficiency without the need of virtualization. In addition, with HXAP leveraging container-native virtualization capabilities, you can run virtual machines (VMs), VM-based containers, and bare-metal containers on the same platform! Cisco Intersight also offers native integrations with Cisco HyperFlex (HX) for enterprise-class storage capabilities (for example, persistent volume claims and public cloud-like object storage) and Cisco Application Centric Infrastructure (Cisco ACI) for networking, in addition to the industry- standard Container Storage Interface and Container Network Interface (for example, Calico).

Intersight Kubernetes Service integrates seamlessly with the other Cisco Intersight SaaS offerings to deliver a powerful, comprehensive cloud operations platform to easily and quickly deploy, optimize, and lifecycle-manage end-to-end infrastructure, workloads, and applications. Figure 5-14 illustrates the benefits of IKS.

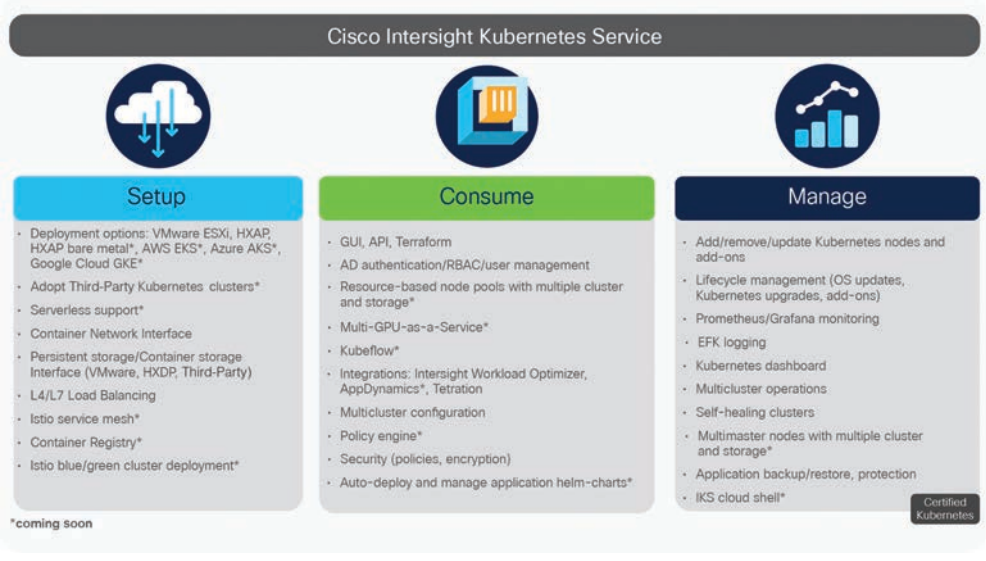

Figure 5-14 *Benefits of IKS*

IKS Release Model

IKS software follows a continuous-delivery release model that delivers features and maintenance releases. This approach enables Cisco to introduce stable and feature-rich software releases in a reliable and frequent manner that aligns with Kubernetes supported releases.

Intersight Kubernetes Service Release and Support Model:

- The IKS team supports releases from N-1 versions of Kubernetes. The team will not fully support/make available IKS versions older than N-1.
- IKS follows a fix-forward model that requires release upgrades to fix issues. Release patches are not necessary with this model.
- Tenant images are versioned according to which version of Kubernetes they contain.

Deploy Kubernetes from Intersight

The Intersight policies allow simplified deployments, as they abstract the configuration into reusable templates. The following sections outline the steps involved in deploying Kubernetes from Intersight.

Step 1: Configure Policies

All policies are created under the **Configure > Polices & Configure > Pools** section on Intersight. You can see the path of the policy at the top of each of the following figures.

1. The IP Pool will be used for IP addresses on your Control and Worker nodes virtual machines, when launched on the ESXi host. Figure 5-15 illustrates the IPv4 Pool details for policy configuration.

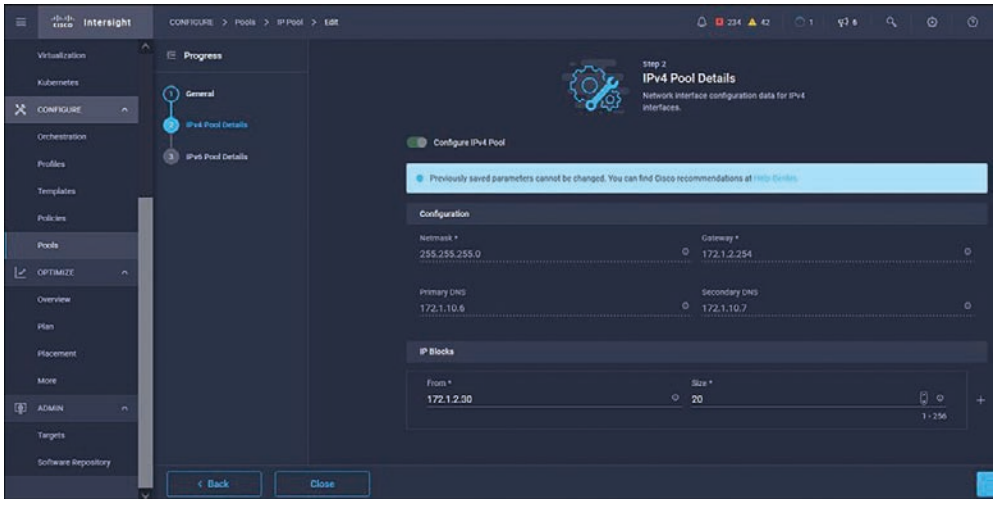

Figure 5-15 *IPv4 Pool details for policy configuration*

2. The Pod and Services Network CIDR is defined for internal networking within the Kubernetes cluster. Figure 5-16 illustrates the CIDR network to be used for the pods and services.

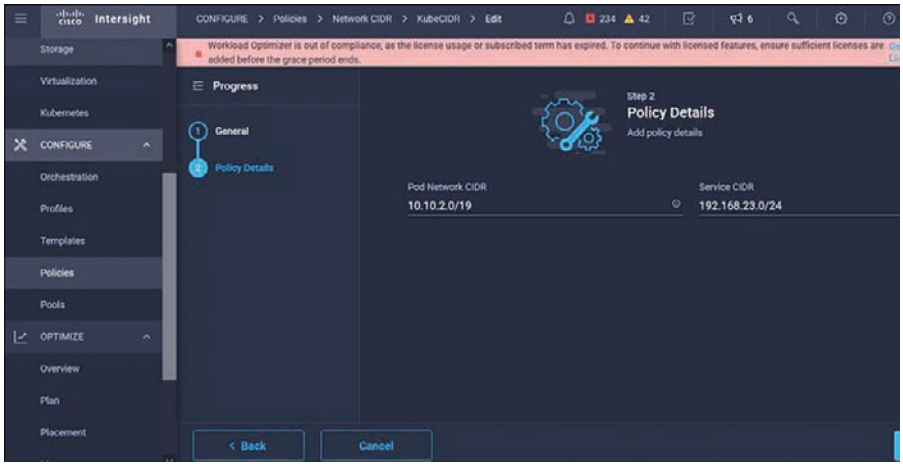

Figure 5-16 *CIDR network to be used for the pods and services*

3. The DNS and NTP configuration policy defines your NTP and DNS configuration (see Figure 5-17).

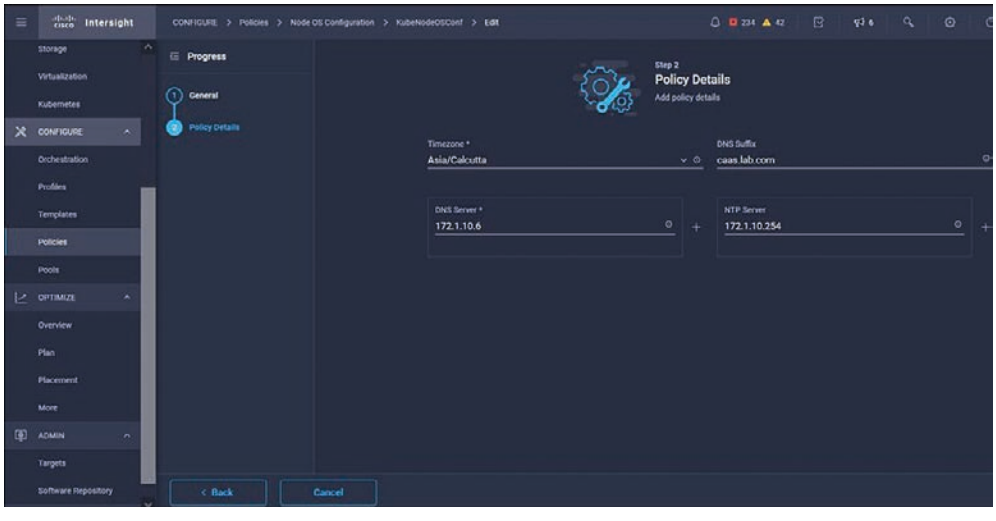

Figure 5-17 *DNS and NTP configuration policy*

4. You can define the proxy configuration policy for your Docker container runtime. Figure 5-18 illustrates this policy.

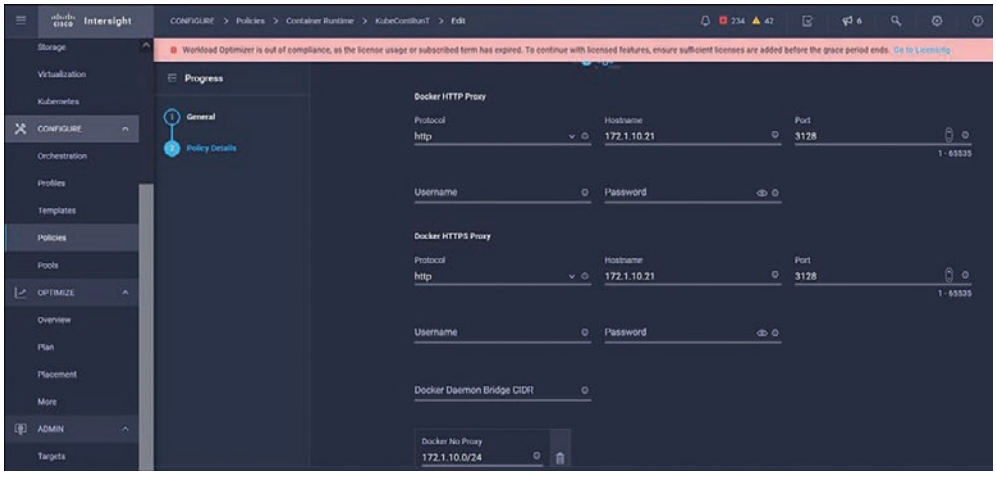

Figure 5-18 *Policy for configuring a proxy for Docker*

5. In the master and worker node VM policy, you define the configuration needed on the virtual machines deployed as Master and Worker nodes (see Figure 5-19).

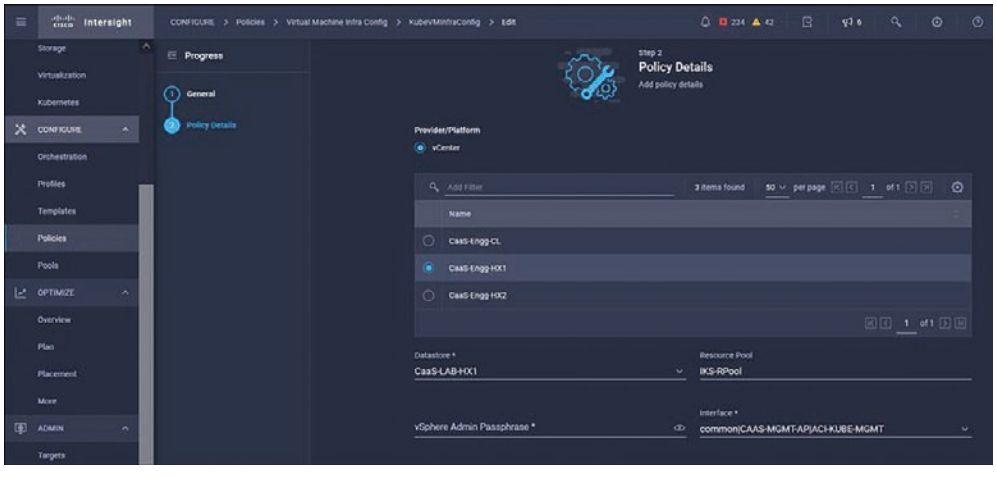

Figure 5-19 *Master and worker node VM policy*

Step 2: Configure Profile

Once we have created the preceding policies, you would then bind them into a profile that you can then deploy.

Deploying the configuration using policies and profiles abstracts the configuration layer so that it can be repeatedly deployed quickly.

1. You can copy this profile and create a new one with modifications on the underlying policies within minutes, to one or more Kubernetes clusters, in a fraction of the time needed for the manual process. Figure 5-20 illustrates the name and tag configuration in the profile.

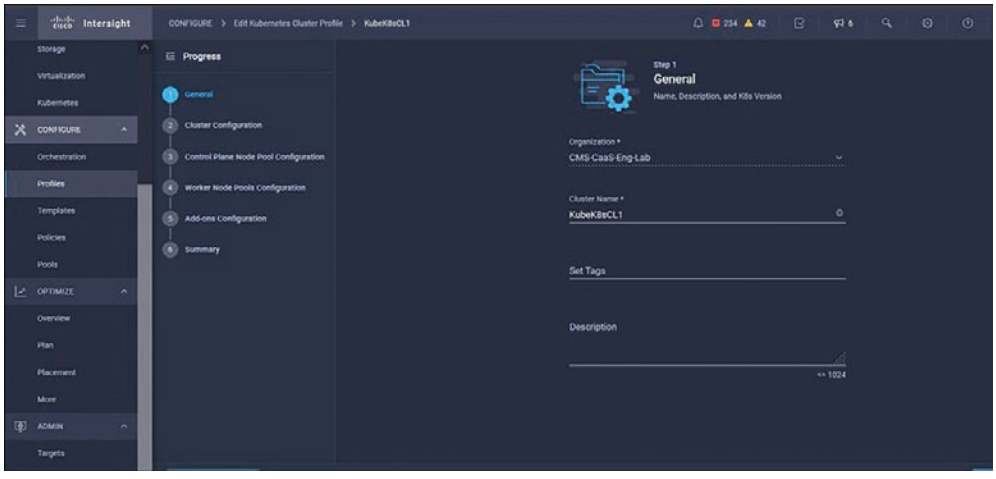

Figure 5-20 *Name and tag configuration in the profile*

2. Set the Pool, Node OS, and Network CIDR policies. You also need to configure a user ID and SSH key (public). Its corresponding private key would be used to ssh into the Master and Worker nodes. Figure 5-21 illustrates the created policies being referred to in the profile.

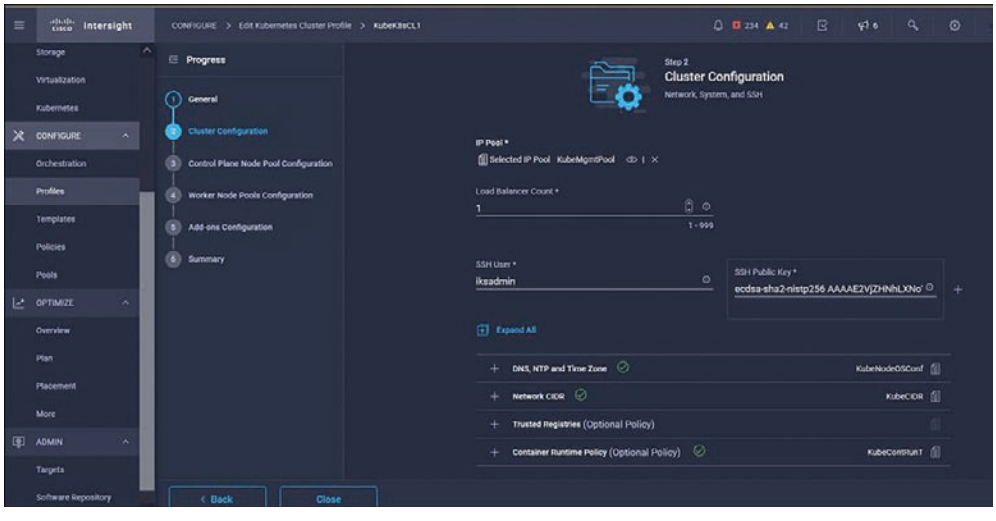

Figure 5-21 *Created policies being referred to in the profile*

3. Configure the control plane. You can define how many Master nodes you would need on the control plane. Figure 5-22 illustrates the K8s cluster configuration and number of Master nodes.

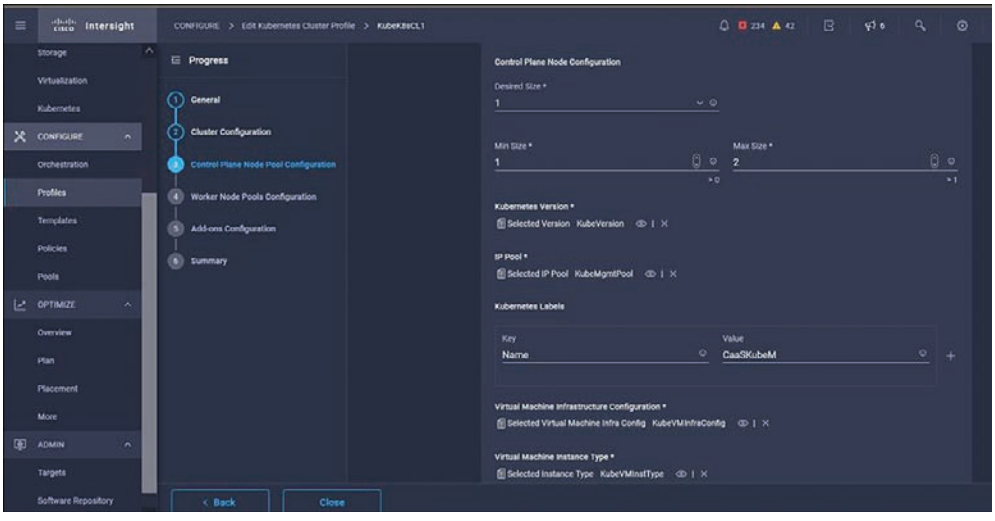

Figure 5-22 *Cluster configuration and number of Master nodes*

4. Configure the Worker nodes. Depending on the application requirements, you can scale up or scale down your Worker nodes. Figure 5-23 illustrates the K8s cluster configuration and number of Worker nodes.

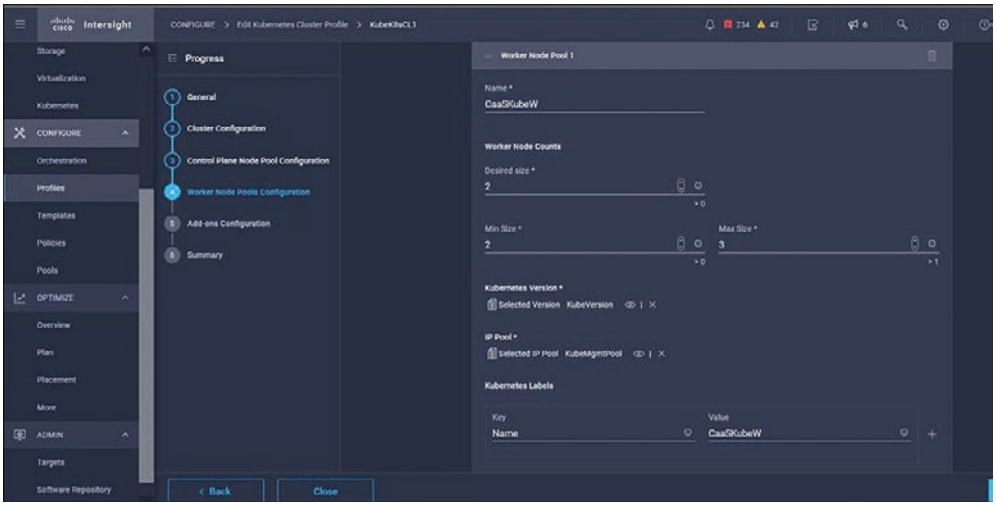

Figure 5-23 *Cluster configuration and number of Worker nodes*

5. Configure add-ons. As of now, you can automatically deploy Kubernetes Dashboard and Graffana with Prometheus monitoring. In the future, you can add more add-ons, which you can automatically deploy using IKS. Figure 5-24 illustrates the K8s cluster add-ons configuration.

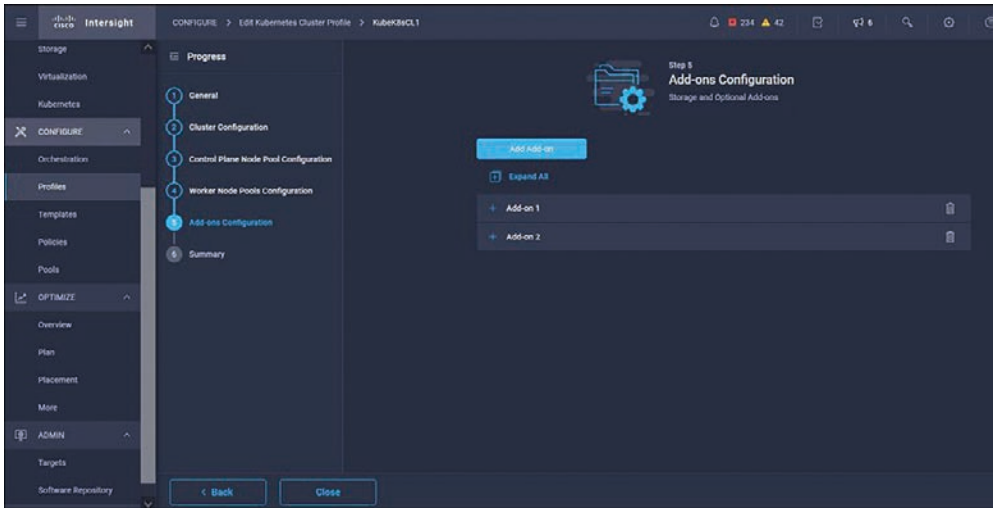

Figure 5-24 *Cluster add-ons configuration*

6. Check the **Summary** and click **Deploy**.

   Figure 5-25 illustrates the K8s cluster **Summary and Deployment** screen.

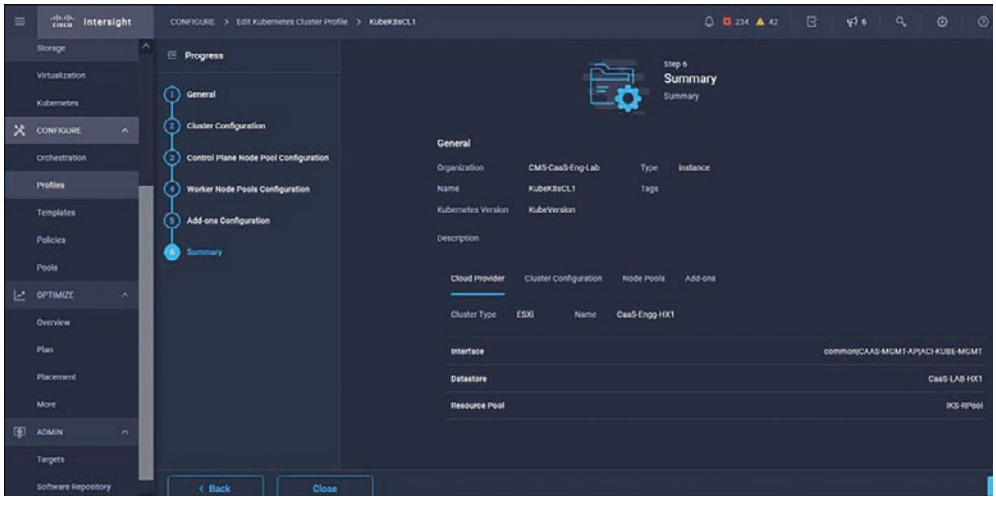

Figure 5-25 *Cluster Summary and Deployment screen*

Summary

Containers are the latest—and arguably one of the most powerful—technologies to emerge over the past few years to change the way we develop, deploy, and manage applications. The days of the massive software release are quickly becoming a thing of the past. In their place are continuous development and upgrade cycles that are allowing a lot more innovation and quicker time to market, with a lot less disruption—for customers and IT organizations alike.

With these new Cisco solutions, you can deploy, monitor, optimize, and auto-scale your applications.

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