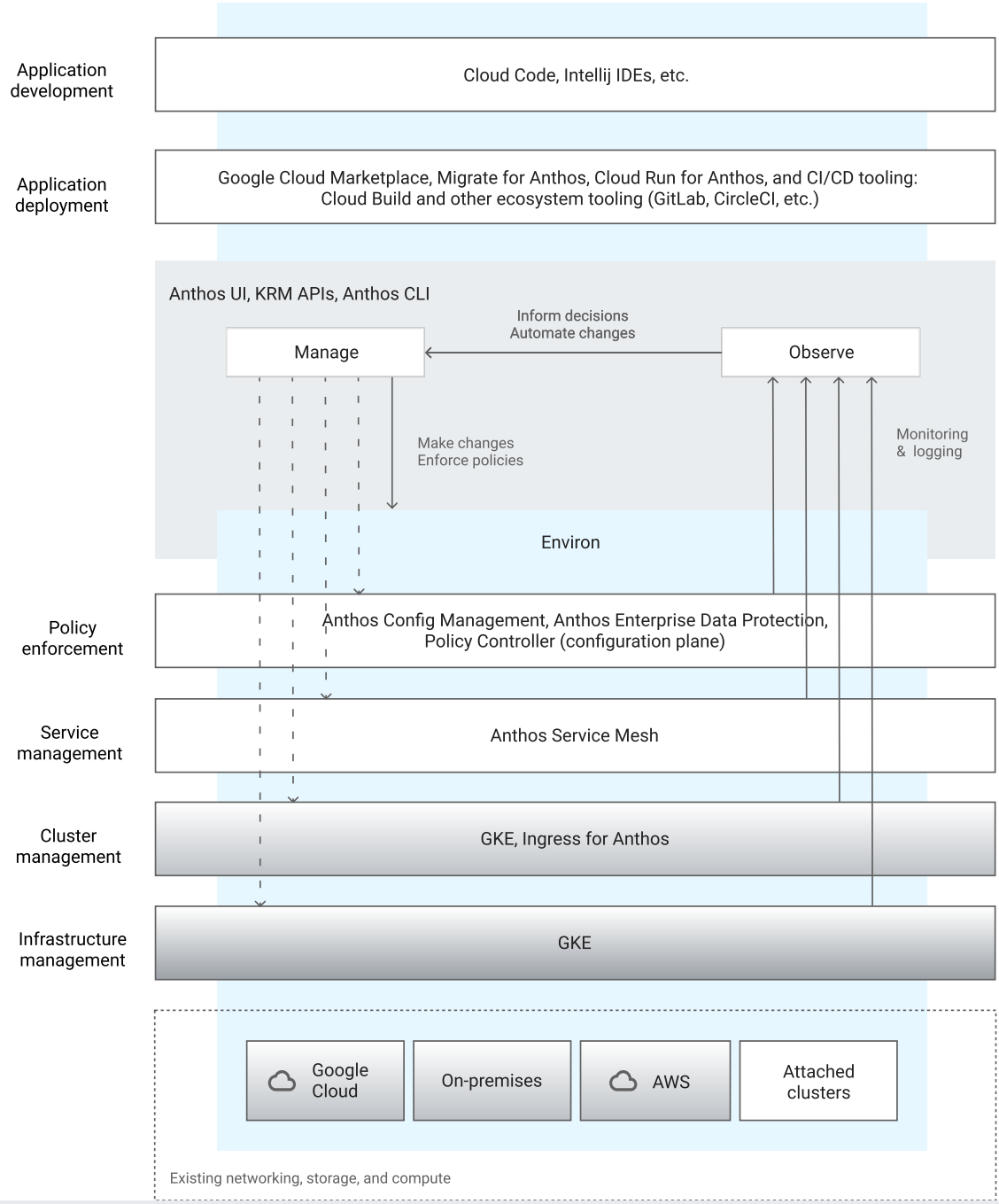
Anthos technical overview

Anthos is a modern application management platform that provides a consistent development and operations experience for cloud and on-premises environments. This page provides an overview of each layer of the Anthos infrastructure and shows how you can leverage its features.

The following diagram shows Anthos components and features and how they provide Anthos's functionality across your environments, from infrastructure management to facilitating application development.



(/anthos/images/anthos-14-components.svg)

The following table shows the components currently available for use on Google Cloud, on AWS, on attached non-GKE clusters, or on-premises. For a full list of the features included in Anthos subscriptions for each deployment option, including product subcomponents, see Anthos deployment options (/anthos/deployment-options).

Core Anthos components	Google Cloud	On-premises	Multi-cloud/AWS	Attached clusters

Core Anthos components	Google Cloud	On-premises	Multi-cloud/AWS	Attached clusters
Infrastructure, container, and cluster management	GKE Ingress for Anthos	GKE on-prem	GKE on AWS	
Multicluster management	Environ, environ-enabled components, and Connect	Environ, environ-enabled components, and Connect	Environ, environ-enabled components, and Connect	Environ, environ-enabled components, and Connect
Configuration management	Anthos Config Management Policy Controller Config Connector	Anthos Config Management Policy Controller Config Connector	Anthos Config Management Policy Controller	Anthos Config Management Policy Controller
Migration	Migrate for Anthos	Migrate for Anthos		
Service management	Anthos Service Mesh Anthos Service Mesh dashboards MeshCA certificate authority	Anthos Service Mesh Grafana and Kiali dashboards Istiod certificate authority	Anthos Service Mesh	Anthos Service Mesh
Serverless	Cloud Run for Anthos	Cloud Run for Anthos		
Secure software supply chain	Binary Authorization	Binary Authorization (preview)		
Logging and monitoring	Cloud Logging and Cloud Monitoring for system components	Cloud Logging and Cloud Monitoring for system components		
Marketplace	Kubernetes Applications in Cloud Marketplace	Kubernetes Applications in Cloud Marketplace		

Computing environment

The primary computing environment for Anthos relies on GKE (/kubernetes-engine) on Google Cloud, on-premises, or multicloud to manage Kubernetes installations in the environments

where you intend to deploy your applications. These offerings bundle upstream Kubernetes releases and provide management capabilities for creating, scaling, and upgrading conformant (https://github.com/cncf/k8s-conformance) Kubernetes clusters. With Kubernetes installed and running, you have access to a common orchestration layer that manages application deployment, configuration, upgrade, and scaling.

Kubernetes has two main parts: the control plane (https://kubernetes.io/docs/concepts/overview/components/#master-components) and the node components (https://kubernetes.io/docs/concepts/overview/components/#node-components). How the environments host the control plane and node components for GKE is described below.

- **Anthos on Google Cloud**
  With Anthos on Google Cloud, Google Cloud hosts the control plane, and the Kubernetes API server is the only control-plane component accessible to customers. GKE manages the node components in the customer's project using instances (/compute/docs/instances) in Compute Engine.
- **Anthos on-prem**
  With GKE on-prem, all components are hosted in the customer's on-prem virtualization environment.
- **Anthos on AWS**
  With GKE on AWS, all components are hosted in the customer's AWS environment.

With Anthos attached clusters (/anthos/docs/setup/attached-clusters), the Kubernetes distribution is offered through another cloud provider. In this deployment option, Anthos does not manage the Kubernetes control plane or node components—only the Anthos services that run on those clusters.

Multi-cluster management

Anthos Kubernetes clusters are registered as part of a Google Cloud environ using Connect (/anthos/multicluster-management/connect), allowing multiple clusters to be viewed and managed together in the Anthos dashboard. You can find out more about environs and the functionality that they enable in our Environs guide (/anthos/multicluster-management/environs), and about the dashboard in our Unified user interface (#unified_user_interface) section below.

Networking environment

This section describes how Kubernetes clusters in Anthos interact with your environment's networks.

Load balancers

Load balancers let you divide requests to your workloads across different pods and environments. Kubernetes allows users to provision Layer 4 (https://kubernetes.io/docs/tasks/access-application-cluster/create-external-load-balancer/) and Layer 7 (https://kubernetes.io/docs/concepts/services-networking/ingress/) load balancers. The following load balancing options are available for GKE, depending on your chosen environment.

- **Anthos on Google Cloud**
    - GKE uses Network Load Balancing (/load-balancing/docs/network) for Layer 4 and HTTP(S) Load Balancing (/load-balancing/docs/https) for Layer 7. Both are managed services and do not require any additional configuration or provisioning on your part.
    - Ingress for Anthos (/kubernetes-engine/docs/how-to/ingress-for-anthos) allows you to deploy a load balancer that serves an application across multiple GKE on Google Cloud clusters.
- **Anthos on-prem**
  GKE on-prem provides an integration with an on-premises load balancing appliance (/anthos/gke/docs/on-prem/how-to/setup-load-balance).
- **Anthos on AWS**
  GKE on AWS provides integrations with AWS Classic ELB, NLB, and ALB (/anthos/gke/docs/aws/how-to/loadbalancer) load balancers.

Connecting across environments

You can connect your on-premises, multicloud, attached clusters, and Google Cloud environments in various ways. The easiest way to get started is by implementing a site-to-site VPN between the environments using Cloud VPN (/network-connectivity/docs/vpn). If you have more stringent latency and throughput requirements, you can choose between Dedicated Interconnect (/network-connectivity/docs/how-to/choose-product#dedicated) and Partner Interconnect (/network-connectivity/docs/how-to/choose-product#partner). For more information

about choosing an interconnect type, see How to choose a Network Connectivity product (/network-connectivity/docs/how-to/choose-product).

Connecting to Google services

Your Anthos environments outside Google Cloud must be able to reach Google's API endpoints for the following services.

Environment	GKE on-prem	GKE on AWS	Attached clusters
	Connect	Connect	Connect
	Cloud Monitoring		
	Cloud Logging		

Microservice architecture support

In Kubernetes, services are composed of many Pods (https://kubernetes.io/docs/concepts/workloads/pods/pod/), which execute containers. In a microservices architecture, a single application may consist of numerous services, and each service may have multiple versions deployed concurrently.

With a monolithic application, you have no network-related concerns, because communication happens through function calls that are isolated within the monolith. In a microservice architecture, service-to-service communication occurs over the network.

Networks can be unreliable and insecure, so services must be able to identify and deal with network idiosyncrasies. For example, if Service A calls Service B, and there is a network outage, what should Service A do when it doesn't get a response? Should it retry the call? If so, how often? Or how does Service A know that it is Service B returning the call?

To solve these problems, you can install Anthos Service Mesh on GKE or attached clusters in your chosen environment. Anthos Service Mesh is based on Istio (https://istio.io/docs/concepts/what-is-istio/), which is an open-source implementation of the service mesh infrastructure layer. Anthos Service Mesh uses sidecar proxies to enhance network security, reliability, and visibility. With Anthos Service Mesh, these functions are

abstracted away from the application's primary container and implemented in a common out-of-process proxy delivered as a separate container in the same Pod.

Anthos Service Mesh features include:

- Fine-grained control of traffic with rich routing rules for HTTP(S), gRPC, and TCP traffic.
- Automatic metrics, logs, and traces for all HTTP traffic within a cluster, including cluster ingress and egress.
- Secure service-to-service communication with authentication and authorization based on service accounts.
- Facilitation of tasks like A/B testing and canary rollouts.

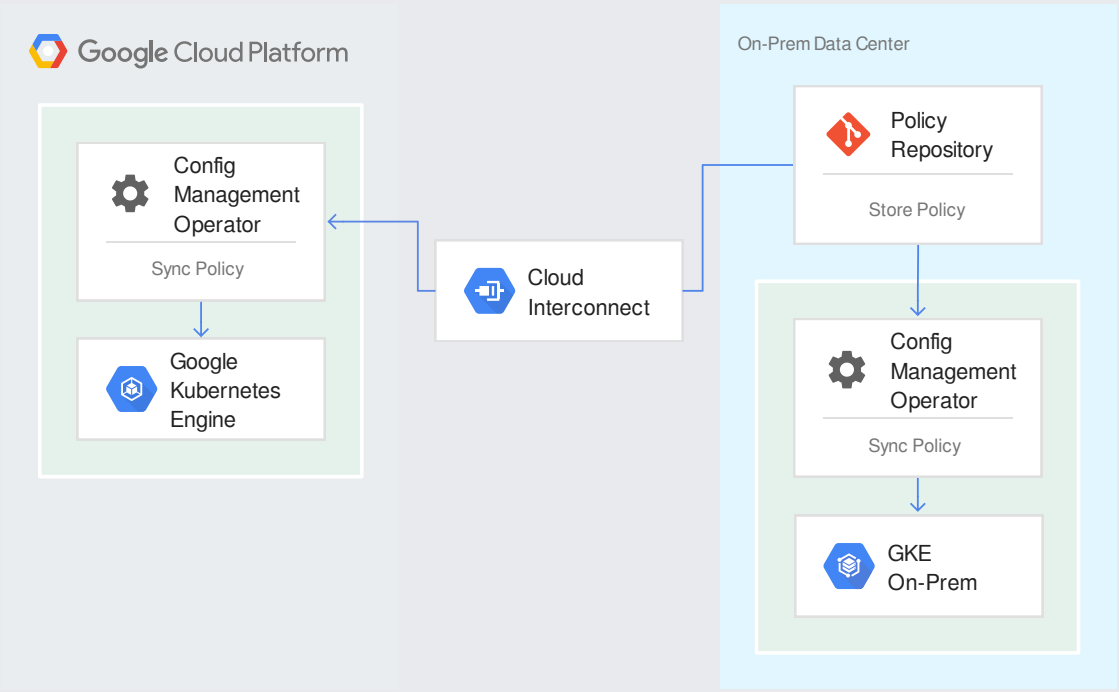
Managed service mesh

For workloads running on Anthos on Google Cloud, Anthos Service Mesh manages your service mesh environment and provides you with many features along with all of Istio's functionality:

- Service metrics and logs for all traffic within your mesh's GKE cluster are automatically ingested to Google Cloud.
- Automatically generated dashboards display in-depth telemetry in the Anthos Service Mesh dashboard, to let you dig deep into your metrics and logs, filtering and slicing your data on a wide variety of attributes.
- Service-to-service relationships at a glance: understand who connects to each service and the services it depends on.
- Secure your inter-service traffic: Anthos Service Mesh certificate authority (Mesh CA) automatically generates and rotates certificates so you can enable mutual TLS authentication (mTLS) easily with Istio policies.
- Quickly see the communication security posture not only of your service, but its relationships to other services.
- Dig deeper into your service metrics and combine them with other Google Cloud metrics using Cloud Monitoring.
- Gain clear and simple insight into the health of your service with service level objectives (SLOs), which allow you to easily define and alert on your own standards of service

health.

Centralized config management



(/anthos/images/config-man.svg)
Anthos Config Management architecture (click to enlarge)

Spanning multiple environments adds complexity in terms of resource management and consistency. Anthos provides a unified declarative model for computing, networking, and even service management across clouds and datacenters.

Configuration as data is one common approach to managing this complexity, allowing you to store the desired state of your hybrid environment under version control and apply it directly with repeatable results. Anthos makes this possible with Anthos Config Management (/anthos-config-management), which integrates with Anthos clusters on-premises or in the cloud. It lets you deploy and monitor configuration changes stored in a central Git repository.

This approach leverages core Kubernetes concepts, such as Namespaces (https://kubernetes.io/docs/concepts/overview/working-with-objects/namespaces/), labels (https://kubernetes.io/docs/concepts/overview/working-with-objects/labels/), and annotations (https://kubernetes.io/docs/concepts/overview/working-with-objects/annotations/) to determine how

and where to apply the config changes to all of your Kubernetes clusters, no matter where they reside. The repo provides a versioned, secured, and controlled single source of truth for all of your Kubernetes configurations. Any YAML or JSON that can be applied with `kubectl` (https://kubernetes.io/docs/reference/kubectl/overview/) commands can be managed with Anthos Config Management and applied to any Kubernetes cluster.

Anthos Config Management also includes the Policy Controller, which enforces custom business logic against every API request to Kubernetes and allows you to use the same logic to scan and audit your clusters. Common security and compliance rules can easily be expressed using the built-in set of rules that deploys with Anthos Config Management, or you can write your own rules using the extensible policy language, based on the open source Open Policy Agent (https://www.openpolicyagent.org/) project.

Anthos Config Management has the following benefits for your Anthos environments:

- Single source of truth, control, and management
    - Enables the use of code reviews, validation, and rollback workflows.
    - Avoids shadows ops, where Kubernetes clusters drift out of sync due to manual changes.
    - Enables the use of CI/CD pipelines for automated testing and rollout.
- One-step deployment across all clusters
    - Anthos Config Management turns a single Git commit into multiple kubectl commands across all clusters.
    - Rollback by simply reverting the change in Git. The reversion is then automatically deployed at scale.
- Rich inheritance model for applying changes
    - Using Namespaces, you can create configuration for all clusters, some clusters, some Namespaces, or even custom resources.
    - Using Namespace inheritance, you can create a layered Namespace model that allows for configuration inheritance across the repo folder structure.
- Advanced policy enforcement and auditing with Policy Controller
    - Use the included policy guardrails to enforce security best practices across your entire environment.

- Continuously audit your environment for configuration that violates business policies.
- Define and deploy your own custom rules, using an expressive custom policy language to encode your unique business logic.

Serverless

Cloud Run for Anthos provides a developer-focused experience for creating modern applications on the Anthos platform. Cloud Run abstracts away the complexities of the underlying platform, making it easier to generate your own customer value in less time.

Instead of focusing on the platform or authoring lots of YAML, Cloud Run provides clean developer abstractions for defining and deploying services, freeing up the developer to deliver more in less time. Cloud Run manages how the service is run, either in the cloud or on-premises, while optimizing resource utilization, horizontal scaling, and integration with networking and Anthos Service Mesh. Cloud Run can even scale apps to and from zero instances based on demand.

Powered by the Knative (https://knative.dev) open source project, Cloud Run packages together Google's years of experience running our own serverless platform, and makes it available in your Anthos environment. With Cloud Run, your teams can be faster and focused on meeting customer demand, instead of building out a platform or being locked in to a specific cloud or vendor.

Cloud Run for Anthos is is generally available for Anthos on Google Cloud and Anthos on-prem deployment options, and is on the roadmap for multi-cloud and attached clusters.

Secure software supply chain

"How do I trust what is running on my production infrastructure?" is one of the top questions we hear from those working in enterprise security and DevOps. Binary Authorization was created to help answer that question. It is a container security feature integrated into Anthos GKE that provides a policy enforcement chokepoint to ensure only signed and authorized images are deployed in your environment.

This capability is especially useful in this era of containerized microservices, as companies often run hundreds to thousands of jobs in production, many of them accessing sensitive and valuable data. Identity-based deployment control (restricting who can deploy) relies on human operational knowledge and trust that cannot scale to meet the needs of enterprises with automated build and release infrastructure, where deployments may happen hundreds of times a day across dozens of teams.

Binary Authorization formalizes and codifies an organization's deployment requirements by integrating with your chosen CI/CD stages to produce signatures, or "attestations", as an image passes through. Binary Authorization acts as an admission controller by preventing images that do not meet these criteria from being deployed. In addition to signature-based verification, Binary Authorization policy also supports whitelisting images using name patterns. You can specify a repository, a path, or particular set of images that are allowed to deploy.

Binary Authorization is currently available for Anthos on Google Cloud and in preview for Anthos on-prem.

Consolidated logging and monitoring

Access to logs for applications and infrastructure components is critical for running and maintaining production infrastructure. Cloud Logging (/logging) provides a unified place to store and analyze logs. Logs generated by your cluster's internal components are sent automatically to Cloud Logging.

For Anthos on Google Cloud, workloads running inside your clusters have logs automatically enriched with relevant labels like the pod labels, pod name, and cluster name that generated them. Once labeled, logs are easier to explore through advanced queries (/logging/docs/view/advanced-filters).

Also for Anthos on Google Cloud, Cloud Audit Logs (https://cloud.google.com/kubernetes-engine/docs/how-to/audit-logging) allows you to capture and analyze the interactions that your applications and human users are having with your control components.

Another key element for operating your Kubernetes environments is the ability to store metrics that provide visibility into your system's behavior and health. Kubernetes Engine Monitoring (/monitoring/kubernetes-engine) provides an automatic and idiomatic integration that stores your

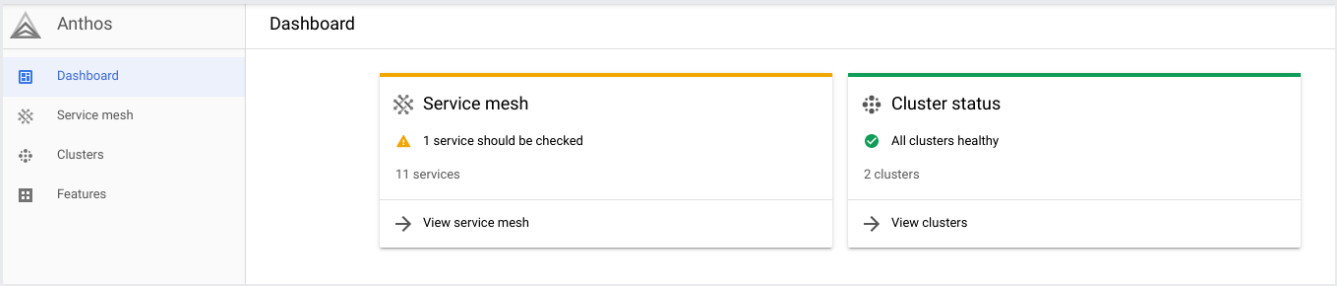
application's critical metrics for use in debugging, alerting, and post-incident analysis. For Anthos on Google Cloud, Kubernetes Engine Monitoring is enabled by default.

Anthos includes Cloud Logging and Cloud Monitoring for system components.

Cloud Audit Logs and Kubernetes Engine Monitoring are currently available only for Anthos on Google Cloud b ilable for GKE on-prem in future releases.

Unified user interface

The Anthos dashboard in the Google Cloud Console provides you with a secure, unified user interface to view and manage your applications, including an out-of-the-box structured view of all your Anthos resources. The dashboard landing page gives you a runtime status summary for all your services and clusters, and a quick getting started experience for first time users.

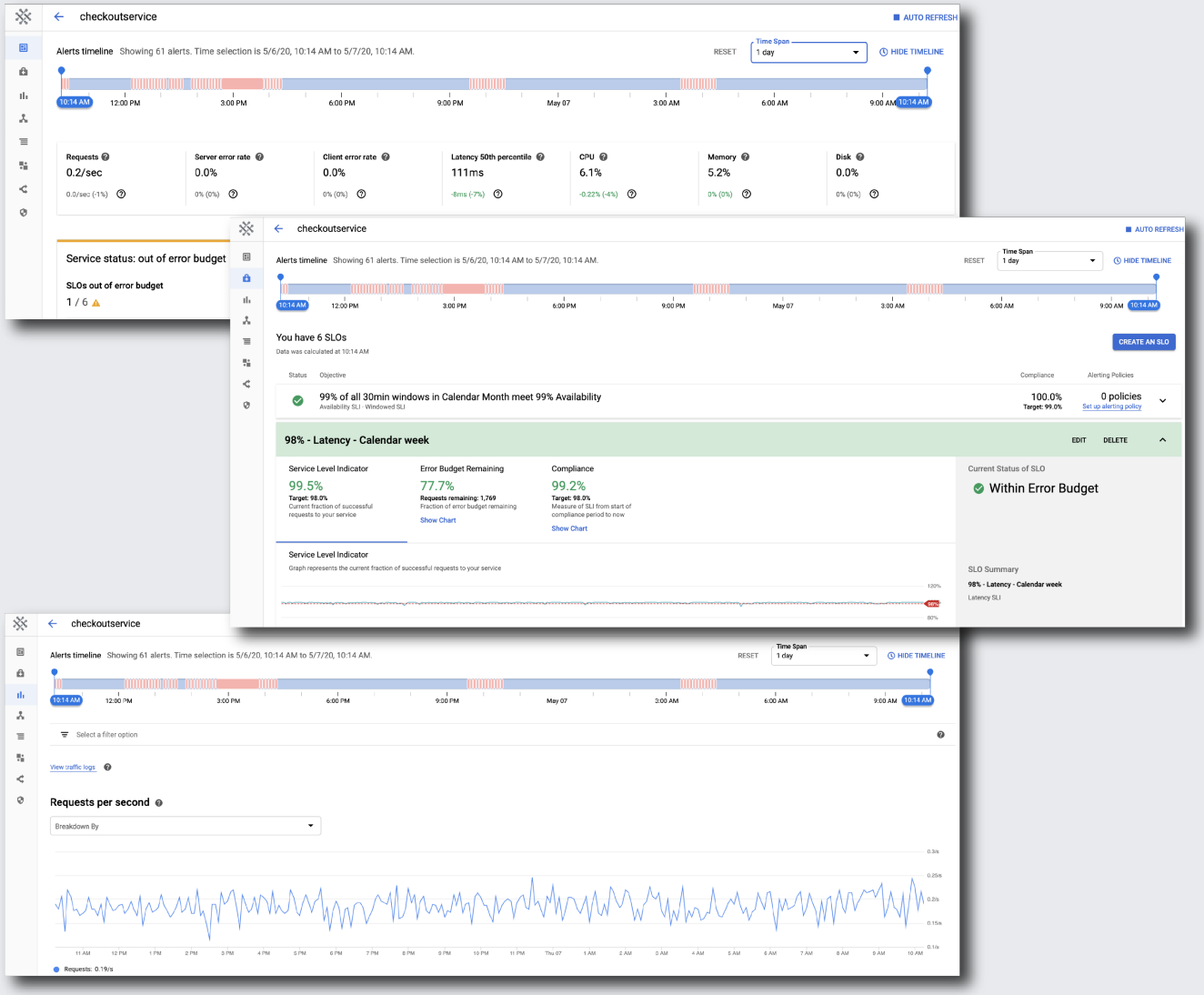


Cluster management

As the number of Kubernetes clusters in an organization increases, it can be difficult to understand what is running across each environment. The Anthos cluster management view (https://console.cloud.google.com/anthos/clusters) provides a secure console to view the state of all your registered clusters (/kubernetes-engine/docs/concepts/dashboards#kubernetes_clusters) and create new clusters for your project. You add clusters to this view by registering them with Connect to your Google Cloud project environ. GKE clusters on-premises and on AWS are registered automatically. An environ provides a unified way to view and manage your clusters and their workloads as part of Anthos, including clusters outside Google Cloud.

Service Mesh dashboard

For workloads running in GKE on Google Cloud, Anthos Service Mesh provides *observability* into the health and performance of your services. Using an adapter, Anthos Service Mesh collects and aggregates data about each service request and response, which means that service developers don't have to instrument their code to collect telemetry data or manually set up dashboards and charts. Anthos Service Mesh automatically uploads metrics and logs to Cloud Monitoring and Cloud Logging for all traffic within your cluster. This detailed telemetry enables operators to observe service behavior, and empowers them to troubleshoot, maintain, and optimize their applications.



On the Service Mesh dashboard, you can:

- Get an overview of all services in your mesh, providing you critical, service-level metrics on three of the four golden signals of monitoring

(https://landing.google.com/sre/sre-book/chapters/monitoring-distributed-systems/#xref_monitoring_golden-signals)
: latency, traffic, and errors.

- Define, review, and set alerts against service level objectives (SLOs), which summarize your service's user-visible performance.
- View metric charts for individual services and deeply analyze them with filtering and breakdowns, including by response code, protocol, destination Pod, traffic source, and more.
- Get detailed information about the endpoints for each service, and see how traffic is flowing between services, and what performance looks like for each communication edge.
- Explore a service topology graph visualization that shows your mesh's services and their relationships.

Currently, the Service Mesh dashboard is supported only for Anthos on Google Cloud clusters, and can't conne
s outside of Google Cloud.

Configuration management

The Anthos dashboard's Configuration Management view (https://console.cloud.google.com/anthos/config_management) gives you an at-a-glance overview of the configuration state of all your clusters with Anthos Config Management enabled, and allows you to quickly add the feature to clusters that haven't been set up yet. You can easily track configuration changes and see which branch and commit tag has been applied to each cluster. Flexible filters make it simple to view configuration rollout status by cluster, branch, or tag.

From this view you can also update or install Anthos Config Management on any of your Anthos clusters.

Anthos features

The Anthos dashboard's Features view (https://console.cloud.google.com/anthos/config_management) lets you view status and manage Anthos features for your registered clusters. Currently you can install Ingress for Anthos on your

registered clusters directly from this view. To enable other features, see their documentation (/anthos/docs/components).

Third-party application marketplace

The Kubernetes ecosystem is continually expanding and creating a wealth of functionality that can be enabled on top of your existing clusters. For easy installation and management of third-party applications, you can use Google Cloud Marketplace (/kubernetes-applications), which can deploy to your Anthos clusters no matter where they are running. You can also search and filter for Anthos apps and easily find Anthos compatible solutions with the Anthos badge. Cloud Marketplace solutions have direct integration with your existing Google Cloud billing and are supported directly by the software vendor.

In the marketplace solution catalog (https://console.cloud.google.com/marketplace/browse?filter=solution-type%3Ak8s), you'll find:

- Storage solutions
- Databases
- Continuous integration and delivery tools
- Monitoring solutions
- Security and compliance tools

Benefits

Anthos is a platform of distinct services that work in concert to deliver value across the entire enterprise. This section describes how it can be used by the various roles in an organization, and the benefits each group will see.

Anthos for development

For the developer, Anthos provides a state-of-the-art container management platform based on Kubernetes. Developers can use this platform to quickly and easily build and deploy existing container-based applications and microservices-based architectures.

Key benefits include:

- Git-compliant management and CI/CD workflows for configuration as well as code using Anthos Config Management.
- Code-free instrumentation (https://istio.io/docs/tasks/telemetry/) of code using Anthos Service Mesh and Cloud Monitoring and Cloud Logging to provide uniform observability.
- Code-free protection of services (https://istio.io/docs/tasks/security/) using mTLS and throttling.
- Support for Google Cloud Marketplace to quickly and easily drop off-the-shelf products into clusters.

Anthos for migration

For migration, Anthos includes Migrate for Anthos, which allows you to orchestrate migrations using Kubernetes in Anthos.

Read about the benefits of migrating to containers with Migrate for Anthos (/velostrata/docs/anthos-migrate/anthos-migrate-benefits).

Anthos for operations

For Operations, Anthos provides centralized, efficient, and templatized deployment and management of clusters, allowing the operations team to quickly provide and manage infrastructure that is compliant with corporate standards.

Key benefits include:

- Centralized configuration management and compliance with configuration-as-code and Anthos Config Management.
- Simplified deployment and rollback with Git check-ins and Anthos Config Management.
- Single pane of glass visibility across all clusters from infrastructure through to application performance and topology.

Anthos for security

For Security, Anthos provides the ability to enforce security standards on clusters, deployed applications, and even the configuration management workflow using a configuration-as-code approach and centralized management.

Key benefits include:

- Centralized, auditable, and securable workflow using Git compliant configuration repos with Anthos Config Management.
- Compliance enforcement of cluster configurations using Namespaces and inherited config with Anthos Config Management.
- Code-free securing of microservices using Anthos Service Mesh, providing in-cluster mTLS and certificate management. For workloads running in Google Kubernetes Engine on Google Cloud, certificates are provided by MeshCA.
- Built-in services protection using Anthos Service Mesh authorization and routing.

What's next

Try Anthos

- The Anthos Sample Deployment on Google Cloud (https://console.cloud.google.com/marketplace/details/click-to-deploy-images/anthos-sample-deployment) is an Anthos deployment on Google Cloud that lets you explore Anthos features following our tutorial (/anthos/docs/tutorials/explore-anthos). This is a fully setup deployment with a sample application, and just requires you to create a Google Cloud project.

Learn more

- Learn about Cloud Interconnect (/network-connectivity/docs/interconnect).
- Learn about GKE on-prem (/gke-on-prem).
- Learn about using Anthos Service Mesh (/service-mesh/docs/overview) to provide a service mesh.
- Learn about Anthos Config Management (/anthos-config-management).

Set up Anthos

- Visit our setup guides (/anthos/docs/setup/overview) to find out how to set up Anthos.

Last updated 2020-08-12 UTC.