DevOps Shack

200 Kubernetes Interview Q & A

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1. **What is Kubernetes?**
   - **Answer:** Kubernetes, also known as K8s, is an open-source platform designed to automate deploying, scaling, and operating application containers. It allows you to manage containerized applications across a cluster of nodes, providing mechanisms for deployment, maintenance, and scaling of applications.
2. **What are the main components of Kubernetes architecture?**
   - **Answer:** The main components of Kubernetes architecture include:
     - **Master Node:** This includes components like the API server, etcd (key-value store), controller manager, and scheduler.
     - **Worker Nodes:** These include the kubelet (agent running on each node), kube-proxy (networking component), and container runtime (e.g., Docker).
     - **Pods:** The smallest deployable units that can contain one or more containers.
     - **Services:** Abstractions that define a logical set of Pods and a policy to access them.
     - **Namespaces:** Provide a way to divide cluster resources between multiple users.
3. **What is a Pod in Kubernetes?**
   - **Answer:** A Pod is the smallest deployable unit in Kubernetes and represents a single instance of a running process in a cluster. A Pod can contain one or more containers that share the same network namespace and storage volumes. Pods are designed to run a single instance of an application or a single task.
4. **How does Kubernetes handle load balancing?**
   - **Answer:** Kubernetes handles load balancing through Services. A Service in Kubernetes defines a logical set of Pods and provides a stable IP and DNS name to access them. It uses label selectors to determine which Pods should

receive traffic. Kubernetes supports several types of services for load balancing:

- **ClusterIP:** Exposes the service on an internal IP in the cluster.
- **NodePort:** Exposes the service on the same port of each selected node.
- **LoadBalancer:** Exposes the service using a cloud provider's load balancer.
- **ExternalName:** Maps the service to the contents of the externalName field (e.g., a DNS name).

5. **What is a ReplicaSet in Kubernetes?**
   - **Answer:** A ReplicaSet ensures that a specified number of pod replicas are running at any given time. It can be used to scale pods up or down, replace failed pods, and ensure the desired state of the application is maintained. A ReplicaSet is defined using a YAML or JSON file, specifying the desired number of replicas and the template for the pods.
6. **What is a Deployment in Kubernetes?**
   - **Answer:** A Deployment provides declarative updates to applications and ensures that the desired number of pod replicas are running. It allows for rolling updates, rollbacks, and scaling of applications. Deployments use a Pod template to create Pods and manage the lifecycle of these Pods through ReplicaSets.
7. **Explain the difference between a ReplicaSet and a ReplicationController.**
   - **Answer:** Both ReplicaSet and ReplicationController ensure a specified number of pod replicas are running at any given time. The main difference is that ReplicaSet supports set-based selector requirements, while ReplicationController only supports equality-based selector requirements. ReplicaSet is the newer and more flexible method for ensuring pod replication.
8. **What is a StatefulSet in Kubernetes?**
   - **Answer:** StatefulSet is used for managing stateful applications that require persistent storage and stable network identities. Unlike Deployments, StatefulSets maintain a sticky identity for each of their pods, ensuring that they are created and deleted in a specific order. They are used for applications like databases that need stable storage and network identities.
9. **What are ConfigMaps in Kubernetes?**
   - **Answer:** ConfigMaps are used to store non-confidential data in key-value pairs. They are used to decouple configuration artifacts from image content to keep containerized applications portable. ConfigMaps can be consumed as environment variables, command-line arguments, or configuration files in volumes.
10. **What are Secrets in Kubernetes?**
    - **Answer:** Secrets are used to store sensitive data, such as passwords, OAuth tokens, and SSH keys. They are similar to ConfigMaps but provide additional functionalities to ensure the data is handled securely. Secrets can be encrypted at rest and are only accessible to Pods that have been explicitly granted access.

11. **How does Kubernetes handle storage?**
    - **Answer:** Kubernetes handles storage through a set of abstractions that allow Pods to request and mount storage resources. The key components include:
        - **Volumes:** Attach storage to Pods, such as emptyDir, hostPath, and network storage options like NFS.
        - **PersistentVolumes (PV):** Storage resources in the cluster that are provisioned by an administrator.
        - **PersistentVolumeClaims (PVC):** Requests for storage by a user, which can be dynamically or statically bound to a PV.
        - **StorageClasses:** Define the types of storage (e.g., SSD, HDD) and allow dynamic provisioning of PVs.
12. **What are DaemonSets in Kubernetes?**
    - **Answer:** DaemonSets ensure that a copy of a Pod runs on all (or some) nodes in the cluster. They are typically used for background processes such as logging, monitoring, and other system-level services that need to run on every node.
13. **What is the role of etcd in Kubernetes?**
    - **Answer:** etcd is a distributed key-value store that stores the configuration data of the Kubernetes cluster. It is used for service discovery and maintaining the cluster state. etcd ensures consistency across distributed systems and provides a reliable way to store and retrieve configuration data.
14. **Explain Kubernetes namespaces and their uses.**
    - **Answer:** Namespaces provide a way to divide cluster resources between multiple users or teams. They create isolated environments within the same cluster, allowing for better resource management, security, and organization. Namespaces are useful for:
        - Organizing resources by project or environment (e.g., development, testing, production).
        - Implementing access control using Kubernetes RBAC (Role-Based Access Control).
        - Limiting resource usage using ResourceQuotas and LimitRanges.
15. **What are Kubernetes Ingress resources?**
    - **Answer:** An Ingress resource manages external access to services within a cluster, typically HTTP and HTTPS traffic. It provides features such as load balancing, SSL termination, and name-based virtual hosting. Ingress rules define how traffic should be routed to services within the cluster.
16. **What is the difference between Ingress and a Service of type LoadBalancer?**
    - **Answer:**
        - **Ingress:** Provides a more flexible and powerful way to manage external access to services, allowing for path-based routing, SSL termination, and virtual hosting.
        - **LoadBalancer Service:** Provisions an external load balancer through the cloud provider to expose a service externally. It provides a single IP

address for accessing the service and handles load balancing but lacks the advanced routing and SSL features of Ingress.

17. **How does Kubernetes implement service discovery?**
    - **Answer:** Kubernetes implements service discovery using two main mechanisms:
        - **Environment Variables:** When a Pod is created, Kubernetes injects environment variables for each service into the Pod.
        - **DNS:** Kubernetes clusters have a built-in DNS server that creates DNS records for each service, allowing Pods to discover services by name.
18. **What is a Kubernetes Job and how does it differ from a Deployment?**
    - **Answer:** A Job in Kubernetes is used to run a finite workload, i.e., a task that is expected to terminate after completing its work. Jobs create one or more Pods and ensure that a specified number of them successfully terminate. Unlike Deployments, Jobs are not meant to run continuously; they are used for batch processing or one-time tasks.
19. **What are CronJobs in Kubernetes?**
    - **Answer:** CronJobs are used to run Jobs on a scheduled basis, similar to cron jobs in Unix/Linux. They automate the creation of Jobs at specific times or intervals, making them useful for tasks like backups, report generation, and periodic data processing.
20. **How do you perform a rolling update in Kubernetes?**
    - **Answer:** Rolling updates in Kubernetes are performed using Deployments. The process involves updating the Deployment's Pod template, which triggers the creation of new Pods while gradually scaling down the old Pods. This ensures zero downtime during the update. The `kubectl set image` command or updating the YAML file can initiate the rolling update.
21. **What is the purpose of the kubelet in Kubernetes?**
    - **Answer:** The kubelet is an agent that runs on each node in the Kubernetes cluster. It ensures that the containers described in PodSpecs are running and healthy. The kubelet communicates with the master components and performs tasks such as pod creation, monitoring, and reporting node status.
22. **How do you manage secrets in Kubernetes?**
    - **Answer:** Secrets in Kubernetes are managed using the Secret resource. They can be created using `kubectl create secret` command or defined in YAML files. Secrets can be accessed by Pods as environment variables or mounted as files in volumes. To ensure security, it is important to use RBAC to control access to secrets and encrypt them at rest.
23. **What is Helm in Kubernetes?**
    - **Answer:** Helm is a package manager for Kubernetes that simplifies the deployment and management of applications. Helm uses charts, which are packages of pre-configured Kubernetes resources, to deploy applications. Helm charts can be used to version, share, and update applications easily.
24. **Explain the concept of a Kubernetes Operator.**
    - **Answer:** An Operator in Kubernetes is a method for packaging, deploying, and managing a Kubernetes application. Operators extend the Kubernetes API to create, configure, and manage instances of complex applications on behalf

of the user. They leverage Custom Resource Definitions (CRDs) and controllers to manage application-specific tasks.

25. **What is a Custom Resource Definition (CRD) in Kubernetes?**
    - **Answer:** A Custom Resource Definition (CRD) allows you to define custom resources, which are extensions of the Kubernetes API. CRDs enable users to create their own API objects and manage them using standard Kubernetes tools like `kubectl`. This is often used to implement Operators and extend Kubernetes functionality.
26. **How does Kubernetes handle network policies?**
    - **Answer:** Network policies in Kubernetes are used to control the traffic flow between Pods. They define rules for allowing or denying traffic to and from Pods based on labels, namespaces, and IP ranges. Network policies are implemented by network plugins and provide a way to enforce security and isolation in the cluster.
27. **What is kube-proxy and what is its role in Kubernetes?**
    - **Answer:** kube-proxy is a network proxy that runs on each node in the Kubernetes cluster. It maintains network rules and handles the forwarding of traffic between Pods and services. kube-proxy ensures that traffic is routed correctly within the cluster and manages the network connectivity required for services to communicate.
28. **How does Kubernetes handle resource limits and requests?**
    - **Answer:** Kubernetes allows you to specify resource requests and limits for CPU and memory in Pod specifications. Resource requests indicate the minimum amount of resources needed for the Pod, while resource limits define the maximum amount of resources the Pod can consume. This helps in resource allocation and ensures fair distribution of resources among Pods.
29. **What is the role of a scheduler in Kubernetes?**
    - **Answer:** The scheduler in Kubernetes is responsible for assigning Pods to nodes based on resource availability and constraints. It evaluates Pods' resource requests and scheduling policies, then selects the most suitable node to run each Pod. The scheduler ensures efficient resource utilization and workload distribution across the cluster.
30. **What is Kubernetes federation?**
    - **Answer:** Kubernetes federation is a mechanism that allows you to manage multiple Kubernetes clusters as a single entity. It provides centralized control over multiple clusters, enabling workload distribution, high availability, and disaster recovery across geographically dispersed clusters. Federation helps achieve a multi-cluster setup with consistent configuration and policies.
31. **What are Kubernetes taints and tolerations?**
    - **Answer:** Taints and tolerations are used to control Pod placement on nodes. Taints are applied to nodes to mark them as unschedulable for certain Pods. Tolerations are applied to Pods to allow them to be scheduled on nodes with matching taints. This mechanism is useful for isolating workloads and ensuring specific Pods run on designated nodes.
32. **What is a Kubernetes context and how is it used?**

- **Answer:** A Kubernetes context is a configuration setting in the kubeconfig file that allows you to switch between multiple clusters and namespaces easily. Contexts define the cluster, user credentials, and namespace to use for `kubectl` commands. They simplify managing multiple environments and switching between them without modifying individual configurations.

33. **What are Kubernetes labels and selectors?**
    - **Answer:** Labels are key-value pairs attached to Kubernetes objects, such as Pods and Services, used for organization and identification. Selectors are used to query and filter objects based on labels. They enable you to group resources, apply configurations, and manage workloads efficiently by selecting objects with matching labels.
34. **How does Kubernetes handle logging and monitoring?**
    - **Answer:** Kubernetes handles logging and monitoring through various components and integrations:
      - **Logging:** Kubernetes supports centralized logging solutions like Fluentd, Elasticsearch, and Kibana (EFK stack), which collect and analyze logs from containers and nodes.
      - **Monitoring:** Kubernetes integrates with monitoring tools like Prometheus and Grafana to collect metrics, monitor cluster health, and visualize performance data. These tools use metrics-server, cAdvisor, and custom metrics to provide insights into cluster operations.
35. **What is a Kubernetes admission controller?**
    - **Answer:** Admission controllers are plugins that intercept requests to the Kubernetes API server before they are persisted in etcd

. They can modify or reject requests based on policies, ensuring compliance and security. Examples of admission controllers include ResourceQuota, LimitRange, and PodSecurityPolicy, which enforce resource limits and security standards.

36. **How do you perform a Kubernetes cluster upgrade?**
    - **Answer:** Performing a Kubernetes cluster upgrade involves several steps:
      - **Backup etcd:** Ensure you have a backup of the etcd data.
      - **Upgrade master components:** Upgrade the kube-apiserver, kube-controller-manager, kube-scheduler, and etcd.
      - **Upgrade worker nodes:** Upgrade kubelet and kube-proxy on each node.
      - **Verify the cluster:** Check the status and functionality of the cluster post-upgrade.
      - **Roll out application updates:** Gradually update application workloads to ensure compatibility with the new cluster version.
37. **What is Kubernetes Horizontal Pod Autoscaler (HPA)?**
    - **Answer:** The Horizontal Pod Autoscaler (HPA) automatically scales the number of Pods in a Deployment, ReplicaSet, or StatefulSet based on observed CPU utilization or other custom metrics. HPA ensures that applications can handle varying loads by adjusting the number of running instances dynamically.

38. **How do you implement blue-green deployment in Kubernetes?**
    - **Answer:** Blue-green deployment involves running two identical production environments (blue and green). At any time, only one environment is live, receiving production traffic. To implement blue-green deployment in Kubernetes:
        - Deploy the new version (green) alongside the current version (blue).
        - Verify the new version (green) works correctly.
        - Switch traffic to the green environment using a Service or Ingress.
        - Retain the blue environment for rollback if needed.
39. **What is the difference between StatefulSets and Deployments?**
    - **Answer:**
        - **StatefulSets:** Used for stateful applications that require persistent storage and stable network identities. Pods in a StatefulSet have a unique, ordered identity and are deployed in a sequential order.
        - **Deployments:** Used for stateless applications that do not require stable identities or persistent storage. Pods in a Deployment are interchangeable and can be scaled up or down without concern for order or uniqueness.
40. **How does Kubernetes manage resource quotas and limits?**
    - **Answer:** Kubernetes manages resource quotas and limits using two main resources:
        - **ResourceQuota:** Defines the total amount of resources (e.g., CPU, memory) that a namespace can consume. It helps in managing resource allocation and ensuring fair usage among namespaces.
        - **LimitRange:** Sets default request and limit values for Pods and Containers in a namespace, ensuring that resource usage stays within specified bounds. This prevents Pods from consuming excessive resources.
41. **What is the role of the Kubernetes API server?**
    - **Answer:** The Kubernetes API server is the central management entity that exposes the Kubernetes API. It handles all RESTful operations, such as creating, updating, and deleting Kubernetes resources. The API server validates and configures data for the API objects, and serves as the front-end to the cluster's shared state.
42. **How does Kubernetes handle service discovery with CoreDNS?**
    - **Answer:** CoreDNS is the default DNS server in Kubernetes. It provides service discovery by maintaining DNS records for Kubernetes Services. When a Pod needs to connect to a Service, CoreDNS resolves the Service name to its corresponding IP address, allowing the Pod to communicate with the Service seamlessly.
43. **What is the purpose of a Kubernetes Service Account?**
    - **Answer:** A Service Account provides an identity for processes running in a Pod to interact with the Kubernetes API. Each Pod can be assigned a Service Account, which determines the permissions and access levels for API requests made from the Pod. Service Accounts are essential for implementing fine-grained access control within the cluster.

44. **Explain the concept of a Kubernetes NodePort Service.**
    - **Answer:** A NodePort Service exposes a Service on the same port number across each node in the cluster. It allocates a static port on each node's IP address, allowing external traffic to reach the Service. NodePort Services are useful for testing and development but are typically combined with LoadBalancer or Ingress for production environments.
45. **How does Kubernetes handle security and authentication?**
    - **Answer:** Kubernetes handles security and authentication through several mechanisms:
        - **Authentication:** Supports various methods, including client certificates, bearer tokens, and external providers like OIDC and LDAP.
        - **Authorization:** Uses RBAC (Role-Based Access Control) to define roles and permissions for users and Service Accounts.
        - **Admission Control:** Applies policies using admission controllers to enforce security standards and compliance.
        - **Network Policies:** Controls traffic flow between Pods to implement network segmentation and isolation.
46. **What is a Kubernetes Volume and how is it used?**
    - **Answer:** A Kubernetes Volume is a directory accessible to containers in a Pod. Volumes provide persistent storage that containers can use for reading and writing data. Kubernetes supports various volume types, including emptyDir, hostPath, configMap, secret, and network storage options like NFS and Ceph.
47. **How does Kubernetes handle application updates and rollbacks?**
    - **Answer:** Kubernetes handles application updates and rollbacks using Deployments. A Deployment manages the rollout of new versions by gradually updating Pods and ensuring zero downtime. If an update fails, the Deployment can be rolled back to the previous stable version. This is achieved through the `kubectl rollout undo` command or by updating the Deployment YAML.
48. **What is a Kubernetes PersistentVolumeClaim (PVC)?**
    - **Answer:** A PersistentVolumeClaim (PVC) is a request for storage by a user. It specifies the desired storage size and access modes, and binds to a PersistentVolume (PV) that meets the requirements. PVCs abstract the underlying storage details, allowing users to request and use storage without managing the specifics of the storage backend.
49. **Explain the concept of Kubernetes RBAC (Role-Based Access Control).**
    - **Answer:** Kubernetes RBAC (Role-Based Access Control) is a method for controlling access to resources in a cluster. It uses roles and role bindings to define permissions for users and Service Accounts. Roles specify the actions that can be performed on resources, while role bindings associate roles with users or groups. RBAC ensures that users have only the necessary permissions for their tasks.
50. **How do you secure a Kubernetes cluster?**
    - **Answer:** Securing a Kubernetes cluster involves several best practices:
        - **Use RBAC:** Implement Role-Based Access Control to manage permissions.

        - **Enable Network Policies:** Control traffic flow between Pods.
        - **Use Secrets:** Store sensitive data securely using Kubernetes Secrets.
        - **Enable Audit Logging:** Monitor and log API server activities.
        - **Use Pod Security Policies:** Enforce security standards for Pods.
        - **Keep Software Updated:** Regularly update Kubernetes and its components.
        - **Use HTTPS and TLS:** Secure communication between components.
51. **What are Kubernetes Admission Webhooks?**
    - **Answer:** Admission Webhooks are HTTP callbacks that intercept API server requests before they are persisted in etcd. There are two types:
        - **Mutating Webhooks:** Modify incoming requests to enforce custom policies.
        - **Validating Webhooks:** Validate requests and reject those that do not comply with policies. Webhooks allow for dynamic admission control and custom validation logic.
52. **How does Kubernetes handle secrets encryption?**
    - **Answer:** Kubernetes supports encrypting Secrets at rest using the EncryptionConfiguration resource. This configuration specifies the encryption providers and keys to use. When enabled, Kubernetes encrypts Secrets before storing them in etcd, ensuring sensitive data is protected from unauthorized access.
53. **What is a Kubernetes ClusterIP Service?**
    - **Answer:** A ClusterIP Service is the default type of Service in Kubernetes. It exposes the Service on an internal IP address, making it accessible only within the cluster. ClusterIP Services are used for internal communication between Pods and provide a stable endpoint for accessing applications.
54. **How does Kubernetes implement container runtime interface (CRI)?**
    - **Answer:** The Container Runtime Interface (CRI) is an API that allows Kubernetes to interact with different container runtimes. It provides a standardized interface for managing container lifecycle operations. Kubernetes supports multiple CRI implementations, including Docker (via dockershim), containerd, and CRI-O.
55. **What is the role of kube-scheduler in Kubernetes?**
    - **Answer:** The kube-scheduler is responsible for assigning Pods to nodes based on resource requirements and constraints. It considers factors like resource availability, affinity/anti-affinity rules, taints, tolerations, and custom scheduling policies. The scheduler ensures efficient resource utilization and balanced workload distribution.
56. **What are Kubernetes ResourceQuotas and how are they used?**
    - **Answer:** ResourceQuotas are used to limit the resource consumption of a namespace. They define the maximum amount of resources (e.g., CPU, memory, storage) that can be used. ResourceQuotas help manage resource allocation and prevent any single namespace from monopolizing cluster resources. They are defined using YAML or JSON files and applied via the `kubectl` command.

57. **What is the purpose of Kubernetes LimitRanges?**
    - **Answer:** LimitRanges are used to set default request and limit values for CPU and memory in a namespace. They ensure that Pods and containers do not exceed specified resource usage bounds, promoting fair resource allocation and preventing resource contention. LimitRanges can also define minimum and maximum resource limits.
58. **How does Kubernetes handle container logs?**
    - **Answer:** Kubernetes handles container logs by writing stdout and stderr streams of each container

to a log file on the node's filesystem. These logs can be accessed using the `kubectl logs` command. For centralized logging, tools like Fluentd, Elasticsearch, and Kibana (EFK stack) can be used to collect, store, and analyze logs from all containers.

59. **What is the Kubernetes Pod lifecycle?**
    - **Answer:** The Kubernetes Pod lifecycle includes several phases:
        - **Pending:** The Pod is accepted by the API server but not yet scheduled.
        - **Running:** The Pod is scheduled to a node, and all containers are running.
        - **Succeeded:** All containers in the Pod have terminated successfully.
        - **Failed:** All containers in the Pod have terminated with at least one container failing.
        - **Unknown:** The state of the Pod could not be obtained due to communication issues.
60. **How do you manage Kubernetes cluster scaling?**
    - **Answer:** Kubernetes cluster scaling can be managed using:
        - **Horizontal Pod Autoscaler (HPA):** Scales the number of Pods based on metrics like CPU utilization.
        - **Cluster Autoscaler:** Adjusts the number of nodes in the cluster based on resource requests and usage. It adds nodes when there are pending Pods and removes nodes when they are underutilized.
61. **What is Kubernetes kubectl and how is it used?**
    - **Answer:** `kubectl` is the command-line tool for interacting with the Kubernetes API. It is used to manage Kubernetes resources, such as creating, updating, and deleting Pods, Services, Deployments, and more. `kubectl` provides various commands and options to facilitate cluster management and troubleshooting.
62. **What are Kubernetes ConfigMaps and how are they used?**
    - **Answer:** ConfigMaps are used to store non-confidential configuration data in key-value pairs. They allow you to decouple configuration artifacts from image content, making applications more portable. ConfigMaps can be consumed by Pods as environment variables, command-line arguments, or mounted as files in volumes.
63. **Explain the concept of Kubernetes affinity and anti-affinity.**

- **Answer:** Affinity and anti-affinity rules control Pod placement on nodes based on labels. Affinity rules specify that Pods should be scheduled on nodes with matching labels, promoting co-location of related Pods. Anti-affinity rules ensure that Pods are not scheduled on the same node, promoting distribution and reducing the risk of failure.

64. **What is Kubernetes cgroup and how is it used?**
    - **Answer:** cgroups (control groups) are a Linux kernel feature used by Kubernetes to manage and isolate resource usage of containers. They limit and prioritize CPU, memory, and I/O resources for containers, ensuring that each container operates within specified bounds. Kubernetes uses cgroups to enforce resource requests and limits defined in Pod specifications.
65. **How do you manage Kubernetes resource requests and limits?**
    - **Answer:** Resource requests and limits are specified in the Pod or container specifications. Requests indicate the minimum amount of resources needed, while limits define the maximum amount that can be consumed. Kubernetes uses these values to schedule Pods on nodes with sufficient resources and enforce limits to prevent resource overuse.
66. **What is Kubernetes kube-proxy and its role?**
    - **Answer:** kube-proxy is a network proxy that runs on each node in the Kubernetes cluster. It maintains network rules and handles traffic routing between services and Pods. kube-proxy ensures that traffic is correctly forwarded to the appropriate Pods and manages the network connectivity required for services to communicate.
67. **How does Kubernetes handle service mesh integration?**
    - **Answer:** Kubernetes integrates with service mesh technologies like Istio, Linkerd, and Consul to provide advanced traffic management, security, and observability features. Service meshes use sidecar proxies to handle service-to-service communication, enabling features like traffic routing, load balancing, security policies, and telemetry collection.
68. **What is Kubernetes kube-controller-manager?**
    - **Answer:** The kube-controller-manager is a component that runs various controllers to manage the state of the cluster. Controllers are responsible for tasks such as node management, replication, and endpoint updates. The kube-controller-manager ensures that the desired state specified in the Kubernetes API is maintained by continuously monitoring and reconciling resources.
69. **Explain the concept of Kubernetes multi-tenancy.**
    - **Answer:** Kubernetes multi-tenancy allows multiple users or teams to share a single Kubernetes cluster while maintaining isolation and security. This is achieved using namespaces, RBAC, network policies, and resource quotas. Multi-tenancy ensures that each tenant has access to their resources without interfering with others.
70. **What are Kubernetes audit logs and how are they used?**
    - **Answer:** Audit logs in Kubernetes provide a record of all requests made to the API server, including details about the requester, the action performed, and the outcome. Audit logs are used for security and compliance purposes, allowing administrators to monitor and review cluster activities. They can be

configured and stored using various backends, such as files or external logging systems.

71. **How does Kubernetes handle stateful applications?**
    - **Answer:** Kubernetes handles stateful applications using StatefulSets, which provide stable network identities, persistent storage, and ordered deployment for Pods. StatefulSets ensure that each Pod has a unique identifier and maintains its state across restarts. They are used for applications like databases that require stable storage and network connections.
72. **What is Kubernetes kube-scheduler and its role?**
    - **Answer:** The kube-scheduler is responsible for assigning Pods to nodes based on resource requirements and constraints. It considers factors like resource availability, affinity/anti-affinity rules, taints, tolerations, and custom scheduling policies. The scheduler ensures efficient resource utilization and balanced workload distribution.
73. **What are Kubernetes service endpoints?**
    - **Answer:** Service endpoints in Kubernetes represent the IP addresses and ports of the Pods that provide a Service. They are managed by the Endpoint controller, which updates the endpoint list based on the state of the Pods. Service endpoints ensure that traffic is correctly routed to the available Pods.
74. **Explain the concept of Kubernetes namespaces.**
    - **Answer:** Namespaces in Kubernetes provide a way to divide cluster resources between multiple users or teams. They create isolated environments within the same cluster, allowing for better resource management, security, and organization. Namespaces are useful for organizing resources by project or environment and implementing access control using RBAC.
75. **What is the purpose of Kubernetes kubeadm?**
    - **Answer:** kubeadm is a tool for bootstrapping a Kubernetes cluster. It provides a simple and standardized way to initialize and configure the cluster, including setting up the control plane, joining nodes, and managing cluster upgrades. kubeadm is commonly used for creating production-ready Kubernetes clusters.
76. **How does Kubernetes handle storage provisioning?**
    - **Answer:** Kubernetes handles storage provisioning through PersistentVolumes (PVs) and PersistentVolumeClaims (PVCs). PVs represent storage resources in the cluster, while PVCs are requests for storage by users. StorageClasses define the types of storage and allow for dynamic provisioning of PVs. Kubernetes automatically binds PVCs to suitable PVs, simplifying storage management.
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    - **Answer:** An Ingress resource manages external access to services within a cluster, typically HTTP and HTTPS traffic. It provides features such as load balancing, SSL termination, and name-based virtual hosting. Ingress rules define how traffic should be routed to services within the cluster.
82. **Explain the difference between Ingress and a Service of type LoadBalancer.**
    - **Answer:** Ingress provides a more flexible and powerful way to manage external access to services, allowing for path-based routing, SSL termination, and virtual hosting. A LoadBalancer Service provisions an external load balancer through the cloud provider to expose a service externally. It provides a single IP address for accessing the service and handles load balancing but lacks the advanced routing and SSL features of Ingress.
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    - **Answer:** Secrets in Kubernetes are managed using the Secret resource. They can be created using `kubectl create secret` command or defined in YAML files. Secrets can be accessed by Pods as environment variables or mounted as files in volumes. To ensure security, it is important to use RBAC to control access to secrets and encrypt them at rest.
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    - Verify the cluster: Check the status and functionality of the cluster post-upgrade.
    - Roll out application updates: Gradually update application workloads to ensure compatibility with the new cluster version.
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112. **What is a Kubernetes Volume and how is it used?** - **Answer:** A Kubernetes Volume is a directory accessible to containers in a Pod. Volumes provide persistent storage that containers can use for reading and writing data. Kubernetes supports various volume types, including emptyDir, hostPath, configMap, secret, and network storage options like NFS and Ceph.
113. **How does Kubernetes handle application updates and rollbacks?** - **Answer:** Kubernetes handles application updates and rollbacks using Deployments. A Deployment manages the rollout of new versions by gradually updating Pods and ensuring zero downtime. If an update fails, the Deployment can be rolled back to the previous stable version. This is achieved through the `kubectl rollout undo` command or by updating the Deployment YAML.
114. **What is a Kubernetes PersistentVolumeClaim (PVC)?** - **Answer:** A PersistentVolumeClaim (PVC) is a request for storage by a user. It specifies the desired storage size and access modes, and binds to a PersistentVolume (PV) that meets the requirements. PVCs abstract the underlying storage details, allowing users to request and use storage without managing the specifics of the storage backend.
115. **Explain the concept of Kubernetes RBAC (Role-Based Access Control).** - **Answer:** Kubernetes RBAC (Role-Based Access Control) is a method for controlling access to resources in a cluster. It uses roles and role bindings to define permissions for users and Service Accounts. Roles specify the actions that can be performed on resources, while role bindings associate roles with users or groups. RBAC ensures that users have only the necessary permissions for their tasks.
116. **How do you secure a Kubernetes cluster?** - **Answer:** Securing a Kubernetes cluster involves several best practices:
    - Use RBAC: Implement Role-Based Access Control to manage permissions.
    - Enable Network Policies: Control traffic flow between Pods.
    - Use Secrets: Store sensitive data securely using Kubernetes Secrets.
    - Enable Audit Logging: Monitor and log API server activities.
    - Use Pod Security Policies: Enforce security standards for Pods.
    - Keep Software Updated: Regularly update Kubernetes and its components.
    - Use HTTPS and TLS: Secure communication between components.

117. **What are Kubernetes Admission Webhooks?** - **Answer:** Admission Webhooks are HTTP callbacks that intercept API server requests before they are persisted in etcd. There are two types:
    - Mutating Webhooks: Modify incoming requests to enforce custom policies.
    - Validating Webhooks: Validate requests and reject those that do not comply with policies. Webhooks allow for dynamic admission control and custom validation logic.
118. **How does Kubernetes handle secrets encryption?** - **Answer:** Kubernetes supports encrypting Secrets at rest using the EncryptionConfiguration resource. This configuration specifies the encryption providers and keys to use. When enabled, Kubernetes encrypts Secrets before storing them in etcd, ensuring sensitive data is protected from unauthorized access.
119. **What is a Kubernetes ClusterIP Service?** - **Answer:** A ClusterIP Service is the default type of Service in Kubernetes. It exposes the Service on an internal IP address, making it accessible only within the cluster. ClusterIP Services are used for internal communication between Pods and provide a stable endpoint for accessing applications.
120. **How does Kubernetes implement container runtime interface (CRI)?** - **Answer:** The Container Runtime Interface (CRI) is an API that allows Kubernetes to interact with different container runtimes. It provides a standardized interface for managing container lifecycle operations. Kubernetes supports multiple CRI implementations, including Docker (via dockershim), containerd, and CRI-O.
121. **What is the role of kube-scheduler in Kubernetes?** - **Answer:** The kube-scheduler is responsible for assigning Pods to nodes based on resource requirements and constraints. It considers factors like resource availability, affinity/anti-affinity rules, taints, tolerations, and custom scheduling policies. The scheduler ensures efficient resource utilization and balanced workload distribution.
122. **What are Kubernetes ResourceQuotas and how are they used?** - **Answer:** ResourceQuotas are used to limit the resource consumption of a namespace. They define the maximum amount of resources (e.g., CPU, memory, storage) that can be used. ResourceQuotas help manage resource allocation and prevent any single namespace from monopolizing cluster resources. They are defined using YAML or JSON files and applied via the `kubectl` command.
123. **What is the purpose of Kubernetes LimitRanges?** - **Answer:** LimitRanges are used to set default request and limit values for CPU and memory in a namespace. They ensure that Pods and containers do not exceed specified resource usage bounds, promoting fair resource allocation and preventing resource contention. LimitRanges can also define minimum and maximum resource limits.

124. **How does Kubernetes handle container logs?** - **Answer:** Kubernetes handles container logs by writing stdout and stderr streams of each container to a log file on the node's filesystem. These logs can be accessed using the `kubectl logs` command. For centralized logging, tools like Fluentd, Elasticsearch, and Kibana (EFK stack) can be used to collect, store, and analyze logs from all containers.
125. **What is the Kubernetes Pod lifecycle?** - **Answer:** The Kubernetes Pod lifecycle includes several phases:
    - Pending: The Pod is accepted by the API server but not yet scheduled.
    - Running: The Pod is scheduled to a node, and all containers are running.
    - Succeeded: All containers in the Pod have terminated successfully.
    - Failed: All containers in the Pod have terminated with at least one container failing.
    - Unknown: The state of the Pod could not be obtained due to communication issues.
126. **How do you manage Kubernetes cluster scaling?** - **Answer:** Kubernetes cluster scaling can be managed using:
    - Horizontal Pod Autoscaler (HPA): Scales the number of Pods based on metrics like CPU utilization.
    - Cluster Autoscaler: Adjusts the number of nodes in the cluster based on resource requests and usage. It adds nodes when there are pending Pods and removes nodes when they are underutilized.
127. **What is Kubernetes kubectl and how is it used?** - **Answer:** `kubectl` is the command-line tool for interacting with the Kubernetes API. It is used to manage Kubernetes resources, such as creating, updating, and deleting Pods, Services, Deployments, and more. `kubectl` provides various commands and options to facilitate cluster management and troubleshooting.
128. **What are Kubernetes ConfigMaps and how are they used?** - **Answer:** ConfigMaps are used to store non-confidential configuration data in key-value pairs. They allow you to decouple configuration artifacts from image content, making applications more portable. ConfigMaps can be consumed by Pods as environment variables, command-line arguments, or mounted as files in volumes.
129. **Explain the concept of Kubernetes affinity and anti-affinity.** - **Answer:** Affinity and anti-affinity rules control Pod placement on nodes based on labels. Affinity rules specify that Pods should be scheduled on nodes with matching labels, promoting co-location of related Pods. Anti-affinity rules ensure that Pods are not scheduled on the same node, promoting distribution and reducing the risk of failure.
130. **What is Kubernetes cgroup and how is it used?** - **Answer:** cgroups (control groups) are a Linux kernel feature used by Kubernetes to manage and isolate resource usage of containers. They limit and prioritize CPU, memory, and I/O resources for containers, ensuring that each container operates within

specified bounds. Kubernetes uses cgroups to enforce resource requests and limits defined in Pod specifications.

131. **How do you manage Kubernetes resource requests and limits?** - **Answer:** Resource requests and limits are specified in the Pod or container specifications. Requests indicate the minimum amount of resources needed, while limits define the maximum amount that can be consumed. Kubernetes uses these values to schedule Pods on nodes with sufficient resources and enforce limits to prevent resource overuse.
132.

What is Kubernetes kube-proxy and its role? - **Answer:** kube-proxy is a network proxy that runs on each node in the Kubernetes cluster. It maintains network rules and handles traffic routing between services and Pods. kube-proxy ensures that traffic is correctly forwarded to the appropriate Pods and manages the network connectivity required for services to communicate.

133. **How does Kubernetes handle service mesh integration?** - **Answer:** Kubernetes integrates with service mesh technologies like Istio, Linkerd, and Consul to provide advanced traffic management, security, and observability features. Service meshes use sidecar proxies to handle service-to-service communication, enabling features like traffic routing, load balancing, security policies, and telemetry collection.
134. **What is Kubernetes kube-controller-manager?** - **Answer:** The kube-controller-manager is a component that runs various controllers to manage the state of the cluster. Controllers are responsible for tasks such as node management, replication, and endpoint updates. The kube-controller-manager ensures that the desired state specified in the Kubernetes API is maintained by continuously monitoring and reconciling resources.
135. **Explain the concept of Kubernetes multi-tenancy.** - **Answer:** Kubernetes multi-tenancy allows multiple users or teams to share a single Kubernetes cluster while maintaining isolation and security. This is achieved using namespaces, RBAC, network policies, and resource quotas. Multi-tenancy ensures that each tenant has access to their resources without interfering with others.
136. **What are Kubernetes audit logs and how are they used?** - **Answer:** Audit logs in Kubernetes provide a record of all requests made to the API server, including details about the requester, the action performed, and the outcome. Audit logs are used for security and compliance purposes, allowing administrators to monitor and review cluster activities. They can be configured and stored using various backends, such as files or external logging systems.
137. **How does Kubernetes handle stateful applications?** - **Answer:** Kubernetes handles stateful applications using

StatefulSets, which provide stable network identities, persistent storage, and ordered deployment for Pods. StatefulSets ensure that each Pod has a unique identifier and maintains its state across restarts. They are used for applications like databases that require stable storage and network connections.

138. **What is Kubernetes kube-scheduler and its role?** - **Answer:** The kube-scheduler is responsible for assigning Pods to nodes based on resource requirements and constraints. It considers factors like resource availability, affinity/anti-affinity rules, taints, tolerations, and custom scheduling policies. The scheduler ensures efficient resource utilization and balanced workload distribution.
139. **What are Kubernetes service endpoints?** - **Answer:** Service endpoints in Kubernetes represent the IP addresses and ports of the Pods that provide a Service. They are managed by the Endpoint controller, which updates the endpoint list based on the state of the Pods. Service endpoints ensure that traffic is correctly routed to the available Pods.
140. **Explain the concept of Kubernetes namespaces.** - **Answer:** Namespaces in Kubernetes provide a way to divide cluster resources between multiple users or teams. They create isolated environments within the same cluster, allowing for better resource management, security, and organization. Namespaces are useful for organizing resources by project or environment and implementing access control using RBAC.
141. **What is the purpose of Kubernetes kubeadm?** - **Answer:** kubeadm is a tool for bootstrapping a Kubernetes cluster. It provides a simple and standardized way to initialize and configure the cluster, including setting up the control plane, joining nodes, and managing cluster upgrades. kubeadm is commonly used for creating production-ready Kubernetes clusters.
142. **How does Kubernetes handle storage provisioning?** - **Answer:** Kubernetes handles storage provisioning through PersistentVolumes (PVs) and PersistentVolumeClaims (PVCs). PVs represent storage resources in the cluster, while PVCs are requests for storage by users. StorageClasses define the types of storage and allow for dynamic provisioning of PVs. Kubernetes automatically binds PVCs to suitable PVs, simplifying storage management.
143. **What are Kubernetes taints and tolerations?** - **Answer:** Taints and tolerations are used to control Pod placement on nodes. Taints are applied to nodes to mark them as unschedulable for certain Pods. Tolerations are applied to Pods to allow them to be scheduled on nodes with matching taints. This mechanism is useful for isolating workloads and ensuring specific Pods run on designated nodes.
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145. **What is the role of etcd in Kubernetes?** - **Answer:** etcd is a distributed key-value store that stores the configuration data of the Kubernetes cluster. It is used for service discovery and maintaining the cluster state. etcd ensures consistency across distributed systems and provides a reliable way to store and retrieve configuration data.
146. **How does Kubernetes handle load balancing?** - **Answer:** Kubernetes handles load balancing through Services. A Service defines a logical set of Pods and provides a stable IP and DNS name to access them. It uses label selectors to determine which Pods should receive traffic. Kubernetes supports several types of services for load balancing, including ClusterIP, NodePort, and LoadBalancer.
147. **What is a Kubernetes Ingress resource?** - **Answer:** An Ingress resource manages external access to services within a cluster, typically HTTP and HTTPS traffic. It provides features such as load balancing, SSL termination, and name-based virtual hosting. Ingress rules define how traffic should be routed to services within the cluster.
148. **Explain the difference between Ingress and a Service of type LoadBalancer.** - **Answer:** Ingress provides a more flexible and powerful way to manage external access to services, allowing for path-based routing, SSL termination, and virtual hosting. A LoadBalancer Service provisions an external load balancer through the cloud provider to expose a service externally. It provides a single IP address for accessing the service and handles load balancing but lacks the advanced routing and SSL features of Ingress.
149. **How does Kubernetes implement service discovery?** - **Answer:** Kubernetes implements service discovery using two main mechanisms:
    - Environment Variables: When a Pod is created, Kubernetes injects environment variables for each service into the Pod.
    - DNS: Kubernetes clusters have a built-in DNS server that creates DNS records for each service, allowing Pods to discover services by name.
150. **What is a Kubernetes Job and how does it differ from a Deployment?** - **Answer:** A Job in Kubernetes is used to run a finite workload, i.e., a task that is expected to terminate after completing its work. Jobs create one or more Pods and ensure that a specified number of them successfully terminate. Unlike Deployments, Jobs are not meant to run continuously; they are used for batch processing or one-time tasks.
151. **What are Kubernetes CronJobs?** - **Answer:** CronJobs are used to run Jobs on a scheduled basis, similar to cron jobs in Unix/Linux. They automate the creation of Jobs at specific times or intervals, making them useful for tasks like backups, report generation, and periodic data processing.

152. **How do you perform a rolling update in Kubernetes?** - **Answer:** Rolling updates in Kubernetes are performed using Deployments. The process involves updating the Deployment's Pod template, which triggers the creation of new Pods while gradually scaling down the old Pods. This ensures zero downtime during the update. The `kubectl set image` command or updating the YAML file can initiate the rolling update.
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- Network Policies: Controls traffic flow between Pods to implement network segmentation and isolation.

178. **What is a Kubernetes Volume and how is it used?** - **Answer:** A Kubernetes Volume is a directory accessible to containers in a Pod. Volumes provide persistent storage that containers can use for reading and writing data. Kubernetes supports various volume types, including emptyDir, hostPath, configMap, secret, and network storage options like NFS and Ceph.
179. **How does Kubernetes handle application updates and rollbacks?** - **Answer:** Kubernetes handles application updates and rollbacks using Deployments. A Deployment manages the rollout of new versions by gradually updating Pods and ensuring zero downtime. If an update fails, the Deployment can be rolled back to the previous stable version. This is achieved through the `kubectl rollout undo` command or by updating the Deployment YAML.
180. **What is a Kubernetes PersistentVolumeClaim (PVC)?** - **Answer:** A PersistentVolumeClaim (PVC) is a request for storage by a user. It specifies the desired storage size and access modes, and binds to a PersistentVolume (PV) that meets the requirements. PVCs abstract the underlying storage details, allowing users to request and use storage without managing the specifics of the storage backend.
181. **Explain the concept of Kubernetes RBAC (Role-Based Access Control).** - **Answer:** Kubernetes RBAC (Role-Based Access Control) is a method for controlling access to resources in a cluster. It uses roles and role bindings to define permissions for users and Service Accounts. Roles specify the actions that can be performed on resources,

while role bindings associate roles with users or groups. RBAC ensures that users have only the necessary permissions for their tasks.

182. **How do you secure a Kubernetes cluster?** - **Answer:** Securing a Kubernetes cluster involves several best practices:
    - Use RBAC: Implement Role-Based Access Control to manage permissions.
    - Enable Network Policies: Control traffic flow between Pods.
    - Use Secrets: Store sensitive data securely using Kubernetes Secrets.
    - Enable Audit Logging: Monitor and log API server activities.
    - Use Pod Security Policies: Enforce security standards for Pods.
    - Keep Software Updated: Regularly update Kubernetes and its components.

    - Use HTTPS and TLS: Secure communication between components.
183. **What are Kubernetes Admission Webhooks?** - **Answer:** Admission Webhooks are HTTP callbacks that intercept API server requests before they are persisted in etcd. There are two types:
    - Mutating Webhooks: Modify incoming requests to enforce custom policies.
    - Validating Webhooks: Validate requests and reject those that do not comply with policies. Webhooks allow for dynamic admission control and custom validation logic.
184. **How does Kubernetes handle secrets encryption?** - **Answer:** Kubernetes supports encrypting Secrets at rest using the EncryptionConfiguration resource. This configuration specifies the encryption providers and keys to use. When enabled, Kubernetes encrypts Secrets before storing them in etcd, ensuring sensitive data is protected from unauthorized access.
185. **What is a Kubernetes ClusterIP Service?** - **Answer:** A ClusterIP Service is the default type of Service in Kubernetes. It exposes the Service on an internal IP address, making it accessible only within the cluster. ClusterIP Services are used for internal communication between Pods and provide a stable endpoint for accessing applications.
186. **How does Kubernetes implement container runtime interface (CRI)?** - **Answer:** The Container Runtime Interface (CRI) is an API that allows Kubernetes to interact with different container runtimes. It provides a standardized interface for managing container lifecycle operations. Kubernetes supports multiple CRI implementations, including Docker (via dockershim), containerd, and CRI-O.
187. **What is the role of kube-scheduler in Kubernetes?** - **Answer:** The kube-scheduler is responsible for assigning Pods to nodes based on resource requirements and constraints. It considers factors like resource availability, affinity/anti-affinity rules, taints, tolerations, and custom scheduling policies. The scheduler ensures efficient resource utilization and balanced workload distribution.
188. **What are Kubernetes ResourceQuotas and how are they used?** - **Answer:** ResourceQuotas are used to limit the resource consumption of a namespace. They define the maximum amount of resources (e.g., CPU, memory, storage) that can be used. ResourceQuotas help manage resource allocation and prevent any single namespace from monopolizing cluster resources. They are defined using YAML or JSON files and applied via the `kubectl` command.
189. **What is the purpose of Kubernetes LimitRanges?** - **Answer:** LimitRanges are used to set default request and limit values for CPU and memory in a namespace. They ensure that Pods and containers do not exceed specified resource usage bounds, promoting fair

resource allocation and preventing resource contention. LimitRanges can also define minimum and maximum resource limits.

190. **How does Kubernetes handle container logs?** - **Answer:** Kubernetes handles container logs by writing stdout and stderr streams of each container to a log file on the node's filesystem. These logs can be accessed using the `kubectl logs` command. For centralized logging, tools like Fluentd, Elasticsearch, and Kibana (EFK stack) can be used to collect, store, and analyze logs from all containers.
191. **What is the Kubernetes Pod lifecycle?** - **Answer:** The Kubernetes Pod lifecycle includes several phases:
    - Pending: The Pod is accepted by the API server but not yet scheduled.
    - Running: The Pod is scheduled to a node, and all containers are running.
    - Succeeded: All containers in the Pod have terminated successfully.
    - Failed: All containers in the Pod have terminated with at least one container failing.
    - Unknown: The state of the Pod could not be obtained due to communication issues.
192. **How do you manage Kubernetes cluster scaling?** - **Answer:** Kubernetes cluster scaling can be managed using:
    - Horizontal Pod Autoscaler (HPA): Scales the number of Pods based on metrics like CPU utilization.
    - Cluster Autoscaler: Adjusts the number of nodes in the cluster based on resource requests and usage. It adds nodes when there are pending Pods and removes nodes when they are underutilized.
193. **What is Kubernetes kubectl and how is it used?** - **Answer:** `kubectl` is the command-line tool for interacting with the Kubernetes API. It is used to manage Kubernetes resources, such as creating, updating, and deleting Pods, Services, Deployments, and more. `kubectl` provides various commands and options to facilitate cluster management and troubleshooting.
194. **What are Kubernetes ConfigMaps and how are they used?** - **Answer:** ConfigMaps are used to store non-confidential configuration data in key-value pairs. They allow you to decouple configuration artifacts from image content, making applications more portable. ConfigMaps can be consumed by Pods as environment variables, command-line arguments, or mounted as files in volumes.
195. **Explain the concept of Kubernetes affinity and anti-affinity.** - **Answer:** Affinity and anti-affinity rules control Pod placement on nodes based on labels. Affinity rules specify that Pods should be scheduled on nodes with matching labels, promoting co-location of related Pods. Anti-affinity rules ensure that Pods are not scheduled on the same node, promoting distribution and reducing the risk of failure.
196. **What is Kubernetes cgroup and how is it used?** - **Answer:** cgroups (control groups) are a Linux kernel feature used by Kubernetes to manage and

isolate resource usage of containers. They limit and prioritize CPU, memory, and I/O resources for containers, ensuring that each container operates within specified bounds. Kubernetes uses cgroups to enforce resource requests and limits defined in Pod specifications.

197. **How do you manage Kubernetes resource requests and limits?** - **Answer:** Resource requests and limits are specified in the Pod or container specifications. Requests indicate the minimum amount of resources needed, while limits define the maximum amount that can be consumed. Kubernetes uses these values to schedule Pods on nodes with sufficient resources and enforce limits to prevent resource overuse.
198. **What is Kubernetes kube-proxy and its role?** - **Answer:** kube-proxy is a network proxy that runs on each node in the Kubernetes cluster. It maintains network rules and handles traffic routing between services and Pods. kube-proxy ensures that traffic is correctly forwarded to the appropriate Pods and manages the network connectivity required for services to communicate.
199. **How does Kubernetes handle service mesh integration?** - **Answer:** Kubernetes integrates with service mesh technologies like Istio, Linkerd, and Consul to provide advanced traffic management, security, and observability features. Service meshes use sidecar proxies to handle service-to-service communication, enabling features like traffic routing, load balancing, security policies, and telemetry collection.
200. **What is Kubernetes kube-controller-manager?** - **Answer:** The kube-controller-manager is a component that runs various controllers to manage the state of the cluster. Controllers are responsible for tasks such as node management, replication, and endpoint updates. The kube-controller-manager ensures that the desired state specified in the Kubernetes API is maintained by continuously monitoring and reconciling resources.