Kubernetes Frequently Asked Questions – Interview Readiness Guide for 3 YoE Cloud/ DevOps Engineer

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Q1. What is Kubernetes, and why is it used?

Technical Answer:
Kubernetes (K8s) is an open-source container orchestration platform originally developed by Google, now maintained by CNCF. It automates the deployment, scaling, and management of containerized applications. Kubernetes abstracts infrastructure, meaning applications can run seamlessly across cloud or on-prem environments. It handles container scheduling, networking, load balancing, and self-healing, helping organizations deploy services faster and with high availability.

Analogy:
Think of Kubernetes as a factory supervisor. Instead of manually assigning workers (containers) to stations, the supervisor automates staffing, ensures workers are healthy, and moves them between lines if needed.

Key Takeaway:
Kubernetes solves container sprawl, reduces manual ops work, and is essential for microservices at scale.

Q2. What are the key features of Kubernetes?

Technical Answer:
Kubernetes offers:

1. **Self-healing:** Automatically restarts failed containers and replaces crashed nodes.
2. **Horizontal Scaling:** Easily scale applications up or down based on traffic.
3. **Service Discovery & Load Balancing:** Routes traffic to healthy Pods automatically.
4. **Automated Rollouts & Rollbacks:** Ensures zero-downtime deployments.
5. **Infrastructure Abstraction:** Consistent platform across cloud/on-prem.
6. **Declarative Configuration:** YAML/JSON defines desired state, Kubernetes enforces it.

Analogy:
Like a smart traffic system that detects broken signals, diverts traffic, and opens new lanes dynamically.

Key Takeaway:
Kubernetes is more than a container manager, it's a **complete orchestration system** for high availability and scalability.

Q3. How does Kubernetes differ from Docker?

Technical Answer:
Docker is a **container runtime** that packages and runs containers. Kubernetes is an **orchestration layer** that manages these containers across multiple hosts. Docker ensures apps run in isolated environments; Kubernetes ensures these apps scale, communicate, and recover automatically. While Docker Swarm also offers orchestration, Kubernetes dominates because of its ecosystem, scalability, and features like operators and CRDs.

Analogy:
Docker is like a shipping container; Kubernetes is the entire port system that manages thousands of containers, ships, and routes.

Key Takeaway:
You **use Docker to create and run containers**, but Kubernetes is what makes running thousands of them practical.

Q4. Explain Kubernetes architecture.

Technical Answer:
Kubernetes follows a **Master-Worker architecture**:

- **Control Plane Components:**

  API Server: Entry point for cluster operations.

  Scheduler: Decides which node runs a Pod.

  Controller Manager: Ensures desired state (replicas, jobs, etc.).

  etcd: Distributed key-value store for cluster state.

- **Worker Nodes:** Run application workloads using **kubelet** and container runtime. Networking is flat; all Pods can talk to each other without NAT.

Analogy:
The control plane is like city planners; worker nodes are the neighborhoods where houses (Pods) are built.

Key Takeaway:
Kubernetes separates **cluster management (control plane)** from **workloads (worker nodes)**, making scaling seamless.

Q5. What is a Pod in Kubernetes?

Technical Answer:
A Pod is the smallest deployable unit in Kubernetes that represents one or more tightly coupled containers. Pods share the same network namespace and storage volumes, making communication between containers inside a Pod easy. Kubernetes schedules Pods, not containers, to nodes. Pods are ephemeral, when they die, a new one is created.

Analogy:
Think of a Pod as a small house; each room (container) shares the same utilities like water and electricity (network and storage).

Key Takeaway:
Pods provide **abstraction over containers**, allowing orchestration, scaling, and networking.

Q6. What is a ReplicaSet?

Technical Answer:
A ReplicaSet ensures a defined number of identical Pods are running at all times. If a Pod crashes, the ReplicaSet creates a replacement. While you can use ReplicaSets directly, Deployments are preferred as they manage ReplicaSets automatically for rolling updates and rollbacks.

Analogy:
A ReplicaSet is like a headcount manager ensuring there are always exactly five waiters in a restaurant, if one leaves, another is brought in.

Key Takeaway:
ReplicaSets guarantee availability by maintaining a desired Pod count.

Q7. What is a Deployment in Kubernetes?

Technical Answer:
A Deployment provides declarative updates for Pods and ReplicaSets. It allows rolling

updates, rollback to previous versions, and zero-downtime releases. Developers define a **desired state** in YAML; Kubernetes adjusts the cluster to match.

Analogy:
If ReplicaSets are managers keeping staff numbers steady, a Deployment is the HR team planning hiring waves and training schedules.

Key Takeaway:
Deployments simplify scaling, updating, and recovering apps with minimal effort.

Q8. What is a Service in Kubernetes?

Technical Answer:
A Service is an abstraction that exposes Pods over a stable IP and DNS name. Since Pods are ephemeral and IPs change, Services ensure a consistent entry point. Types include **ClusterIP** (internal access), **NodePort** (basic external access), and **LoadBalancer** (cloud-managed external access).

Analogy:
A Service is like a receptionist at a company who always has the same phone number, even when staff changes.

Key Takeaway:
Services enable **reliable communication** between components in a dynamic Kubernetes cluster.

Q9. Differentiate ClusterIP, NodePort, and LoadBalancer.

Technical Answer:

- **ClusterIP:** Default; exposes a Service only within the cluster.
- **NodePort:** Opens a static port (30000–32767) on all nodes for external traffic.
- **LoadBalancer:** Integrates with cloud load balancers to provide a single external IP.

Analogy:
ClusterIP is like an office phone line only used internally; NodePort is a direct extension line outsiders can call; LoadBalancer is a receptionist routing calls to staff.

Key Takeaway:
ClusterIP = internal, NodePort = basic external, LoadBalancer = production-ready external access.

Q10. What is the difference between ReplicaSet and Deployment?

Technical Answer:
ReplicaSet only ensures Pod availability. It doesn't support rolling updates or version history. A Deployment manages ReplicaSets, providing declarative updates, rollbacks, and strategies like blue/green or canary deployments.

Analogy:
A ReplicaSet is a simple counter ensuring staff numbers; a Deployment is a full HR department managing recruitment waves and version upgrades.

Key Takeaway:
Always use **Deployments** for stateless apps; ReplicaSets are low-level constructs.

Q11. How does Kubernetes achieve service discovery?

Technical Answer:
Kubernetes creates a DNS entry for each Service. Pods can access other Services by DNS names like service-name.namespace.svc.cluster.local. The **kube-dns** or **CoreDNS** add-ons handle resolution. Environment variables for services are also injected into Pods.

Analogy:
Like an internal phone directory; every new employee (Pod) gets a consistent contact extension for a department (Service).

Key Takeaway:
DNS-based service discovery simplifies communication without hardcoding IPs.

Q12. What is kube-proxy?

Technical Answer:
kube-proxy runs on every node and handles Service networking. It configures iptables or IPVS rules to route external/internal traffic to the right Pods. Without kube-proxy, Services would not be reachable.

Analogy:
It's like a traffic cop at every intersection ensuring drivers (requests) reach the correct destination (Pods).

Key Takeaway:
kube-proxy is essential for load balancing and Service routing.

Q13. What is etcd in Kubernetes?

Technical Answer:
etcd is a highly available, distributed key-value store used by Kubernetes to store all cluster configuration and state. If etcd fails, the cluster loses its brain. Backing up etcd is critical for disaster recovery.

Analogy:
Think of etcd as the master ledger of a bank. Every transaction (Pod creation, scaling, etc.) is written here.

Key Takeaway:
Protect etcd, it's the single source of truth for your cluster.

Q14. What are Namespaces in Kubernetes?

Technical Answer:
Namespaces logically divide a cluster into isolated environments. Teams can create resources in separate namespaces without affecting each other. Resource quotas and network policies often leverage namespaces for multi-tenancy.

Analogy:
Namespaces are like separate departments in a company, each with its own budget and projects.

Key Takeaway:
Namespaces improve organization, security, and multi-tenancy.

Q15. What is a Node in Kubernetes?

Technical Answer:
A Node is a worker machine (VM or physical) that runs Pods. Each node runs a kubelet, container runtime, and kube-proxy. Control Plane nodes manage the cluster but don't usually run workloads.

Analogy:
A Node is a hotel floor; Pods are rooms, and kubelet is the floor manager.

Key Takeaway:
Nodes provide the compute resources for Pods.

Q16. What is kubelet?

Technical Answer:
The kubelet is an agent that runs on every node, communicating with the API server. It ensures containers described in PodSpecs are running, healthy, and ready.

Analogy:
If Kubernetes is a city, kubelet is the building supervisor ensuring all tenants (Pods) are safe and functioning.

Key Takeaway:
Kubelet enforces Pod specifications at the node level.

Q17. What are Labels and Selectors?

Technical Answer:
Labels are key-value pairs attached to Kubernetes objects (Pods, Services, etc.). Selectors query objects by labels to enable service discovery, scaling, or automation.

Analogy:
Labels are like name tags on employees; selectors are filters like “find all engineers in HR.”

Key Takeaway:
Labels and selectors are the glue that binds Kubernetes automation.

Q18. What is a DaemonSet?

Technical Answer:
A DaemonSet ensures a copy of a Pod runs on every node (or subset of nodes). It’s commonly used for log collection, monitoring agents, and networking services.

Analogy:
Think of security guards stationed on every floor of a building, regardless of tenant changes.

Key Takeaway:
DaemonSets are perfect for node-level services like monitoring or security.

Q19. What is a StatefulSet?

Technical Answer:
StatefulSets manage stateful applications, giving each Pod a persistent identity and stable storage. Unlike Deployments, Pods have sticky names and ordered scaling.

Analogy:
It's like assigning permanent seats to students; even if they leave temporarily, they return to the same desk.

Key Takeaway:
StatefulSets are essential for databases and apps needing persistent identity.

Q20. Explain Kubernetes Ingress.

Technical Answer:
Ingress is an API object that manages external HTTP/S access to services. Instead of exposing multiple NodePorts, Ingress consolidates routing with a single entry point and rules for domains and paths.

Analogy:
Ingress is like a receptionist at a company who not only answers calls but routes them to the correct department based on caller requests.

Key Takeaway:
Ingress simplifies and centralizes routing for multiple services.

Q21. What is the difference between a Pod and a Container?

Technical Answer (Deep):
A **container** is a lightweight, isolated runtime environment for your application, created by container runtimes like Docker, containerd, or CRI-O. A **Pod**, on the other hand, is a higher-level Kubernetes abstraction that encapsulates one or more tightly coupled containers, along with shared networking and storage resources.

- **Networking:** Each Pod gets its own IP, and containers inside the same Pod share the same network namespace.

- **Storage:** Pods can mount shared volumes, enabling inter-container communication through files.
- **Lifecycle:** Kubernetes schedules Pods (not containers) to Nodes, and Pods are ephemeral, new Pods get new IPs when rescheduled.
- **Scalability:** Pods are designed to represent a single unit of deployment (one app component), while multiple Pods are scaled to serve load.

Analogy:
A container is a single tenant in an apartment; a Pod is the entire apartment unit that may house one or multiple roommates who share utilities like Wi-Fi and kitchen space.

Key Takeaway:
Pods are Kubernetes' smallest deployable unit, abstracting containers for scheduling and networking.

Q22. How does Kubernetes schedule a Pod?

Technical Answer (Deep):
When you create a Pod, the API Server stores it in **etcd**, and the Scheduler watches for unscheduled Pods. The Scheduler uses multiple factors to select a node:

1. **Node Resources:** CPU, memory requests vs. available capacity.
2. **Node Selectors & Affinity:** User-specified rules for Pod placement.
3. **Taints & Tolerations:** Used to repel or allow specific workloads.
4. **Topology & Load Distribution:** Ensures Pods are spread evenly across nodes.
   Once a Node is chosen, the PodSpec is sent to the node's **kubelet**, which pulls images, creates containers, and reports Pod status back to the API server.

Analogy:
Imagine a logistics company assigning delivery trucks (nodes) based on available storage space, proximity, and special conditions like refrigeration needs.

Key Takeaway:
Scheduling is dynamic and rule-driven, ensuring efficient resource use and high availability.

Q23. What are Taints and Tolerations in Kubernetes?

Technical Answer (Deep):

- **Taints:** Applied to nodes to **repel** certain Pods. They define conditions that Pods must explicitly tolerate to run on a node.

- **Tolerations:** Set on Pods to match node taints, allowing exceptions.
- Syntax example:
- kubectl taint nodes node1 key=value:NoSchedule

  Only Pods with a matching toleration can run there.

- Used for dedicating nodes to specific workloads (e.g., GPU nodes for ML).

Analogy:
Taints are like "No Entry" signs on a room; tolerations are special passes that allow certain people to enter.

Key Takeaway:
Taints & Tolerations provide **fine-grained control over Pod placement**, critical in production.

Q24. What are Node Affinity and Anti-Affinity?

Technical Answer (Deep):

- **Node Affinity:** Soft/Hard rules that tell Kubernetes **where** to place Pods based on node labels.
  - requiredDuringSchedulingIgnoredDuringExecution: Hard requirement.
  - preferredDuringSchedulingIgnoredDuringExecution: Soft preference.
- **Pod Anti-Affinity:** Prevents placing multiple Pods on the same node for HA.
- Example use: Spread replicas across Availability Zones.

Analogy:
Think of it as Airbnb filters: "Must have Wi-Fi" (hard requirement) or "Prefer pool" (soft preference).

Key Takeaway:
Affinity and Anti-Affinity ensure **fault tolerance and intelligent workload distribution**.

Q25. Explain Horizontal Pod Autoscaler (HPA).

Technical Answer (Deep):
HPA automatically scales Pods based on metrics like CPU utilization, memory, or custom metrics from Prometheus.

1. You define targetCPUUtilizationPercentage.

2. The **metrics server** gathers resource usage.
3. Kubernetes scales replicas up or down accordingly.
4. It requires Deployments or ReplicaSets (not standalone Pods).

Example:

```
kubectl autoscale deployment demo --cpu-percent=50 --min=2 --max=10
```

Analogy:
Like a thermostat that turns air conditioners on/off automatically based on temperature (CPU load).

Key Takeaway:
HPA enables **automatic scaling**, optimizing performance and costs.

Q26. How do you perform a rolling update in Kubernetes?

Technical Answer (Deep):

- **Rolling Updates:** Deployments gradually replace Pods with new ones, ensuring at least some Pods are always running.
- You control `maxSurge` (extra Pods during updates) and `maxUnavailable` (how many can be offline).
- Rollback is supported using:
- `kubectl rollout undo deployment demo`
- Achieves **zero-downtime releases** if configured correctly.

Analogy:
Imagine replacing bus drivers one by one instead of shutting down the whole transport service at once.

Key Takeaway:
Rolling updates are **safe and gradual**, avoiding outages during deployments.

Q27. What is a Kubernetes Job vs. CronJob?

Technical Answer (Deep):

- **Job:** Ensures a Pod runs to completion (one-time tasks).
- **CronJob:** Schedules Jobs at fixed intervals (like a cron scheduler).
- Examples:
    - Job: Data migration scripts.

    - CronJob: Daily database backups.
- Syntax example for CronJob:
- schedule: "0 0 * * *"

Analogy:
Jobs are like running errands once; CronJobs are recurring calendar reminders.

Key Takeaway:
Jobs ensure reliable one-time execution; CronJobs add **repeat scheduling**.

Q28. How does Kubernetes handle Configurations (ConfigMap) and Secrets?

Technical Answer (Deep):

- **ConfigMaps:** Store non-sensitive configuration data in key-value pairs.
- **Secrets:** Store sensitive data (Base64-encoded) like passwords or tokens.
- Both can be mounted as environment variables or files inside Pods.
- Encryption at rest and RBAC are recommended for security.

Analogy:
ConfigMaps are like sticky notes on your desk, while Secrets are locked inside a safe.

Key Takeaway:
Separate code from configuration; treat Secrets securely.

Q29. Explain Persistent Volume (PV) and Persistent Volume Claim (PVC).

Technical Answer (Deep):

- **Persistent Volume:** A storage resource provisioned in a cluster, independent of Pods.
- **Persistent Volume Claim:** A request for storage by a Pod.
- StorageClasses dynamically provision volumes.
- Decoupling ensures storage persists even if Pods die.

Analogy:
A PV is like a permanent parking spot; a PVC is a car owner requesting it.

Key Takeaway:
PVs and PVCs provide **durable, decoupled storage**, essential for stateful apps.

Q30. What is a StorageClass?

Technical Answer (Deep):
StorageClass defines different types of storage (e.g., SSD, HDD) dynamically provisioned by cloud providers. Each StorageClass has parameters like replication, encryption, and performance tiers.

Analogy:
Like choosing "Business" vs. "Economy" seats when booking flights, different features, same destination.

Key Takeaway:
StorageClasses automate storage provisioning for PVCs.

Q31. Explain Network Policies in Kubernetes.

Technical Answer (Deep):
Network Policies control traffic flow at Pod level using labels. By default, all Pods can talk to each other; Policies **restrict ingress/egress** based on namespaces, IPs, or Ports. They rely on CNI plugins (e.g., Calico).

Analogy:
Think of Network Policies as firewall rules for Kubernetes Pods.

Key Takeaway:
Essential for securing workloads in production environments.

Q32. How does Kubernetes manage Load Balancing?

Technical Answer (Deep):

- **Internal LB:** Services (ClusterIP) route traffic internally via kube-proxy.
- **NodePort:** Opens a static port on all nodes for manual external routing.
- **External LB:** Integrates with cloud-native load balancers (AWS ELB, GCP LB).
- **Ingress:** Consolidates multiple routes under one external IP.

Analogy:
Think of a mall with multiple entrances but a single reception desk (Ingress) directing you to different stores.

Key Takeaway:
Load balancing in Kubernetes is **multi-layered**, from internal Pod routing to external access.

Q33. What is the role of the Metrics Server?

Technical Answer (Deep):
The Metrics Server collects resource usage (CPU/memory) across nodes and Pods. It powers **kubectl top** and Horizontal Pod Autoscaler. It's a lightweight, scalable API, not meant for long-term storage (use Prometheus for that).

Analogy:
Metrics Server is like a fitness tracker showing real-time stats but not storing years of data.

Key Takeaway:
Metrics Server enables **real-time scaling decisions** in Kubernetes.

Q34. What is the Kubernetes Dashboard?

Technical Answer (Deep):
The Dashboard is a web UI for Kubernetes, allowing cluster visualization, Pod management, and troubleshooting. It's a convenience tool but not always used in production due to RBAC and security risks.

Analogy:
It's like a car dashboard that shows speed and fuel levels, convenient, but professionals often rely on deeper telemetry tools.

Key Takeaway:
The Dashboard is useful for demos or small teams, but enterprise clusters rely on CLI/automation.

Q35. What happens when you run `kubectl apply`?

Technical Answer (Deep):
`kubectl apply` sends your resource YAML to the API Server, which validates and stores it in etcd. Controllers reconcile the cluster's **current state** with the **desired state** described in the manifest. If objects don't exist, they're created; if they differ, they're updated.

Analogy:
It's like placing a recurring order at a store, they'll deliver exactly what you want, even if they need to replace old items.

Key Takeaway:
Kubernetes is **declarative**: You specify the desired state, and it continuously enforces it.

Q36. What is the role of kube-proxy in Kubernetes?

Technical Answer (Deep):

- **kube-proxy** is a network component that runs on each Node and manages service networking rules.
- It watches the API server for Service and Endpoint changes, then updates **iptables** or **IPVS** rules to route traffic to the correct Pod endpoints.
- It enables load balancing at the cluster level without requiring an external LB.
- In IPVS mode, it provides faster performance than iptables by using kernel-level load balancing.

Analogy:
Imagine kube-proxy as a receptionist who maintains a directory of all employees (Pods) and ensures incoming calls (traffic) are routed to the right desk.

Key Takeaway:
kube-proxy is the **traffic router** that makes Kubernetes services work seamlessly.

Q37. Explain Ingress in Kubernetes.

Technical Answer (Deep):

- Ingress is an API object that manages external access to services within a cluster.
- Instead of exposing each Service separately, Ingress provides a single entry point, handling:
  - URL-based routing (/api → one service, /app → another)
  - SSL termination (TLS)
  - Load balancing
- Requires an Ingress Controller (e.g., NGINX, Traefik).

Analogy:
Ingress is like a single building entrance with a receptionist who tells you which department to visit based on your request.

Key Takeaway:
Ingress simplifies and secures **external traffic routing** for multiple services.

Q38. What is a DaemonSet?

Technical Answer (Deep):

- A DaemonSet ensures a copy of a Pod runs on **every node** (or selected nodes).
- Used for cluster-wide services like log collectors (Fluentd), monitoring agents (Prometheus Node Exporter), or storage drivers.
- When a node is added, the DaemonSet controller schedules Pods there automatically.

Analogy:
Think of DaemonSet Pods as security guards stationed at every building entrance.

Key Takeaway:
DaemonSets ensure **node-wide coverage** of critical services.

Q39. Explain StatefulSets.

Technical Answer (Deep):

- StatefulSets manage Pods with **stable network identities** and **persistent storage**.
- Pods are created sequentially, maintaining order (0,1,2).
- Useful for databases (MySQL, Cassandra, Kafka) that need identity and persistent storage.
- Combined with PersistentVolumeClaims for durable data.

Analogy:
Think of StatefulSets like hotel rooms with fixed numbers and keys, even if guests change, rooms (identity) stay consistent.

Key Takeaway:
StatefulSets are for **stateful workloads** that require predictable Pod names and storage.

Intermediate Level Questions

Q40. What are Custom Resource Definitions (CRDs)?

Technical Answer (Deep):

- CRDs let you define your own Kubernetes resource types beyond built-in ones like Pods or Deployments.
- With CRDs, you can extend Kubernetes API to manage anything (e.g., databases, ML pipelines).
- Combined with **Controllers**, CRDs form the basis of **Operators**.

Analogy:
CRDs are like adding new columns or tables in a database schema to handle custom business data.

Key Takeaway:
CRDs make Kubernetes **extensible** for any type of infrastructure or application automation.

Q41. Explain Operators in Kubernetes.

Technical Answer (Deep):

- An Operator is a **custom controller** built around CRDs to automate complex application management tasks (installation, upgrades, failover).
- Encodes operational knowledge into software.
- Examples: Prometheus Operator, ElasticSearch Operator.

Analogy:
Operators are like having a subject-matter expert (SME) on-call 24/7, but automated in software.

Key Takeaway:
Operators let Kubernetes manage **complex, stateful apps** in a declarative way.

Q42. How does Kubernetes ensure high availability (HA)?

Technical Answer (Deep):

- **Control Plane HA:** API server replicas behind a load balancer, multiple etcd nodes.
- **Node HA:** Multiple worker nodes; kubelet detects node failures, reschedules Pods.
- **Pod HA:** Deployments, ReplicaSets, and anti-affinity rules spread replicas.
- **Network HA:** Redundant CNI plugins and cloud/network failover.

Analogy:
Think of HA as having multiple spare tires, drivers, and backup routes in a logistics network.

Key Takeaway:
HA is achieved by **replication, distribution, and automated failover** at all layers.

Q43. What is etcd and why is it important?

Technical Answer (Deep):

- etcd is a distributed key-value store used by Kubernetes to store **cluster state**.
- API server reads/writes all configuration data in etcd.
- etcd is highly consistent (Raft consensus) and fault-tolerant.
- Backup and disaster recovery are critical.

Analogy:
etcd is like the central ledger or accounting book that tracks every asset in a company.

Key Takeaway:
etcd is the **single source of truth** for Kubernetes.

Q44. How do you back up and restore etcd?

Technical Answer (Deep):

1. Use `etcdctl snapshot save` to take a backup.
2. Store backups securely (encrypted).
3. Restore with `etcdctl snapshot restore`.
4. Update API server to point to restored data directory.

Key Takeaway:
Regular etcd backups are critical for **disaster recovery**.

Q45. Explain the difference between Requests and Limits.

Technical Answer (Deep):

- **Requests:** Minimum CPU/memory guaranteed for a Pod. Used by Scheduler to place Pods.
- **Limits:** Maximum CPU/memory a Pod can use; beyond this, Pod may be throttled or killed.
- Properly setting them avoids node overcommitment.

Analogy:
Requests are like reserved parking space size; limits are like "car size limit."

Key Takeaway:
Requests and Limits enable **resource guarantees** and prevent noisy neighbor problems.

Q46. How do you debug a CrashLoopBackOff error?

Technical Answer (Deep):

1. kubectl describe pod <name> – check events.
2. kubectl logs <name> – get error logs.
3. kubectl exec -it <name> – test environment.
4. Check image version, readiness/liveness probes, configs.

Key Takeaway:
CrashLoopBackOff often indicates **misconfigurations** or app startup failures.

Q47. What is a Readiness vs. Liveness Probe?

Technical Answer (Deep):

- **Liveness Probe:** Checks if app is alive; restarts container if failing.
- **Readiness Probe:** Checks if app is ready to serve traffic; failing Pods are removed from Service endpoints.

Analogy:
Liveness is like "heartbeat monitoring"; Readiness is like checking if a restaurant is ready to take customers.

Key Takeaway:
Probes improve **reliability and zero-downtime deployments**.

Q48. Explain the Kubernetes control loop.

Technical (Deep):

- Every controller (e.g., Deployment, ReplicaSet, Node) uses **informers** to watch the API server cache for changes, then enqueues "work items."
- Controllers compare **desired state** (spec in etcd via API server) with **observed state** (status/events from kubelet, endpoints, etc.).
- When drift occurs (e.g., a Pod dies), the controller issues actions (create/replace/update) until the live state matches the spec.
- This is **level-based reconciliation** (idempotent), not edge-triggered; repeated runs converge on the same result.
- The API server is the front door; etcd stores truth; controllers are the **brains** that continuously reconcile.

Analogy: A thermostat constantly checks room temperature and nudges heating/cooling to maintain your setpoint.

Key Takeaways: Declarative model + continuous reconciliation = self-healing, eventual consistency, and operational simplicity.

Q49. Explain Pod Security Policies (PSP) and Pod Security Standards (PSS).

Technical (Deep):

- **PSP** (deprecated; removed in 1.25) were admission-time checks controlling capabilities like **privileged**, **hostNetwork**, **runAsNonRoot**, etc. They were complex to manage and order-dependent.
- **PSS (Pod Security Admission)** replaces PSP with three label-based levels: **Privileged**, **Baseline**, **Restricted**, enforced per-namespace via an admission controller.
- PSS focuses on sane defaults and consistency; for richer policy, teams use **OPA Gatekeeper** or **Kyverno**.
- Enforcement happens on create/update via admission; tied to RBAC for who can set labels or bypass.

Analogy: PSP was a giant rulebook; PSS is a simpler, color-coded dress code. For custom policies, you hire a dedicated security guard (Gatekeeper/Kyverno).

Key Takeaways: Know PSP is gone; PSS + policy engines are the modern, maintainable approach.

Q50. What is RBAC in Kubernetes?

Technical (Deep):

- **RBAC** maps *subjects* (users, groups, service accounts) to *permissions* (verbs on resources).
- **Role** (namespace-scoped) and **ClusterRole** (cluster/global scope) define permissions; **RoleBinding/ClusterRoleBinding** attach them to subjects.
- Verbs: `get`, `list`, `watch`, `create`, `update`, `patch`, `delete`, `deletecollection`. Resources include core and API groups (e.g., `pods`, `deployments.apps`).
- Aggregated ClusterRoles allow building higher-level roles from smaller ones; `resourceNames` narrow to specific objects.

Analogy: It's a set of keycards (bindings) granting door access (verbs) to specific rooms (resources) in a building (namespace/cluster).

Key Takeaways: Least-privilege via Roles/ClusterRoles + Bindings; always scope to namespace when possible.

Q51. Explain service accounts.

Technical (Deep):

- A **service account (SA)** is an identity for Pods to authenticate to the API server.
- The kubelet mounts a **token** (now usually a **Bound Service Account Token**, short-lived + audienced) into Pod filesystem via a projected volume.
- You can control mounting with `automountServiceAccountToken: false`.
- Pair SAs with RBAC to limit what running workloads can do (e.g., only list ConfigMaps).

Analogy: Think of an SA as a bot's badge that grants limited access inside your building.

Key Takeaways: Use per-app SAs + tight RBAC; prefer projected tokens; don't run everything as `default` SA.

Q52. What is a CNI plugin?

Technical (Deep):

- Kubernetes delegates networking to **CNI** implementations (Calico, Flannel, Cilium, Weave).
- CNI assigns **Pod IPs**, sets up **routing/encapsulation** (VXLAN/Geneve) or **native routing**, and programs host networking.
- CNI ensures "**every Pod gets its own IP**" and "**pods can reach each other**" (cluster-wide L3).
- NetworkPolicy enforcement requires a CNI that supports it (e.g., Calico/Cilium).

Analogy: CNI is the electrician wiring every apartment (Pod) so they can communicate and access utilities.

Key Takeaways: CNI is the data-plane engine; choose one that supports your needs (NetworkPolicy, performance, eBPF, encryption).

Q53. Explain kubelet.

Technical (Deep):

- **kubelet** runs on each node; it watches PodSpecs assigned to that node and ensures containers run as declared.
- Talks to container runtime via **CRI** (containerd, CRI-O), gathers metrics via cAdvisor, reports **Node/Pod status**.
- Executes probes (liveness/readiness/startup), mounts volumes, injects secrets/configs.
- Handles graceful termination and preStop hooks; can launch **ephemeral containers** for debugging.

Analogy: kubelet is the node's foreman—ensuring the right containers start, stay healthy, and report status.

Key Takeaways: kubelet = execution + health + status bridge between control plane and runtime.

Q54. Difference between Deployment and StatefulSet.

Technical (Deep):

- **Deployment**: stateless; Pods are fungible; rolling updates with maxUnavailable/maxSurge; no identity guarantees.
- **StatefulSet**: stable identity name-ordinal (e.g., db-0), ordered create/delete, persistent storage via per-Pod PVCs, often with a **Headless Service**.

- StatefulSets support **partitioned rolling updates** and **ordered guarantees** vital for quorum systems.

Analogy: Deployment = food trucks; any truck serves. StatefulSet = numbered hotel rooms; each room keeps its identity and baggage.

Key Takeaways: Use Deployment for stateless web tiers; StatefulSet for databases, queues, and stateful systems.

Q55. Explain Vertical Pod Autoscaler (VPA).

Technical (Deep):

- **VPA** recommends or sets CPU/memory **requests/limits** based on observed usage.
- Components: **Recommender** (suggests), **Updater** (evicts when needed), **Admission Controller** (applies on create).
- Modes: `Off`, `Initial`, `Auto`. Memory changes typically require restart; CPU limit changes may throttle without restart.
- Coordinate with **HPA** (avoid conflicts); common pattern is HPA for replicas + VPA for requests.

Analogy: VPA is a tailor who resizes your clothes as you grow—sometimes you need to change outfits (restart).

Key Takeaways: VPA rightsizes resources over time; combine thoughtfully with HPA; expect restarts for some changes.

Q56. Explain Cluster Autoscaler.

Technical (Deep):

- Watches for **unschedulable Pods** due to resource shortage and asks the cloud provider to add nodes.
- Scales **down** by identifying underutilized nodes that can be drained (respecting **PDBs**, **node taints**, and pod constraints).
- Integrates with managed node groups (EKS, GKE, AKS) or autoscaling groups in IaaS.
- Avoids evicting DaemonSet pods and non-evictable workloads.

Analogy: It's a smart facilities manager who rents more office space when desks run out and releases floors when empty.

Key Takeaways: Node count adapts to demand; design Pods to be drainable (PDBs, disruption-friendly) for effective scale-down.

Q57. Explain Admission Controllers.

Technical (Deep):

- Admission runs **after authentication/authorization** but before object persistence.
- Two phases: **Mutating** (can change the request) and **Validating** (can accept/reject).
- Built-in controllers (e.g., `LimitRanger`, `ResourceQuota`, `NamespaceLifecycle`) enforce cluster policies.
- You can extend with **webhooks** (external HTTP callbacks) for custom logic.

Analogy: Gatekeepers at the door, one can adjust your form (mutating), another checks rules before filing (validating).

Key Takeaways: Admission is the policy choke point; understand order and failure policies for reliability.

Q58. What are Mutating and Validating Webhooks?

Technical (Deep):

- **MutatingWebhookConfiguration** runs first; can inject sidecars, defaults, labels/annotations.
- **ValidatingWebhookConfiguration** runs after; enforces rules (e.g., deny privileged containers).
- They're HTTPS endpoints (often exposed via a Service); require TLS, timeouts, and `failurePolicy` (Fail/Ignore).
- Must be idempotent and fast; excessive latency blocks API writes.

Analogy: First editor fixes your form, second auditor approves or rejects it.

Key Takeaways: Powerful but sharp tools—secure, make fast, and test carefully to avoid cluster-wide outages.

Q59. Explain sidecar pattern in Kubernetes.

Technical (Deep):

- A **sidecar** container runs alongside the main app within the same Pod (shared network and volumes).
- Common uses: logging/metrics agents, proxies (Envoy), config reloaders, file watchers, adapters.
- Lifecycle coupling: if the Pod dies, both die; termination order matters; resource requests add up.
- Service Meshes rely on auto-injected sidecars for mTLS, telemetry, retries.

Analogy: Your main chef shares a kitchen with a sous-chef (sidecar) who preps ingredients and delivers plates.

Key Takeaways: Sidecars extend apps without code changes; mind resources, startup/termination order, and observability.

Q60. Explain Init Containers.

Technical (Deep):

- **Init containers** run **sequentially** before app containers start; each must complete successfully.
- Use cases: wait for dependencies, schema migration, pre-warming caches, pulling configs.
- They have their own images/permissions; share volumes and network with the app container(s).
- Failures block app startup, making them a guardrail for prerequisites.

Analogy: Stage crew sets the stage perfectly before actors come on.

Key Takeaways: Perfect for one-time setup and dependency gating; keep them quick, reliable, and observable.

Q61. How does Kubernetes handle secrets at runtime?

Technical (Deep):

- **Secret** objects are base64-encoded (not encryption by default in YAML). Enable **encryption at rest** (e.g., aescbc) in the API server.
- Mounted as **tmpfs** volumes or exposed as env vars; volumes avoid lingering in process lists.

- **Bound SA tokens** are short-lived and projected; rotate credentials; restrict RBAC on Secrets.
- Consider external secret managers (AWS Secrets Manager, Vault, GCP SM) with operators.

Analogy: Secrets are kept in a locked, in-memory drawer; don't photocopy them (env vars) unless necessary.

Key Takeaways: Turn on encryption at rest; prefer volume mounts; restrict access; integrate external secret managers when needed.

Q62. Explain Pod Disruption Budgets (PDB).

Technical (Deep):

- **PDB** limits *voluntary* disruptions (e.g., node drain, upgrades) via `minAvailable` or `maxUnavailable`.
- They don't protect against **involuntary** failures (node crash).
- The eviction API honors PDBs; if budgets are tight, drains will block until replacement Pods become ready.
- Critical for HA apps to avoid dropping below quorum.

Analogy: A shop ensures enough staff are on shift before letting others take breaks.

Key Takeaways: Always set PDBs for critical deployments; test drains to ensure healthy budgets.

Q63. How does Kubernetes achieve self-healing?

Technical (Deep):

- Controllers recreate Pods when they vanish; kubelet restarts containers on failure per `restartPolicy`.
- **Probes** remove bad Pods from service endpoints and trigger restarts if needed.
- Node controller detects unresponsive nodes and reschedules pods elsewhere.
- ReplicaSets/Deployments maintain replica counts and continuity.

Analogy: A factory keeps spare workers and auto-assigns replacements when someone calls in sick.

Key Takeaways: Redundancy + reconciliation + health checks = resilient workloads.

Q64. How does Kubernetes handle rolling restarts?

Technical (Deep):

- kubectl rollout restart deployment/<name> bumps a pod template annotation to trigger a new ReplicaSet.
- **RollingUpdate** strategy controls surge/unavailable to keep capacity during replacement; integrates with readiness/liveness to avoid sending traffic early.
- **rollout status/history/undo** give control and traceability.
- Readiness gates + PDBs ensure zero/minimal downtime.

Analogy: Swapping train cars one at a time while the train keeps running.

Key Takeaways: Use rolling restarts with proper probes and budgets; monitor rollout status.

Q65. Explain Helm.

Technical (Deep):

- **Helm** packages Kubernetes manifests as **charts** with templates and **values.yaml** for parameterization.
- A **release** tracks a deployed chart + values; you can upgrade, rollback, and view **diffs**.
- Supports dependencies, hooks, and CI/CD integration.
- Risks: over-templating; mitigate with linting, testing, and chart best practices.

Analogy: Helm is apt/yum for Kubernetes, install, upgrade, rollback apps as packages.

Key Takeaways: Great for reusable app deployments; keep values clean and document overrides.

Q66. What is Kustomize?

Technical (Deep):

- **Kustomize** does **template-free** YAML customization using **overlays** (dev/stage/prod), **patches**, and **vars**.
- Core concepts: kustomization.yaml, resources, patchesStrategicMerge, patchesJson6902, configMapGenerator/secretGenerator.

- Integrated into kubectl (kubectl kustomize / kubectl apply -k).
- Ideal for GitOps and environment-specific diffs without templating logic.

Analogy: It's a stack of transparent filters placed over a base picture to adapt it for each environment.

Key Takeaways: Simple, native way to manage env overlays; complements or replaces Helm in some workflows.

Q67. Explain Service Mesh (Istio/Linkerd).

Technical (Deep):

- Meshes inject **sidecar proxies** (Envoy/Linkerd) to handle **mTLS**, **traffic routing** (retries, timeouts, circuit breaking), and rich **telemetry**, without app code changes.
- Control plane (Istio: Pilot/Galley/Citadel → now istiod) programs the data plane via xDS APIs.
- Overhead: extra proxies = CPU/mem + latency; operational complexity to weigh against benefits.
- Great for zero-trust, canary, A/B, and deep observability.

Analogy: A fleet of chauffeurs (proxies) added to every car, enforcing safe driving rules and reporting metrics centrally.

Key Takeaways: Powerful traffic/security layer; use where policy/observability justify the complexity.

Q68. Kubernetes vs Docker Swarm.

Technical (Deep):

- **Kubernetes**: rich APIs, declarative controllers, powerful networking (CNI, NetworkPolicy), pluggable storage, autoscaling, Operators, ecosystem depth.
- **Swarm**: simpler, tighter Docker integration, but fewer primitives and weaker ecosystem; basic overlay networking and rolling updates.
- Most enterprises standardize on Kubernetes for scale/feature needs.

Analogy: Swarm is a compact toolbox; Kubernetes is a full workshop with specialized tools.

Key Takeaways: For production-grade orchestration and ecosystem integrations, Kubernetes is the industry default.

Q69. Namespaces vs Clusters.

Technical (Deep):

- **Namespace**: logical partition inside one cluster, scopes names, quotas, RBAC, and (with NetPolicies) traffic isolation. Shared control plane and worker nodes.
- **Cluster**: separate control plane + nodes; hard isolation of upgrades, CRDs, API rate limits, and trust boundaries.
- Multi-tenancy often starts with namespaces; compliance or noisy-neighbor issues may require separate clusters.

Analogy: Namespace = departments in one company building; Cluster = separate buildings with their own security and utilities.

Key Takeaways: Namespaces are lightweight isolation; clusters are strong isolation, choose based on security and operational needs.

Q70. Your approach to troubleshooting in Kubernetes?

Technical (Deep):

1. **Scope & Symptoms:** What broke? Which namespace? Since when? Any change deployed?
2. **Objects & Events:** kubectl get/describe Deploy/RS/Pods; check **events** for scheduling/images/probes.
3. **Logs:** kubectl logs -f (use -p for previous), check sidecars, init containers.
4. **Health & Resources:** Probes, top pods/nodes, Requests/Limits, OOMKilled, throttling.
5. **Networking/DNS:** kubectl get svc/endpoints/endpointslices, in-cluster busybox to nslookup/curl, check **NetworkPolicies**, kube-proxy mode.
6. **Node/CNI:** kubectl describe node, CNI pods/logs (Calico/Cilium), routing/iptables/ipvs; disk pressure/NotReady.
7. **Rollbacks & Guards:** PDBs blocking rollout? rollout history, undo. Admission webhooks failing? Timeouts?
8. **Deep Debug: ephemeral containers**, tcpdump/strace, increased logging, isolate minimal repro.

Analogy: A doctor's workflow: triage, vitals, labs, imaging, targeted treatment, then observe.

Key Takeaways: Be systematic. Read events. Separate app bugs from platform issues. Use throwaway debug pods and rollbacks wisely.
