Kubernetes Core Concepts

Cluster Architecture

- Cluster: A set of worker machines managed by a control plane.
- Control Plane: Manages the cluster, making scheduling/scaling decisions.
- Nodes: Worker machines (VMs or physical) running applications.

Basic Units

- Pod: Smallest deployable unit in Kubernetes.
- Container: Runs inside a Pod.
- Volume: Storage attached to a Pod.

Workload Resources

- ReplicaSet: Ensures desired number of Pod replicas are running.
- Deployment: Manages ReplicaSets, supports rolling updates/rollbacks.
- StatefulSet: For stateful apps with stable identity & storage.
- DaemonSet: Ensures a Pod runs on each Node.
- Job: Runs a Pod to completion.
- CronJob: Runs Jobs on a schedule.

Service Discovery & Networking

- Service: Stable endpoint for Pods (ClusterIP, NodePort, LoadBalancer).
- Ingress: Manages external access (HTTP/HTTPS) to Services.
- Network Policies: Control traffic between Pods/Services.

Configuration & Secrets

- ConfigMap: Stores configuration data in key-value pairs.
- Secret: Stores sensitive information (passwords, tokens, certificates).
- Environment Variables: Pass configuration into Pods.

Storage

- PersistentVolume (PV): Abstraction of physical storage.
- PersistentVolumeClaim (PVC): Request for storage by a Pod.
- StorageClass: Defines types of storage (SSD, network storage, etc.).

Scheduling & Scaling

- Scheduler: Assigns Pods to Nodes.
- Horizontal Pod Autoscaler (HPA): Scales Pods based on resource usage.
- Vertical Pod Autoscaler (VPA): Adjusts Pod resource requests/limits.
- Cluster Autoscaler: Adds/removes Nodes in the cluster.

Security & RBAC

- RBAC: Role-Based Access Control for permissions.
- Service Accounts: Provides identities to Pods.
- Pod Security Standards (PSS): Defines security levels for Pods.
- Network Policies: Restrict communication between Pods.

Observability

- Logging: Collect logs from Pods.
- Metrics: Resource usage and app metrics.
- Events: Cluster activities (e.g., Pod creation, failures).
- Probes: Liveness, Readiness, Startup checks.

Extensions & Custom Resources

- Custom Resource Definition (CRD): Extend Kubernetes with new resources.
- Operators: Automate complex application management.