Principles and roadmap
DevOps Cycle: plan->code->build->test->release->deploy->operate->monitor
Culture – Collaborative and customer-centred **Automation** – Integration testing, deployments, IaC **Lean** – Agile, scrappy, lean teams to minimize WIP (2-pizza rule) **Measurement** – Track and measure data to celebrate wins & pre-empt faults **Sharing** – Teach & learn from each other
Gene Kim's 3 ways: • Flow - Convert a business hypothesis into a technology-enabled service that delivers value to the customer • Learning – Ensure fast/constant feedback in all stages of the value stream • Feedback – Prioritize organizational learning and safety culture
Flow: • Make work visible • Limit WIP • Reduce batch size and handoffs • Identify and elevate constraints • Eliminate waste in the value stream
Feedback • Monitoring to see problems as they occur • Swarming problems to build new knowledge • Quality at source • Optimize for downstream work centres
Continual learning and experimentation • Improve daily work • Local discoveries to global improvements • Resilience patterns that introduce chaos and tension • Leadership – creating conditions for success
Microservice: Anything that provides functionality over a network – logically represents a business capability, otherwise treated as a black box that can be independently developed/deployed
Microservice architecture: An assembly of fine-grained services that allow independent, continuous deployment
Docker
Choreography: Services communicate with each other asynchronously
Orchestration: Composite services invoke atomic services to fulfil business functions
Atomic service: Provides functionality related to 1 capability. Self-contained and do not depend on any other services
Drawbacks of microservices: • Microservices make things worse, not better, if developers have a poor testing culture • Decomposing a service incorrectly gives a distributed monolith • Distributed systems are inherently more complex
Docker networking: All traffic is routed through docker engine. Containers can communicate with each other within the network, but outside applications must use forwarded ports as specified by Dockerfile/docker-compose.yml
Continuous Integration
Test pyramid (descending order of difficulty, brittleness and cost): -UI testing -End-to-end testing -Component testing

-Integration testing
-Unit testing
-Code analysis

Continuous Deployment

Continuous delivery – releases are automated, deployments are manual
Continuous deployment – deployments are fully automated

Benefits: Lower failure rates, faster feedback, faster flow, reliable releases
Tradeoffs: Building binaries for diff platforms, customer perceptions of CD, only works with a testing culture

Release versioning: Traditionally semantic versioning <major>.<minor>.<patch>

- Major: breaking, incompatible API changes
- Minor: backwards-compatible functionalities
- Patch: backwards compatible bug fixes

Serverless deployment: Abstracts away infra & resources, invoking microservices implemented as lambda functions.

- Pros: Very lightweight and scalable
- Cons: Cold starts, large functions, not suitable for long-running jobs

Service as a container: Package as a Docker image and deploy each service as a container. Each service has its own IP and file system

- Pros: Portable, isolated, constrained resources, encapsulation
- Cons: Responsibility for administering images and specifying/administering container infrastructure

AWC ECS concepts:

- Task definition: Describes containers that form your app – images and resource constraints
- Service: Runs and maintains a specified number of tasks (can set auto-scaling as well)
- Cluster: Logical grouping of tasks and services. Able to orchestrate containers across multiple EC2 instances

Deployment patterns

- Rolling: Gradually replace container instances, specifying a minimum healthy %
- Blue-green: Transfer all traffic to new container instances; old instances on 'standby' for rollback
- Canary: Release to a small subset of users first

Feature flags: Allow new features to be enabled/disabled on toggle, promoting easy rollback, graceful degrades, resilience in deploys

Microservices communication

Styles: 1-1 sync(HTTP, gRPC), 1-1 async(fire & forget, async request/reply), 1-many async (pub/sub)

Message-oriented middleware: Acts as a broker for any communication style

Communication patterns
1. Orchestration – Stateless composite service that manages atomic services
2. Choreography – Atomic services communicate with each other asynchronously
3. Choreo with process engine – Combines async behaviour & process visibility

AMQP: A public message queueing protocol that runs on top of TCP
Publisher -> Exchange -> Queue -> Subscriber. Publishers publish message to an exchange, exchanges are bound to queues using a routing key (direct/fanout/topic), subscribers consume messages from queues.

Saga pattern: Create a set of compensating transactions for every local transaction that a microsvc makes. Since microservices are not isolated, concurrency is still an issue.

Solutions: RabbitMQ (message broker for AMQP), prog. language implementations (pika, etc.)

API gateways

Strangler fig pattern: Gradually decouple the system from top-down, starting with edge services and working to core. Transform -> Co-exist -> Eliminate

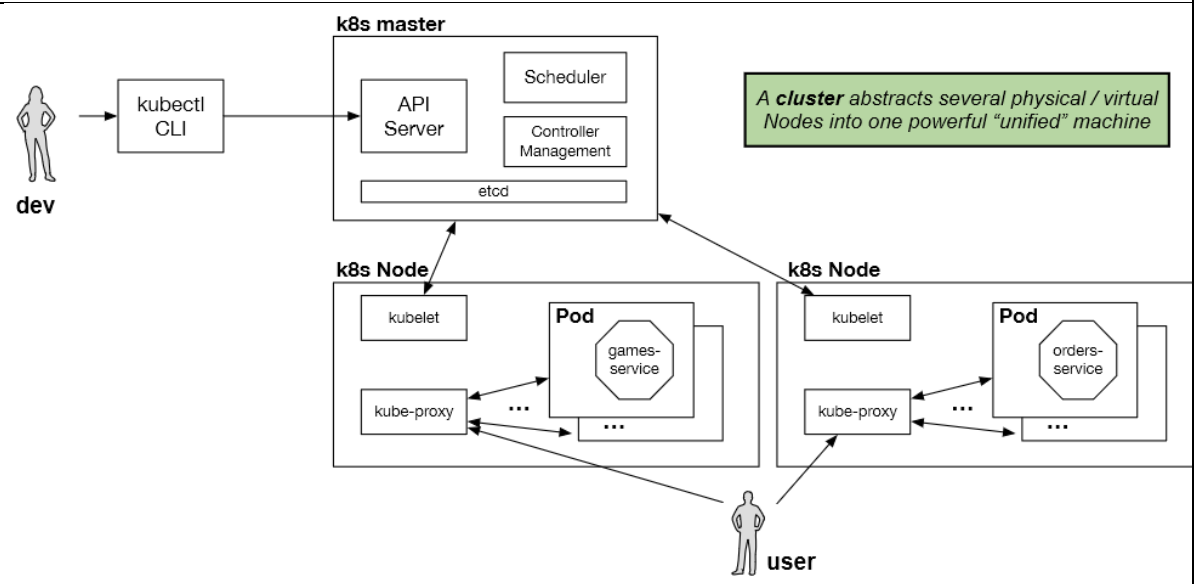
API gateway patterns:
1. Composition – aggregating requests to atomic svcs
2. Protocol translation
3. Edge functions (auth, rate limiting, caching, metric, logging), consider *separation of concerns*

+ Encapsulation/façade + Reduces network overhead + Simplify client-side interactions + Loose coupling	- More management - Must be highly available - May cause development bottleneck - No clear ownership
General purpose: One API gateway for all frontend clients - General purpose, multiple responsibilities, no clear ownership (against DevOps style)	**Backends for frontends (BFF)**: Each frontend (mobile/web/native) has its own gateway - Frontend oriented, more separated responsibilities, easier tracking, possible code duplication

Solutions: AWS API gateway, Kong, DIY (nginx, zuul, etc.)

Kubernetes

Declarative model: Use manifest files (YAML) to specify desired state, and k8s takes actions to achieve that desired state



Node: Contains services required to run pods
Kubelet: Agent that runs on a node, ensuring that pods are running and healthy
kube-proxy: Allows communication over virtual network
Pod: A basic unit of deployment, with at least 1 container sharing an internal IP address and storage volume. Meant to be ephemeral and replaced
API-server: Allows dev to interact with k8s deployment through UI, CLI or REST calls
Controller manager: Keeps track of cluster state and makes adjustments if necessary
Scheduler: Watches for newly created pods and selects nodes for them to run on

Service: Abstraction that provides a static network location that exposes some pods. Internal addresses of Pods may change, but service ip/port does not change

- *ClusterIP*: Service reachable on an internal IP
- *NodePort*: Service reachable on Node's IP at a static port, externally reachable at <NodeIP>:<NodePort>
- *LoadBalancer*: Service exposed externally using cloud provider's load balancer (1-to-1)

Ingress: Exposes multiple Services through a single cloud load balancer
Ingress controller: Implementations include cloud providers, nginx, etc

Rolling updates: Default rolling update has a limit of 25% unavailable pods/extra pods
Auto-scaling rules can be set based on CPU usage, min or max replicas

Monitoring

Telemetry: Automated process of collecting/transmitting metrics from remote points to monitoring systems. 1-Instrument systems, 2-Collect metrics from systems, 3-Monitor through alerts and visualizations

Challenges: Number of components, data quantity, silos, maintenance burden

What to monitor?:
Work metrics – Throughput, success, errors, latency
Resource metrics – Utilization, saturation, availability
Events - Code changes, alerts, scaling events
CI/CD – Time taken for pipeline stages, pass/fail events

Log levels: DEBUG -> INFO -> WARN -> ERROR -> FATAL, severity level dictates incident response

Self-service: Metrics should be easily accessible, "info radiators" w/o privileged access

Analysis: Through statistical operations or anomaly detection (independent of probability distribution)

Prometheus: Centralized telemetry software, stores metrics in time series database, taken from service endpoints in a PULL model. Query language PromQL allows selection and aggregation of data. Data can then be visualized through software like *Grafana*

Infrastructure as Code

IAC tools:
- Shell scripts
- Configuration management: Install/manage software on servers
- Provisioning: Create ephemeral resources (servers, brokers, security groups)

Terraform
- `init`: Initialize current working directory and prepare files for use w Terraform
- `fmt`: Rewrite .tf files to a canonical style
- `plan`: Reads remote state, updates local state, compares local state with .tf files and proposes changes to make remote object match desired configuration
- `show`: Displays local state snapshot
- `destroy`: Destroys remote infra managed by Terraform

Importing infrastructure
- Declare a blank resource type and resource name
- `terraform import resource_type.resource_name <remote.id>`
- Copy local state into configuration file, making sure to delete any ephemeral resource fields (e.g. ARN, ID, IP address)