Fullstack Development

Backend Architecture

Content

- What is backend architecture?
- Backend architecture components
- Backend practices

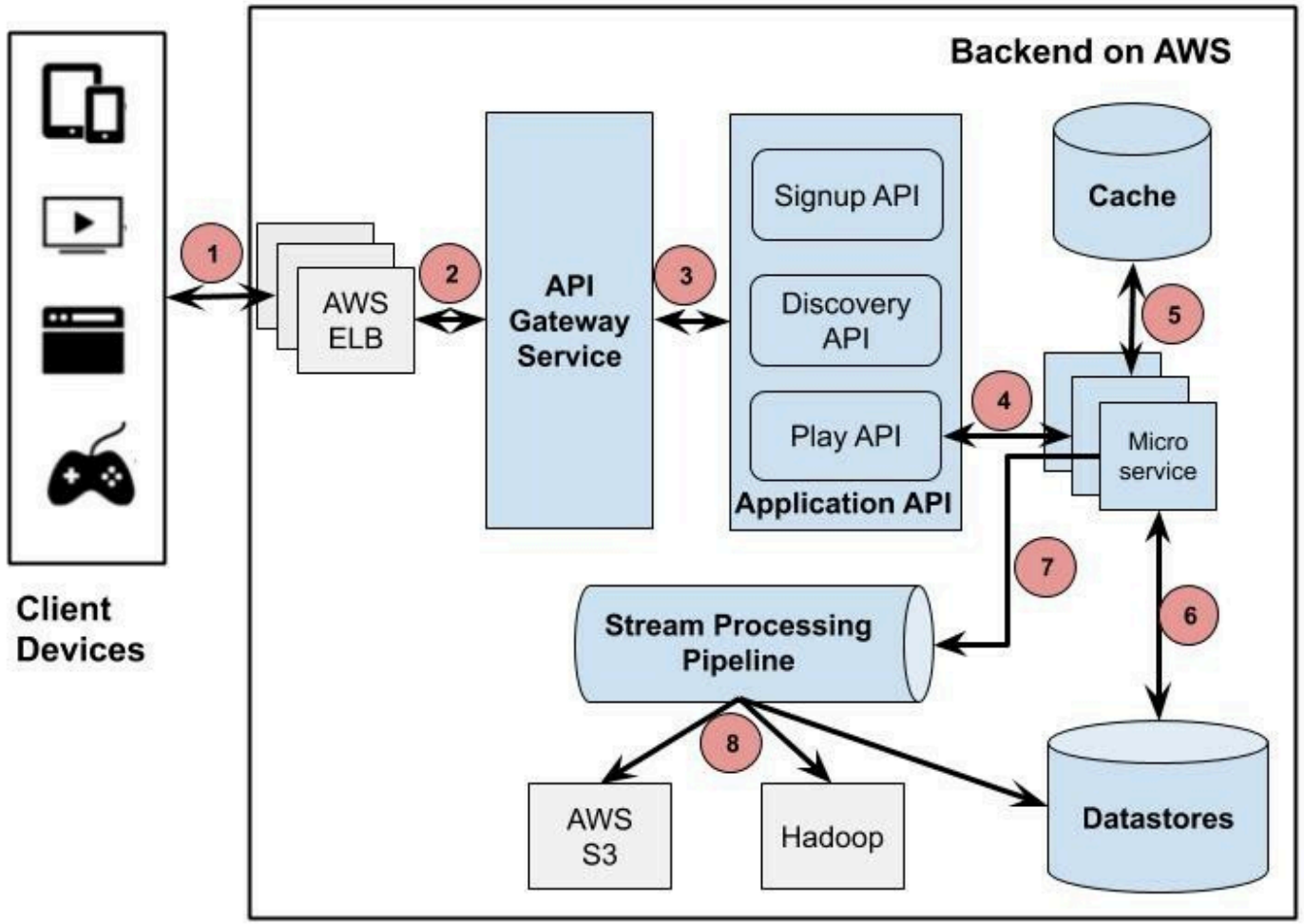
What is backend architecture?

- The conceptual design and structure of server-side compoments
  - Business logic
  - Data layers
  - Security layers
  - 3rd-party integrations
- Involving deciding on and documentating a `blueprint` for the system

Backend architecture components

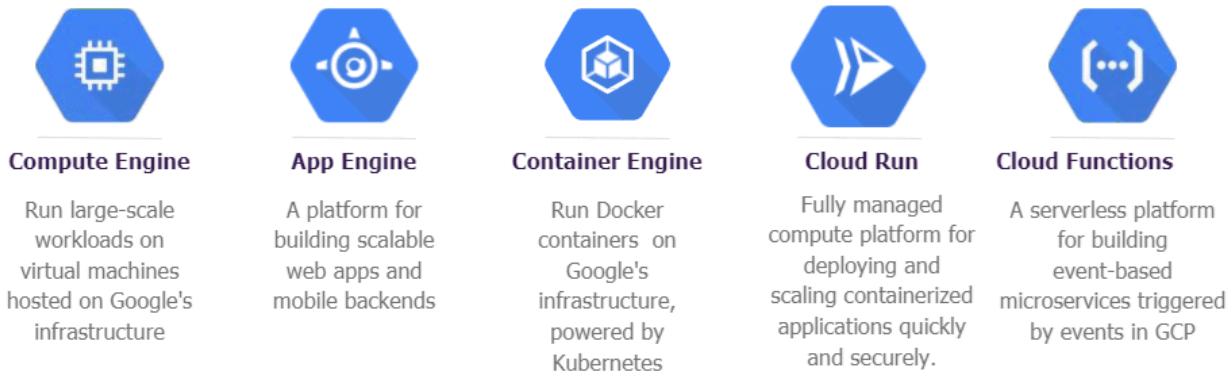
- Servers
- Databases
- APIs
- Caching solutions
- Asynchronous messaging
- Authentication and authorization
- Other components

Example: Netflix backend overview



Servers

- Compute services
  - `Bare metal`, `Virtual machine`, `Container`, `Serverless`
- Provides resources, data, and services to clients
- Running server-side code
  - `business logic`, `process requests`, `manage data storage and retrieval`



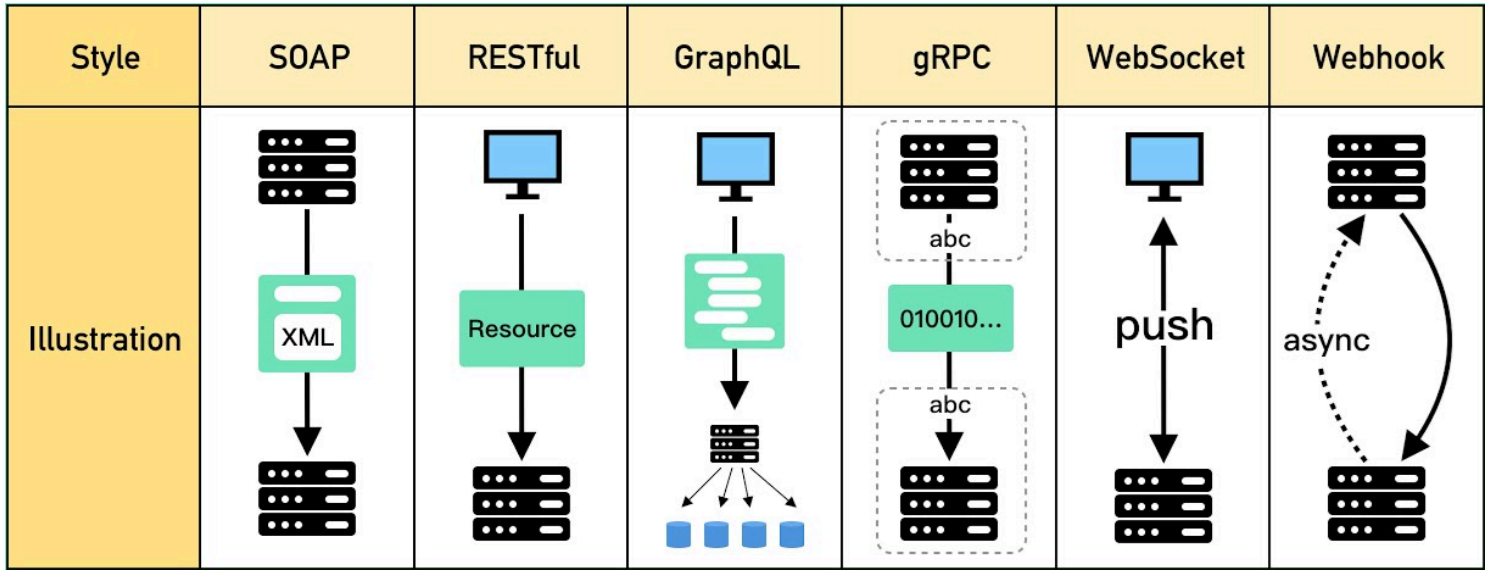
Databases

- Manages, retrieves, and stores data
  - `SQL databases` organizes data via tables with predefined schema
  - `NoSQL databases` provides more flexible schema
- Typically implemented via `DBMS`
  - MySQL, PostgreSQL, MongoDB, Elasticsearch, ...

see more detail in the `database design concepts`. <HTML | PDF>

APIs

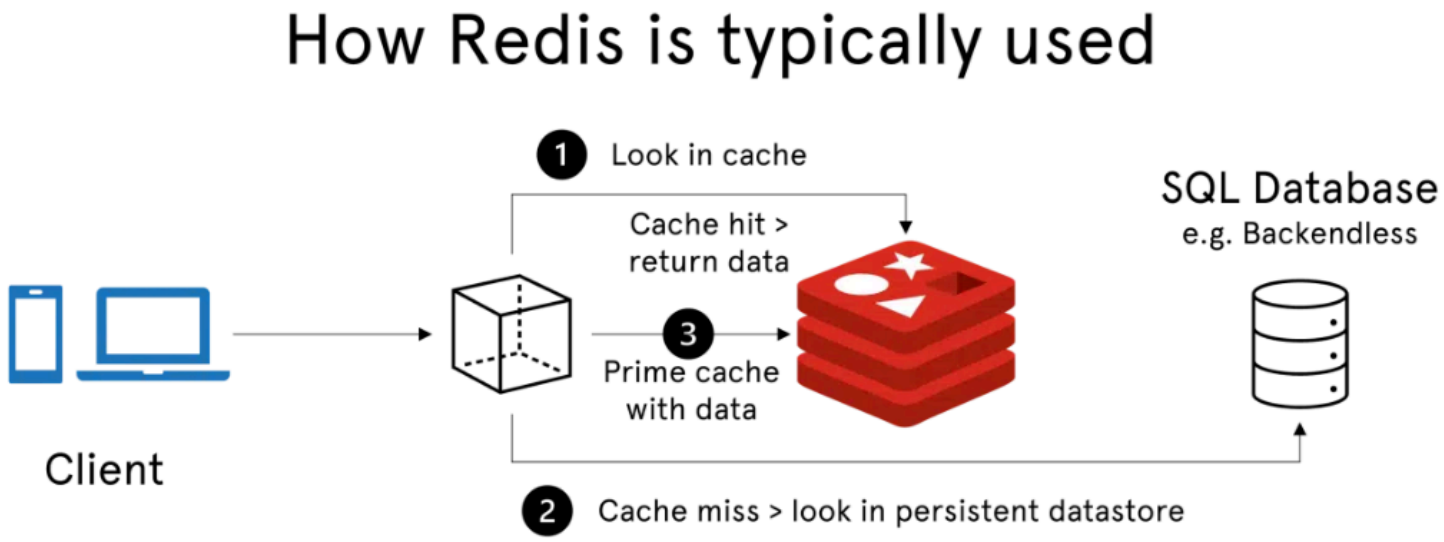
- **Application Programming Interfaces**
- Provides communication and data exchange between components
- Defines `rules`, `protocols`, `URIs`, `URLs` and `data formats` for request/response



Caching Solutions

- Temporarily stores data in fast-access storage layer
- Improveing performance by reducing the need for `repeated queiries` or `API calls`
- Implementation options:
  - Web browser's localStorage, Application code (variables)
  - CDNs (`Cloudflare Cache`, `Amazon Cloudfront`)
  - In-memory caches (`Redis`)

Caching Solutions - Redis

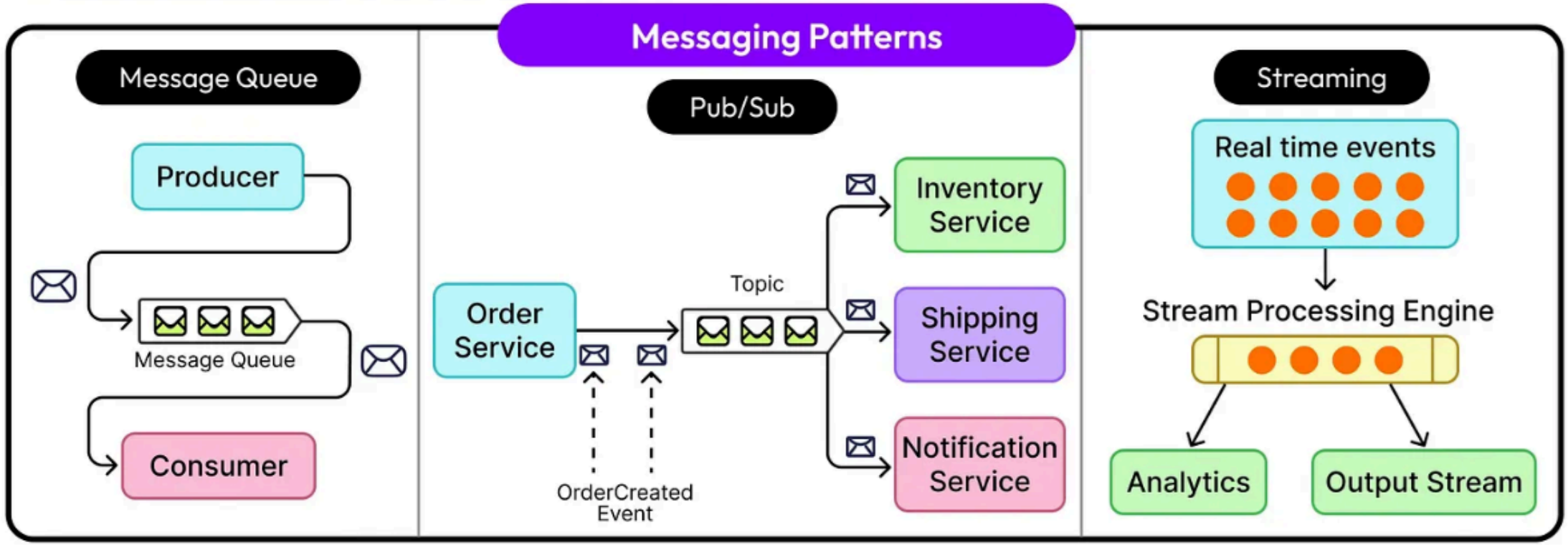


Asynchronous messaging

- Enables decoupled, `asynchronous communication` between sender and receiver
- `Messages` (requests/responses) are safely stored in a **broker**
- **No waiting for response** (better performance, scalability, and reliability)
- Typically used in `serverless` or `microservices architectures`
- Messaging pattern : `publish-subscribe`, `FIFO message queues`, `event streams`
- Message broker : Redis, Kafka, RabbitMQ

How to choose a message queue?

Asynchronous messaging (2)



ByteByteGo

Authentication and Authorization

- Ensure that only authenticated `client/user` can access the system
- Client/user has the `necessary permissions` to access resources or perform actions
- Authentication methods
  - `Password-based`, `MFA`, `OAuth`
- Authorization policies
  - `Role-based access control` (RBAC), `policy-based access control`, …

Other components

- **Object Storage service**
  - Amazon S3, Azure Blob Storage, Google Cloud Storage
  - Minio, Garage
- **Network services**
  - Reverse Proxy: Nginx, Traefik
  - Load balancers, Firewall/Security group
- **3rd-party integrations**
  - Payment service: 2C2P, Omise, Stripe, Bank APIs
  - Streaming service

Other components (2)

- Logging and monitoring
  - Application logs, Clickstream, Network logs
- CI/CD pipelines
  - Jenkins
  - GitHub Action, GitLab CI/CD
  - Azure Pipelines, AWS CodePipeline
  - Argo CD (for Kubernetes)
- Infrastructure as code (IaC)
  - Terraform, Ansible

Backend practices

- The scope and nature of backend systems vary across different use cases
  - Types of applications, size, development team, time and budget
- Challenges
  - Ensuring scalability and reliability
  - Effective communication
  - Data managment

Backend practices (2)

- A number of **[distributed system design patterns]** (https://www.multiplayer.app/distributed-systems-architecture/distributed-systems-design/) have emerged to address common issues
- **Utilize a CI/CD pipeline**: based on `reliable testing` and `test automation`
  - Keep `test scripts` up to date (update test script along with app code)
  - Regularly maintain `test suites` (keep test suites lightweight)
  - Choose a suitable `testing environment` (isolated and representative of prod environment)

Backend practices (3)

- **Design for modularity**
  - A system should be composed of `loosely coupled modules` (better scalability)
  - Each module is its own independent unit with `minimal dependencies`
  - `Utilize an API gateway` (a single entry point for an app)
    - Receives all client requests
    - Routes them to the correct backend component or service
    - Allows updating and adding new components without affecting the client interface

Example

An example of a system architecture diagram for a microserivces

Reference

- Backend Architecture: Tutorial & Best Practices
- How to Choose a Message Queue?
- Netflix System Design - Backend Architecture 2021