

# Serverless Architecture

*Software Architecture*

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### *Oxymoron 1.* Serverless

Logic running on someone else's server.

Developers can focus on logic, not infrastructure to deliver it.

*Definition 1.* Backend as a Service (BaaS)

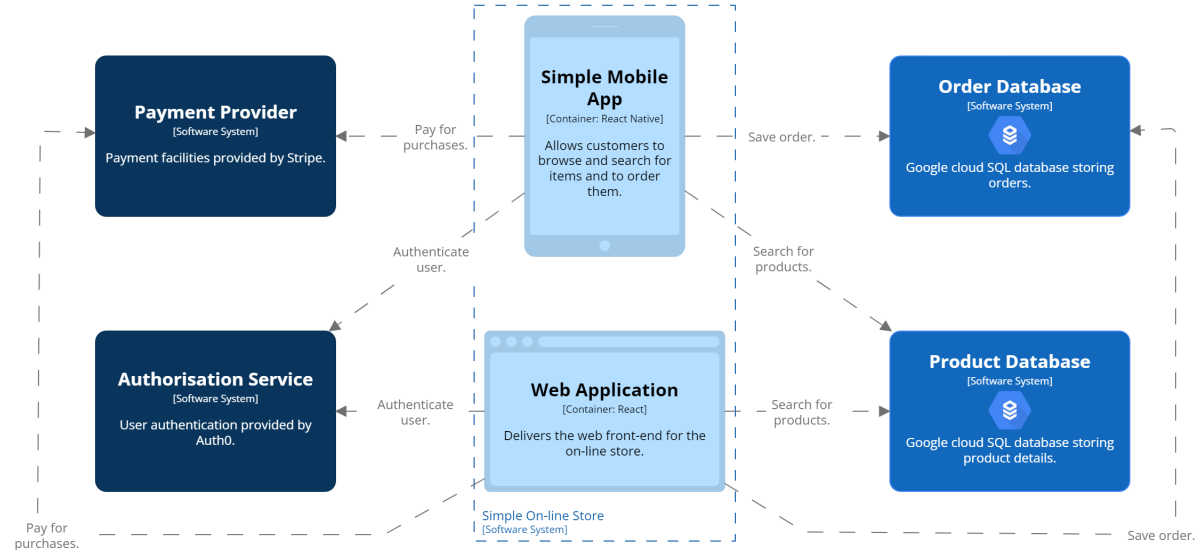
Cloud-hosted applications or services that deliver functionality used by an application front-end.

- Front-end may be a SPA or mobile app.
- Back-end provides sophisticated functionality (e.g. database, machine learning, location services, authentication, ...).
- Front-end ties back-end services together to deliver the application's functionality.

# BaaS Iceberg *[Brunko, 2019]*



## BaaS Example



- Example of simple system with back-end functionality delivered entirely via BaaS.
- Feature-rich front-ends coordinate behaviour delivered by BaaS.
- Consequence: Front-ends are tightly coupled to BaaS.
- Consequence: Front-ends are have both UI and functional behaviour logic.
- Front-end could have a layered design, though many SPAs don't.

*Definition 2.* Functions as a Service (FaaS)

Application logic that is triggered by an event and runs in a transient, stateless compute node.

- Node may only exist for duration of function call.
- Server infrastructure (e.g. type of node, lifespan, scaling, ...) are managed by hosting provider.
- e.g. AWS Lambda, Google App Engine, Azure Automation, ....

# FaaS Iceberg *[Brunko, 2019]*



# FaaS Example



- Example of simple system with back-end functionality delivered entirely by FaaS.
- Feature-rich front-ends coordinate behaviour delivered by FaaS.
- Front-ends invoke functions via an API.
- API Gateway provides some separation between front-end and functions.
- May allow a bit more separation between UI and logic.

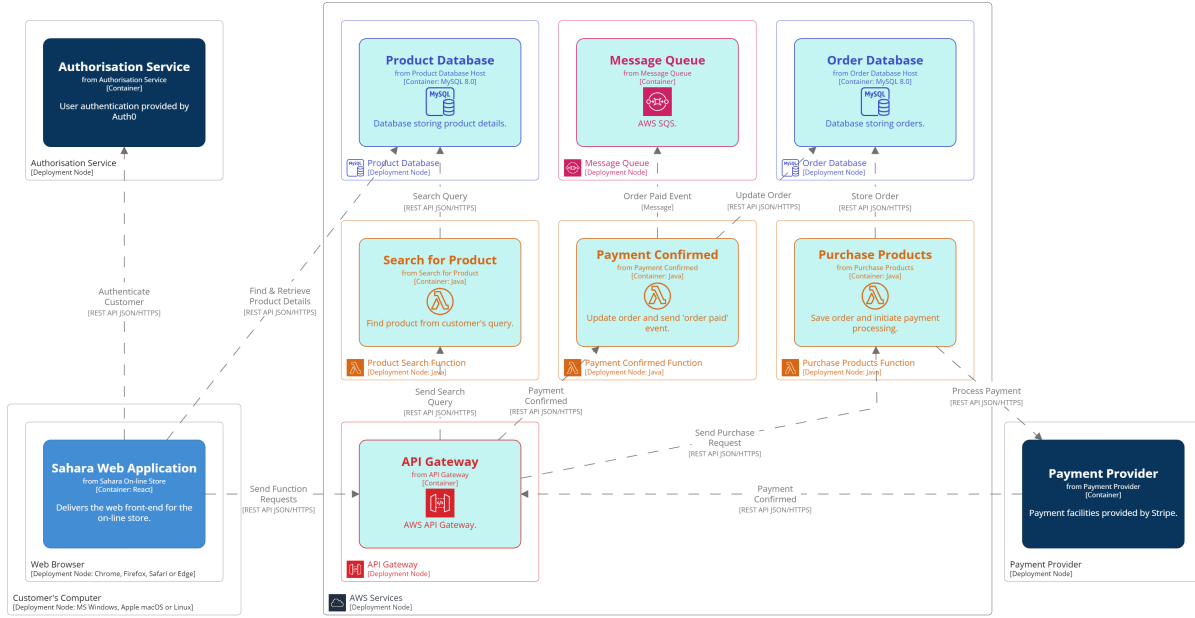


### *Definition 3. Serverless Architecture*

Software system delivering functionality through BaaS or FaaS.

- Many people focus on FaaS when considering Serverless.
- Some simple Single Page Web Apps (SPA) coordinate.
- Front-end ties back-end services together to deliver the application's functionality.

## Sahara Browse & Order



- Sahara eCommerce example as a serverless app.
- Only browse, search and purchase are shown.
- Point out that it uses both BaaS & FaaS.
- Shopping cart is implemented within the web and mobile app for this architecture.
- Order Scenario 1: Customer checks out their shopping cart in the web or mobile app.
- Order Scenario 2: App calls Purchase Products function via API Gateway.
- Order Scenario 3: Purchase Products stores order in DB and sends a payment request to Payment Provider.
- Order Scenario 4: We provide Payment Provider with API end point to call to report payment result.
- Order Scenario 5: Payment success causes Payment

The diagram illustrates the architecture of an e-commerce system using AWS services. The components and their interactions are as follows:

- API Gateway** (from API Gateway [Container]) is the entry point for the system. It receives requests from the **API Gateway** (Deployment Node) and interacts with the **Order Status** service.
- Order Status** (from Order Status [Container: Java]) responds to customer queries with the current status of the order. It interacts with the **Order Database** and the **Order Shipped** service.
- Order Database** (from Order Database Host [Container: MySQL 8.0]) stores orders. It is managed by the **Order Database** (Deployment Node).
- Order Shipped** (from Order Shipped [Container: Java]) sends an email to the customer via the **Email Service** and updates the **Order Database**. It is managed by the **Order Shipped Function** (Deployment Node: java).
- Email Service** (from Email Service [Container]) sends emails using **AWS SES**. It is managed by the **Email Service** (Deployment Node).
- Lambda Service** (from Lambda Service [Container]) polls the **Message Queue** and batches messages to send to **Lambda Functions**. It is managed by the **Lambda Service** (Deployment Node).
- Message Queue** (from Message Queue [Container]) is used for asynchronous communication. It is managed by the **Message Queue** (Deployment Node).
- Fulfill Order** (from Fulfill Order [Container: Java]) sends a pick list for the order to the warehouse. It is managed by the **Fulfill Order Function** (Deployment Node: java).
- Fulfillment Mobile Device** (from Sahara On-line Store [Container: React Native]) coordinates fulfillment of orders. It is managed by the **Fulfillment Mobile Device** (Deployment Node: Android or iOS).

The flow of data and control is as follows:

- The **API Gateway** (Deployment Node) sends a **Query Order Status** request to the **Order Status** service.
- The **Order Status** service sends a **Query Order Status** request to the **Order Database**.
- The **Order Database** returns the **Order Status** to the **Order Status** service.
- The **Order Status** service sends an **Order Shipped** message to the **Order Shipped** service.
- The **Order Shipped** service sends an **Order Shipped** message to the **Email Service** and updates the **Order Database**.
- The **Order Shipped** service sends an **Order Shipped** message to the **Message Queue**.
- The **Message Queue** sends a **Message** to the **Lambda Service**.
- The **Lambda Service** sends a **Message** to the **Fulfill Order** service.
- The **Fulfillment Mobile Device** sends a **Send Pick List** message to the **Fulfill Order** service.
- The **Fulfill Order** service sends a **Message** to the **Message Queue**.
- The **Message Queue** sends a **Message** to the **Order Shipped** service.
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- The **Order Status** service sends a **Message**

- Sahara eCommerce example as a serverless app.
- Only fulfilment functions are shown.
- Shows Lambda Service polling Queue, demonstrating how Lambda Functions are invoked via events in a message queue.
- Fulfilment Scenario 1: Lambda Service monitors Queue for 'ship order' messages.
- Fulfilment Scenario 2: Lambda Service batches groups of 'ship order' messages and sends them to Fulfill Order function.
- Fulfilment Scenario 3: Fulfill Order gets order details from DB and sends pick list to Fulfilment App.
- Fulfilment Scenario 4: When order is shipped, Fulfilment App calls Order Shipped function via API Gateway.

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- Automatic scaling
  - Multiple instances of function
- Reduced cost for dynamic loads
  - No server idle time
- Reduced server management
- Easier to run closer to client
  - Launch in same zone as client

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- Front-end accesses database directly
  - Front-end needs to sanitise inputs
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    - Front-end needs to sanitise inputs
    - Easy to spoof messages from front-end
      - Hope DB provider is secure
  - Application logic is in front-end
    - Less modularisation
    - Duplication of logic with multiple front-ends
      - Web, mobile, ...
  - No control over server optimisation
- Spoofing messages is an issue for all BaaS services.
  - Modern expectations are that almost all systems will have multiple front-ends.
  - Duplication of front-end logic is a smaller, but still partial, concern for FaaS.

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  - Startup latency
    - Functions take time to start
      - Some languages worse than others (e.g. Java)
  - Proliferation of functions
    - Loss of encapsulation
- Server running function can be killed when function is not running.
  - Can occasionally send messages to functions to keep them alive.
  - Java has concurrency benefits over other languages.

*Question*

When is serverless appropriate?

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*Answer*

- Rich client apps with common backend
  - BaaS



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- Rich client apps with common backend
  - BaaS
- High latency processing
  - Within function duration constraints
- Apps with variable load
  - Take advantage of auto-scaling

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### *Answer*

- Quick response required
  - Can't wait for FaaS to start
- Compute intensive processing
- Apps with steady load
  - Server-based approaches are cheaper

*Self-Study Exercise*

- Redesign your scalability assignment to be serverless.
  - What parts of your design would benefit from being serverless?
- Implement your revised design.

Pros & Cons

Extensibility		
Reliability		
Interoperability		
Scalability		
Deployability		
Modularity		
Testability		
Security		<ul style="list-style-type: none"><li>• Modularity: Deployed functions are naturally modular.</li><li>• Modularity: Higher-level abstractions to group deployed functions is difficult.</li><li>• Testability: Unit testing FaaS functions is easy.</li><li>• Testability: Integration testing is hard.</li><li>• Security BaaS: Front-end access database directly. No server-side protection of db.</li><li>• Security FaaS: Every function needs its own security policy (e.g. IAM), which is easy to get wrong.</li></ul>
Simplicity		



## References

- [Brunko, 2019] Brunko, P. (2019).  
Serverless architecture: When to use this approach and what benefits it gives.  
<https://apiko.com/blog/serverless-architecture-benefits//>.