# Serverless Architecture

Software Architecture

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# Oxymoron 1. Serverless

Logic running on someone else's server.

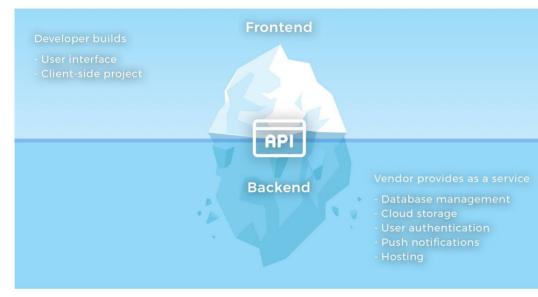
Developers can focus on logic, not infrastructure to deliver it.

# Definition 0. Backend as a Service (BaaS)

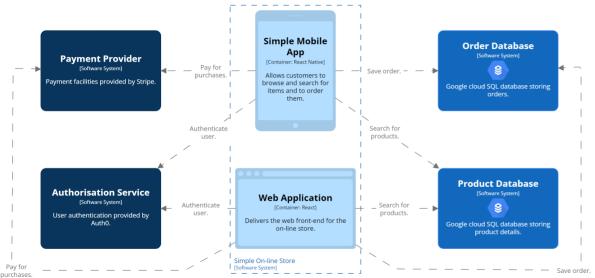
Cloud-hosted applications or services that deliver functionality used by an application front-end.

- 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 have both UI and functional behaviour logic.
- Front-end could have a layered design, though many SPAs don't.

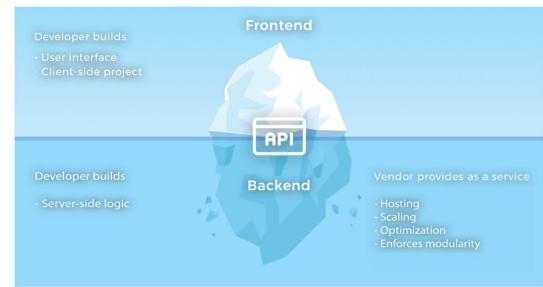
# Definition 0. Functions as a Service (FaaS)

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

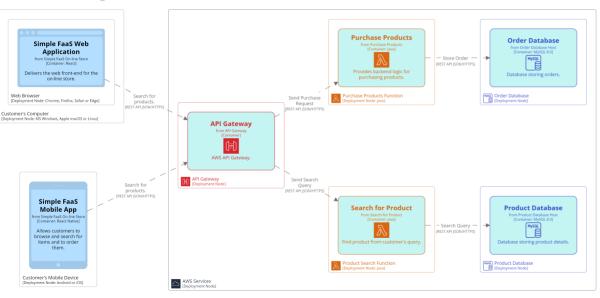
- Node may only exist for duration of function call.
- Server infrastructure (e.g. type of node, lifespan, scaling, ...) are managed by hosting provider.
- e.g. AWS Lambda, Google App Engine, Azure Automation,

. . . .

FaaS Iceberg [Brunko, 2019]



### FaaS Example



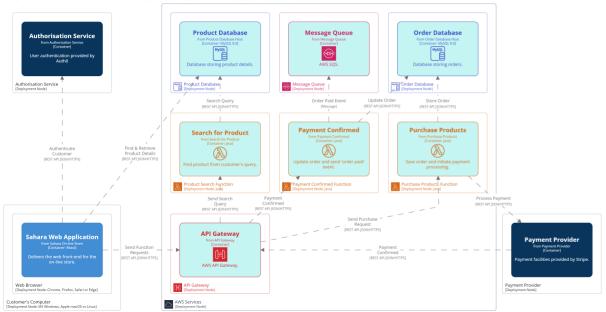
- Example of simple system with back-end functionality delivered by FaaS.
  - Some services delivered via BaaS.
    (e.g. Authentication not shown on diagram for simplicity.)
- Feature-rich front-ends coordinate behaviour delivered by FaaS.
- Front-ends invoke functions via an API.
- API Gateway provides some separation between front-end and functions.
- Allows a bit more separation between UI and logic.

# Definition 0. Serverless Architecture Software system delivering functionality

Software system delivering functionality through BaaS or FaaS.

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

#### Sahara Browse & Order — Serverless



- Only browse, search and purchase are shown.
- 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 5-9: Notes continue on next slide.

Sahara Fulfilment — Serverless **Email Service** AWS API Gateway. oordinates fulflime Requests Lambda Service **Order Status** Sahara Web Application Order Status Order Database Fulfill Order Order Picking Order Database

[REST API JSON/HTTPS

- 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: Fulfil 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.
- Fulfilment Scenario 5-8: Notes continue on next slide.

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  - Multiple instances of function

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

### BaaS Tradeoffs

- Front-end accesses database directly
  - Front-end needs to sanitise inputs
  - Easy to spoof messages from front-end
    - Hope DB provider is secure

Spoofing messages is an issue for all BaaS services.

### BaaS Tradeoffs

- Front-end accesses database directly
  - 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, ...

- 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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- Application logic is in front-end
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  - Duplication of logic with multiple front-ends
    Web, mobile, . . .
- No control over server optimisation

# • No server state

FaaS Tradeoffs

- All state needs to be saved (e.g. Redis, S3, ...)
  - Not just persistent state

- Server running function can be killed when function is not running.
- Can occasionally send messages to functions to keep them alive — Not ideal.

# FaaS Tradeoffs • No server state

- - All state needs to be saved (e.g. Redis, S3, ...)
    - Not just persistent state

• AWS Lambda – up to 15 minutes

- Execution duration
  - Can't be long running process

# • No server state • All state needs to be saved (e.g. Redis, S3, ...)

FaaS Tradeoffs

- Not just persistent state
- Execution duration
  - Can't be long running process
- AWS Lambda up to 15 minutes
- Startup latency • Functions take time to start

  - Some languages worse than others (e.g. Java)

Java has concurrency benefits over other languages.

# FaaS Tradeoffs • No server state • All state needs to be saved (e.g. Redis, S3, ...) • Not just persistent state • Execution duration • Can't be long running process • AWS Lambda – up to 15 minutes • Startup latency • Functions take time to start • Some languages worse than others (e.g. Java) • Proliferation of functions • Loss of encapsulation

When is serverless appropriate?

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- Rich client apps with common backend
  - BaaS

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- High latency processing
  - Within function duration constraints

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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

When is serverless *not* appropriate?

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- Quick response required
  - Can't wait for FaaS to start

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- Quick response required
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- Compute intensive processing

When is serverless not appropriate?

- 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 • Modularity: Deployed functions are naturally modular. Extensibility • Modularity: Higher-level abstractions to group deployed 000 Reliability functions is difficult. Interoperability • Testability: Unit testing FaaS functions is easy. • Testability: Integration testing is harder. Scalability • Maintainability: Backend modularity and independence 00 Deployability should facilitate its maintenance. Modularity • Maintainability: Frontend contains UI and application logic. Testability • Security BaaS: Front-end access database directly. No server-side protection of db. Maintainability • Security FaaS: Every function needs its own security policy Security (e.g. IAM), which is easy to get wrong.

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/.