Introduction to Serverless Computing

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IBM **Code**

What is Serverless?

What is Serverless?

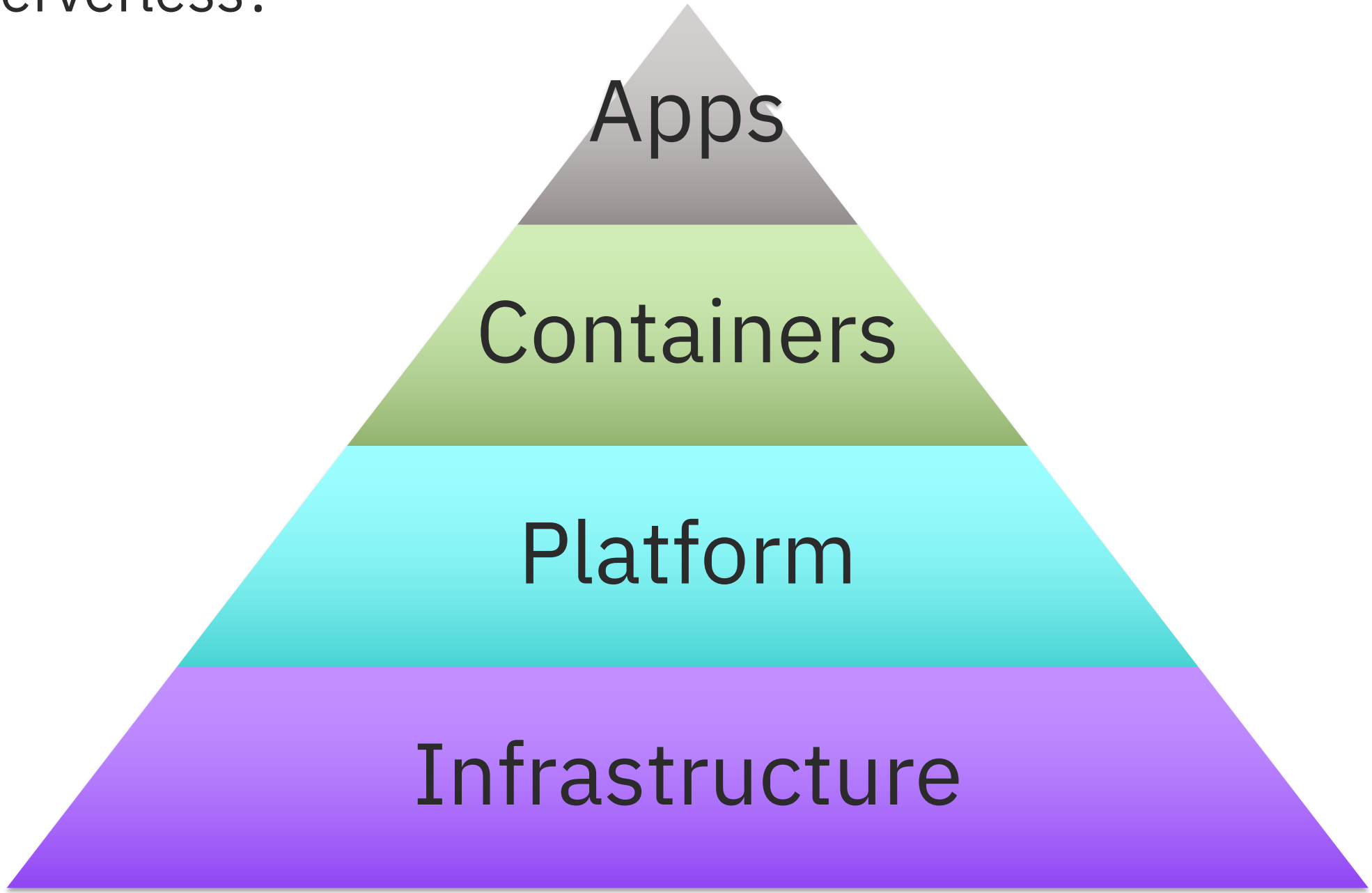
Serverless computing refers to the concept of building and running applications that do not require server management.

It describes a finer-grained deployment model where applications, bundled as one or more functions, are uploaded to a platform and then executed, scaled, and billed in response to the exact demand needed at the moment.

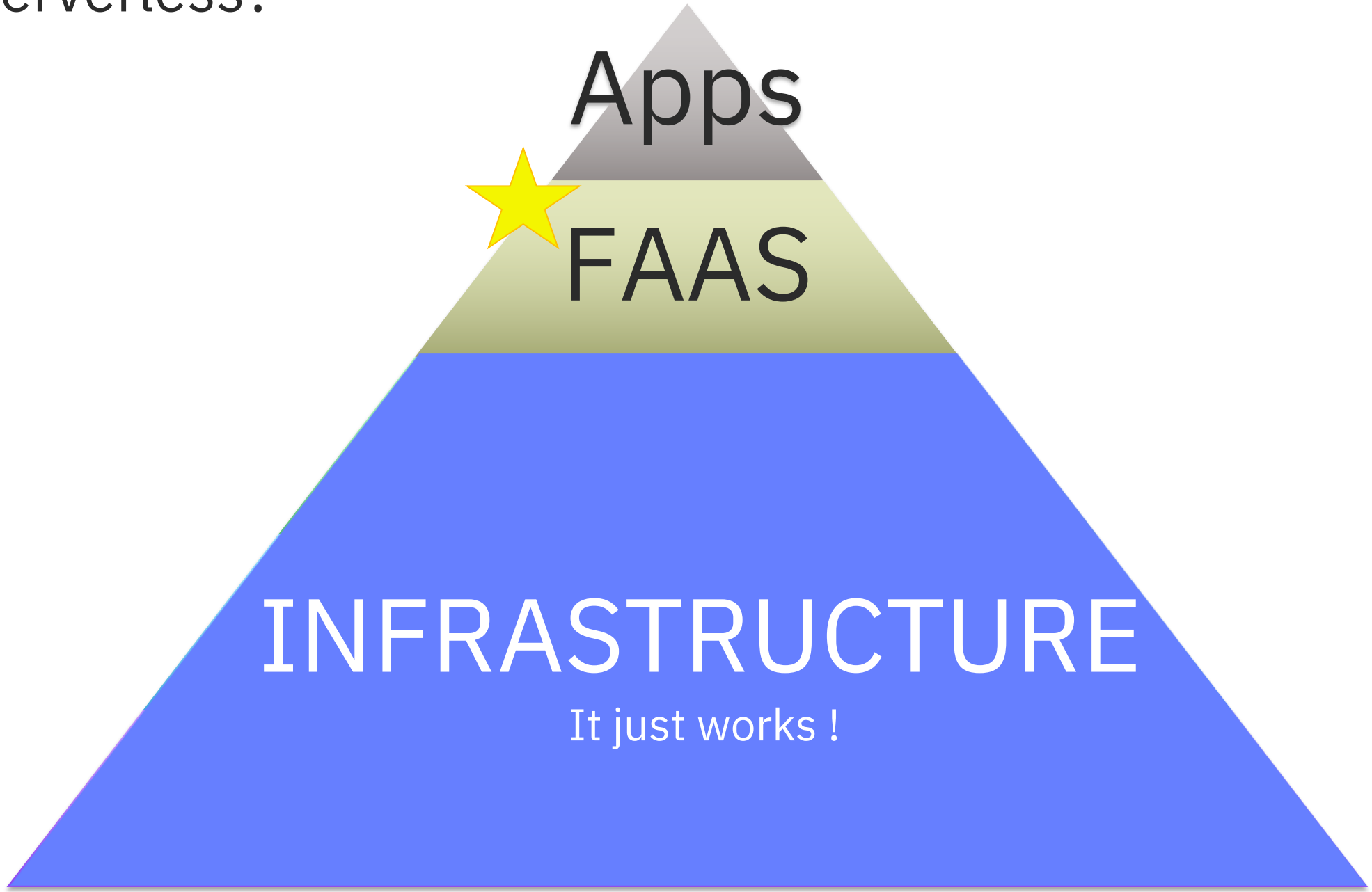
It refers to the idea that consumers of serverless computing no longer need to spend time and resources on server provisioning, maintenance, updates, scaling, and capacity planning. Instead, all of these tasks and capabilities are handled by a serverless platform and are completely abstracted away from the developers

- Cloud Native Computing Foundation
https://github.com/cncf/wg-serverless/tree/master/whitepapers/serverless-overview

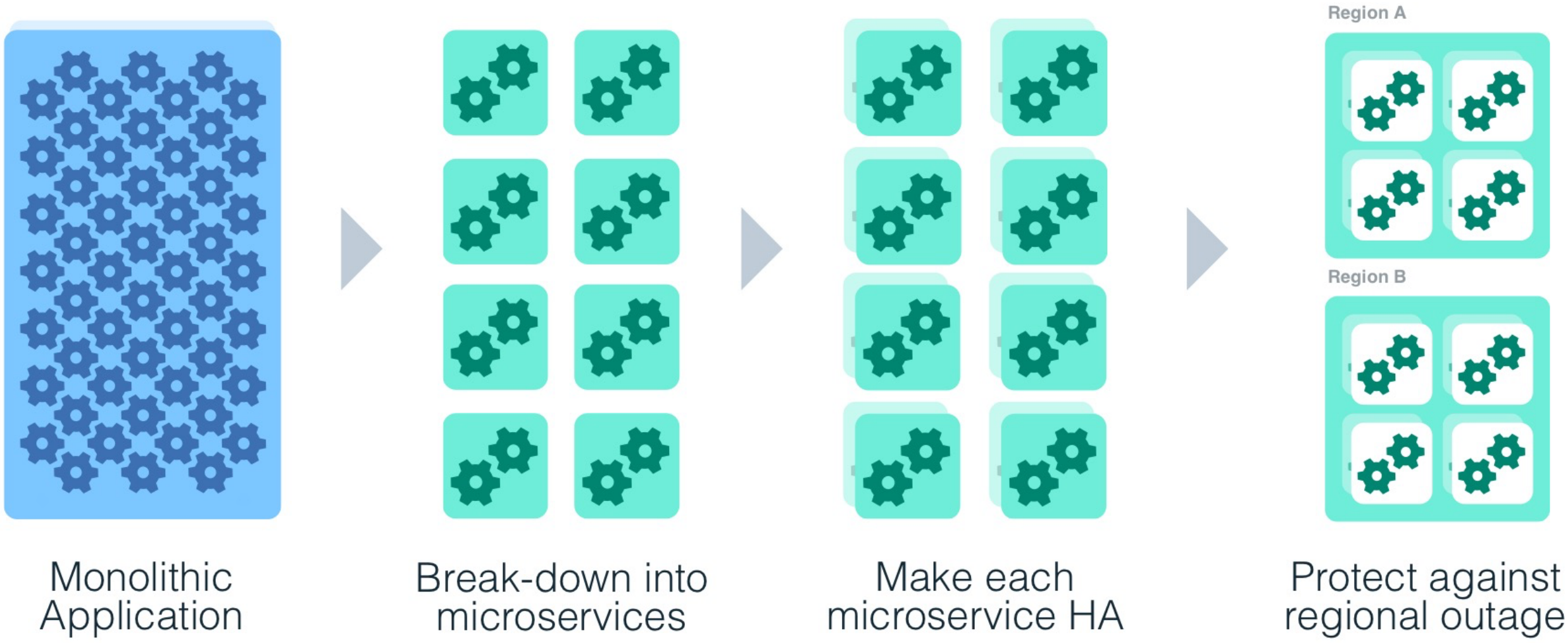
What is Serverless?



What is Serverless?



What is Serverless?



Use Cases

Small, focused, asynchronous, concurrent, easy to parallelize into independent units of work

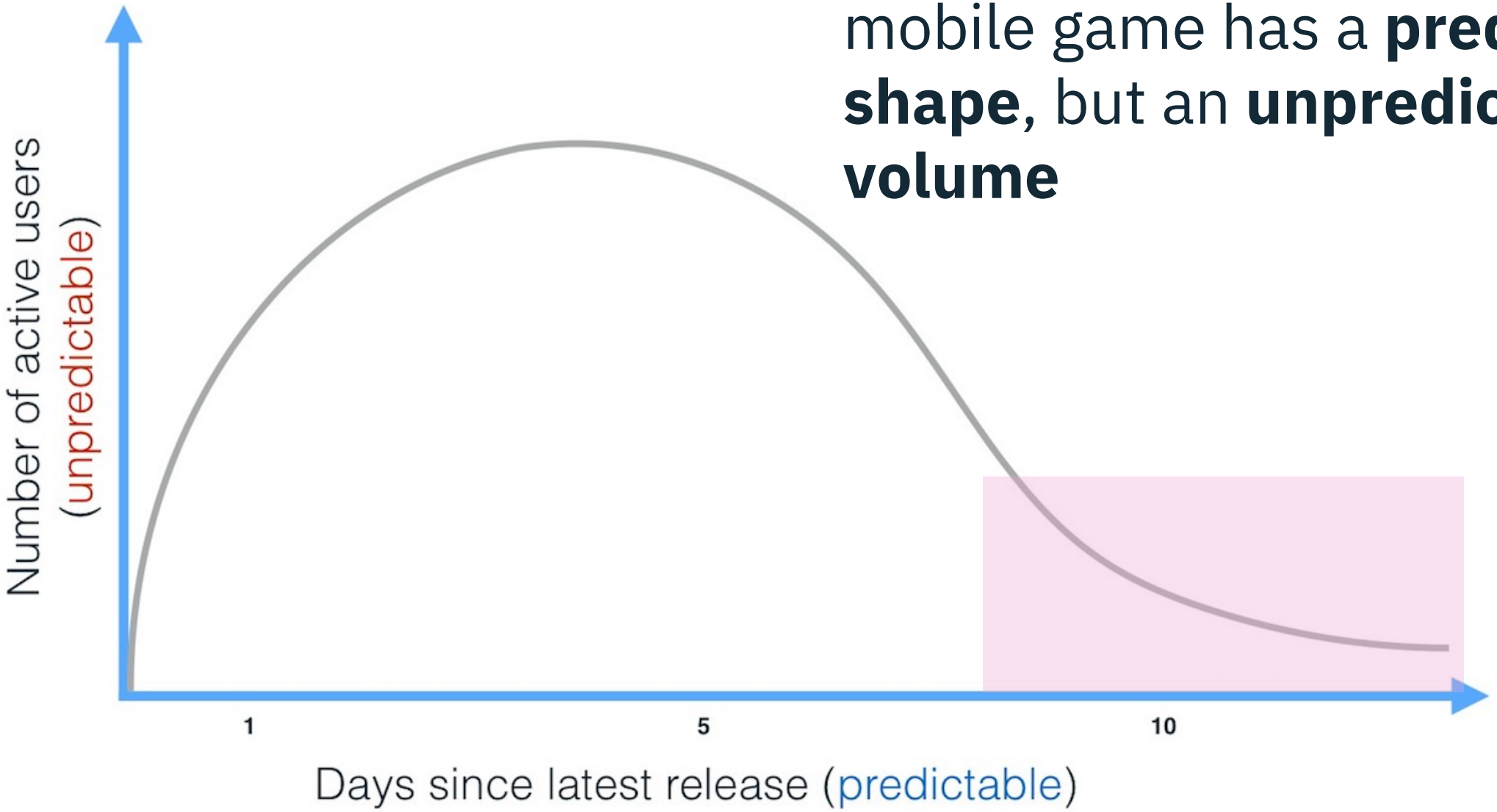
Infrequent or has sporadic demand, with large, unpredictable variance in scaling requirements

Stateless, ephemeral, without a major need for instantaneous cold start time

Highly dynamic in terms of changing business requirements that drive a need for accelerated developer velocity

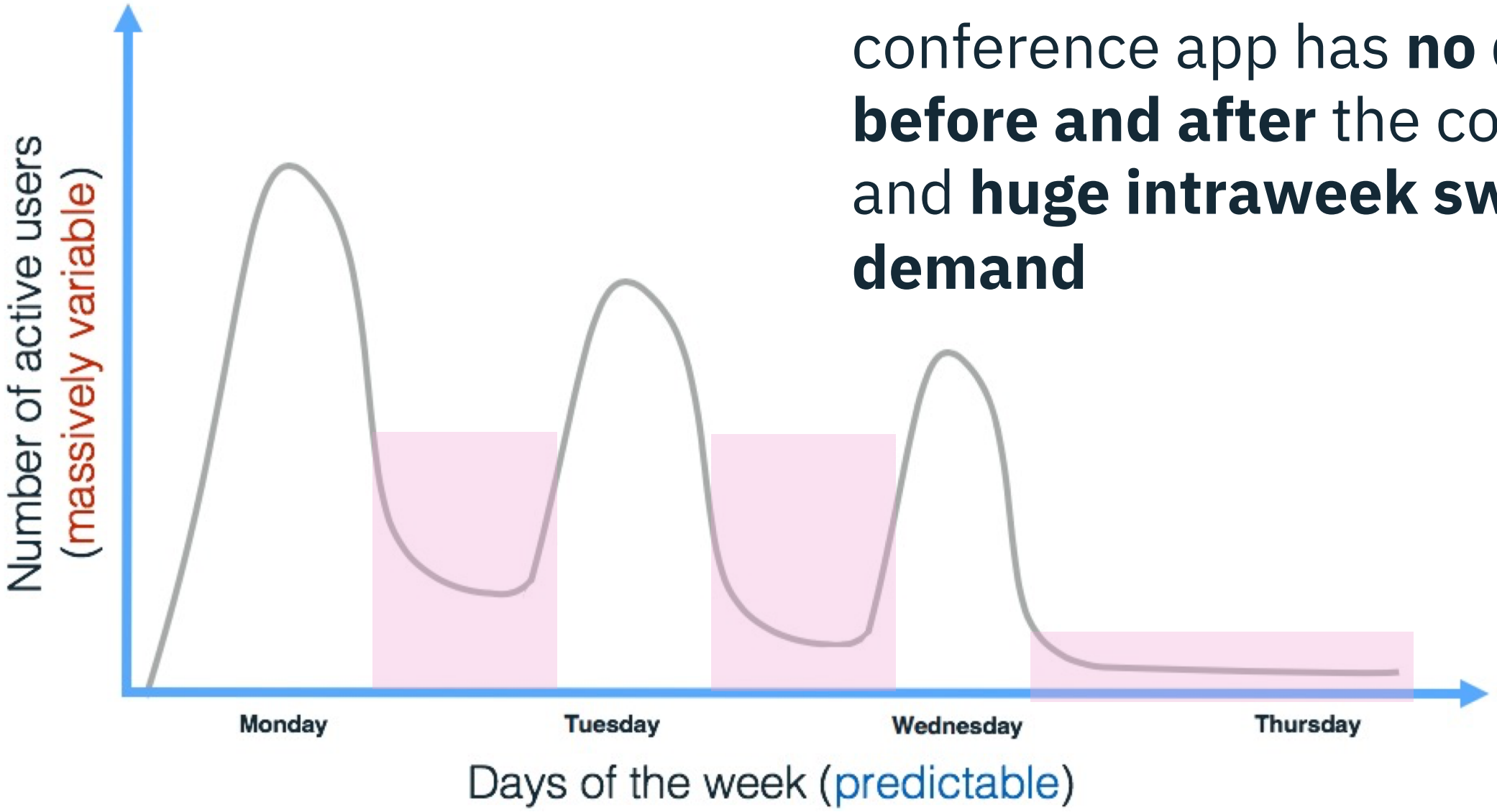
Why Serverless?

Active users curve for a new mobile game has a **predictable shape**, but an **unpredictable volume**

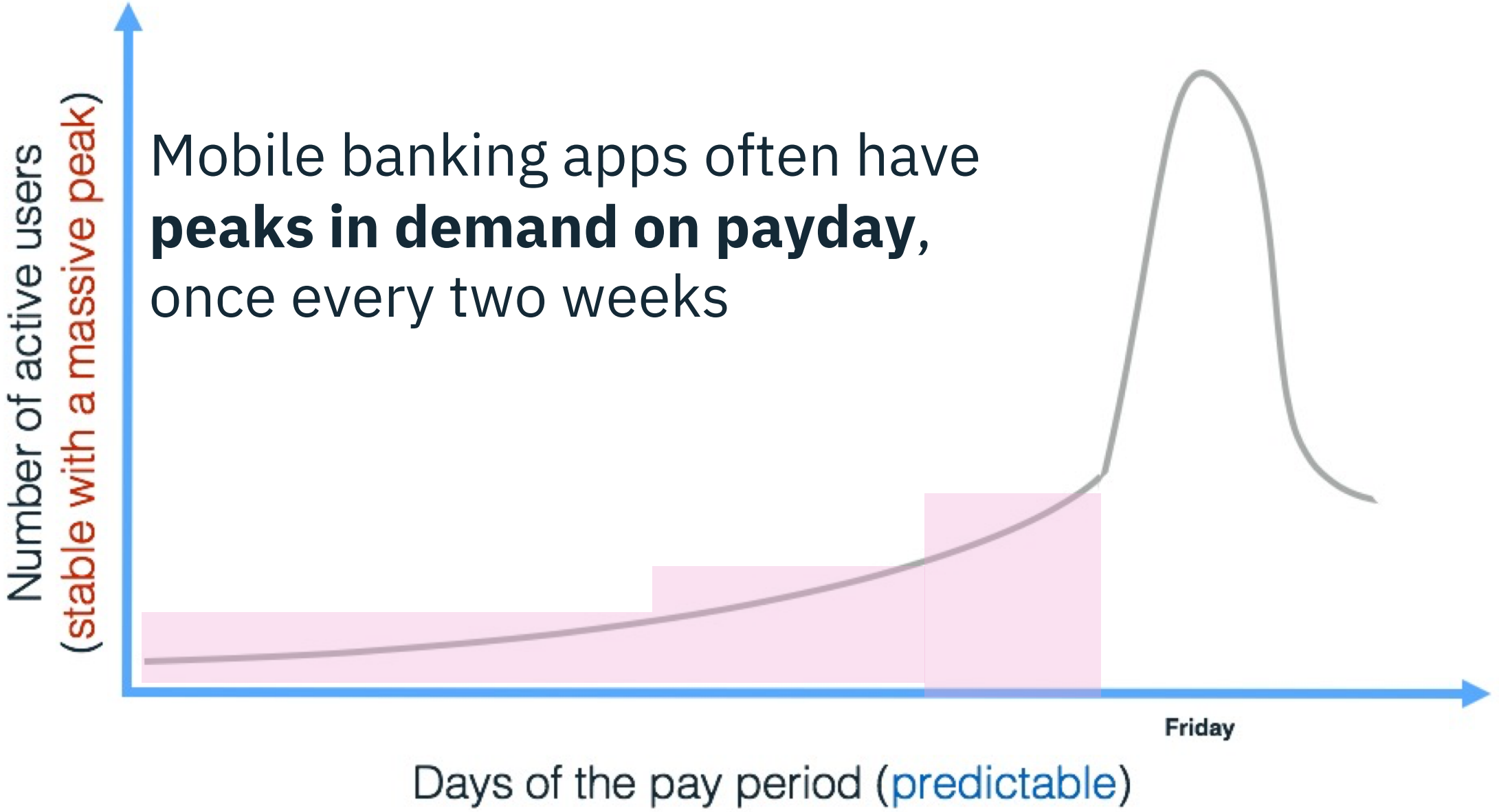


Why Serverless?

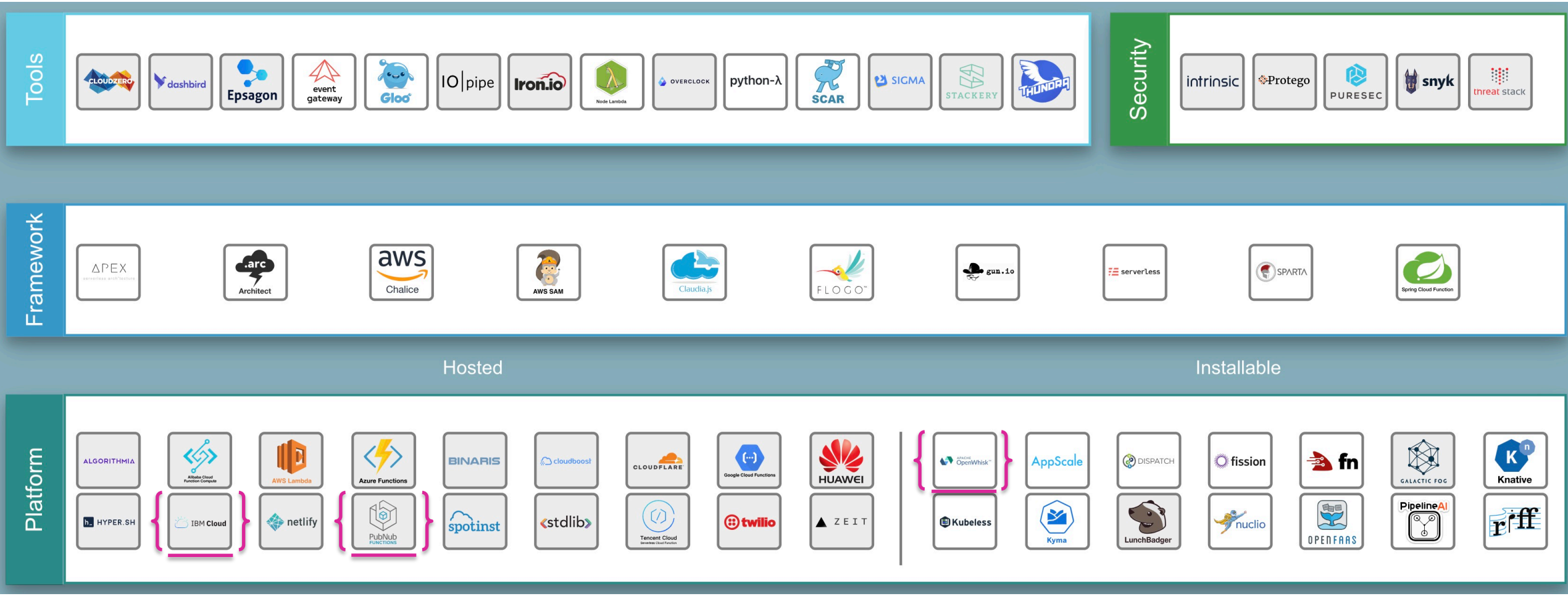
Active users curve for a mobile conference app has **no demand before and after** the conference, and **huge intraweek swings in demand**



Why Serverless?



Server Landscape (Cloud Native Computing Foundation)



Server Landscape – features

Amazon Lambda

- Node.js, Python, Java, C# and Go

Apache OpenWhisk

- Node.js 8, Node.js 6, Python 3.6.4, Python 3.6.1, PHP 7.1, PHP 7.2, and Swift 4, Swift 3.1.1, Ruby 2.5
- Other languages can be added via Docker container (for example Java)
- Based on open source OpenWhisk serverless platform. Can create your own serverless platform based on OpenWhisk

Microsoft Azure

- C#, F#, Node.js (in GA)
- Java, Python, PHP, TypeScript, Bash, PowerShell (experimental mode)

Google Cloud Function

- Node.js, Python

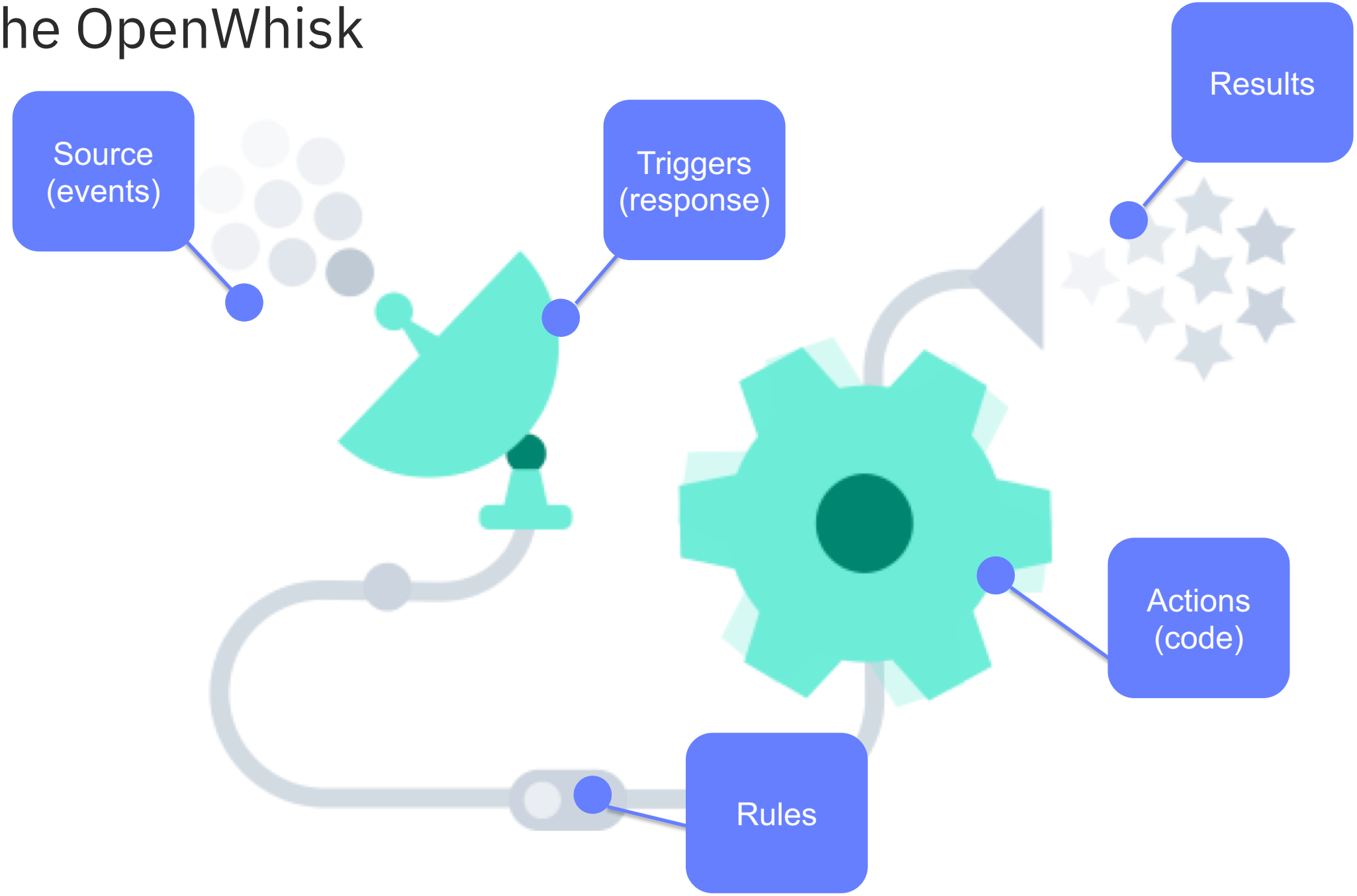
- **Many many more and constantly changings**

Apache OpenWhisk

Apache OpenWhisk (Incubating) is an open source, distributed Serverless platform that executes functions (fx) in response to events at any scale.

The OpenWhisk platform supports a programming model in which developers write functional logic (called Actions), in any supported programming language, that can be dynamically scheduled and run in response to associated events (via Triggers) from external sources (Feeds) or from HTTP requests.

Apache OpenWhisk



Apache OpenWhisk

T *A class of events that can occur*

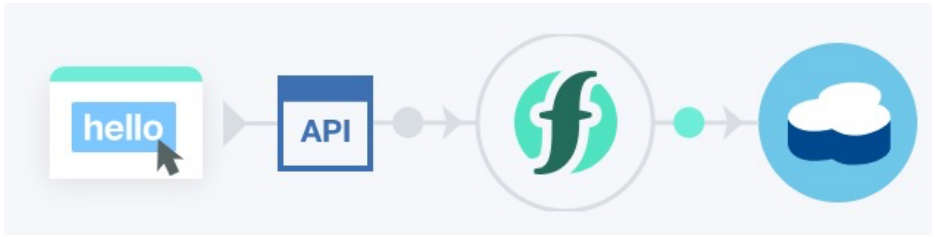
R *An association of a trigger to an action in a many to many mapping.*

A Can be written in a variety of languages, such as JavaScript, Python, Java, PHP, and Swift

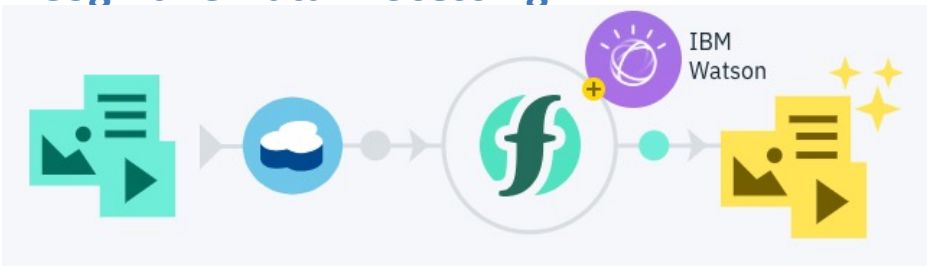
JS/NodeJS 8	Swift 4	Go	Ruby
Java	Docker	Rust	bash
Python 3	PHP 7	C	…

Use cases

Serverless Backends



Cognitive Data Processing

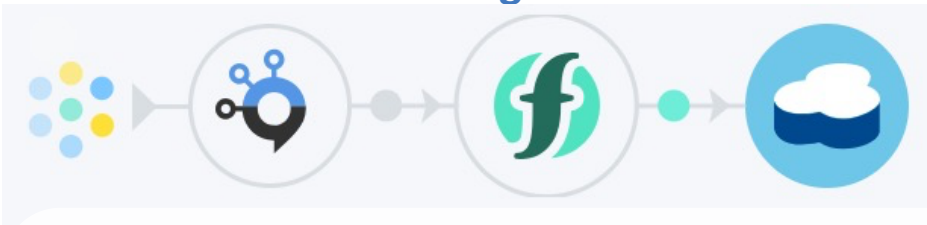


Mobile Backend

IoT Ready

Data Processing

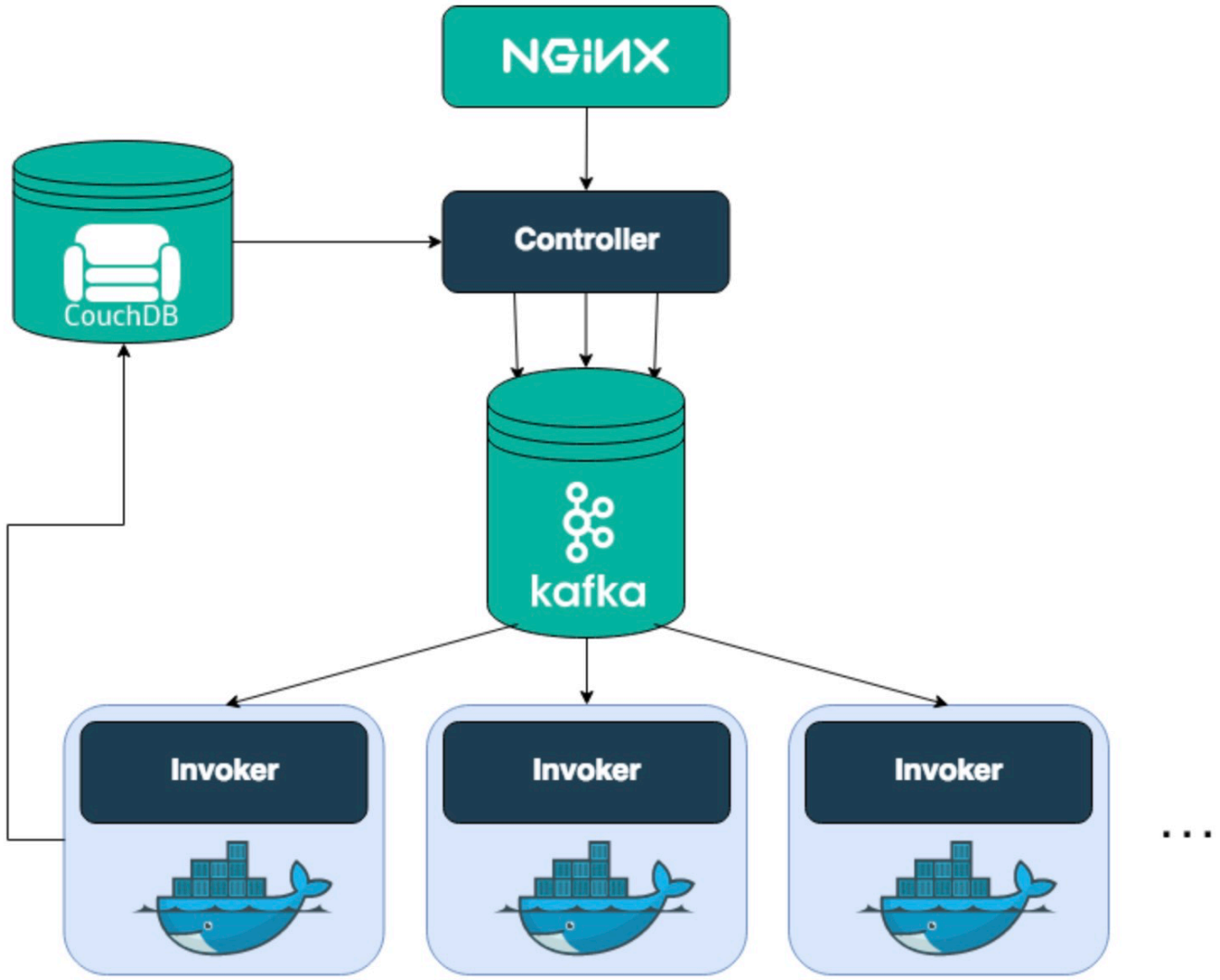
Event Stream Processing



Conversational Scenarios

Scheduled Tasks

Apache OpenWhisk



Entering the system: nginx
"an HTTP and reverse proxy server".

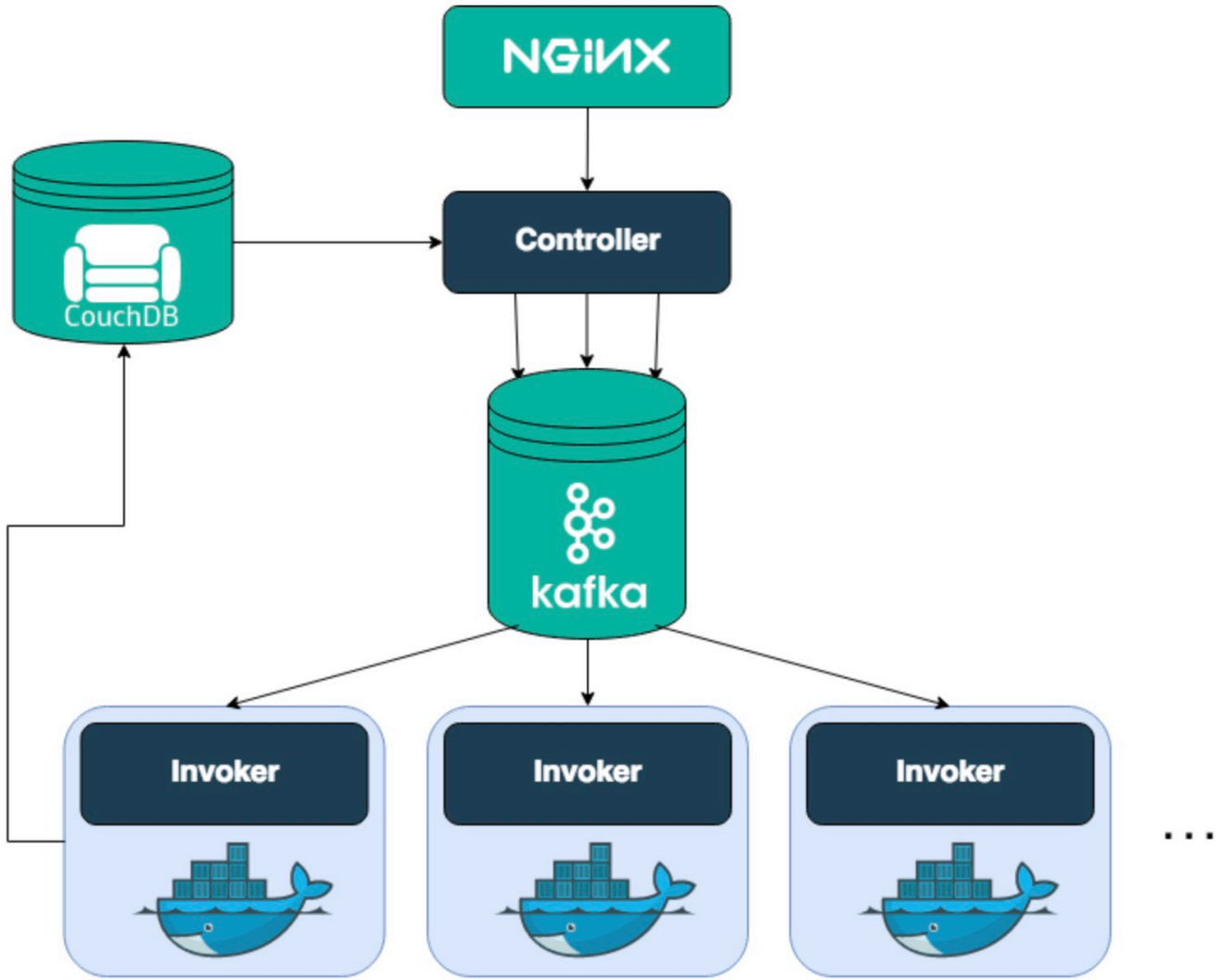
Entering the system: Controller
serves as the interface for everything a user can do, including CRUD requests for your entities in OpenWhisk and invocation of actions

Authentication and Authorization: CouchDB
check that the user exists in OpenWhisk's database and that it has the privilege to invoke the action myAction

Getting the action: CouchDB... again
Load the action from the **whisks** database in CouchDB.
The record of the action contains mainly the code to execute (shown above) and default parameters that you want to pass to your action, merged with the parameters you included in the actual invoke request. It also contains the resource restrictions imposed on it in execution, such as the memory it is allowed to consume.

Who's there to invoke the action: Load Balancer
has a global view of the executors available in the system by checking their health status continuously. Those executors are called **Invokers**. The Load Balancer, knowing which Invokers are available, chooses one of them to invoke the action requested.

Apache OpenWhisk



Please form a line: Kafka
"a high-throughput, distributed, publish-subscribe messaging system". Controller and Invoker solely communicate through messages buffered and persisted by Kafka.

Actually invoking the code already: Invoker
The Invoker's duty is to invoke an action. To execute actions in an isolated and safe way it uses **Docker.**
Example: the Invoker will start a Node.js container, inject the code from *myAction*, run it with no parameters, extract the result, save the logs and destroy the Node.js container again.

Storing the results: CouchDB again
As the result is obtained by the Invoker, it is stored into the **activations** database as an activation. The record contains both the returned result and the logs written. It also contains the start and end time of the invocation of the action.

The system itself mainly consists of only two custom components, the **Controller** and the **Invoker**. **Everything else is already there, developed by so many people out there in the open-source community.**

Apache OpenWhisk

```
~/D/c/o/incubator-openwhisk-devtools  …  docker-compose  docker ps --format "{{.ID}}: {{.Names}} {{.Image}}"
9c38cfa1cf6a: wsk0_36_prewarm_nodejs6 openwhisk/nodejs6action:latest
6b316404834c: wsk0_35_prewarm_nodejs6 openwhisk/nodejs6action:latest
33c7227b23af: openwhisk_apigateway_1 openwhisk/apigateway:latest
e62416c40058: openwhisk_invoker_1 openwhisk/invoker
d13f1d3157ec: openwhisk_controller_1 openwhisk/controller
672608ddb366: openwhisk_kafka-topics-ui_1 landoop/kafka-topics-ui:0.9.3
7654709edd2b: openwhisk_kafka-rest_1 confluentinc/cp-kafka-rest:3.3.1
af68360a86c2: openwhisk_kafka_1 wurstmeister/kafka:0.11.0.1
422c91ddf86a: openwhisk_db_1 apache/couchdb:2.1
dedb8e4552c8: openwhisk_zookeeper_1 zookeeper:3.4
d254ec1388ca: openwhisk_redis_1 redis:2.8
5ca234738543: openwhisk_minio_1 minio/minio:RELEASE.2018-07-13T00-09-07Z
```

Apache OpenWhisk – create an action

```java
import com.google.gson.JsonObject;
import com.google.gson.JsonPrimitive;

import java.util.logging.Logger;

/**
 * Hello FunctionApp
 */
public class FunctionApp {
    protected static final Logger logger = Logger.getLogger("basic");
    public static JsonObject main(JsonObject args) {

        JsonObject response = new JsonObject();
        JsonPrimitive nameArg = args.getAsJsonPrimitive("name");
        String result;
        if (nameArg == null) {
            result = "Hello! Welcome to OpenWhisk";
        } else {
            result = "Hello " + nameArg.getAsString() + " Welcome to OpenWhisk";
        }
        response.addProperty("greetings", result);

        logger.info("invoked with params:");
        return response;
    }
}
```

Entry point

Parameters

Return Object

Apache OpenWhisk – create an action

```xml
<project
  xmlns="http://maven.apache.org/POM/4.0.0"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.org/maven-v4_0_0.xsd">
  <modelVersion>4.0.0</modelVersion>
  <groupId>com.example</groupId>
  <artifactId>hello-world-java</artifactId>
  <version>1.0-SNAPSHOT</version>
  <url>https://openwhisk.apache.org/</url>
  <properties>
    <project.build.sourceEncoding>UTF-8</project.build.sourceEncoding>
    <maven.compiler.source>1.8</maven.compiler.source>
    <maven.compiler.target>1.8</maven.compiler.target>
    <gson.version>2.8.2</gson.version>
  </properties>
  <dependencies>
    <dependency>
      <groupId>com.google.code.gson</groupId>
      <artifactId>gson</artifactId>
      <version>${gson.version}</version>
    </dependency>
    <dependency>
      <groupId>junit</groupId>
      <artifactId>junit</artifactId>
      <version>4.12</version>
      <scope>test</scope>
    </dependency>
  </dependencies>
  <build>
    <finalName>hello-world-java</finalName>
    <plugins>
      <!-- This helps in packaging the function depeendencies as uber jar-->
      <plugin>
        <groupId>org.apache.maven.plugins</groupId>
        <artifactId>maven-shade-plugin</artifactId>
        <version>3.1.0</version>
        <executions>
          <execution>
            <phase>package</phase>
            <goals>
              <goal>shade</goal>
            </goals>
          </execution>
        </executions>
      </plugin>
    </plugins>
  </build>
</project>
```

gson Dependency

JAR

Apache OpenWhisk - wsk

```
}
~/D/c/openwhisk-example wsk


      ____      ___                   _    _ _     _     _
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Usage:
  wsk [command]

Available Commands:
  action      work with actions
  activation  work with activations
  package     work with packages
  rule        work with rules
  trigger     work with triggers
  sdk         work with the sdk
  property    work with whisk properties
  namespace   work with namespaces
  list        list entities in the current namespace
  api         work with APIs
  bluemix     bluemix integration

Flags:
      --apihost HOST         whisk API HOST
      --apiversion VERSION   whisk API VERSION
  -u, --auth KEY             authorization KEY
      --cert string          client cert
  -d, --debug                debug level output
  -h, --help                 help for wsk
  -i, --insecure             bypass certificate checking
      --key string           client key
  -v, --verbose              verbose output
```

```
~/D/c/openwhisk-example wsk action --help
work with actions
Usage:
  wsk action [command]

Available Commands:
  create      create a new action
  update      update an existing action, or create an action if it does not exist
  invoke      invoke action
  get         get action
  delete      delete action
  list        list all actions in a namespace or actions contained in a package

Global Flags:
      --apihost HOST         whisk API HOST
      --apiversion VERSION   whisk API VERSION
  -u, --auth KEY             authorization KEY
      --cert string          client cert
  -d, --debug                debug level output
  -i, --insecure             bypass certificate checking
      --key string           client key
  -v, --verbose              verbose output
```

```
~/D/c/openwhisk-example wsk trigger --help
work with triggers
Usage:
  wsk trigger [command]

Available Commands:
  fire        fire trigger event
  create      create new trigger
  update      update an existing an trigger, or create a trigger if it does not exist
  get         get trigger
  delete      delete trigger
  list        list all triggers

Global Flags:
      --apihost HOST         whisk API HOST
      --apiversion VERSION   whisk API VERSION
  -u, --auth KEY             authorization KEY
      --cert string          client cert
  -d, --debug                debug level output
  -i, --insecure             bypass certificate checking
      --key string           client key
  -v, --verbose              verbose output
```

DEMO

IBM **Code**

Apache OpenWhisk – create an action

```
~/D/c/colorado-spring-openwhisk  * serverless-java-mini-workshop  tree src/
src/
├── main
│   └── java
│       └── com
│           └── example
│               └── FunctionApp.java
└── test
    └── java
        └── com
            └── example
                └── FunctionAppTest.java
```

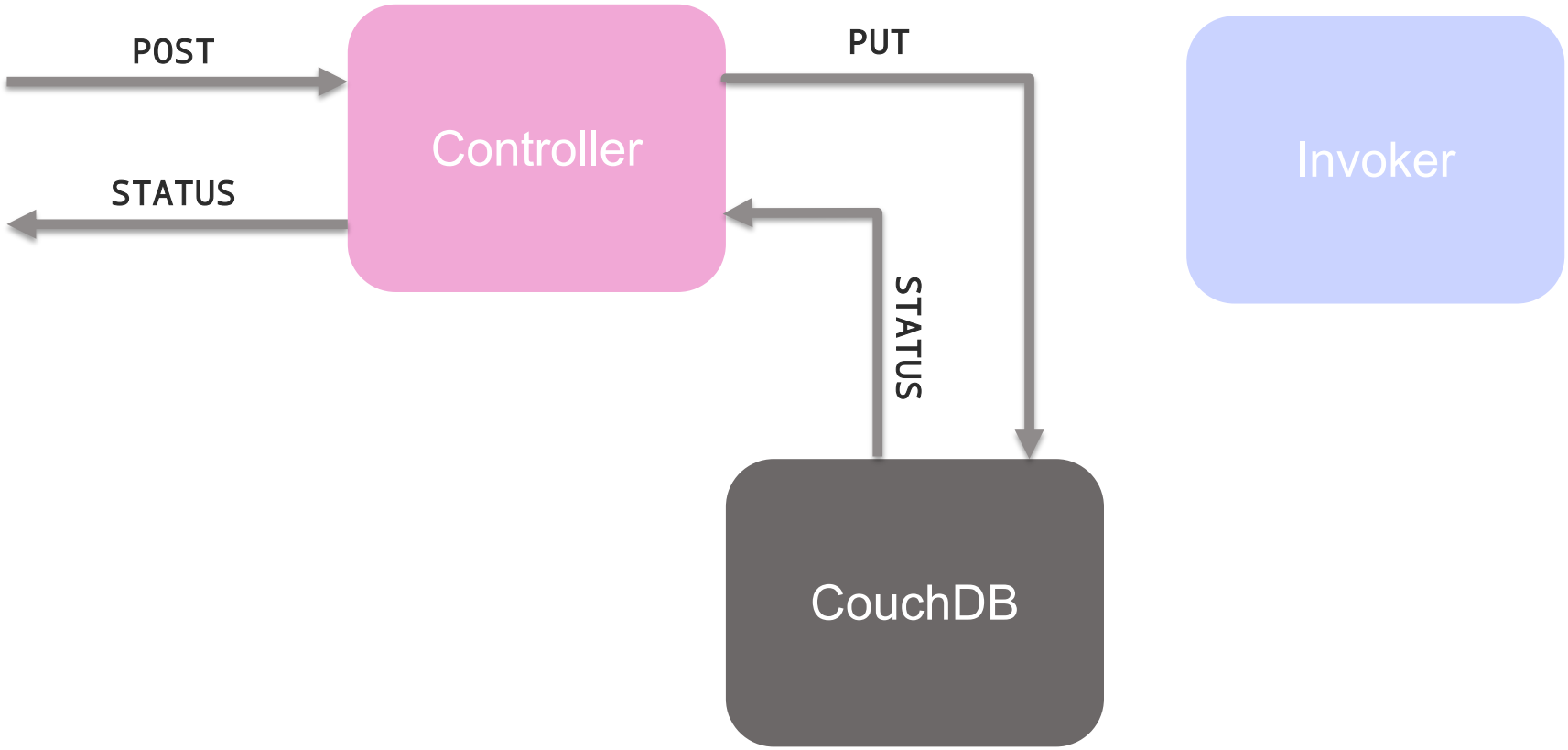
```
~/D/c/colorado-spring-openwhisk  * serverless-java-mini-workshop  wsk action list -i
actions
```

```
~/D/c/colorado-spring-openwhisk  * serverless-java-mini-workshop  wsk action create helloJava target/hello-world-java.jar \
                                                                  --main com.example.FunctionApp -i
ok: created action helloJava
```

```
~/D/c/colorado-spring-openwhisk  * serverless-java-mini-workshop  wsk action list -i
actions
/guest/helloJava                                                  private java
```

Apache OpenWhisk – create an action

```
wsk action create helloJava target/hello-world-java.jar
--main com.example.FunctionApp -i
```



Apache OpenWhisk – invoke an action

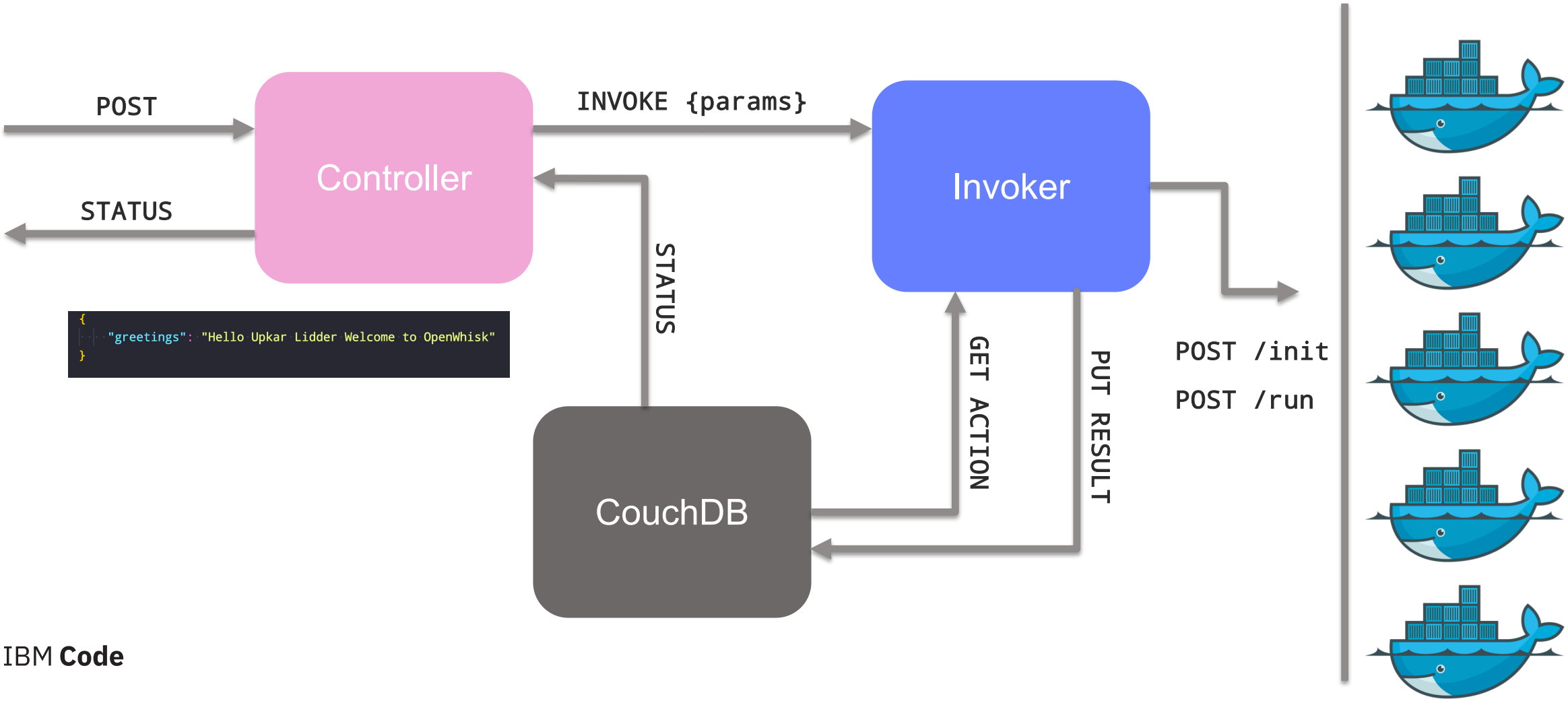
```
~/D/c/colorado-spring-openwhisk  master *  serverless-java-mini-workshop  wsk action invoke -ivr helloJava -p name "Upkar Lidder"
REQUEST:
[POST]  https://localhost/api/v1/namespaces/_/actions/helloJava?blocking=true&result=true
Req Headers
{
  "Authorization": [
    "Basic MjNiYzQ2YjEtNzFmNi00ZWQ1LThjNTQtODE2YWE0ZjhjNTAyOjEyM3pPM3haQ0xyTU42djJCS0sxZFhZRnBYbFBrY2NPRnFtMTJDZEFzTWdSVTRWck5aOWx5R1ZDR3VNREdJd1A="
  ],
  "Content-Type": [
    "application/json"
  ],
  "User-Agent": [
    "CloudFunctions-CLI/1.0 (2018-07-12T22:20:03+00:00) darwin amd64"
  ]
}
Req Body
{"name":"Upkar Lidder"}

RESPONSE:Got response with code 200
Resp Headers
{
  "Access-Control-Allow-Headers": [
    "Authorization, Origin, X-Requested-With, Content-Type, Accept, User-Agent"
  ],
  "Access-Control-Allow-Methods": [
    "GET, DELETE, POST, PUT, HEAD"
  ],
  "Access-Control-Allow-Origin": [
    "*"
  ],
  "Connection": [
    "keep-alive"
  ],
  "Content-Length": [
    "55"
  ],
  "Content-Type": [
    "application/json"
  ],
  "Date": [
    "Mon, 03 Dec 2018 06:32:36 GMT"
  ],
  "Server": [
    "openresty/1.13.6.2"
  ],
  "X-Openwhisk-Activation-Id": [
    "8ef60362830641ddb60362830641dd7b"
  ],
  "X-Request-Id": [
    "b9C9bdibQFNMxP27NO4yLYxUvSjhK839"
  ]
}
Response body size is 55 bytes
Response body received:
{"greetings":"Hello Upkar Lidder Welcome to OpenWhisk"}
{
    "greetings": "Hello Upkar Lidder Welcome to OpenWhisk"
}
```

```
{
    "greetings": "Hello Upkar Lidder Welcome to OpenWhisk"
}
```

Apache OpenWhisk – invoke an action

```
wsk action invoke -ivr helloJava -p name "Upkar Lidder"
```



IBM Cloud Functions

	Open source	Hosted service
Serverless engine	**Apache OpenWhisk**	**IBM Cloud Functions**
API Gateway	**LoopBack**	**IBM API Gateway**
Databases	**Apache CouchDB** **MySQL**	**IBM Cloudant** **IBM Compose**
Message streams	**Apache Kafka**	**IBM Message Hub**

DEMO

Things to consider

- Functions are stateless. Need some sort of persistence between runs.
- Are you able to test and develop locally ? Does provider have CLI ?
- Can you easily version your functions ? Source control ?
- Can you easily monitor your functions ?
- Security and API gateway
- Avoid long-running loops / mini-monoliths ?
- Latency (cold, warm and hot loads)
- How do you track dependencies ?

System Limitations

limit	description	configurable	unit	default
timeout	a container is not allowed to run longer than N milliseconds	per action	milliseconds	60000
memory	a container is not allowed to allocate more than N MB of memory	per action	MB	256
logs	a container is not allowed to write more than N MB to stdout	per action	MB	10
concurrent	no more than N activations may be submitted per namespace either executing or queued for execution	per namespace	number	100
minuteRate	no more than N activations may be submitted per namespace per minute	per namespace	number	120
codeSize	the maximum size of the actioncode	not configurable, limit per action	MB	48
parameters	the maximum size of the parameters that can be attached	not configurable, limit per action/package/trigger	MB	1
result	the maximum size of the action result	not configurable, limit per action	MB	1

Resources

Lists

- https://github.com/anaibol/awesome-serverless
- https://github.com/pmuens/awesome-serverless
- https://twitter.com/tmclaughbos/lists/serverless

Email newsletter

- https://serverless.email/

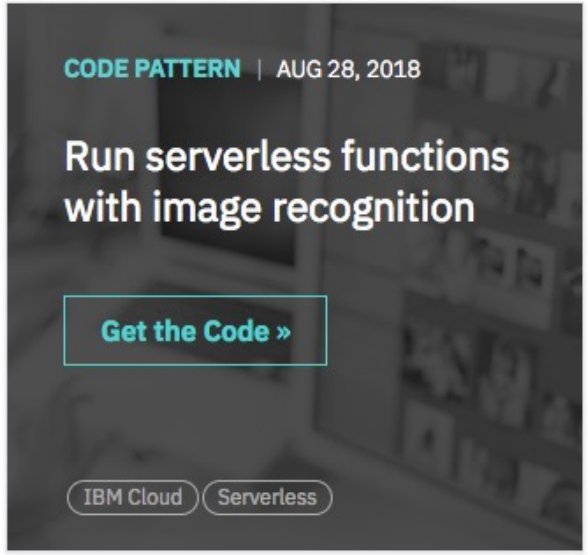
Code Patterns

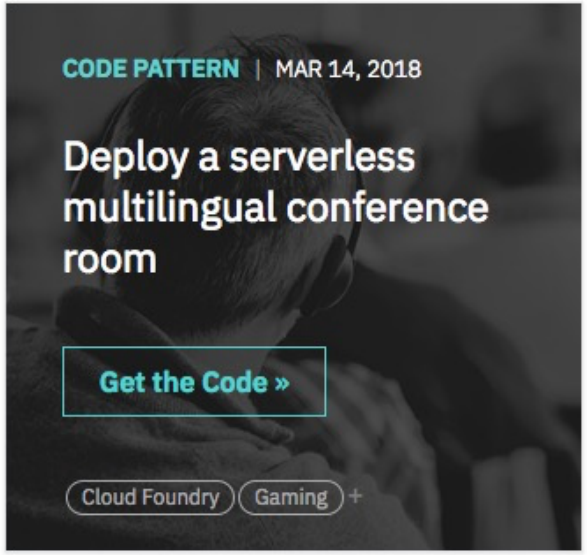
- https://developer.ibm.com/patterns/category/serverless/

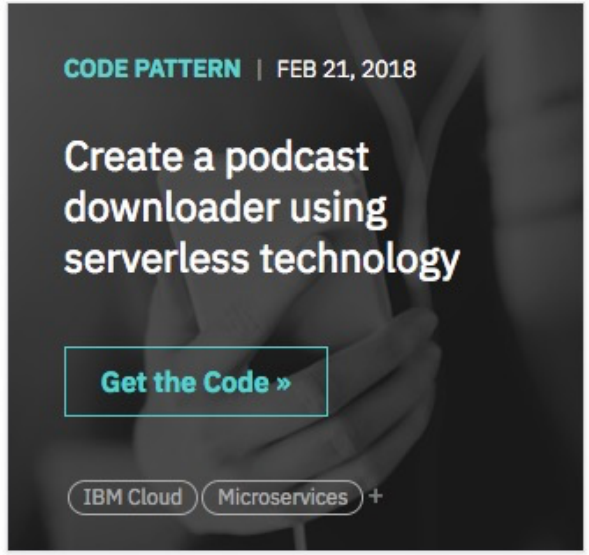
Serverless architecture

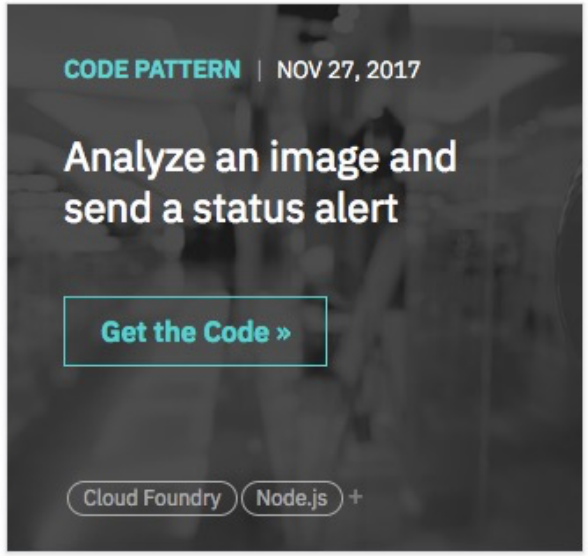
- https://martinfowler.com/articles/serverless.html

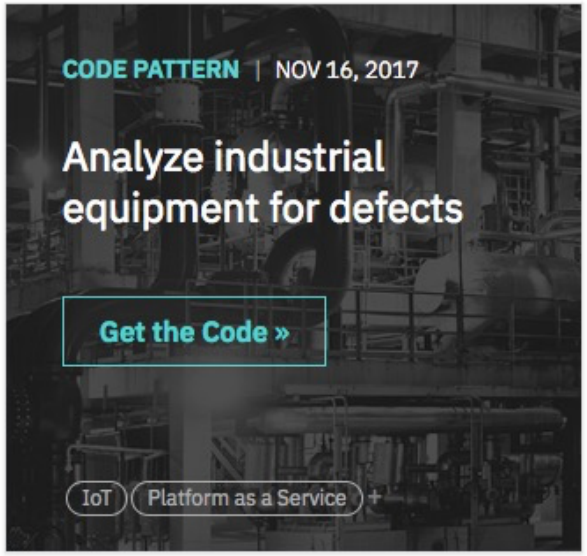
Code Patterns 🛠️

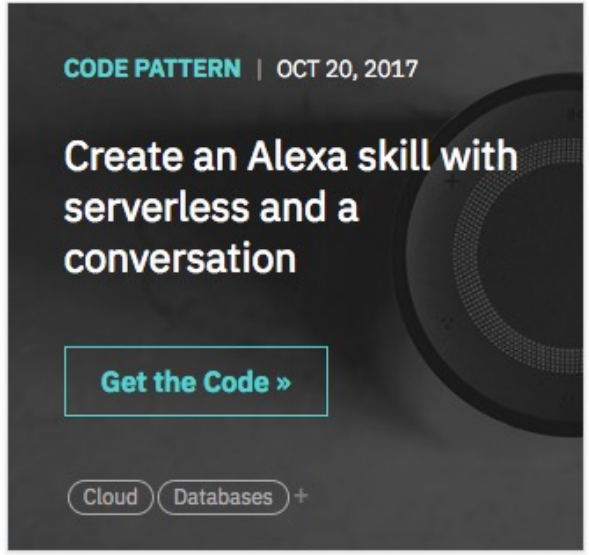












1500 Drones Are Ready To Fly

IBM Developer Drone Challenge

Challenge runs from November 12 through December 16 and those 18 years of age or older residing in the US and Canada are eligible to enter

Enter at https://developer.ibm.com/contest

Once per week during the 5 weeks of the contest a random drawing
Will be held to determine the winners (watch for the drawing on Twitch)

Winners will receive a DJI Tello programmable drone,
an IBM Developer T-shirt, and an IBM Developer laptop sticker

Winners will also receive a special code to unlock more challenges and given the opportunity to contribute back to the challenge

#IBMDroneDrop

Thank you!

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IBM **Code**