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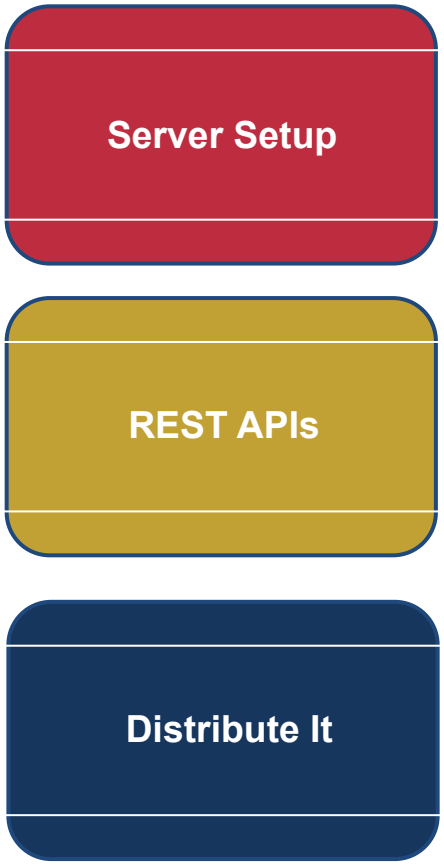
Microservices FTW

Nelson Gomes / BitSight Technologies

Presentation Topics



- Microservices Introduction
- Setting up Jetty/Jersey
- Database Access
- Caching

- Swagger Introduction
- Swagger File Generation
- Client Generation
- Jackson Behaviour Control

- Circuit Breakers
- Hazelcast Introduction
- Distributed Processing
- Dockerize it

"Most good programmers do programming not because they expect to get paid or get adulation by the public, but because it is fun to program." **- Linus Torvalds**

Server Setup

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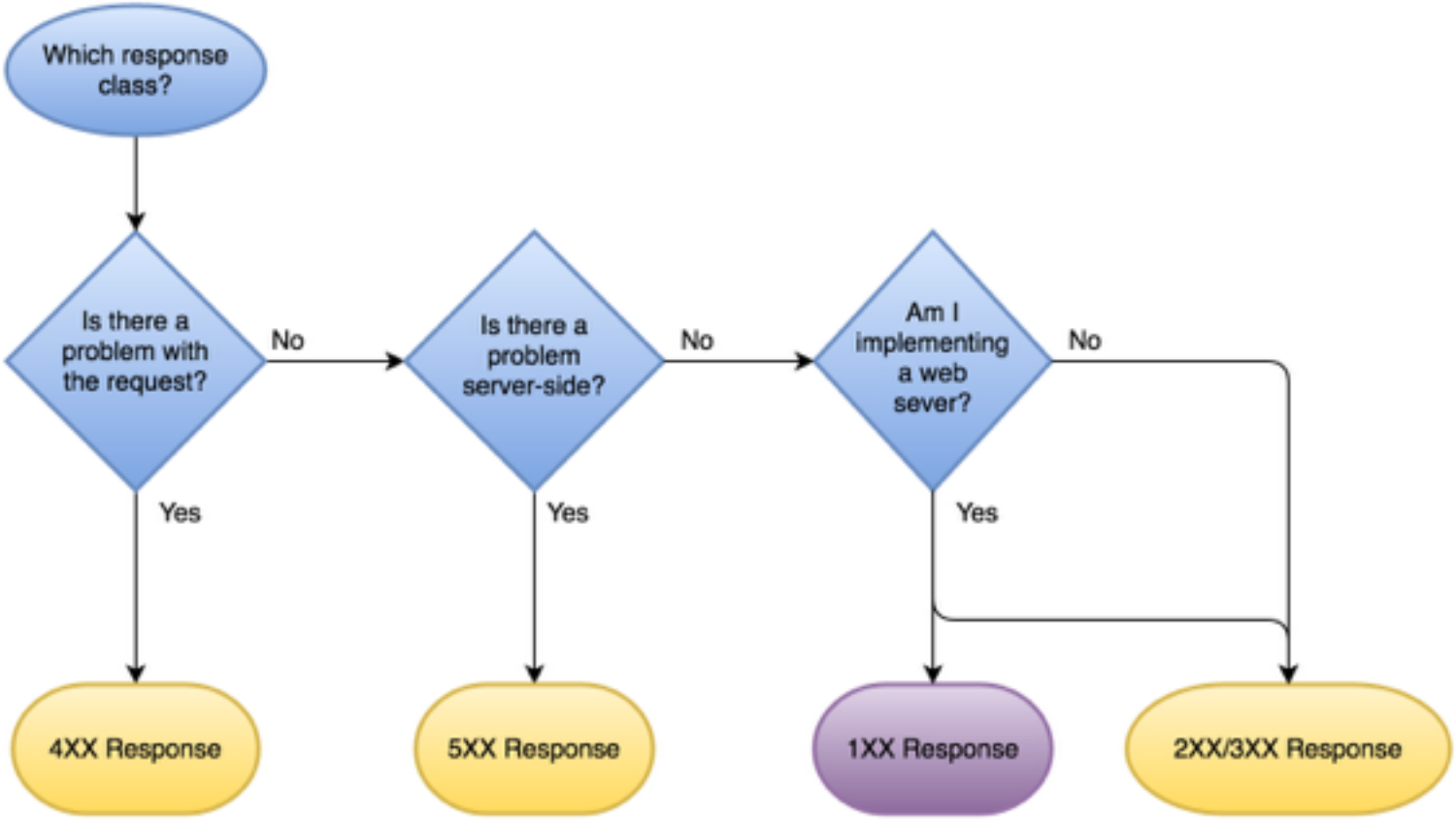
Microservices Introduction

Microservices refers to a software design architecture where applications are made of independently deployable services.

- Small pieces of software exposed via HTTP/REST
- Each resource should be a noun (ex: user, company, product)
- HTTP provides the verbs for CRUD operations:
  - Create = POST
  - Read = GET
  - Update = PUT
  - Delete = DELETE
- Stateless, Cacheable, Layered system

Roy Thomas Fielding dissertation for further reading.

HTTP Response Codes applied to REST:



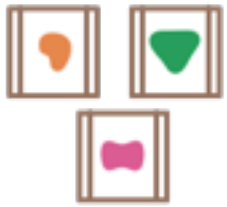
Read about at http://racksburg.com/choosing-an-http-status-code/

Microservices should not be confused with REST APIs. A Microservice should be:

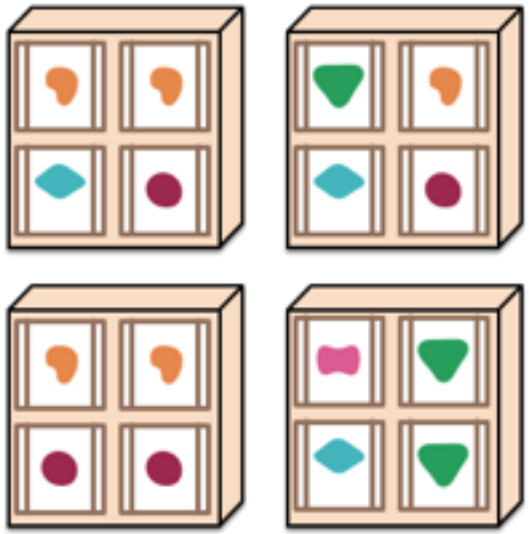
- **Scalable** - adding more servers to handle specific REST calls
- **Layered** - abstracting what server handles the request
- **Redundant** - a server down will have theoretically no impact
- **Stateless** - no server side state, each request must provide all information
- **Unique functionality** - only one service implements it

Microservices architecture:

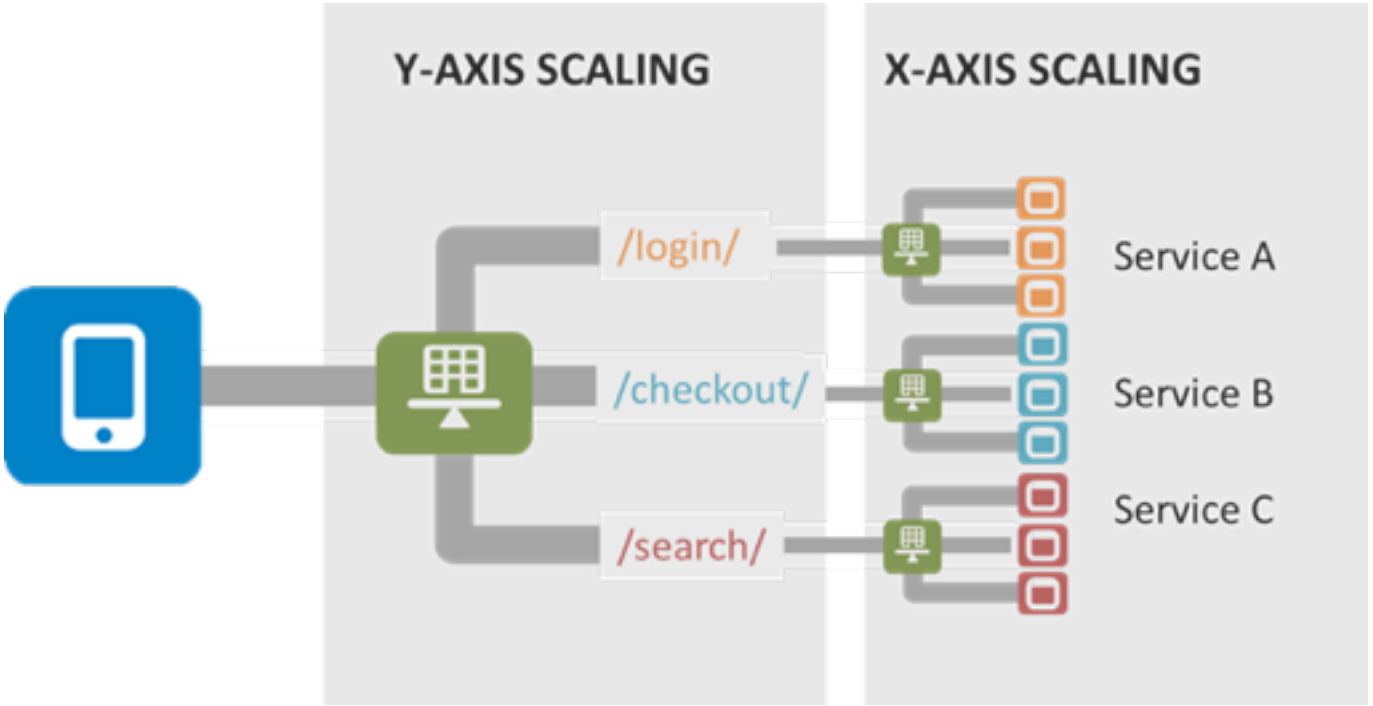
A microservices architecture puts each element of functionality into a separate service...



... and scales by distributing these services across servers, replicating as needed.



Microservices architecture:



Usually Y-AXIS scaling is done using hardware load balancers or software load balancers like Nginx or HAProxy. X-AXIS can be hosts, VMs or containers.

Microservices disadvantages:

- Distributed architectures are hard to implement
- Operational complexity
  - service monitoring
  - control cascading effect
  - problem detection
- Complexity of cross-service refactoring
- Service dependency and versioning

The very first thing you should have operational is a metrics system to allow global monitoring of the system, otherwise you won't have any awareness of it's health.

Server Setup

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Setting up Jetty/Jersey

Setup steps:

- Create a java project with war packaging
- Add maven dependencies (see the github link for this)
- There are at least two ways to start a jetty server:
  - Start a main class (useful for development), or
  - Use jetty-runner to deploy the project after packaging

```
$ mvn package
$ java -jar jetty-runner.jar application.war
```

Server Setup - Setting up Jetty/Jersey

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Jetty is a Java standalone web server and servlet container.

Jersey is a framework for RESTful web services.

```
public static void main(String[] args) throws Exception {
    ServerMain.log.info("Starting jetty version {}", Server.getVersion());

    // configure jetty server
    Server jettyServer = new Server(8080);

    // setup up access log
    final NCSARequestLog requestLog = new NCSARequestLog("logs/access-yyyy_mm_dd.log");
    requestLog.setAppend(true);
    requestLog.setExtended(true);
    requestLog.setLogTimeZone("GMT");
    jettyServer.setRequestLog(requestLog);

    // setup web app
    final WebAppContext webapp = new WebAppContext();
    webapp.setResourceBase("src/main/webapp/");

    // pass webapp to jetty
    jettyServer.setHandler(webapp);

    // start web server
    jettyServer.start();
    jettyServer.join();
}
```

At this point we should have a HTTP server ready to run on port 8080:

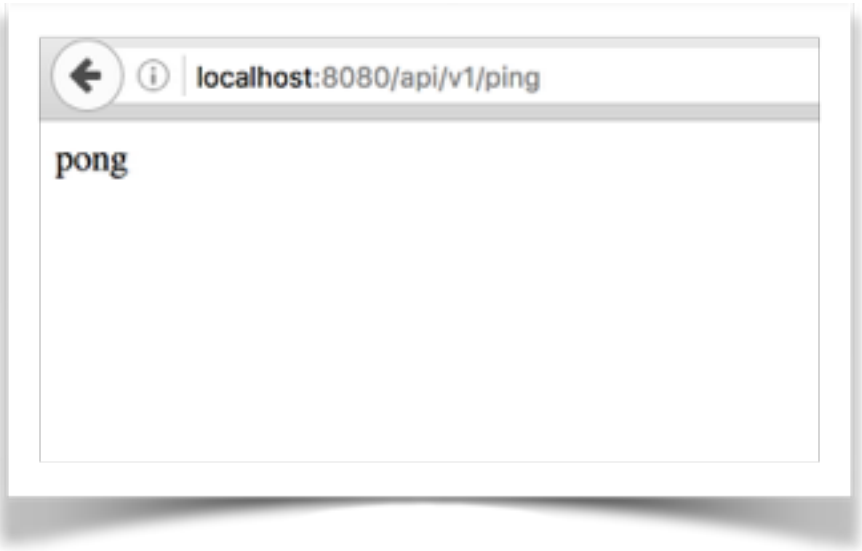
Now let's configure our web app:

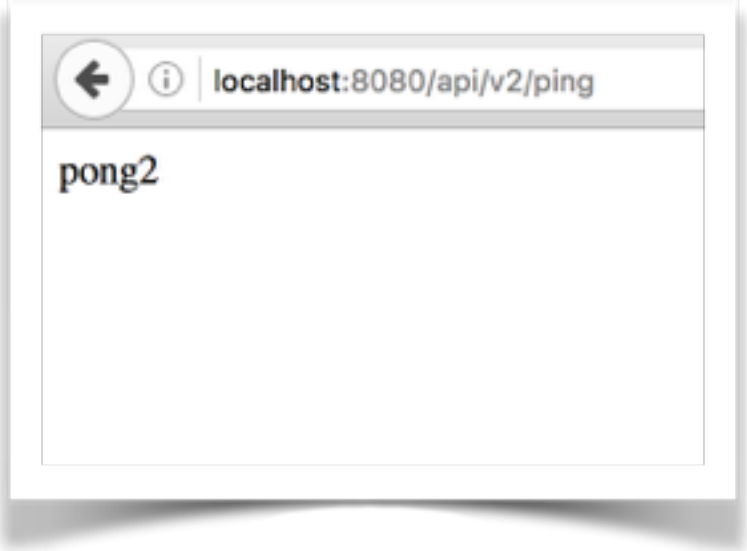
- Let's create a WEB-INF/web.xml file in our webapp folder

```
<web-app>
  <welcome-file-list>
    <welcome-file>index.html</welcome-file>
  </welcome-file-list>

  <servlet>
    <servlet-name>RestApi</servlet-name>
    <servlet-class>org.glassfish.jersey.servlet.ServletContainer</servlet-class>
    <init-param>
      <param-name>jersey.config.server.provider.packages</param-name>
      <param-value>
        com.msftw.api.v1,
        com.msftw.api.v2
      </param-value>
    </init-param>
    <load-on-startup>1</load-on-startup>
  </servlet>

  <servlet-mapping>
    <servlet-name>RestApi</servlet-name>
    <url-pattern>/api/*</url-pattern>
  </servlet-mapping>
</web-app>
```

```
@Path("/v1")
public class ApiV1 {

  @Path("/ping")
  @GET
  public String ping() {
    return "pong";
  }
}
```

At this point we should have a HTTP server responding on/ api/v1/ping and api/v2/ping





Server Setup

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Database Access

There are a lot of database access layers. You should choose the on that brings you the most benefits:

- Raw JDBC - avoid it at all cost, because resource management and connection pool are hard to manage
- Apache DbUtils - very reliable and very fast, my favourite
- JDBI - reliable, simple to use, but not so fast
- jOOQ - an ORM engine, gains on relations, loses some performance
- Hibernate - another ORM engine
- Sql2o - faster than DbUtils, to monitor in the future

These frameworks usually depend on some other framework for connection pooling like Apache DBCP or HikariCP

My favourite combination is DbUtils with HikariCP

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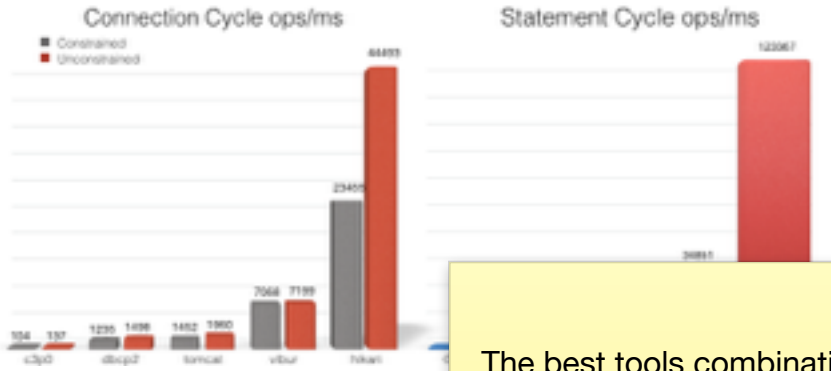
DBUtils is a very fast, lightweight and reliable framework, HikariCP is a high performance JDBC connection pool



The best tools combination will cre
the best projects

```
public class DatabaseHelper implements AutoCloseable {
  private static Map<String, HikariDataSource>
    pools = new  ConcurrentHashMap<String, HikariDataSource>();

  public static DataSource getDataSource(String config) {
    if (!pools.containsKey(config)) createDataSource(config);
    return pools.get(config);
  }

  private static synchronized void createDataSource(String config) {
    if (!pools.containsKey(config))
      pools.put(config, new HikariDataSource(new HikariConfig(config)));
  }

  public void close() throws Exception {
    pools.clear();
  }
}
```

```
QueryRunner runner = new QueryRunner(DatabaseHelper.getDataSource("config"));
```

Server Setup

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Caching

Caching Paradigms:

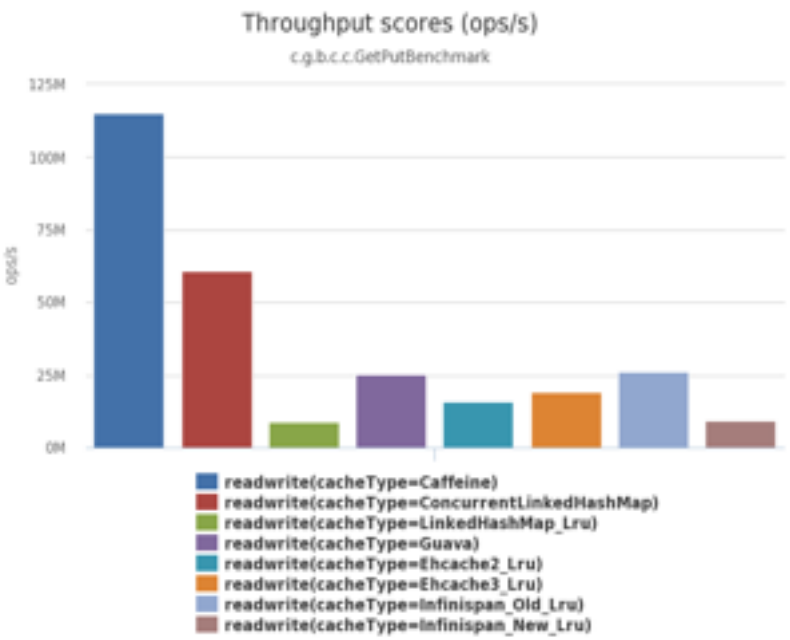
- Reactive - cache is generated on first miss, used when the cache domain is too big. Generates race conditions on heavy load. Usually has a TTL and is dropped by LRU algorithm.
- Proactive - cache domain is limited, can fit in memory and is generated beforehand. Usually this cache won't have a single miss, and is refreshed periodically or when an event occurs.

You should cache as much as you can if you want performance. If it saves you a query, a system call or some communication, cache it even for a short TTL.

Caching Levels:

- Static - cache content for URIs that don't change often
- Response - cache responses using call and parameters as key
- Data - cache data processed by some key
- Remote - cache remote call responses using call and parameter as key
- Query - cache query responses using the query and parameters as key

Caching Frameworks:



Read (75%) / Write (25%)

- Caffeine - very fast, Java 8, Guava drop-in replacement
- ConcurrentLinkedHashMap
- Google Guava
- Ehcache - distributed cache
- Infinispan - distributed cache
- HazelCast - distributed cache

A good option is to combine local cache with a distributed one, improving in speed and reliability.

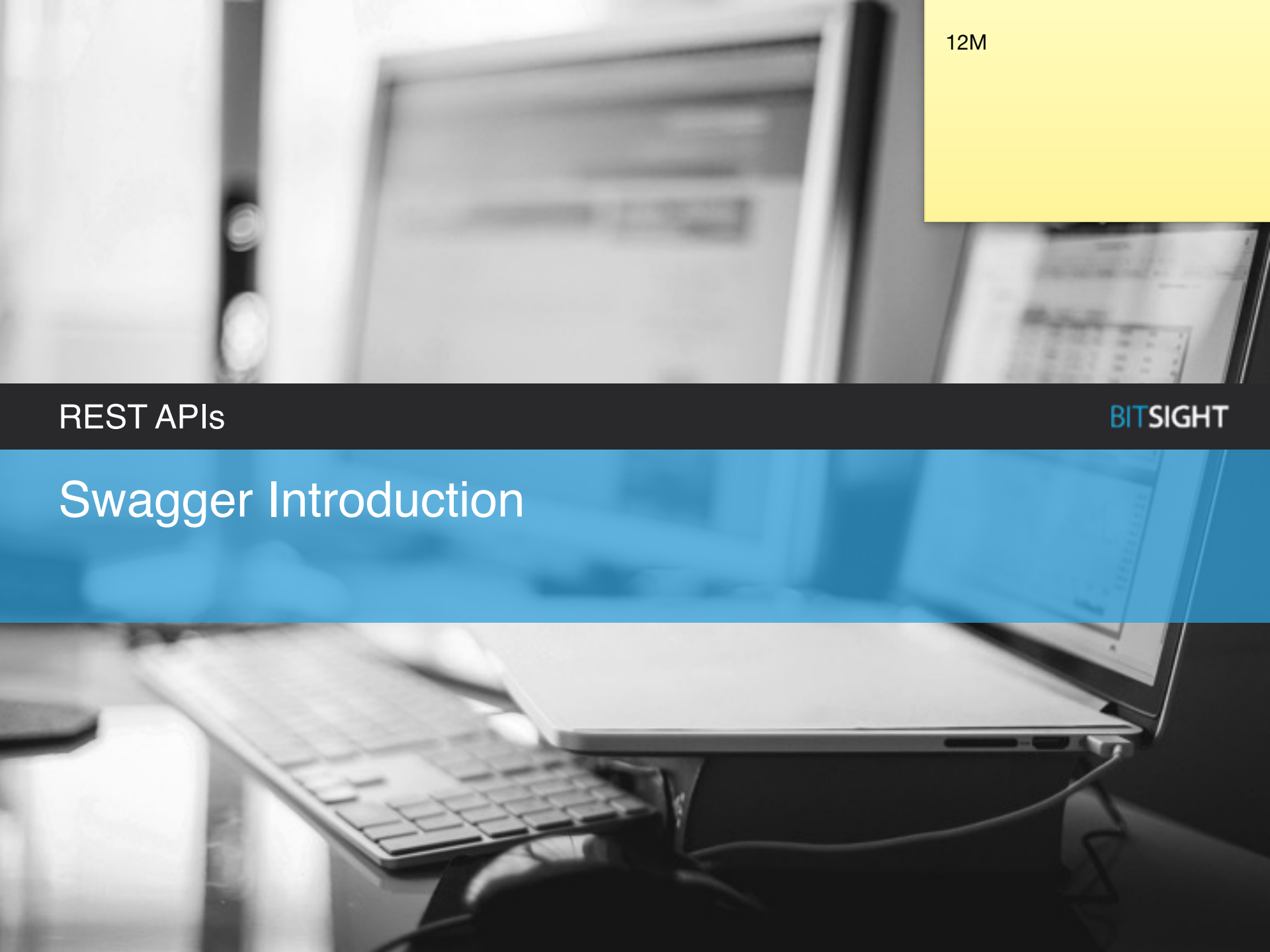
Caching engine should be chosen by application requirements: Speed vs Reliability

Sample Caching:

```
LoadingCache<Key, Graph> graphs = Caffeine.newBuilder()
    .maximumSize(10_000)
    .expireAfterWrite(5, TimeUnit.MINUTES)
    .refreshAfterWrite(1, TimeUnit.MINUTES)
    .build(key -> createExpensiveGraph(key));
```

```
Cache<Key, Graph> graphs = Caffeine.newBuilder()
    .maximumSize(1000)
    .expireAfterWrite(3600, TimeUnit.SECONDS)
    .build();

Graph graph = graphs.getIfPresent(key);
if(graph == null){
    // generate graph and cache it
    graph = createExpensiveGraph(key);
    graphs.put(key, graph);
}
```



REST APIs

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Swagger Introduction

Swagger is a simple yet powerful representation of your RESTful API.

In today's presentation we'll demonstrate three tools:

- **Swagger file generation in Java**
- **Swagger UI**
- **Swagger Editor**

- Swagger Specification has been donated to the Open API Initiative
- It's adoption has several benefits:
  - Interactive documentation
  - Client SDK generation
  - Server generation
  - API discoverability
  - Lots of development goodies

Swagger file

For our project to generate Swagger information we'll add annotations to our methods.

- Annotating Java code is a simple way of maintaining your API
- The maven plugin will do the rest by reflection and produce documentation and the Swagger file, advantages:
  - Easy update and addition of methods
  - No need to diff generated code with your codebase
  - Technology independent
  - Easier to maintain versions

Some common annotations:

- @Api - to declare an API resource (class level)
- @ApiModel - provides additional information

```
@Api
@ApiModel(value = "APIv1", description = "Microservices FTW Methods")
@Path("/v1")
public class ApiV1 {
```

Some common annotations:

- @ApiOperation
- @ApiResponses

```
@GET
@Path("/ping")
@Produces(MediaType.TEXT_PLAIN)
@ApiOperation(value = "Ping method", notes = "Method to check API connectivity.")
@ApiResponses(value = {
    @ApiResponse(code = 200, message = "successful operation",
                 response = String.class) })
public String pingMethod(@Context final HttpServletRequest request) {
  log.info("Received request for {} from IP {}", request.getRequestURI(),
      request.getRemoteAddr());
  return "pong";
}
```

Some common annotations:

- @ApiOperation
- @ApiResponses

```
@GET
@Path("/ping")
@Produces(MediaType.TEXT_PLAIN)
@ApiOperation(value = "Ping method", notes = "Method to check API connectivity.")
@ApiResponses(value = {
    @ApiResponse(code = 200, message = "successful operation",
                 response = String.class) })
public String pingMethod(@Context final HttpServletRequest request) {
  return "pong";
}
```

Some common annotations:

- @ApiParam
- @ResponseHeaders

```
@POST
@Path("/books")
@Produces(MediaType.APPLICATION_JSON)
@ApiOperation(value = "Create Books method", notes = "Method to create books.")
@ApiResponses(value = {
    @ApiResponse(code = 200, message = "successful operation”,
       response = Boolean.class, responseContainer = "List"),
    @ApiResponse(code = 500, message = "unsuccessful operation”, response = String.class,
      responseHeaders = {@ResponseHeader(name="X-Host",
                          description="hostname that failed")}) })
public Response createBooks(
  @ApiParam(value="Json array of Books", required = true) final LinkedList<Book> books,
  @ApiParam(value="sample comment") @QueryParam("comment") String comment) {
```

@FormParam, @QueryParam @PathParam("dept")Long dept, @Context
outras annotations
responseContainer types

Some common annotations:

- @ApiModelProperty

```
public class Book {
  @ApiModelProperty(value = "Book id", required = false, example = "1")
  private Integer id;
  @ApiModelProperty(value = "Book title", required = true, example = "Book Title")
  private String title;
  @ApiModelProperty(value = "Book ISBN", required = true, example = "Book ISNTitle")
  private String isbn;
  @ApiModelProperty(value = "Book Price", required = true, example = "12.12")
  private Float price;
  @ApiModelProperty(value = "Publisher Name", required = true, example = "Publisher")
  private String publisher;

  public Integer getId() {
    return id;
  }

  (…)
```

REST APIs

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Swagger File Generation

We're going to use Swagger Maven plugin to generate our Swagger file

- Download latest version and copy folder test/resources/templates to src/main/resources
- Now we just need to hook it to our Maven project
- Now your Swagger API and file will be updated instantly every time you package your project

```
$ mvn package
```

Download source from http://kongchen.github.io/swagger-maven-plugin/

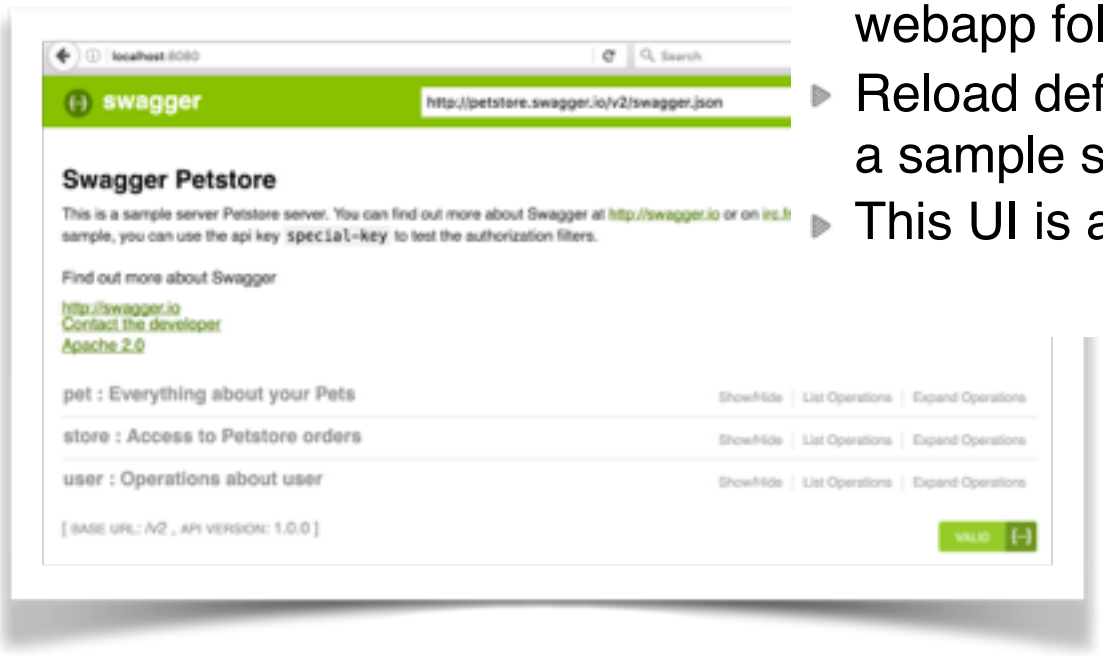
changes to pom.xml

```
<plugin>
  <groupId>com.github.kongchen</groupId>
  <artifactId>swagger-maven-plugin</artifactId>
  <version>3.1.3</version>
  <configuration>
    <apiSources>
      <apiSource>
        <springmvc>false</springmvc>
        <locations><!-- declare packages -->
          com.msftw.api.v1
        </locations>
        <schemes>http</schemes>
        <basePath>/api</basePath>
        <info> (…) </info>
        <templatePath>(…)/strapdown.html.hbs</templatePath>
        <outputPath>(…)/webapp/documentation.html</outputPath>
        <swaggerDirectory>(…)/webapp</swaggerDirectory>
        <outputFormats>yaml,json</outputFormats>
        <attachSwaggerArtifact>true</attachSwaggerArtifact>
      </apiSource>
    </apiSources>
  </configuration>
  (…)
```

At this point we should have documentation generated and an empty Swagger file generated:

Now let's setup Swagger-UI:

- Go to http://swagger.io/swagger-ui/ for documentation
- Download latest Swagger UI from https://github.com/swagger-api/swagger-ui/releases
- Decompress and copy dist folder contents to our project src/main/webapp folder
- Reload default webpage to see a sample swagger interface
- This UI is a very useful tool



REST APIs

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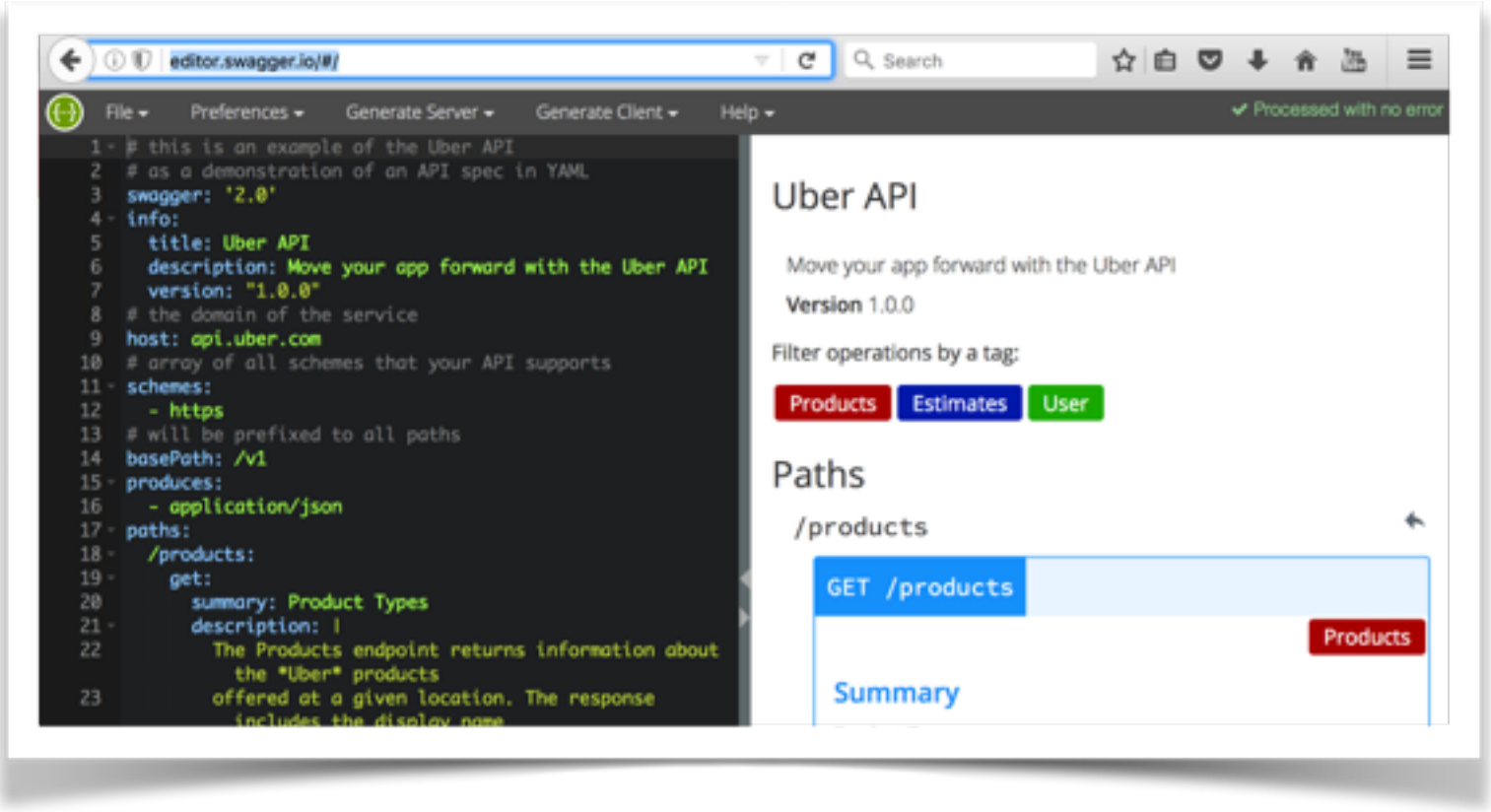
Client Generation

The biggest benefit in using Swagger is the easiness to generate client stubs for almost every language:

- Go to http://editor.swagger.io/ to generate your client/server
- Automate code generation into your development cycle



REST APIs - Client Generation

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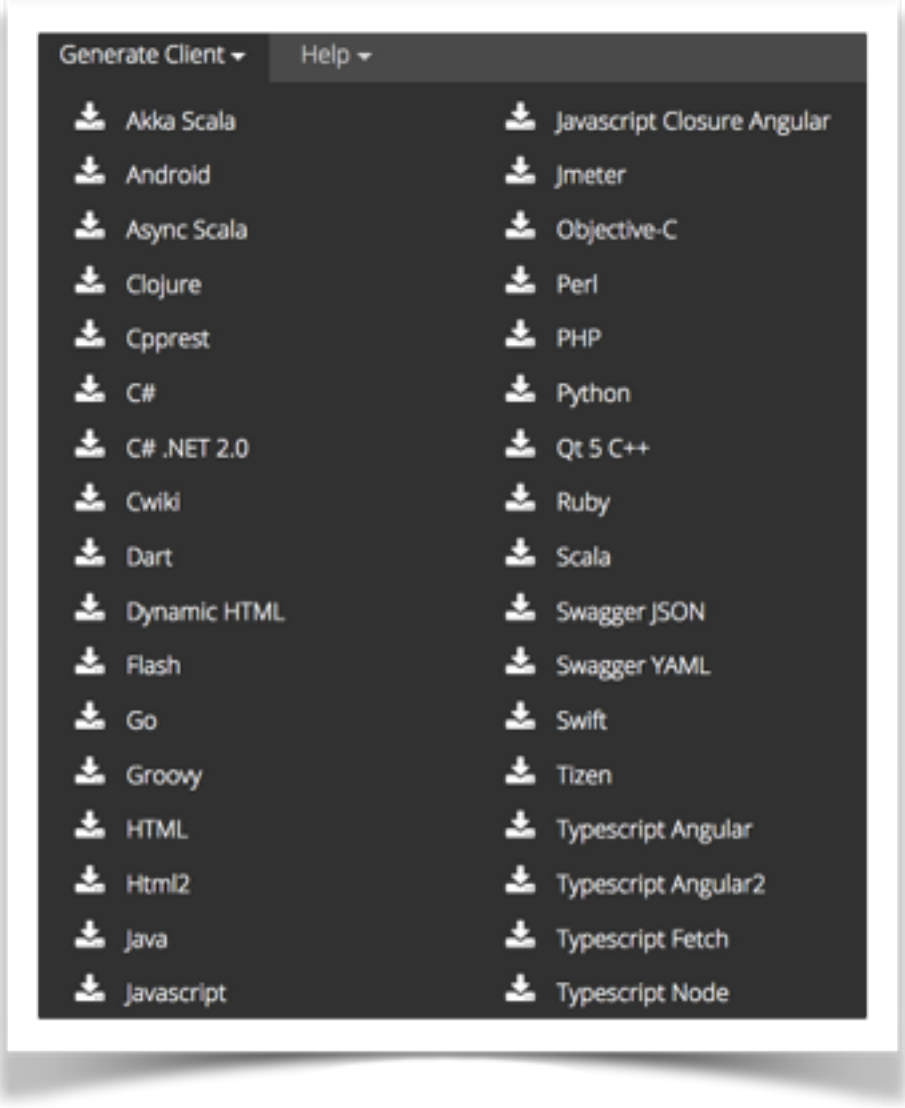

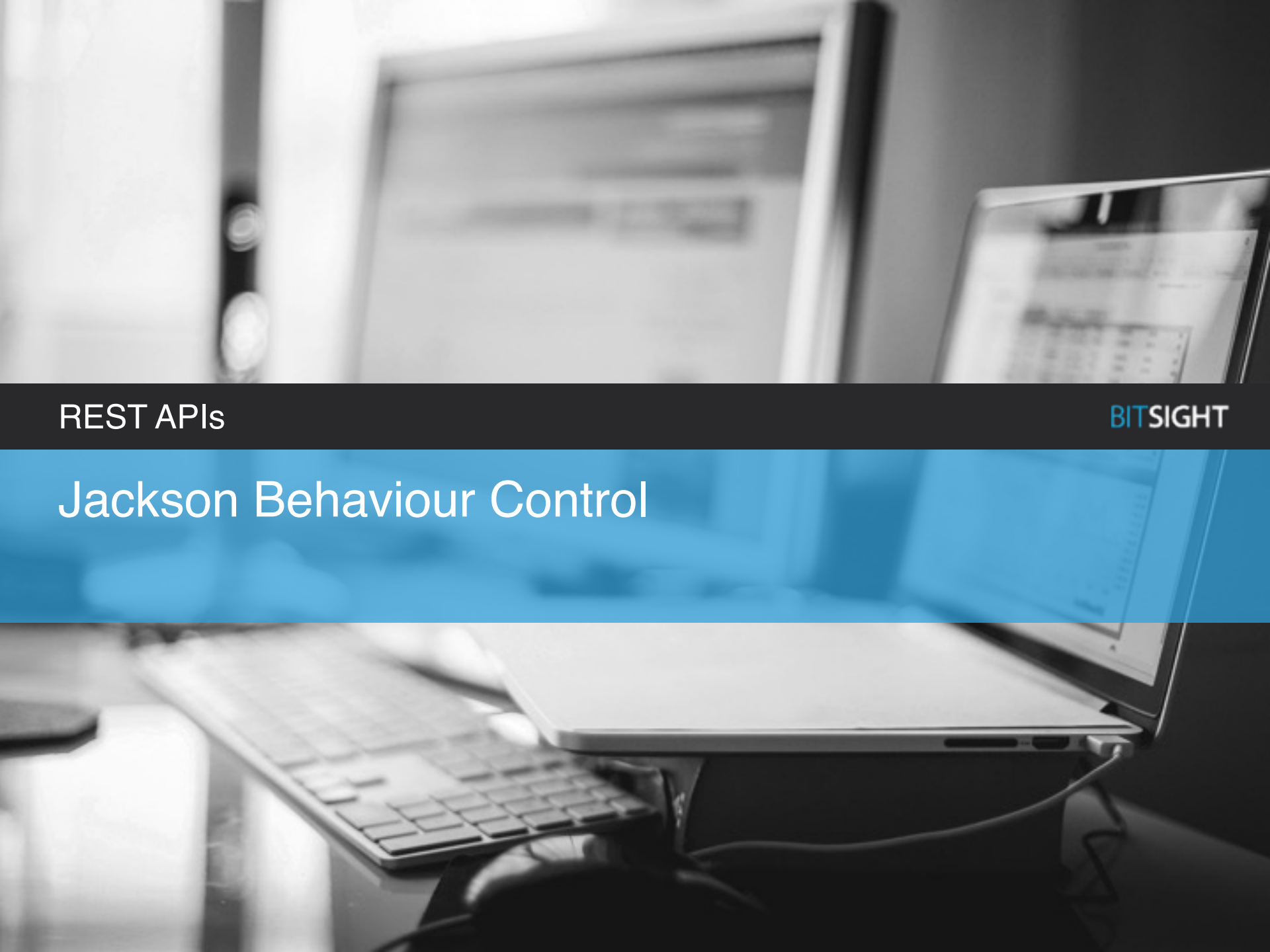

REST APIs

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Jackson Behaviour Control

Jackson handles json parsing but does not handle some special cases:

- An empty POST gives a 500 error before calling our method
- This change allows receiving null objects in our methods and handle those errors

```
@Provider
public class CustomJsonProvider extends JacksonJaxbJsonProvider {
  private static ObjectMapper mapper = new ObjectMapper();
  static {
    CustomJsonProvider.mapper.configure(
      DeserializationFeature.ACCEPT_EMPTY_STRING_AS_NULL_OBJECT, true);
  }

  public CustomJsonProvider() {
    super();
    this.setMapper(CustomJsonProvider.mapper);
  }
}
```


Distribute It
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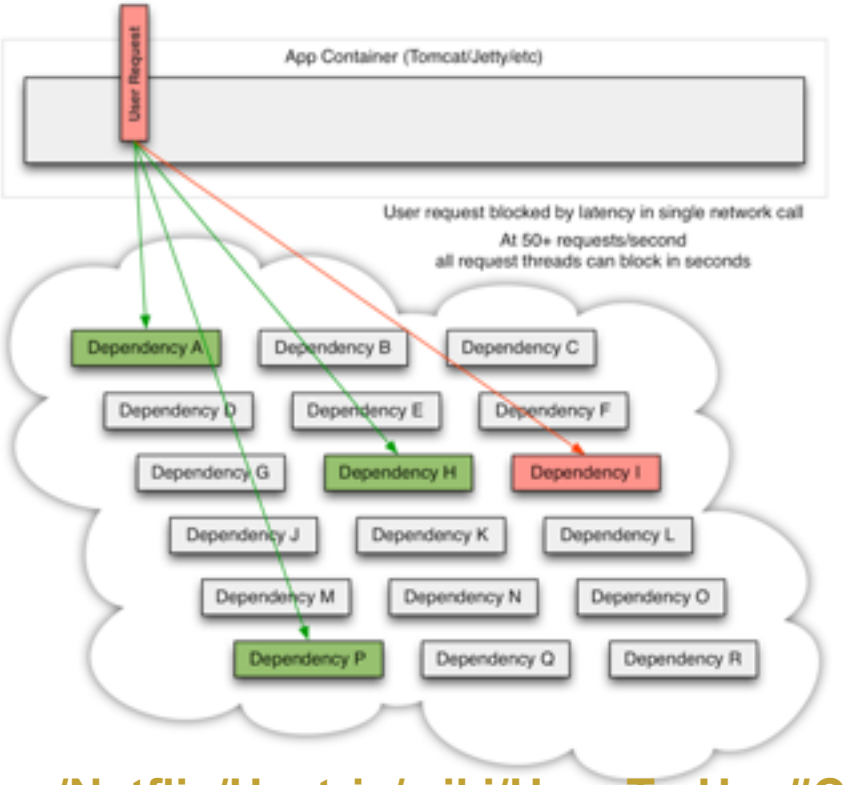
Circuit Breakers

Circuit Breakers are a very important feature to avoid domino effect when failures occur in chained Microservices

- Hystrix is a good framework to help implement circuit breakers



https://github.com/Netflix/Hystrix/wiki/How-To-Use#Common-Patterns

Hystrix helps alleviate the domino effect than can cause crashes in distributed systems

- Preventing any single dependency from using up all user threads.
- Shedding load and failing fast instead of queueing.
- Providing fallbacks wherever feasible to protect users from failure.
- Using isolation techniques to limit the impact of any one dependency.
- Optimizing for time-to-discovery through near real-time metrics, monitoring, and alerting
- Optimizing for time-to-recovery
- Protecting against failures in the entire dependency client execution, not just in the network traffic.

Distribute It

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Hazelcast Introduction

Hazelcast is a zero configuration cluster framework

- With Hazelcast you can create a cluster with 1 line of code

```
private static HazelcastInstance
   clusterNode = Hazelcast.newHazelcastInstance(new Config());
private static ConcurrentMap<String, String> map;

static {
  // initialize our distributed map
  map = clusterNode.getMap("my-distributed-map");
}

// Concurrent Map methods
map.putIfAbsent("somekey", "somevalue");
map.replace("key", "value", "newvalue");
```

https://hazelcast.org/
https://hazelcast.org/features/

Microservices are not the answer to everything:

- If you can process a request later, put it in a queue
- Parallelise your task if possible
- Avoid long waits on responses
- Cache everything you can
- Your system should be resource aware
- Avoid multi-request transactions
- Page your results to avoid large requests

Consul can be useful to help managing distributed systems.


Distribute It
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Dockerize It

Containers are a very useful tool when you want to scale:

- A single docker image can be replicated to hundreds of machines
- Tools like Kubernetes, Docker Swarm, Amazon ECS automate this
- Containers usually have a small footprint and are very fast to deploy
- Need to test a specific Linux distribution?

```
# Download an ubuntu image
docker pull ubuntu
# run shell
docker run -it ubuntu /bin/bash
```

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Demo Time!!!

https://github.com/nelsongomes/microservices-ftw

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QUESTIONS?

For more information:

nelson.gomes@bitsighttech.com

BitSight Technologies
125 CambridgePark Drive, Suite 204
Cambridge, MA 02140
www.bitsighttech.com