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Cloud-Ready: Introduction to Distributed Lambdas

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Live for the Code

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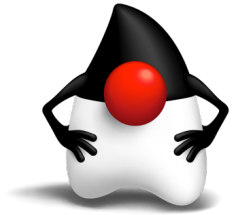
Program Agenda

1. Lambdas
2. Remote Functional Interfaces & Lambdas
3. Demonstrations!
4. The Challenges and Limitations
5. Next Steps

Introduction to Lambdas

Introduction to Lambdas

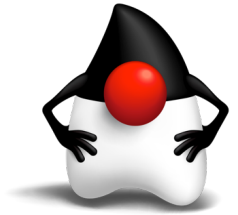


A defining new feature of the Java 8 Platform

- Enable hybrid, object-oriented / functional programming in Java
- Allow you to pass code-as-data
  - **Both** as arguments and as return values
- Extensive enhancement of existing Java libraries to support them

```
Map<Integer, String> champs = new HashMap<>();

champs.put(2016, ”Nico Rosberg");
champs.put(2015, ”Lewis Hamilton");
champs.put(2014, ”Lewis Hamilton");

champs.forEach((k, v) -> System.out.printf("key: %s, value: %s\n", k, v));
```

Introduction to Lambdas

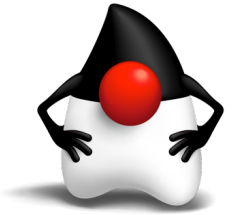


Automatically Capture Surrounding “effectively final” Context = Closures!

- Closures = function + environment

```
int nLast = 2016;

Map<Integer, String> champs = new HashMap<>();

champs.put(2016, "Nico Rosberg");
champs.put(2015, "Lewis Hamilton");
champs.put(2014, "Lewis Hamilton");

champs.forEach((k, v) -> System.out.printf("%s is the latest champ? %s\n", v, k == nLast));
```

Introduction to Lambdas



Replace anonymous “functional interface” inner-classes with lambdas

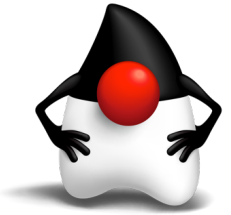
- Before:

```
executor.submit(new Runnable()
   {
   public void run()
      {
      System.out.println("Hello from anonymous class!");
      }
   });
```

- After:

```
executor.submit(() -> System.out.println("Hello from lambda!"));   // Beautiful ☺
```

Introduction to Lambdas

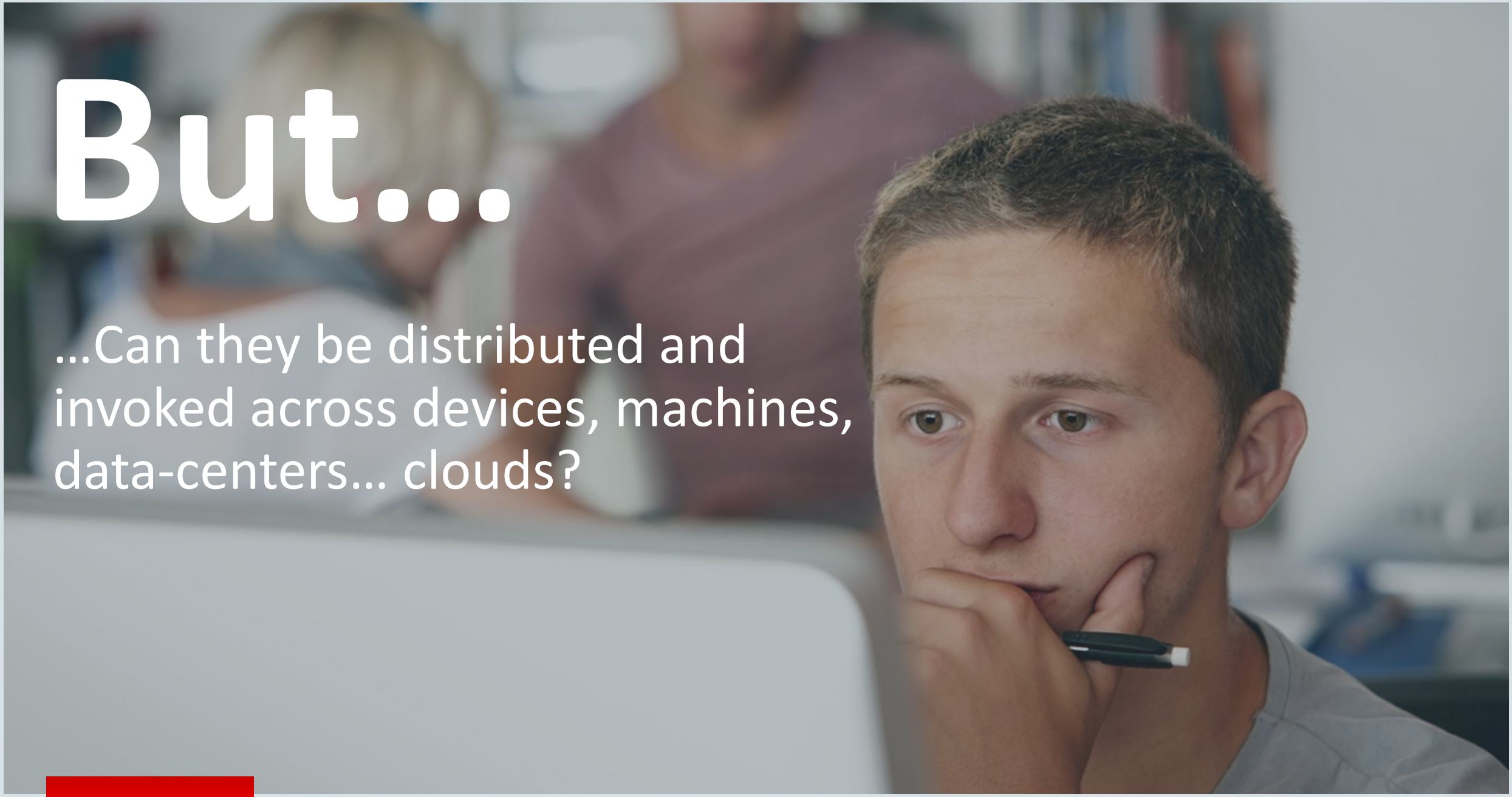


What qualifies as a @FunctionalInterface?

- Runnable Interface in Java 8:

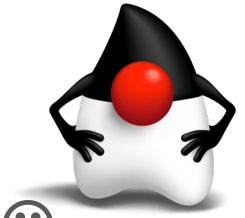
```
@FunctionalInterface
public interface Runnable {
   /**
    * When an object implementing interface <code>Runnable</code> is used
    * to create a thread, starting the thread causes the object's
    * <code>run</code> method to be called in that separately executing
    * thread.
    * <p>
    * The general contract of the method <code>run</code> is that it may
    * take any action whatsoever.
    */
   public void run();
}
```

But…



…Can they be distributed and invoked across devices, machines, data-centers… clouds?

Introduction to Lambdas



Standard Functional Interfaces and thus Lambdas are not serializable by default ☹

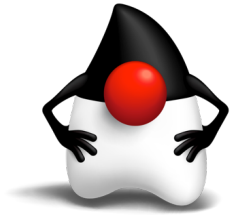
- We can cast them though…

```
Runnable r = (Runnable & Serializable)
        () -> System.out.println("Hello from lambda!");
```

- Output*:

```
SerializedLambda[capturingClass=class JavaExamples,
        functionalInterfaceMethod=java/lang/Runnable.run:()V,
        implementation=invokeStatic JavaExamples.lambda$serialization$2feeadd5$1:()V,
        instantiatedMethodType=()V, numCaptured=0]
```

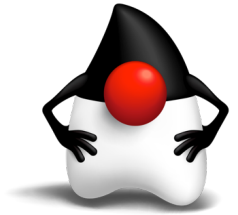
Introduction to Lambdas



None of the new functional interfaces are Serializable ☹

- There are many new *functional interfaces* in Java 8:
  - java.util.function.**Function**<T, R>
  - java.util.function.**Predicate**<T>
  - java.util.function.**Supplier**<T>
  - java.util.function.**Consumer**<T>
  - java.util.function.**BiConsumer**<T, U>
  - java.util.function.**UnaryOperator**<T>
  - java.util.function.**BinaryOperator**<T>
  - … and their primitive variants

Introduction to Lambdas



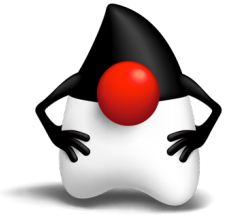
None of the existing functional interfaces are Serializable ☹

- And some of our old friends are also *functional interfaces*:
  - java.lang.**Runnable**
  - java.util.concurrent.**Callable**<V>
  - java.util.**Comparator**<T>

- **Perhaps all unusable in a distributed environment?**

Remote Functional Interfaces

Remote Functional Interfaces



Extensions of existing functional interfaces to support Serialization ☺

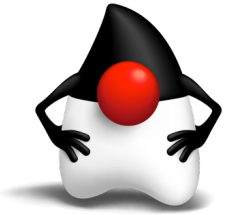
- Eg: The Coherence Remote Class defines serializable functional interfaces

```
public class Remote
    {
    @FunctionalInterface
    public interface Function<T, R>
            extends java.util.function.Function<T, R>, Serializable {}

    @FunctionalInterface
    public interface Runnable
            extends java.lang.Runnable, Serializable {}

    ...
    }
```

Where’s the Cloud?

Introduction to Coherence

Remote Functional Interfaces



Most specific methods win!

- In addition to the standard Map method:

```
V computeIfAbsent(K key, Function<? super K, ? extends V> mappingFunction);
```

- Coherence NamedCache also defines:

```
V computeIfAbsent(K key, Remote.Function<? super K, ? extends V> mappingFunction);
```

- Java Compiler resolves to use the “most specific overloaded method”… so we’re ready to do some distributed lambdas!

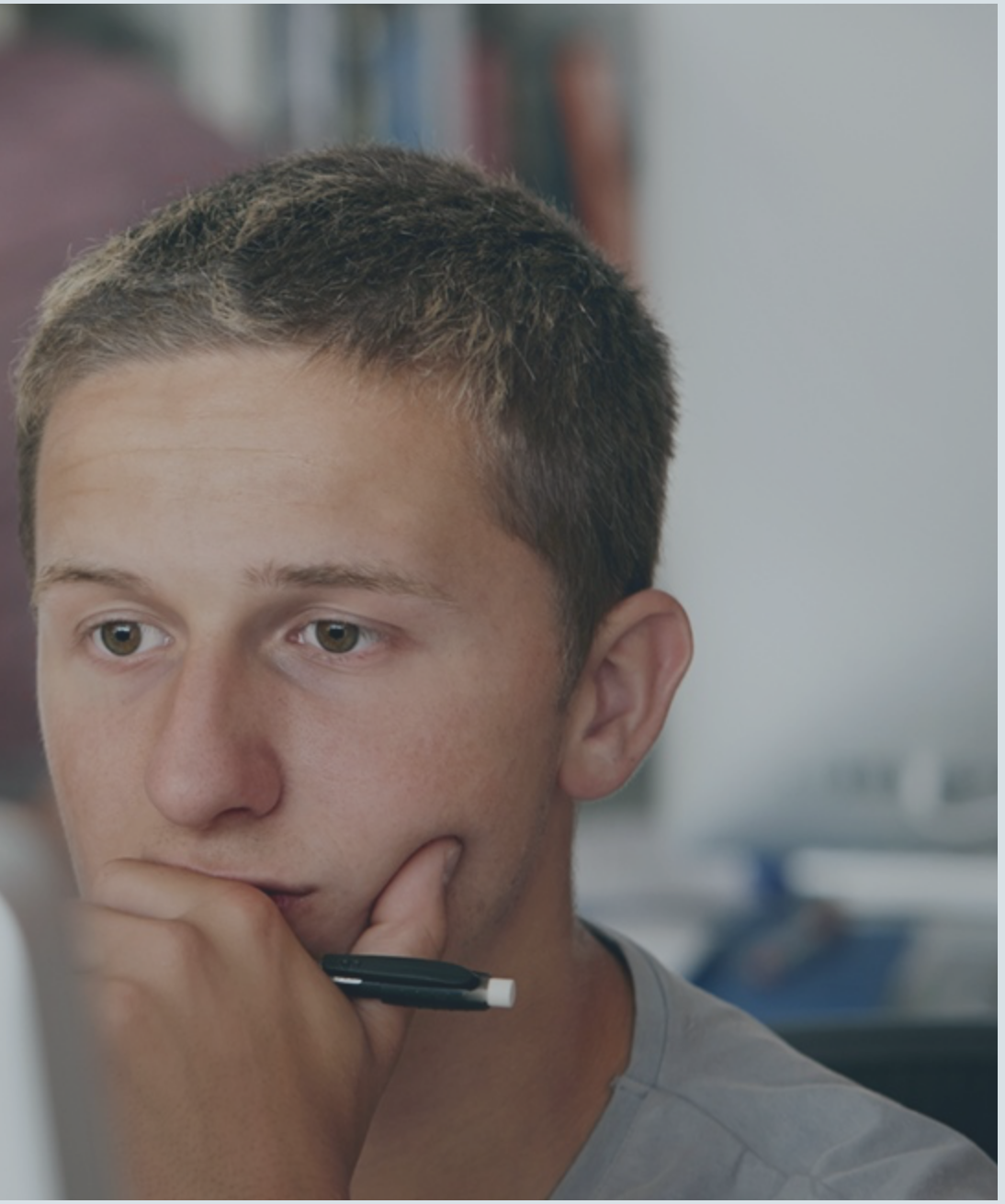
Demo time!

Challenges and Limitations

Oh!

“Serialization: The gift that keeps on giving”

Brian Goetz
Java Language Architect



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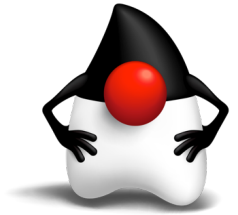
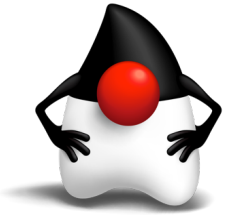
Challenge: Lambda Serialization



Java provides the bare minimum… in a distributed environment we need a lot more

- Developers use multiple types of serialization
  - Java only provides one
- Lambdas need to be stable across application versions
  - Java does not provide any such guarantees; it's weak at best
- Developers want to introduce new lambdas without restarting
  - Java expects the same version of the capturing class to exist everywhere
- Coherence provides a custom and yet completely compatible remoting framework to solve these challenges

Limitation: Closure Serialization

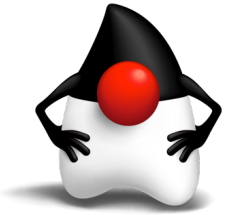


Lambdas need to be self contained and serializable

- Should not reference fields or methods of the capturing class
- Should not reference anything that isn't certain to exist both on the client and on the server
- Should only capture local serializable variables (use a static factory!)

```
public static Remote.BiFunction<String, String, String> changeName(String name)
    {
    return (key, value) ->
        {
        return name;
        };
    }
}
```

Limitation: Closure Serialization



Lambdas need to be self contained and serializable

- Should not nest other non-serializable lambdas
- Don’t do this:

```
Map<Integer, String> names = champs.invokeAll((entry) -> entry.extract(Champ::getName));
```

- Instead do this:

```
ValueExtractor<Champ, String> extractor = Champ::getName;

Map<Integer, String> names = champs.invokeAll((entry) -> entry.extract(extractor));
```

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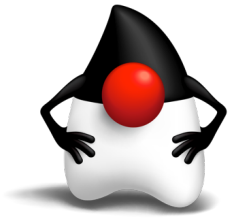
Summary

Summary



Distributed Lambdas Rock! Imagine the possibilities!

- Lambdas are a defining feature of Java 8
- Coherence 12.2.1 allows you to use lambdas
  - Like standard Java, but both locally & in a distributed manner
  - Allows in-place update without locking / synchronization
  - With existing Coherence features (like Entry Processors, Listeners…)
  - To perform stream-based operations
- Coherence adds support for serialization of standard functional interfaces
- Coherence handles distributed stream & lambdas in a dynamic way
  - Supports multiple versions of clients seamlessly running side-by-side without restart

Next Steps

Start Playing!

Coherence for Developers!

CREATE THE FUTURE

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