

# *Project Loom:*

## *A Summary For Busy Developers*

Michael Easter

@codetojoy

# Project Loom

## ~~Fibers~~ and Continuations



# OpenJDK

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## JDK 19

This release will be the Reference Implementation of version 19 of the Java SE Platform.

### Status

The main-line code repository is open for bug fixes, small enhancements, and JEPs as proposed and tracked via the JEP Process.

### Schedule

2022/06/09	Rampdown Phase One (fork from main line)
2022/07/21	Rampdown Phase Two
2022/08/11	Initial Release Candidate
2022/08/25	Final Release Candidate
2022/09/20	General Availability

# OpenJDK

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## JEP 425: Virtual Threads (Preview)

**OpenJDK**

**JEP 428: Structured Concurrency (Incubator)**

# Virtual Threads

## Platform threads

```
14 void createManyThreads(int numThreads) throws Exception {  
15     Thread thread = null;  
16  
17     for (int i = 0; i < numThreads; i++) {  
18         thread = new Thread(Runner::doWork);  
19         thread.start();  
20     }  
21  
22     thread.join();  
23 }
```

## Platform threads

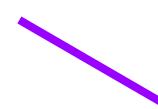
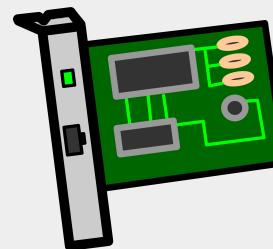
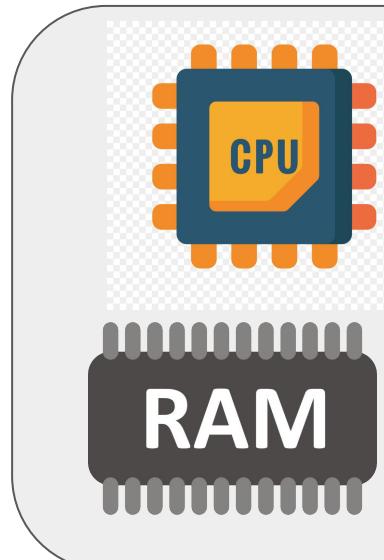
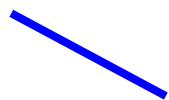
```
TRACER working t: Thread[#4092,Thread-4064,5,main]
TRACER working t: Thread[#4093,Thread-4065,5,main]
TRACER working t: Thread[#4094,Thread-4066,5,main]
Exception in thread "main" java.lang.OutOfMemoryError:
unable to create native thread:
possibly out of memory or process/resource limits reached
at java.base/java.lang.Thread.start0(Native Method)
at java.base/java.lang.Thread.start(Thread.java:1531)
at net.codetojoy.Runner.createManyThreads(Runner.java:19)
```

# Virtual threads

```
14 void createManyThreads(int numThreads) throws Exception {  
15     Thread thread = null;  
16  
17     for (int i = 0; i < numThreads; i++) {  
18         thread = Thread.startVirtualThread(Runner::doWork);  
19     }  
20  
21     thread.join();  
22 }
```

# Virtual threads

```
TRACER working t: VirtualThread[#400029]/Runnable@ForkJoinPool-1-worker-1
TRACER working t: VirtualThread[#400031]/Runnable@ForkJoinPool-1-worker-6
TRACER working t: VirtualThread[#400032]/Runnable@ForkJoinPool-1-worker-2
TRACER working t: VirtualThread[#400030]/Runnable@ForkJoinPool-1-worker-5
TRACER working t: VirtualThread[#400033]/Runnable@ForkJoinPool-1-worker-1
TRACER working t: VirtualThread[#400034]/Runnable@ForkJoinPool-1-worker-8
TRACER working t: VirtualThread[#400036]/Runnable@ForkJoinPool-1-worker-2
```













# OS (Kernel)





JVM



OS (Kernel)



JVM



OS (Kernel)



CPU  
core

Platform  
thread

# OS (Kernel)



CPU  
core



Platform  
thread



## Virtual Thread

JVM



# Scheduler

JVM



OS (Kernel)



# Scheduler

Heap

JVM



OS (Kernel)



# Scheduler

Heap

Continuation

JVM



# OS (Kernel)



# Project Loom

## ~~Fibers~~ and Continuations





# Project Loom

## ~~Fibers~~ and Continuations





# Project Loom

## ~~Fibers~~ and Continuations



# Pull Request

openjdk/jdk Public

Watch 298 Fork 3.6k Starred 13.2k

Code Pull requests 213 Security Insights

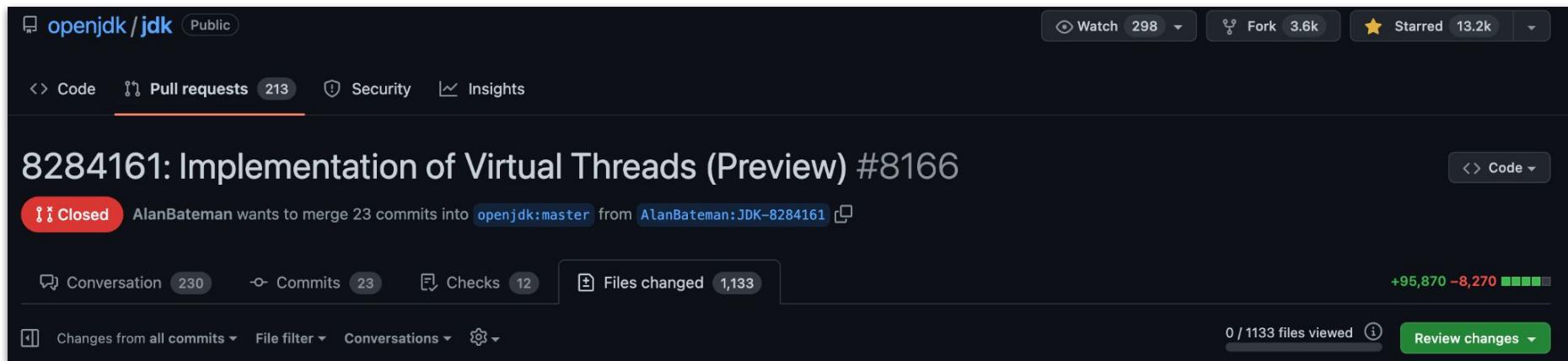
## 8284161: Implementation of Virtual Threads (Preview) #8166

Closed AlanBateman wants to merge 23 commits into `openjdk:master` from `AlanBateman:JDK-8284161`

Conversation 230 Commits 23 Checks 12 Files changed 1,133 +95,870 -8,270

Changes from all commits File filter Conversations Review changes

0 / 1133 files viewed



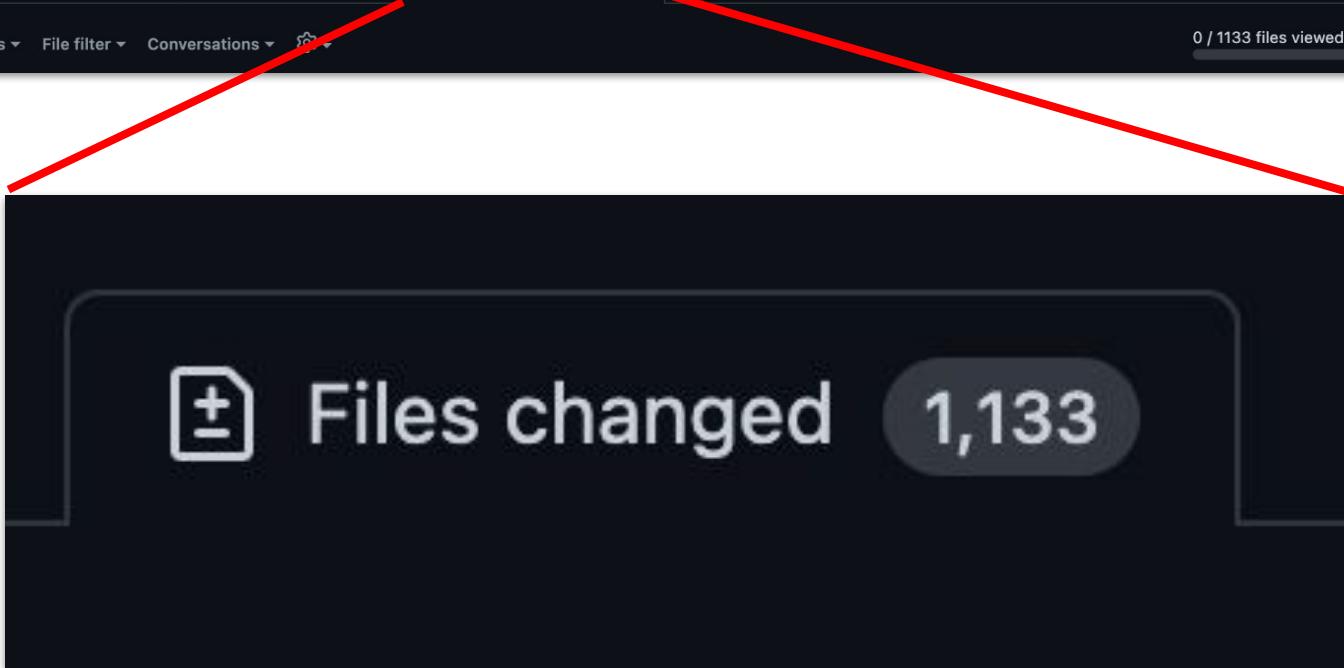
# Pull Request

Screenshot of a GitHub Pull Request page for issue #8166.

The pull request is titled "8284161: Implementation of Virtual Threads (Preview) #8166". It is marked as "Closed" and shows AlanBateman merging 23 commits from "openjdk:master" into "AlanBateman:JDK-8284161".

The "Files changed" section indicates 1,133 files have been modified. A red arrow points from the top of the "Files changed" section down to the summary box below.

Below the summary box, there is a "Review changes" button.



Conversation 230 Commits 23 Checks 12 Files changed 1,133 +95,870 -8,270

Changes from all commits ▾ File filter ▾ Conversations ▾ 0 / 1133 files viewed Review changes

# Pull Request

openjdk/jdk Public

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## 8284161: Implementation of Virtual Threads (Preview) #8166

**Closed** AlanBateman wants to merge 23 commits into `openjdk:master` from `AlanBateman:JDK-8284161` ⚙

Conversation 230 Commits 23 Checks 12 Files changed 1,133 +95,870 -8,270

Changes from all commits ▾ File filter ▾ Conversations ▾ ⚙ 0 / 1133 files viewed ⓘ Review changes ▾



# Pull Request

openjdk/jdk Public

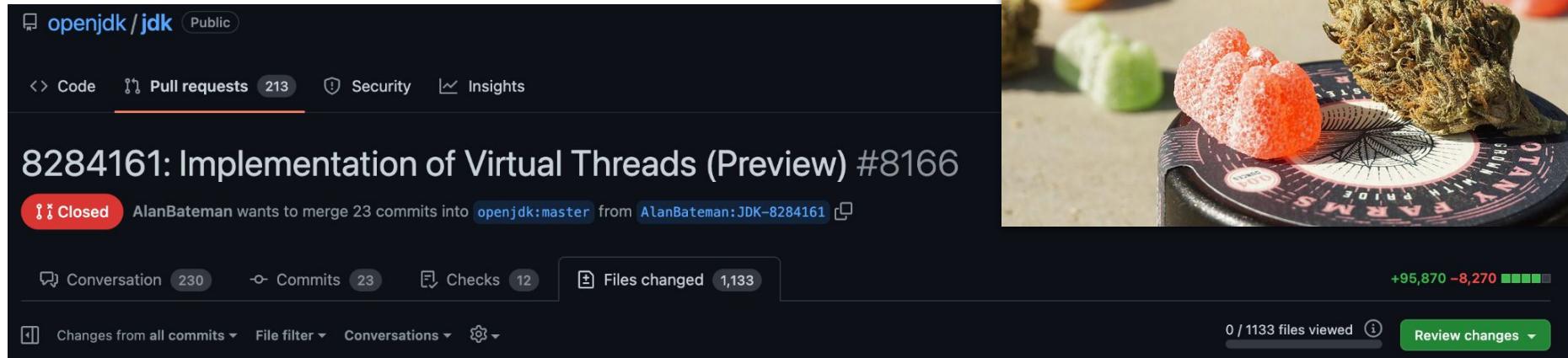
<> Code Pull requests 213 Security Insights

## 8284161: Implementation of Virtual Threads (Preview) #8166

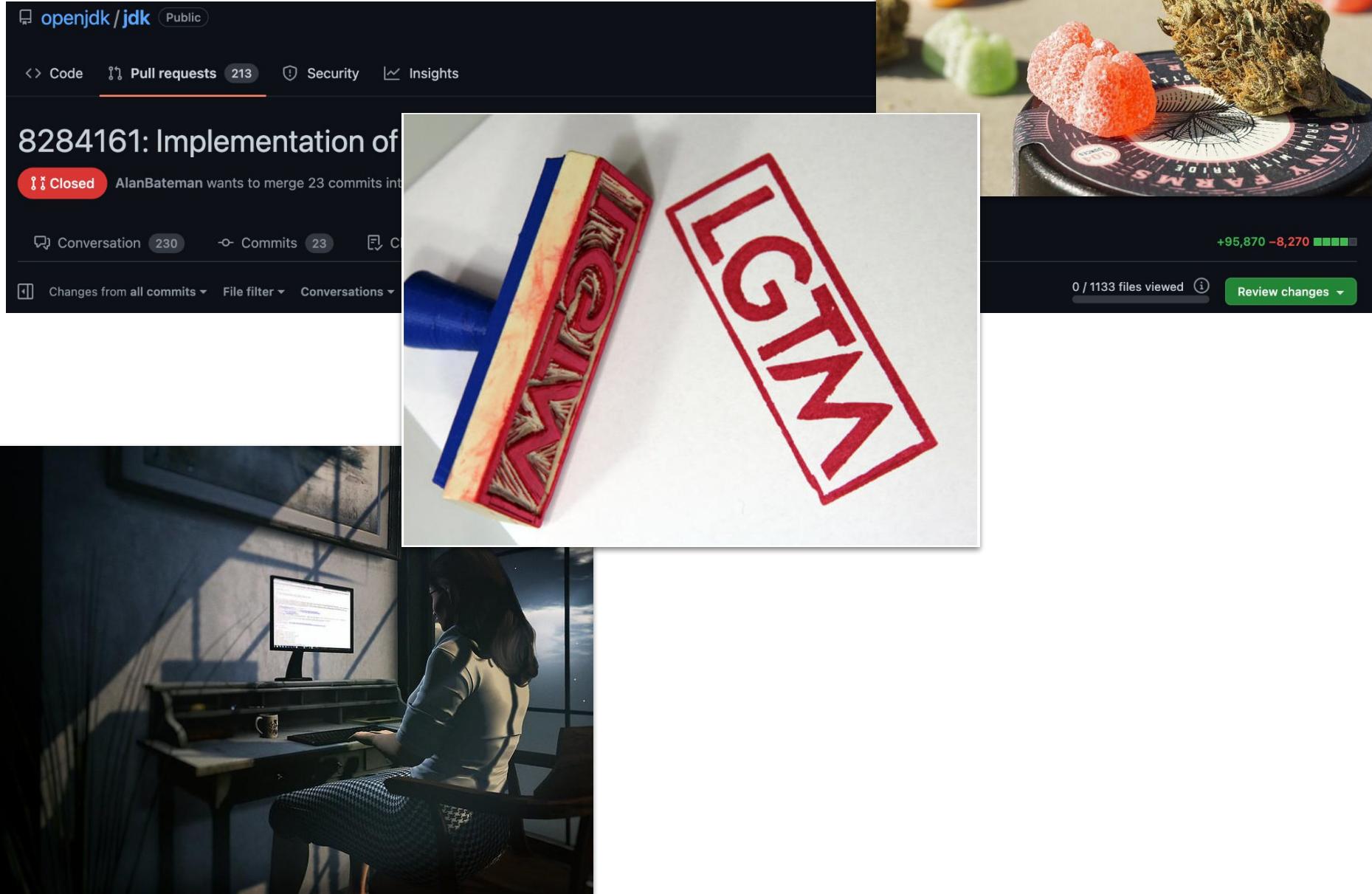
**Closed** AlanBateman wants to merge 23 commits into `openjdk:master` from `AlanBateman:JDK-8284161`

Conversation 230 Commits 23 Checks 12 Files changed 1,133 +95,870 -8,270

Changes from all commits ▾ File filter ▾ Conversations ▾ Review changes ▾



# Pull Request



## *Codes like sync, scales like async*

```
49 void run() throws Exception {  
50     try (var executor = Executors.newVirtualThreadPerTaskExecutor()) {  
51         int numTasks = 10;  
52         for (int i = 0; i < numTasks; i++) {  
53             executor.submit(new MyTask(i, database));  
54         }  
55     }  
56 }
```

*Codes like sync, scales like async*

```
30 class MyTask implements Runnable {  
31     @Override  
32     public void run() {  
33         var user = database.findUser(id);  
34         // ...  
35     }
```

# Pros

JVM



Pros

sync

JVM



Pros

sync

scale

JVM



Pros

sync

scale

JVM

simple



Pros

sync

scale

JVM



simple

debug,  
tooling,  
monitoring

# Loom C5M

:≡ README.md

## Project Loom C5M

Project Loom C5M is an experiment to achieve 5 million persistent connections each in client and server Java applications using OpenJDK Project Loom virtual threads.

# Hype



r/java

## Posts



Posted by u/Carlislee 1 year ago 



**133 Loom cant come fast enough**

Complete throwaway post but I am super excited for project Loom. Tons of complexity is about to be thrown out the window when it comes to WebFlux, CompletableFuture, complex Flow<> objects....

# Hype



joshlemer · 1 yr. ago

Couldn't agree more! What if the whole reactive programming paradigm (futures, observables, ...) turns out to be a temporary fad because we just didn't have the tools to simply program with light threads?

 28 

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# Hype



african\_or\_european · 1 yr. ago

I hate reactive java so much and I've fought it tooth and nail at work, but was never able to clearly describe why it's so terrible besides basically "... just look at it!" I'm absolutely going to be using this.

 13 

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“Loom will kill Reactive programming”

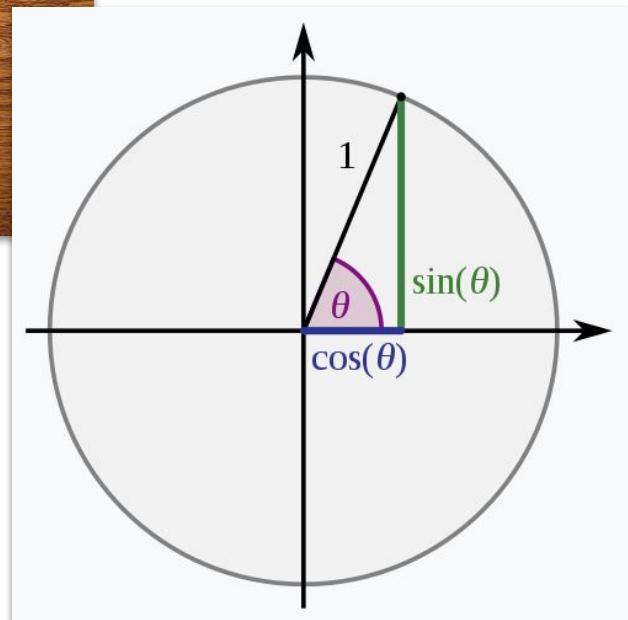


OSSA ROMANI PRES.  
IN CEMET. S. HELENAE  
VIA LABIC.  
SUB PRÆPOSITO LAPIDE  
REPERTA  
HIC SITA SUNT  
A. D. MDCCXLIX

OSSA ROMANI PRESA  
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VIA LABIC<sup>A</sup>  
SUB PR<sup>A</sup>POSITO LAPIDE  
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A<sup>D</sup> MDCCXLIX



# Reactive

:-|



Oleh Dokuka

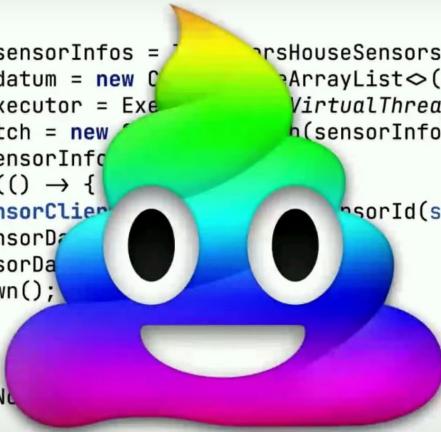
:-|



:-|



```
List<SensorInfo> sensorInfos = ...  
List<SensorData> datum = new ConcurrentSkipListArrayList<>();  
ExecutorService executor = Executors.newVirtualThreadPerTaskExecutor();  
CountDownLatch latch = new CountDownLatch(sensorInfos.size());  
for (SensorInfo sensorInfo : sensorInfos) {  
    executor.submit(() -> {  
        double t = sensorClient.readDouble(sensorId(sensorInfo.id()));  
        SensorData sensorData = new SensorData(t);  
        datum.add(sensorData);  
        latch.countDown();  
    });  
}  
latch.await(1000, TimeUnit.MILLISECONDS);  
executor.shutdownNow();
```



A large, colorful emoji of a smiling face, transitioning through the colors of a rainbow (red, orange, yellow, green, blue, purple). It has large, expressive eyes and a wide, open-mouthed smile.



# ReactiveX

An API for asynchronous programming  
with observable streams

Choose your platform

# Languages

- Java: [RxJava](#)
- JavaScript: [RxJS](#)
- C#: [Rx.NET](#)
- C#(Unity): [UniRx](#)
- Scala: [RxScala](#)
- Clojure: [RxClojure](#)
- C++: [RxCpp](#)
- Lua: [RxLua](#)
- Ruby: [Rx.rb](#)
- Python: [RxPY](#)
- Go: [RxGo](#)
- Groovy: [RxGroovy](#)
- JRuby: [RxJRuby](#)
- Kotlin: [RxKotlin](#)
- Swift: [RxSwift](#)
- PHP: [RxPHP](#)
- Elixir: [reaxive](#)
- Dart: [RxDart](#)

# ReactiveX

An API for asynchronous programming  
with observable streams

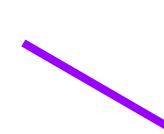
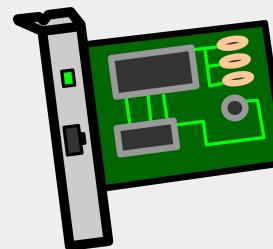
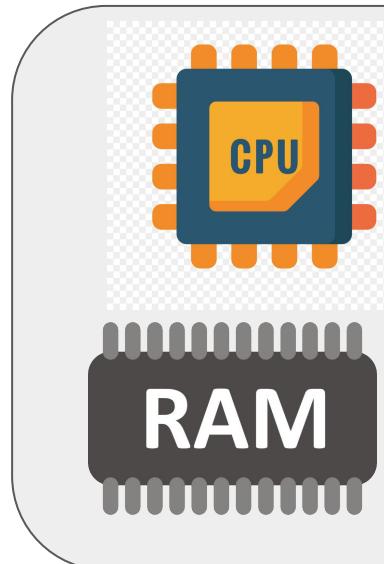
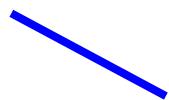
Choose your platform

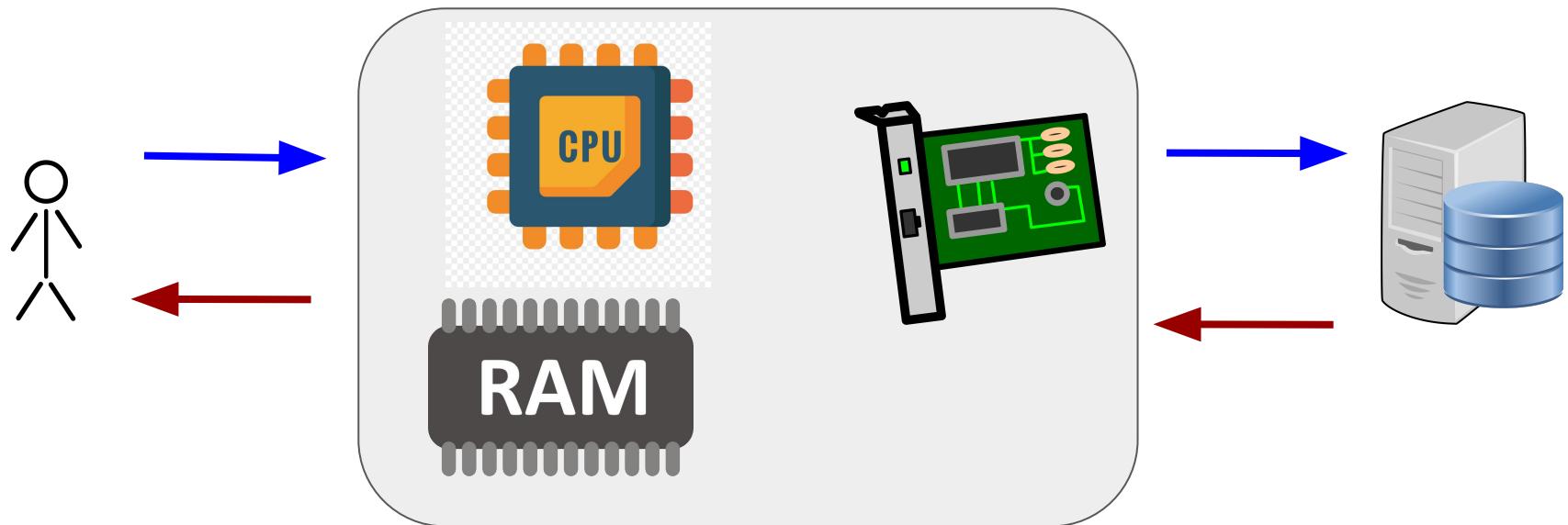
# The Reactive Manifesto

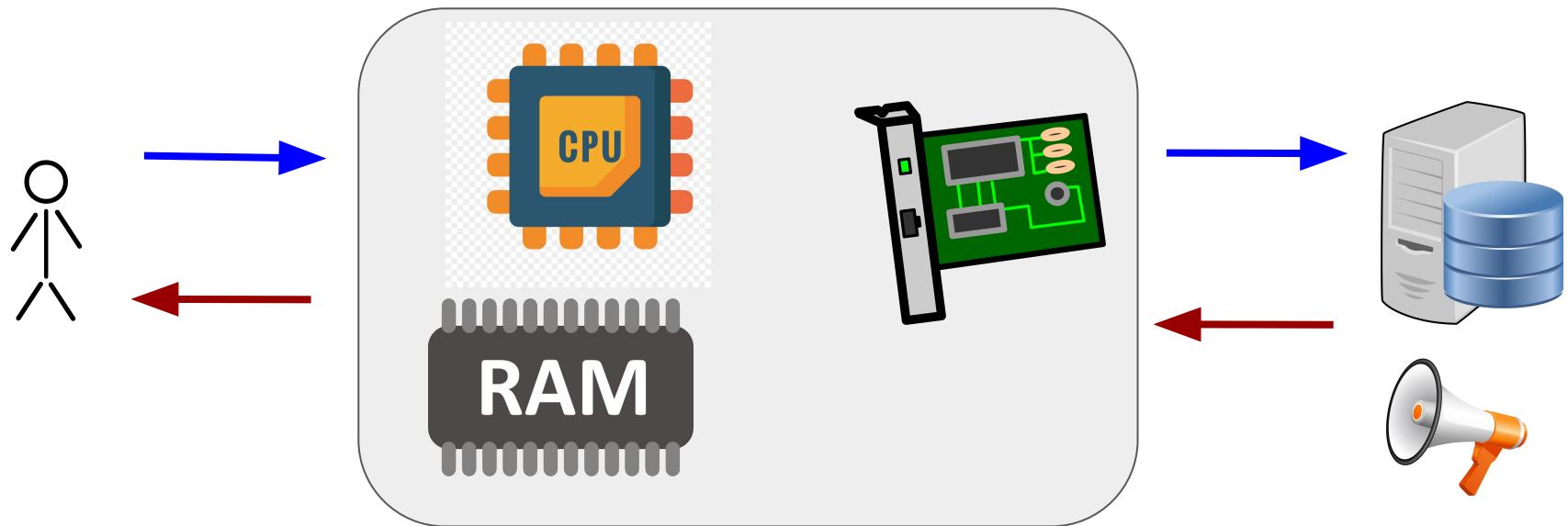
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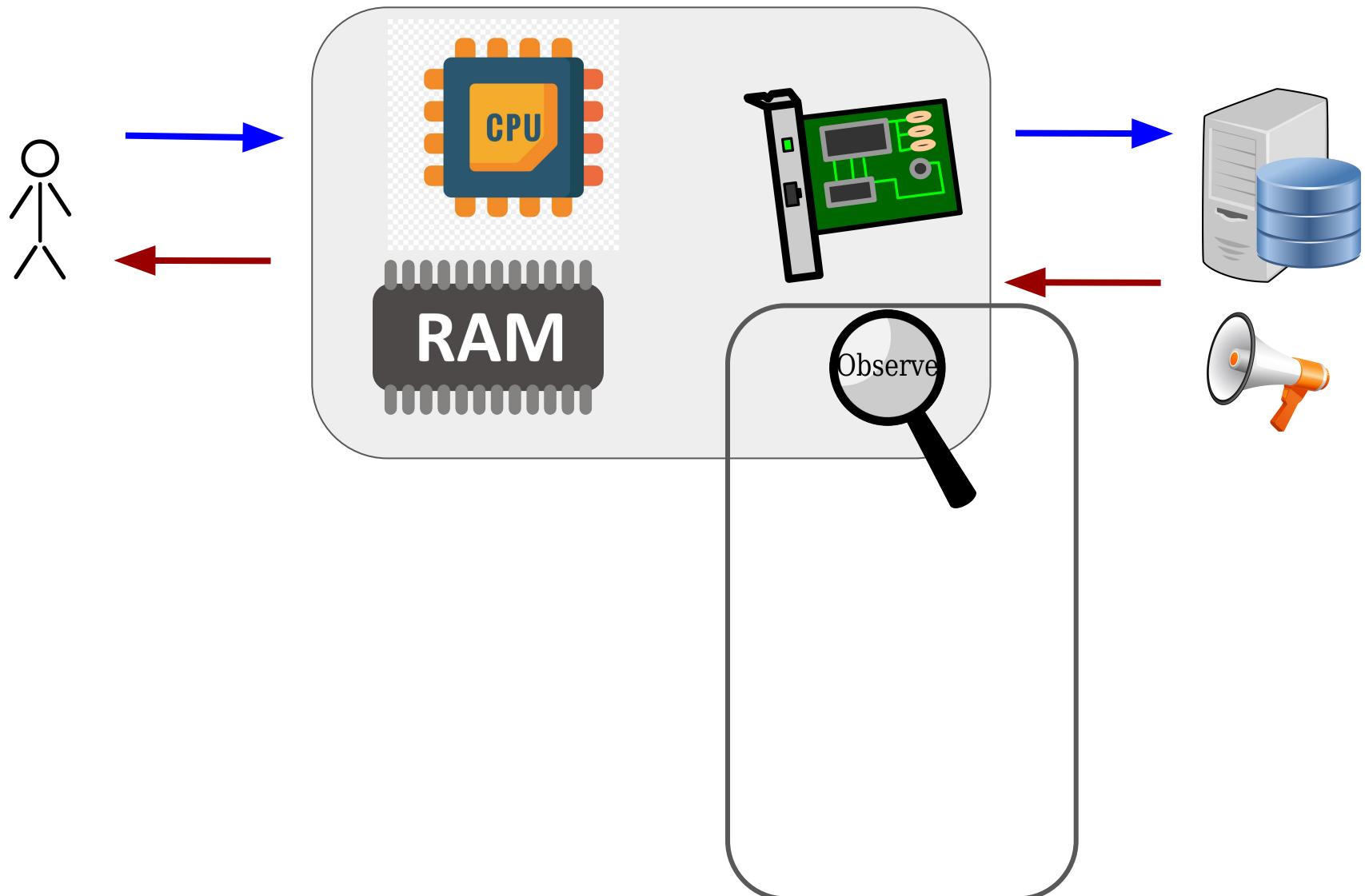
*Published on September 16 2014. (v2.0)*

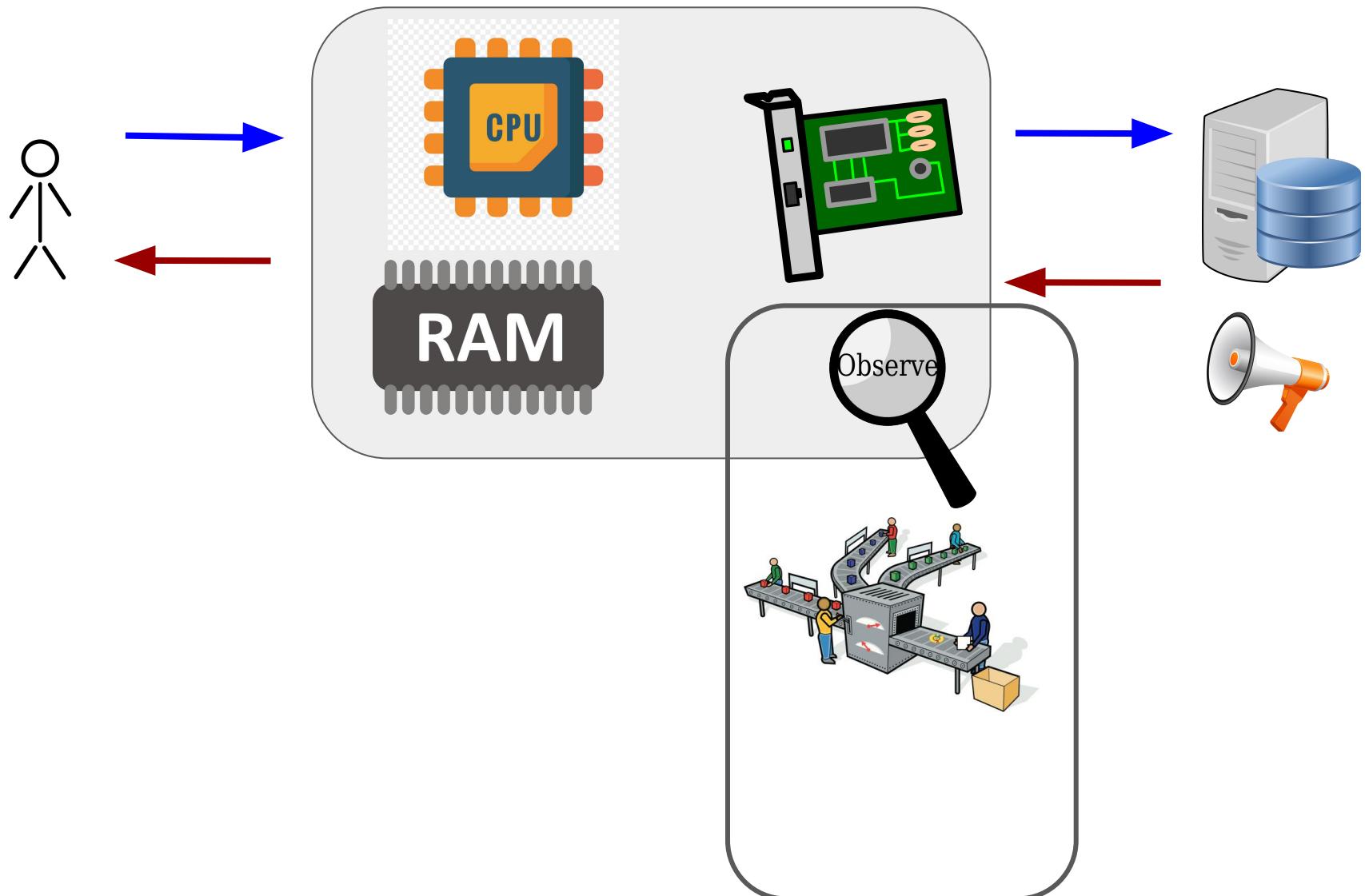


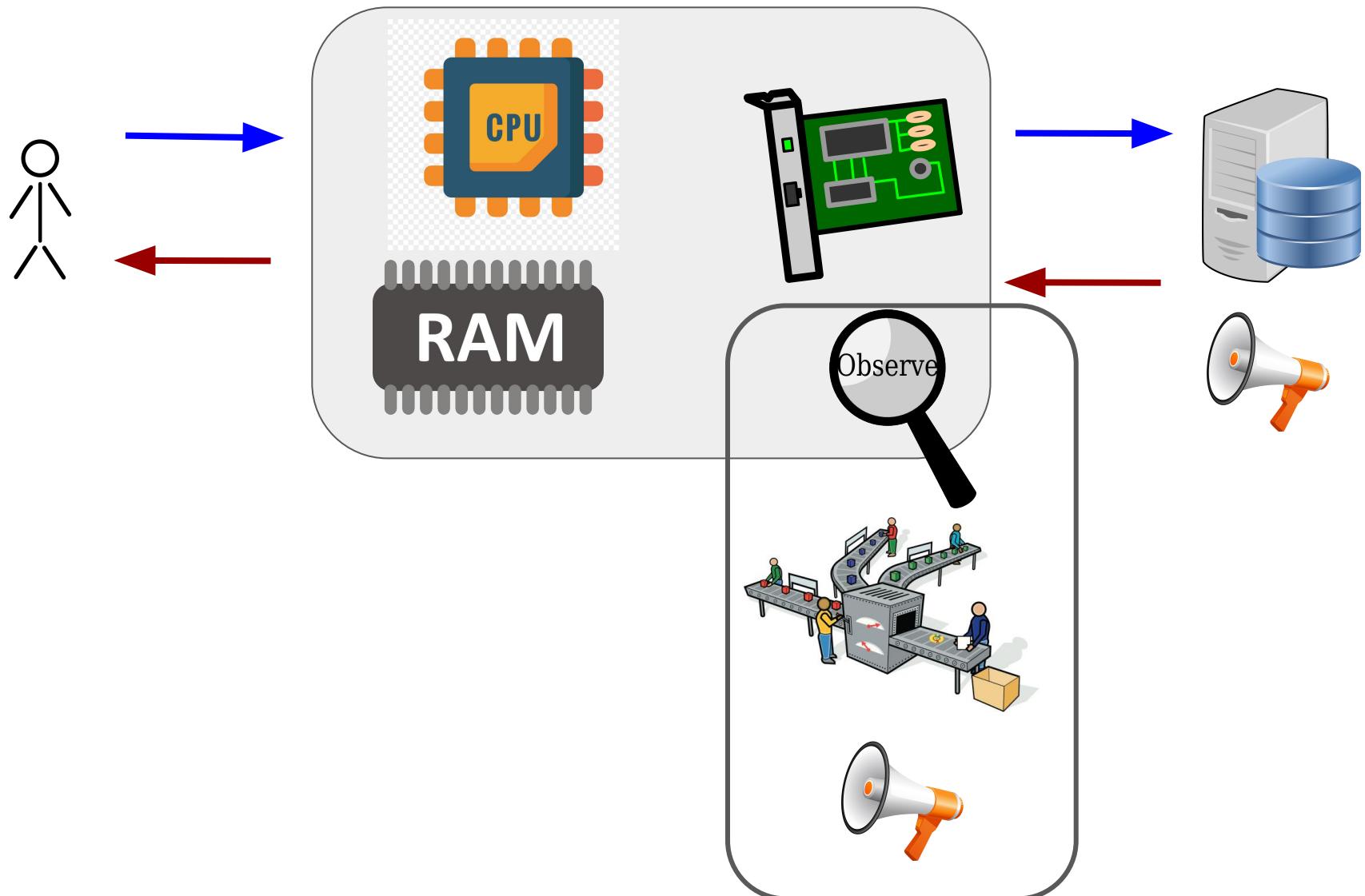


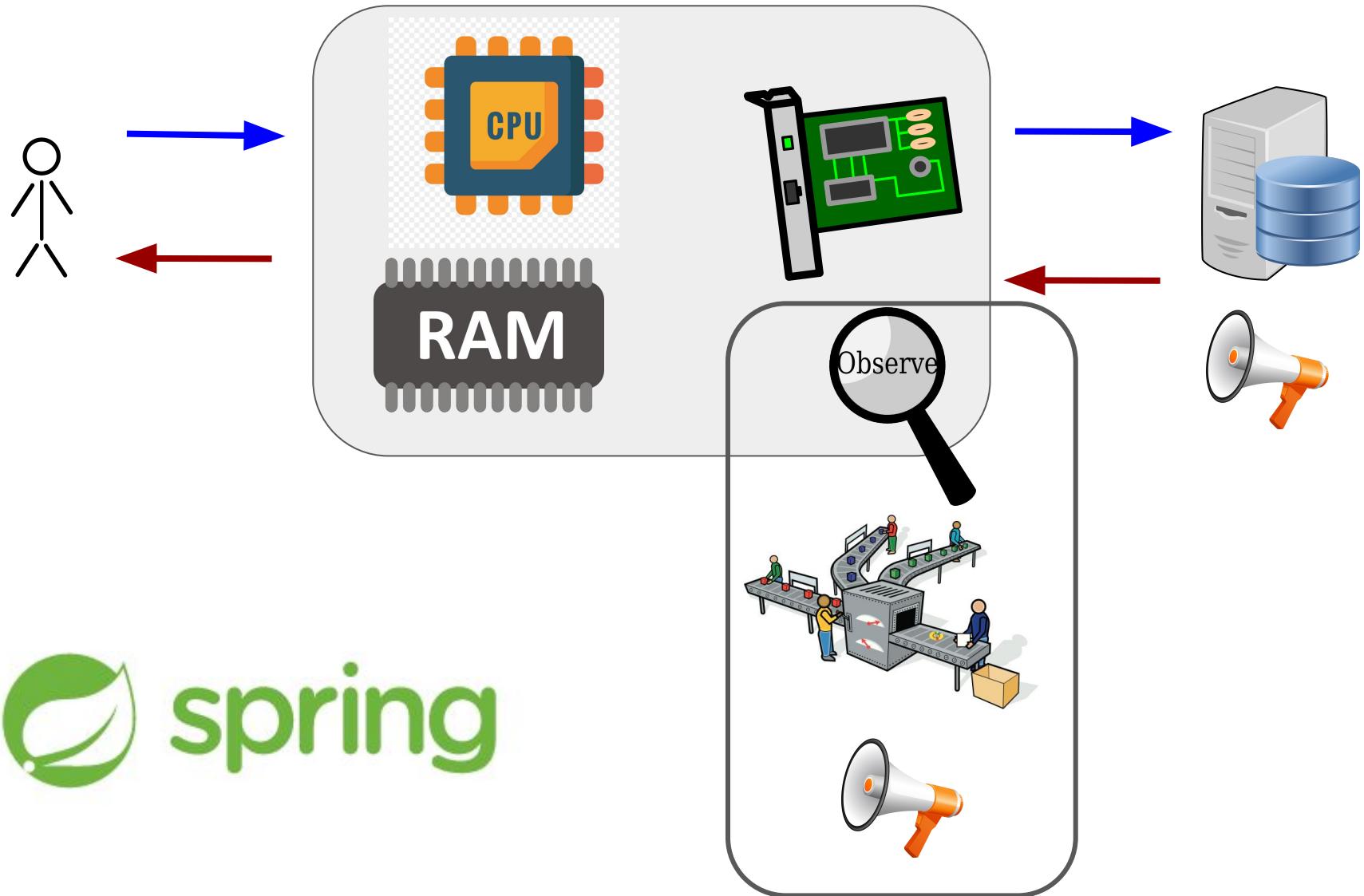












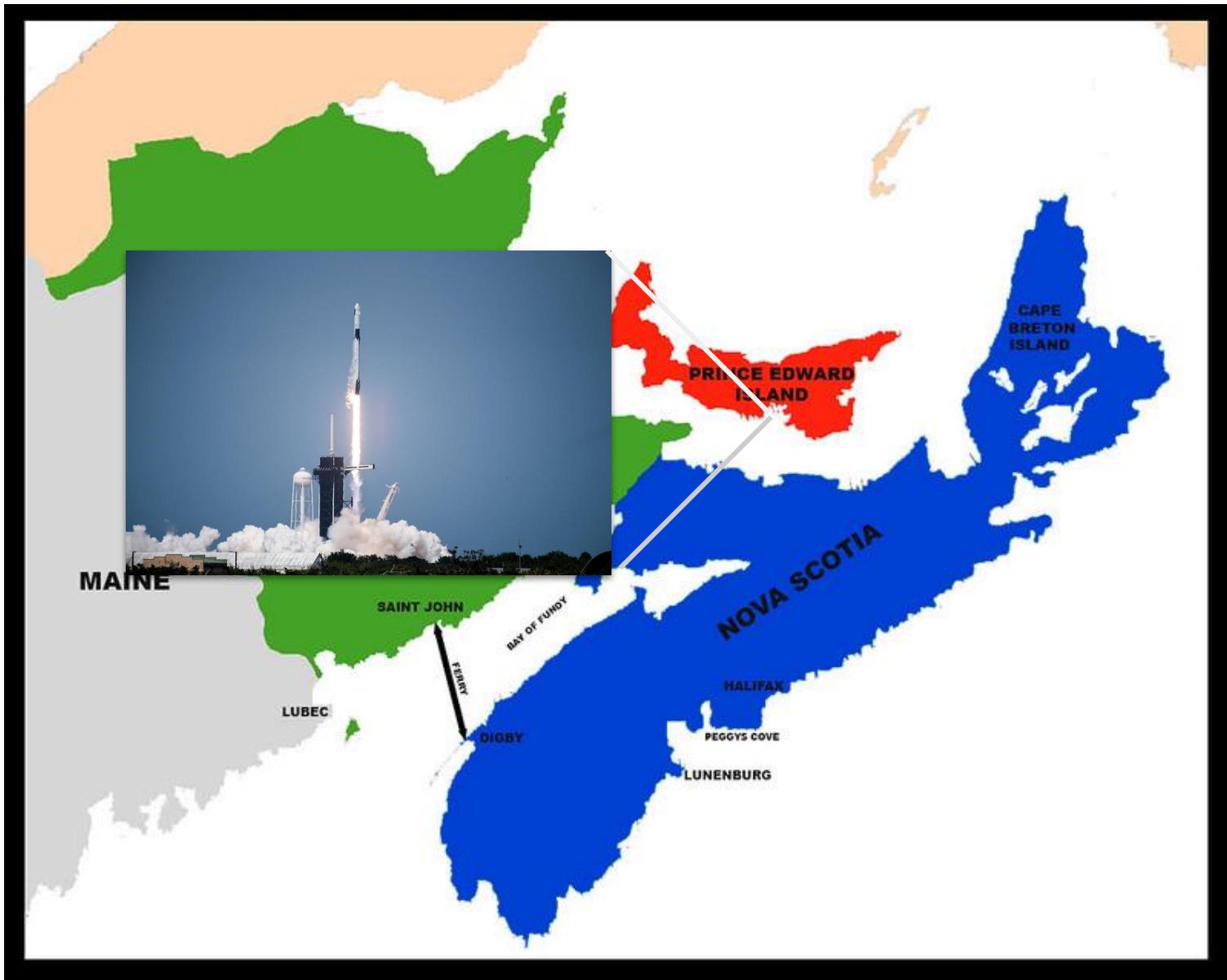
# FAANG

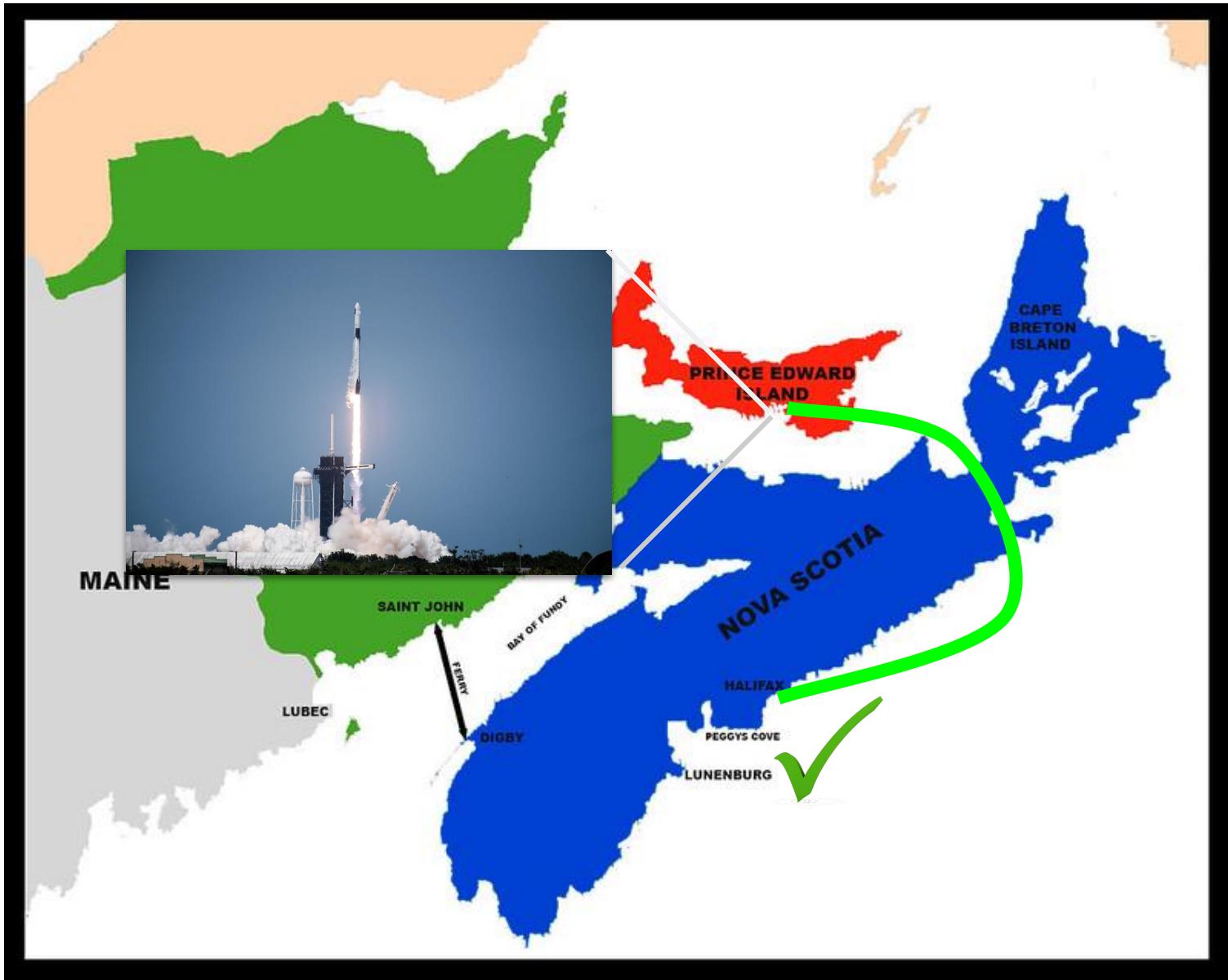


~~FAANG~~ -> MAANA







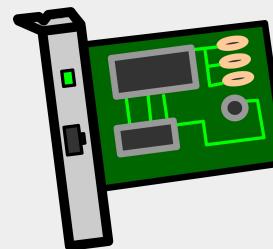
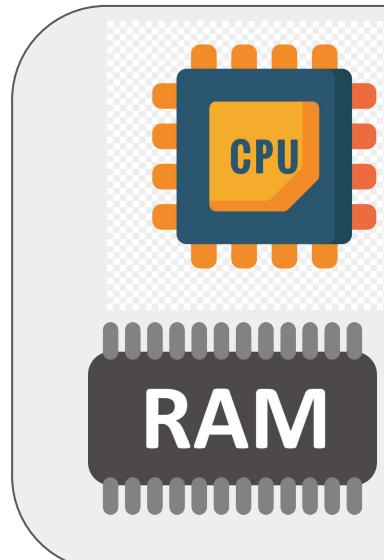
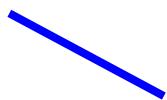


Cons

**scale**

**JVM**

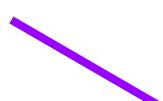
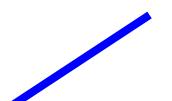
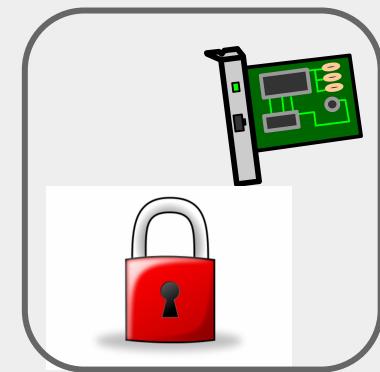
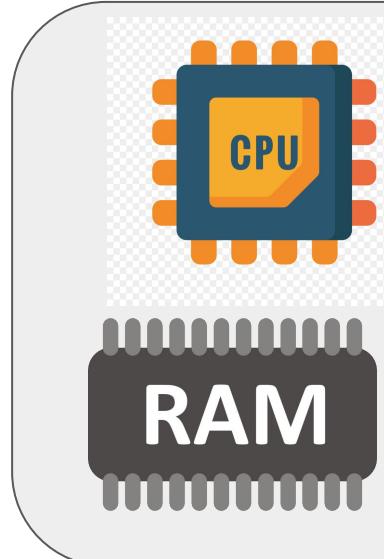
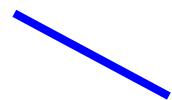






CPAT





## Locks

```
45  class MyTask implements Runnable {  
46      @Override  
47      public void run() {  
48          try {  
49              var database = pool.acquireDatabase();  
50              var user = database.findUser(id);  
51              // ...  
52          } catch (Exception ex) {  
53              // #yolo  
54          } finally {  
55              pool.releaseDatabase();  
56          }  
57      }  
58  }
```

## Locks

```
30  class ConnectionPool {  
31      private static final int MAX_AVAIL = 2;  
32      private final Semaphore available = new Semaphore(MAX_AVAIL);  
33      private final Database database = new Database();  
34  
35      Database acquireDatabase() throws InterruptedException {  
36          available.acquire();  
37          return database;  
38      }  
39  
40      void releaseDatabase() {  
41          available.release();  
42      }  
43  }
```

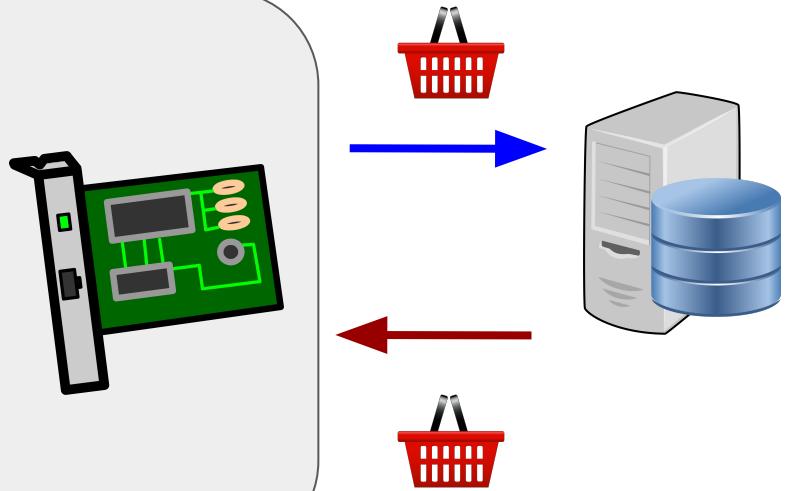
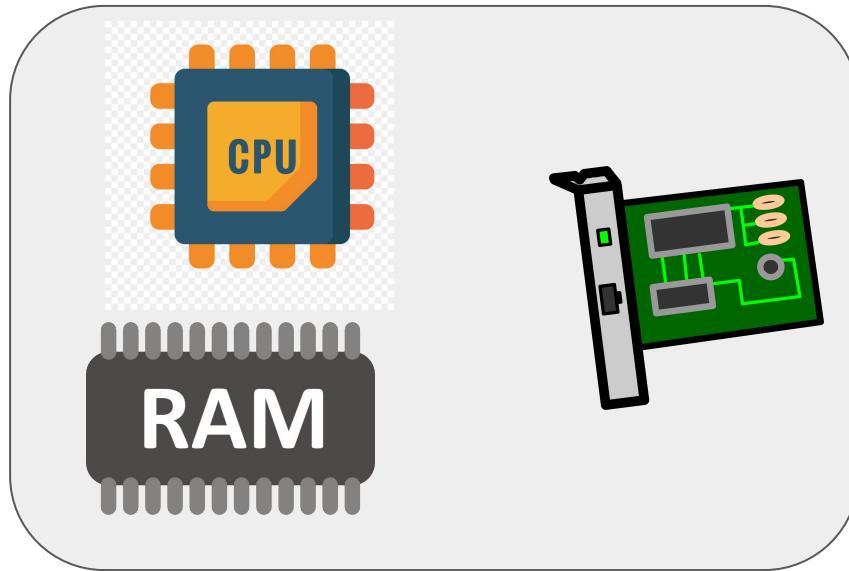
Cons

JVM



scale

back  
pressure







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## Project Loom C5M

Project Loom C5M is an experiment to achieve 5 million parallel client and server Java applications using [OpenJDK Project Loom](#).



☰ README.md

## Project Loom C5M

Project Loom C5M is an experiment to achieve 5 million p  
client and server Java applications using [OpenJDK Project](#)





☰ README.md

## Project Loom C5M

Project Loom C5M is an experiment to achieve 5 million parallel client and server Java applications using OpenJDK Project Loom.



# Structured Concurrency

```
1 i=0;  
2 i=i+1;  
3 PRINT i; "squared=";i*i;  
4 IF i>=100 THEN GOTO 6;  
5 GOTO 2;  
6 PRINT "Program Completed.";  
7 END
```

# STRUCTURED PROGRAMMING AND PROBLEM-SOLVING WITH PASCAL

Richard B. Kleburz

`Z := 1;`

`while N > 0`

`if N is odd`

`then`

`Z := Z * E;`

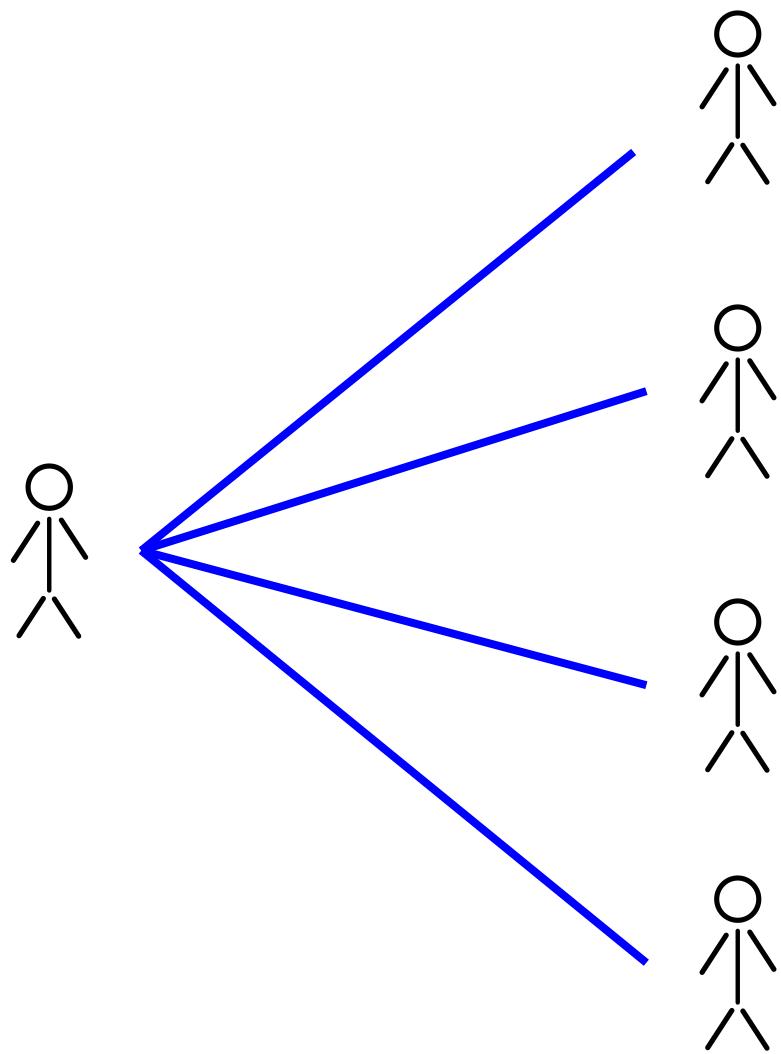
`N := N - 1;`

`else`

`E := E * E;`

`N := N div 2;`

`result is Z`



# njs blog

[My homepage](#)

| [Blog archive](#)

WED 25 APRIL 2018

## Notes on structured concurrency, or:

# njs blog

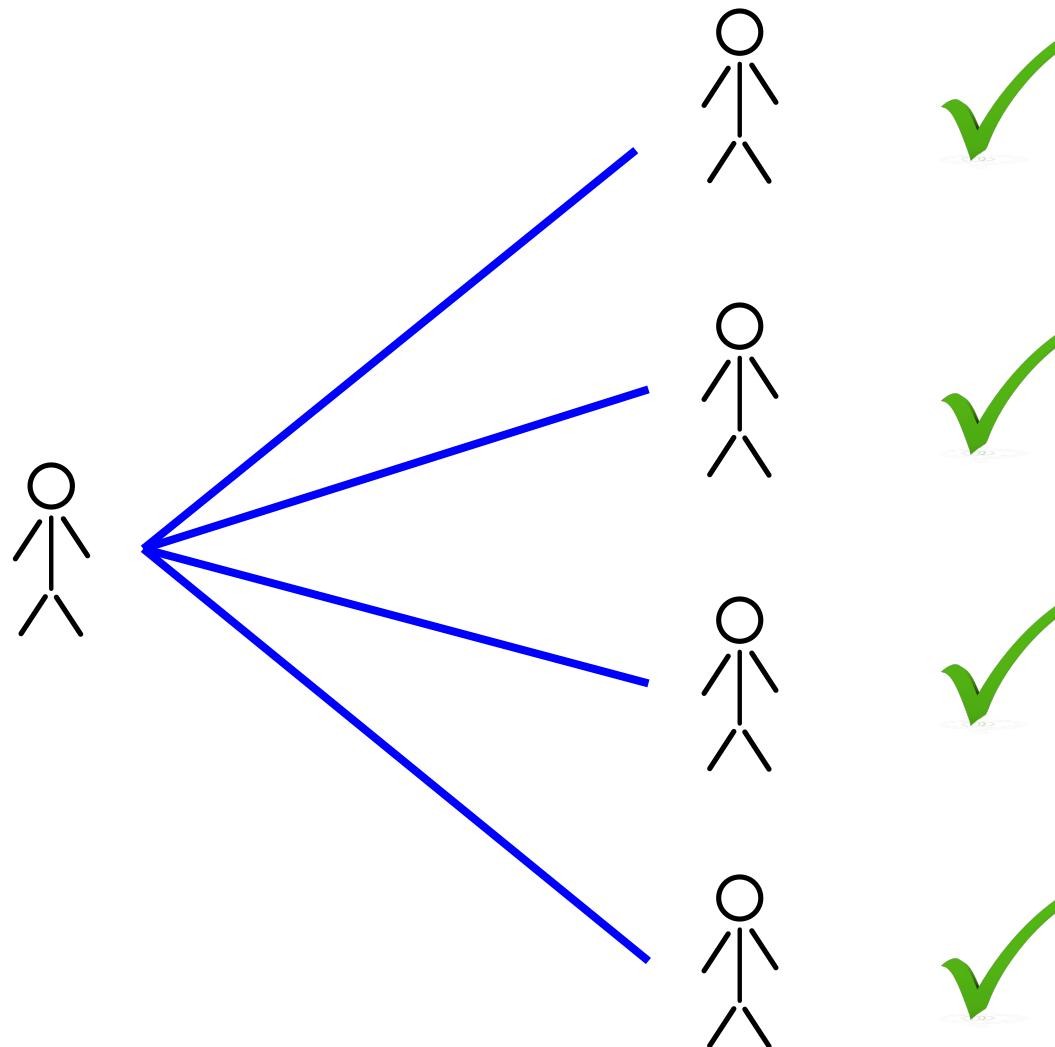
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## **Notes on structured concurrency, or: Go statement considered harmful**

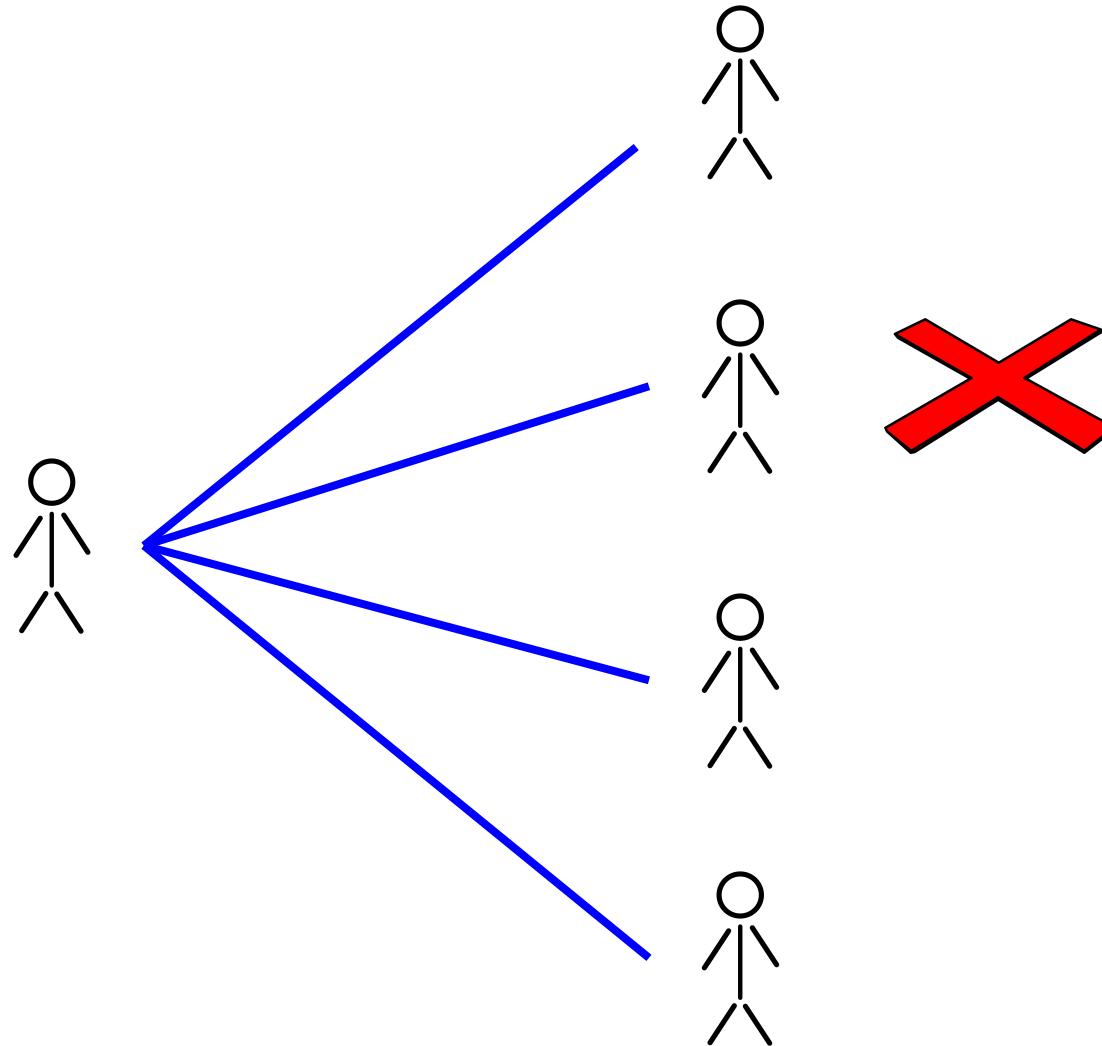
# Invoke All



## Invoke All

```
35 ~ String run() throws Exception {  
36     try (var scope = new StructuredTaskScope.ShutdownOnFailure()) {  
37         Future<String> foo = scope.fork(() -> taskFoo());  
38         Future<String> bar = scope.fork(() -> taskBar());  
39  
40         scope.join();  
41  
42         return foo.resultNow() + " " + bar.resultNow();  
43     }  
44 }
```

# Invoke All



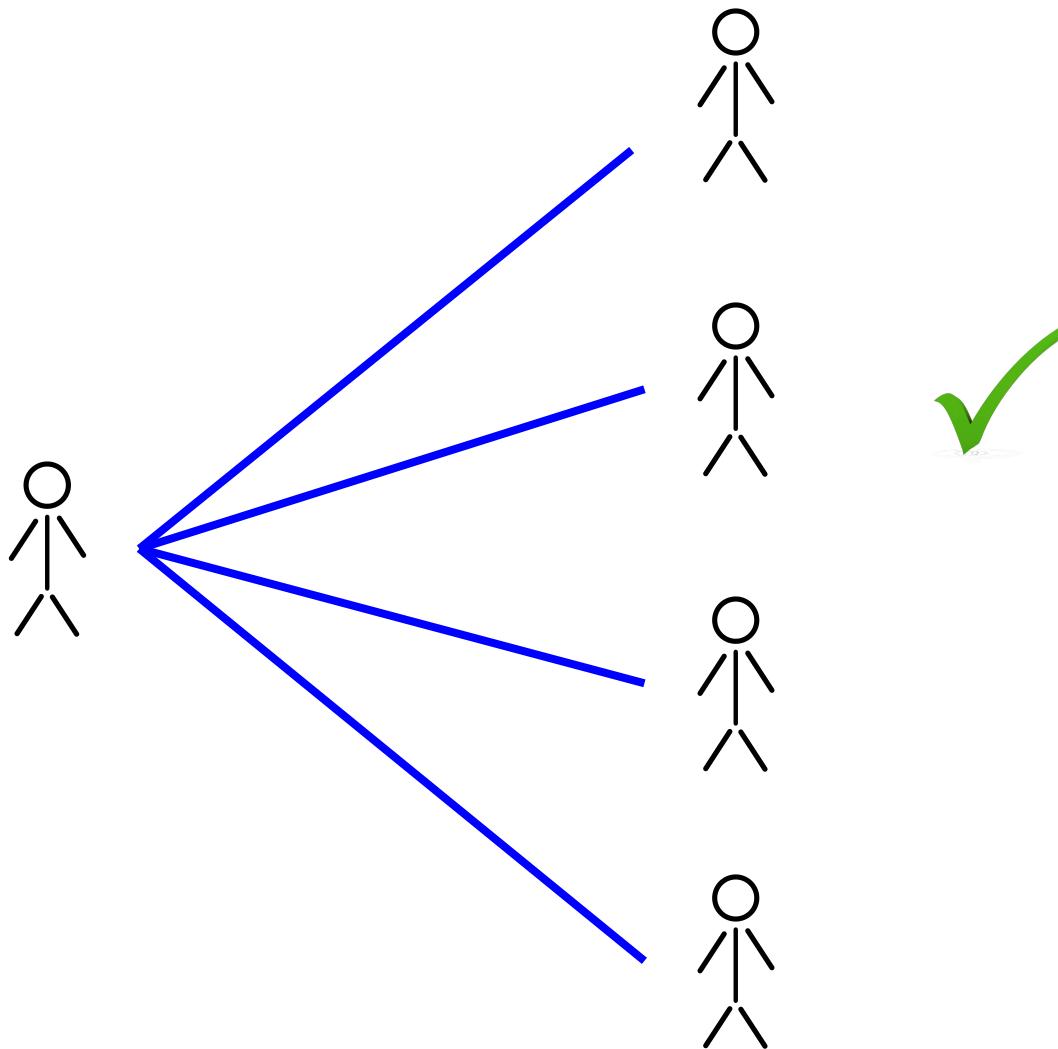
## Invoke All

```
35 String run() throws Exception {  
36     try (var scope = new StructuredTaskScope.ShutdownOnFailure()) {  
37         Future<String> foo = scope.fork(() -> taskFoo());  
38         Future<String> bar = scope.fork(() -> taskBar());  
39  
40         scope.join();  
41         scope.throwIfFailed();  
42  
43         return foo.resultNow() + " " + bar.resultNow();  
44     }  
45 }
```

JVM



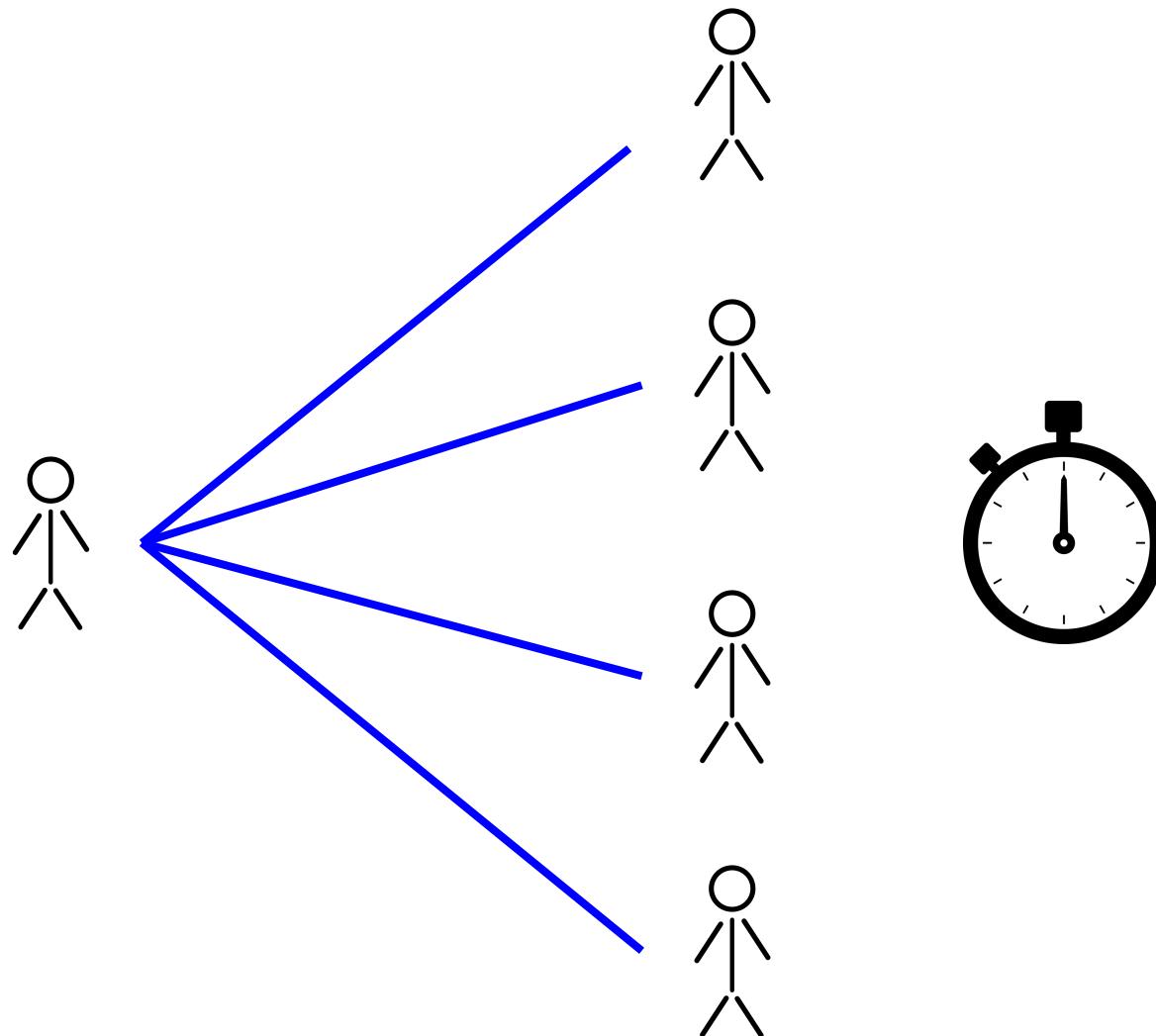
# Invoke Any



## Invoke Any

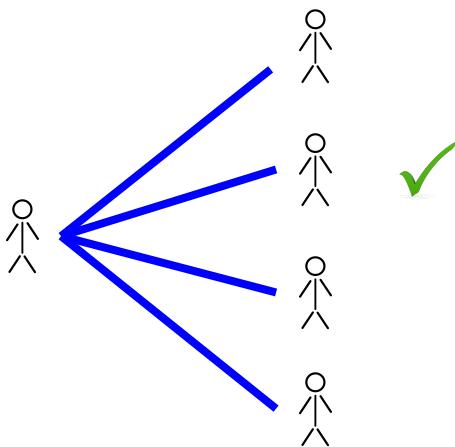
```
35 String run() throws Exception {
36     try (var scope =
37             new StructuredTaskScope.ShutdownOnSuccess<String>()) {
38         Future<String> foo = scope.fork(() -> taskFoo());
39         Future<String> bar = scope.fork(() -> taskBar());
40
41         scope.join();
42
43         return scope.result();
44     }
45 }
```

# Deadline



# Deadline

```
35 | String run() throws Exception {
36 |     try (var scope =
37 |             new StructuredTaskScope.ShutdownOnSuccess<String>()) {
38 |         Future<String> foo = scope.fork(() -> taskFoo());
39 |         Future<String> bar = scope.fork(() -> taskBar());
40 |
41 |         var deadline = Instant.now().plusSeconds(secondsToAdd: 2);
42 |         scope.joinUntil(deadline);
43 |
44 |         return scope.result();
45 |     }
46 | }
```



☰ README.md

## Project Loom C5M

Project Loom C5M is an experiment to achieve 5 million parallel client and server Java applications using OpenJDK Project Loom.



# Code, Credits, Links

Available [here](#) on GitHub

