

# Distributed Systems I

## *Software Architecture*

Brae Webb & Richard Thomas

March 24, 2025



**Mathias Verras**  
@mathiasverraes

There are only two hard problems  
in distributed systems:

2. Exactly-once delivery
1. Guaranteed order of messages
2. Exactly-once delivery

*Going forward*

Investigating architectures that are *distributed*.

## *Distributed Systems Series*

Distributed I    *Reliability* and *scalability* of  
*stateless* systems.

Distributed II    *Complexities* of *stateful*  
systems.

Distributed III    *Hard problems* in distributed  
systems.

*What are the benefits?*

- Improved *reliability*
- Improved *scalability*
- Improved *latency*

*What are the drawbacks?*

- Increased *complexity*
- Increased *attack surface*
- Increased *latency*
- Introduce *consistency* problems

# § *Fallacies*

*A few reasons for complexity*

Fallacies of *Distributed Computing*

*Fallacy #1*

The network is reliable









# Exponential Backoff

```
1  retries = 0
2  do:
3      status = service.request()
4
5      if status != SUCCESS:
6          retries += 1
7          wait(2 ** retries)
8  while (status != SUCCESS and retries < MAX_RETRIES)
```







*Fallacy #2*

Latency is zero

## *Network Statistics*

Home to UQ

Home to us-east-1

EC2 to EC2

## *Network Statistics*

Home to UQ 20.025ms

Home to us-east-1

EC2 to EC2

## *Network Statistics*

Home to UQ 20.025ms

Home to us-east-1 249.296ms

EC2 to EC2

## *Network Statistics*

Home to UQ 20.025ms

Home to us-east-1 249.296ms

EC2 to EC2 0.662ms

*Fallacy #3*

Bandwidth is infinite

*Definition 0.* Stamp Coupling

Components which share a composite data structure.

*Fallacy #4*

The network is secure





*Fallacy #5*

The topology never changes

*Fallacy #6*

There is only one administrator

*Fallacy #7*

Transport cost is zero

*Remember*

Distributed systems are *hard*. Choosing to use them should be *well considered*.

*When you need to, maybe prove it?*



Sept 13-14, 2019  
[thestrangeloop.com](http://thestrangeloop.com)



*Or, more realistically,*

Use *existing* algorithms and software

## *Distributed Systems Series*

Distributed I    *Reliability* and *scalability* of  
*stateless* systems.

Distributed II    Complexities of stateful  
systems.

Distributed III Hard problems in distributed  
systems.

## *Stateless vs. Stateful Systems*

Stateless Does *not* utilise *persistent data*.

Stateful Does utilise *persistent data*.

*Question*

What makes software *reliable*?

*Definition 0.* Reliable Software

Continues to work, even when things go wrong.

*Definition 0.* Fault

Something goes wrong.

Death, taxes, and computer system failure are all inevitable to some degree.

*Plan for the event.*

*– Howard and LeBlanc*

*Reliable software is*

Fault *tolerant*

*Problem*

Individual computers fail *all the time*

## *Solution*

Spread the risk of faults over *multiple computers* or *nodes*

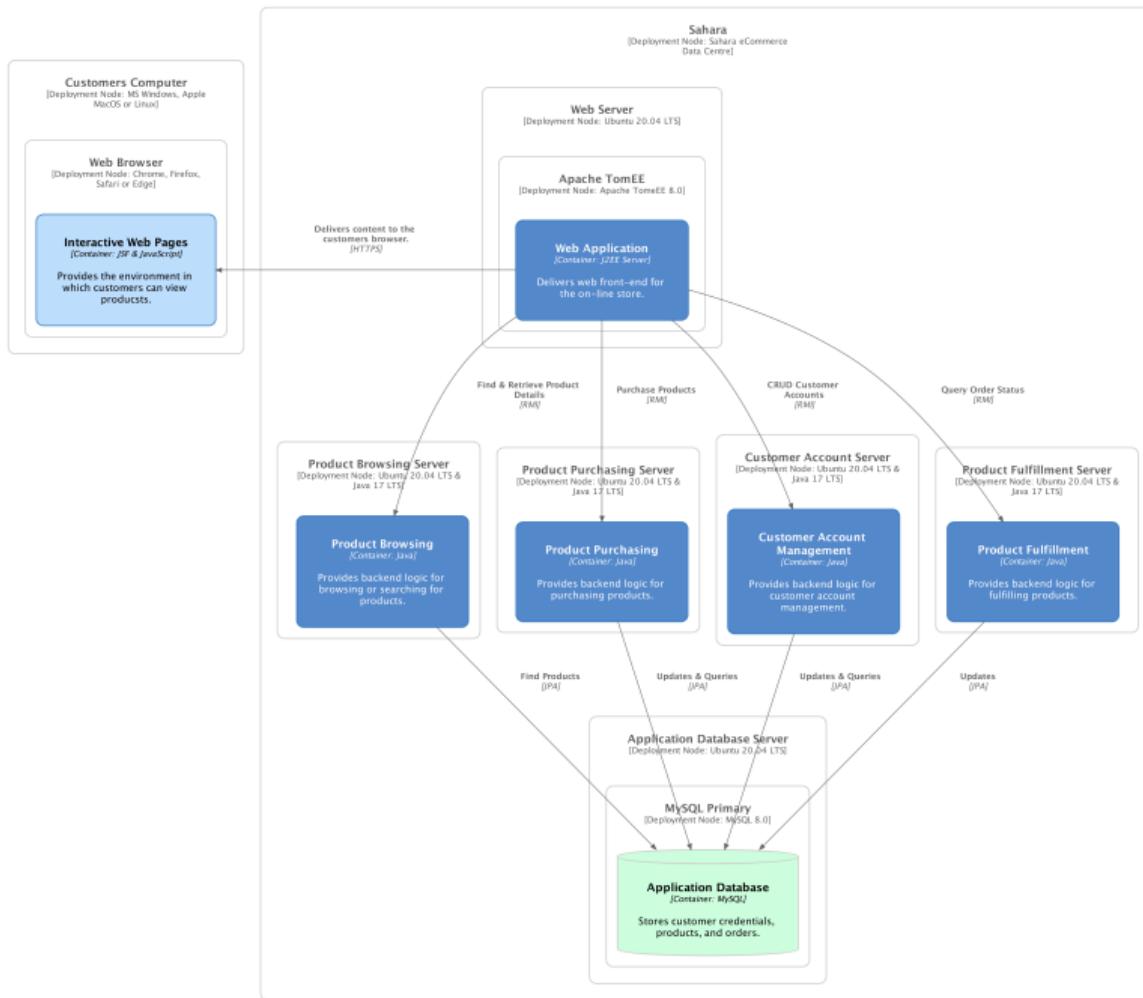
## *Spreading Risk*

If you have software that works with *just one* computer, spreading the software over *two* computers *halves* the risk that your software will fail.

## *Spreading Risk*

If you have software that works with *just one* computer, spreading the software over *two* computers *halves* the risk that your software will fail.

Adding *100* computers reduces the risk by *100*.



*Question*

Who has used *auto-scaling*?

## Auto-Scaling Terminology

Auto-scaling group A *collection of instances* managed by auto-scaling.

# Auto-Scaling Terminology

Auto-scaling group A *collection of instances* managed by auto-scaling.

Capacity Amount of instances *currently* in an auto-scaling group.

# Auto-Scaling Terminology

Auto-scaling group A *collection of instances* managed by auto-scaling.

Capacity Amount of instances *currently* in an auto-scaling group.

Desired Capacity Amount of instances *we want to have* in an auto-scaling group.

# Auto-Scaling Terminology

Auto-scaling group A *collection of instances* managed by auto-scaling.

Capacity Amount of instances *currently* in an auto-scaling group.

Desired Capacity Amount of instances *we want to have* in an auto-scaling group.

Scaling Policy How to determine the desired capacity.

# Auto-Scaling Terminology

**Auto-scaling group** A *collection of instances* managed by auto-scaling.

**Capacity** Amount of instances *currently* in an auto-scaling group.

**Desired Capacity** Amount of instances *we want to have* in an auto-scaling group.

**Scaling Policy** How to determine the desired capacity.

**Minimum/Maximum Capacity** *Hard limits* on the minimum and maximum number of instances.

*What we really want*

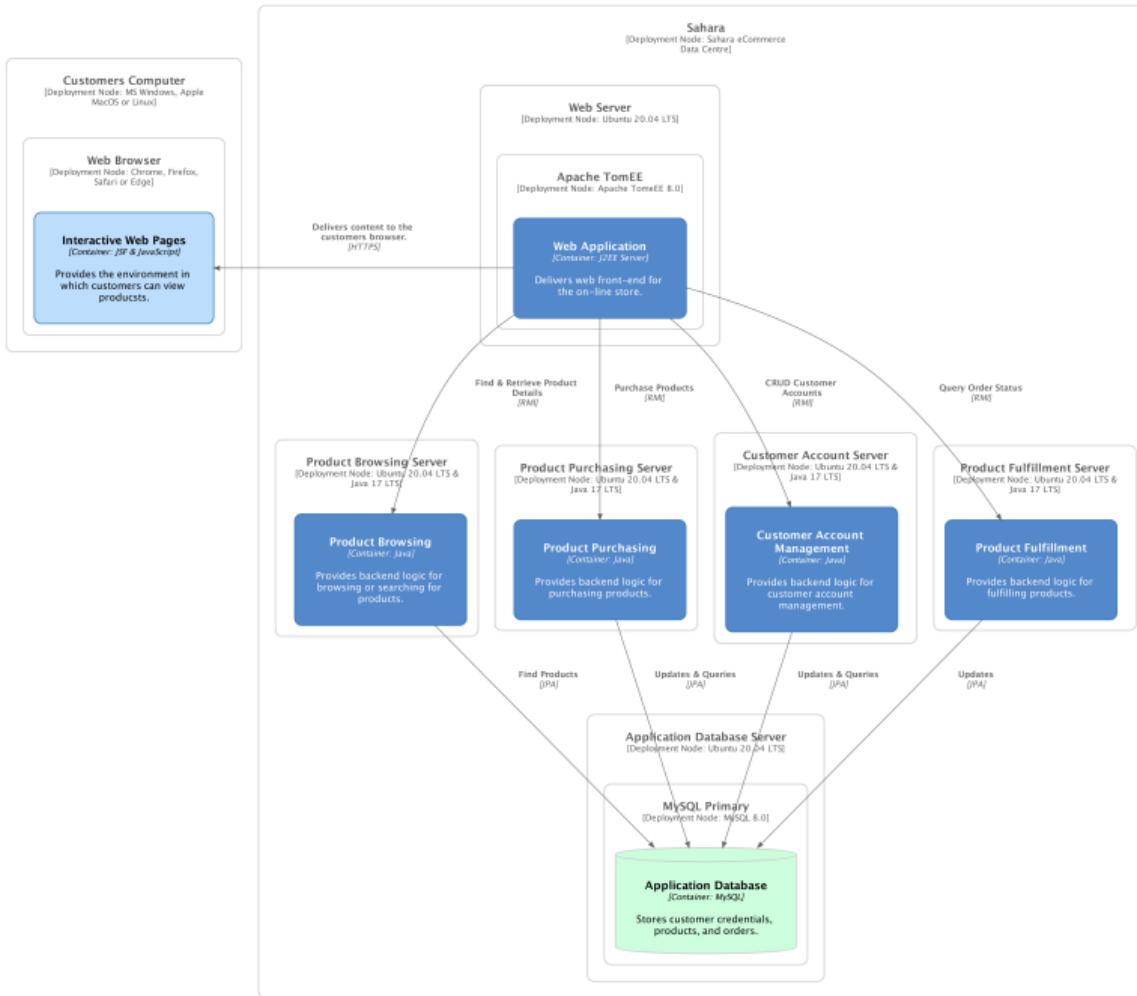
Desired Capacity Amount of *healthy* instances  
we want to have in an auto-scaling group.

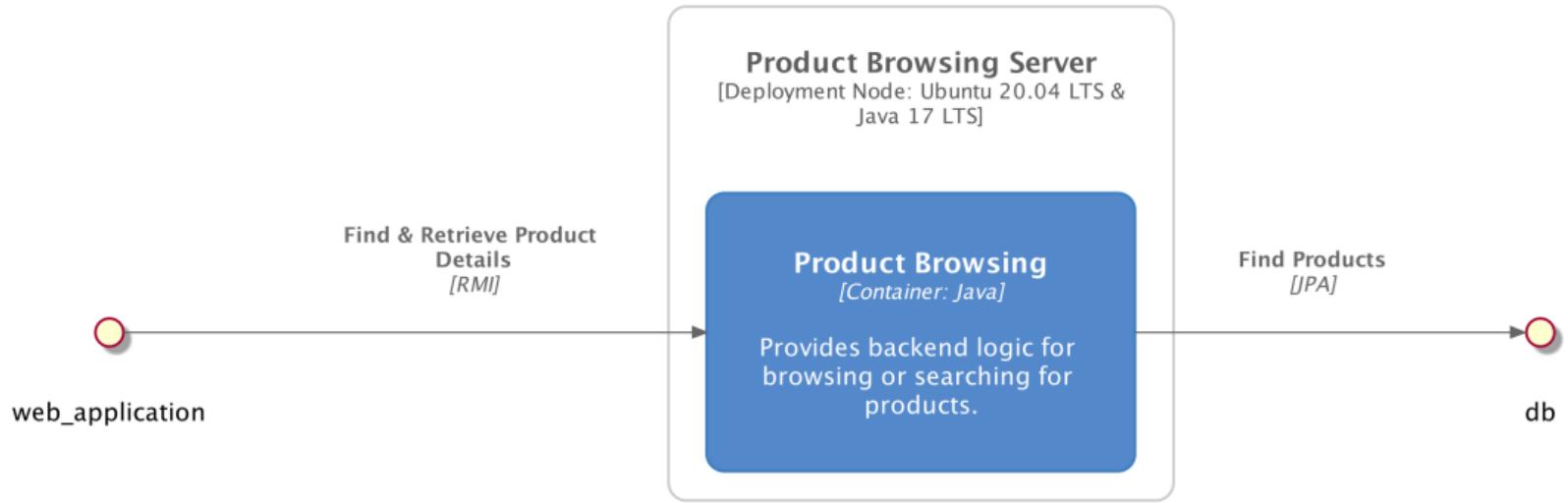
## *Health check*

Mechanism to determine whether an instance is *healthy*.

## *Auto-scaling*

An example

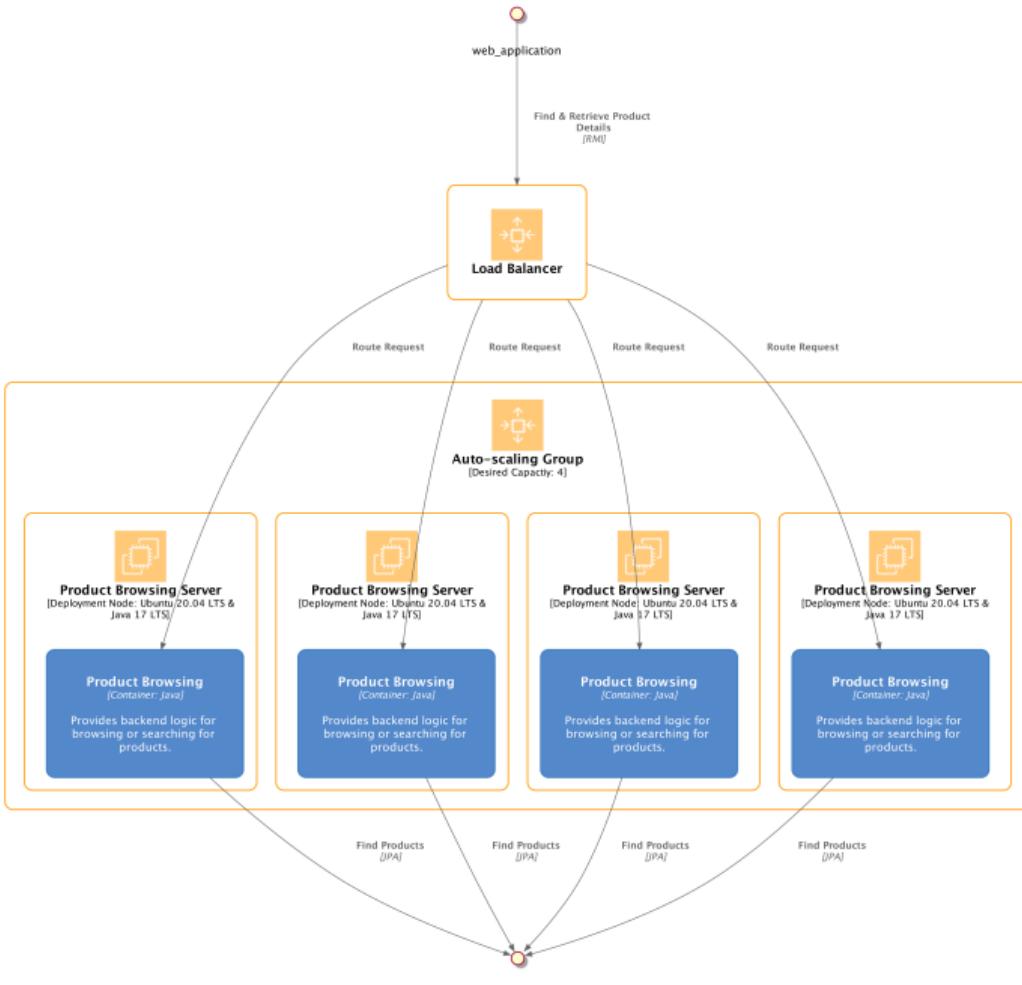














# In Summary

Simplicity

Reliability

Scalability

## In Summary

Simplicity *Minimal network communication* (compared to other distributed systems), less impacted by fallacies.

Reliability

Scalability

## In Summary

Simplicity *Minimal network communication* (compared to other distributed systems), less impacted by fallacies.

Reliability Traffic is spread to various services, still *partially operational* if one goes down. Auto-scaling allows for *basic replication*.

Scalability

## In Summary

- Simplicity *Minimal network communication* (compared to other distributed systems), less impacted by fallacies.
- Reliability Traffic is spread to various services, still *partially operational* if one goes down. Auto-scaling allows for *basic replication*.
- Scalability Auto-scaling and load balancing allows *individual services to scale*. However, the *database is a bottleneck*.