

# Distributed Systems I

## *Software Architecture*

Brae Webb

March 18, 2024



**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 vector*.
- Increased *latency*.
- Introduce *consistency* problems.

# $\S$ *Fallacies*

*A few reasons for complexity*

The Fallacies of *Distributed Computing*.

*Fallacy #1*

The network is reliable.









## Exponential backoff

```
1  retry = True
2  do:
3      status = service.request()
4
5      if status != SUCCESS:
6          wait(2 ** retries)
7      else:
8          retry = False
9  while (retry 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.

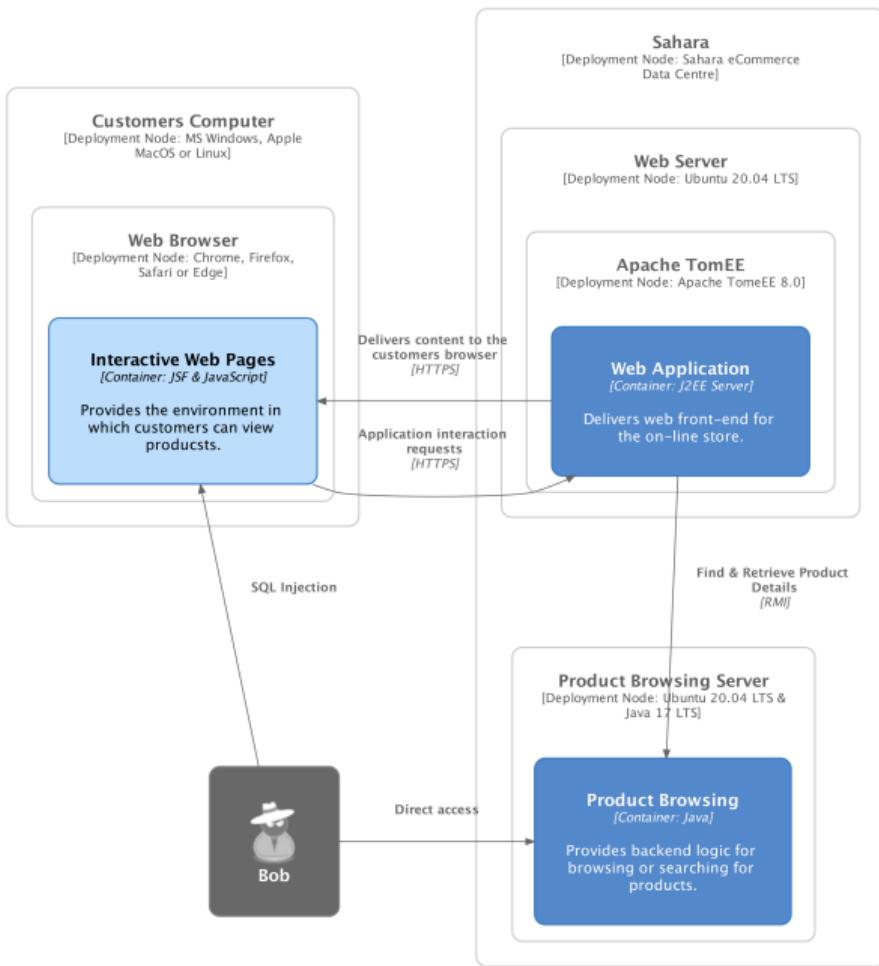
*Definition 1.* Stamp Coupling

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*.

The choice 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* utilize *persistent data*.

Stateful Does utilize *persistent data*.

*Question*

What makes software *reliable*?

*Definition 2.* Reliable Software

Continues to work, even when things go wrong.

*Definition 3.* 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 cuts 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 minimal and maximum amount 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 bottle-neck*.