

# Distributed Computing I

CSSE6400

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There are only two hard problems in distributed systems: 2. Exactly-once delivery 1. Guaranteed order of messages 2. Exactly-once delivery

Lecture Goal: Balance a healthy love-hate relationship with distributed systems

Previously in CSSE6400...

## Service-based Architecture

Re-visiting service-based architectures from last lecture

Previously in CSSE6400...

Simplicity For a distributed system



Modularity Services



Extensibility New services



Deployability Independent services



Testability Independent services



Security API layer



Reliability Independent services



Interoperability Service APIs



Scalability Coarse-grained services



Concluded on these attributes

Previously in CSSE6400...

**Simplicity** For a distributed system



**Reliability** Independent services



**Scalability** Coarse-grained services



Let's revisit these attributes

Previously in CSSE6400...

Simplicity *For a distributed system*



This condition is doing a lot of work

## Simplicity



We'll look at a few reasons that distributed systems are *fundamentally* quite challenging

Question

What is a *fallacy*?

### **Definition 1. Fallacy**

Something that is believed or assumed to be true  
but is not.

A few reasons for complexity

## The Fallacies of *Distributed Computing*

Sun Microsystems in 1994, primarily accredited to Peter Deutsch  
(doy-ch)

Fallacy #1

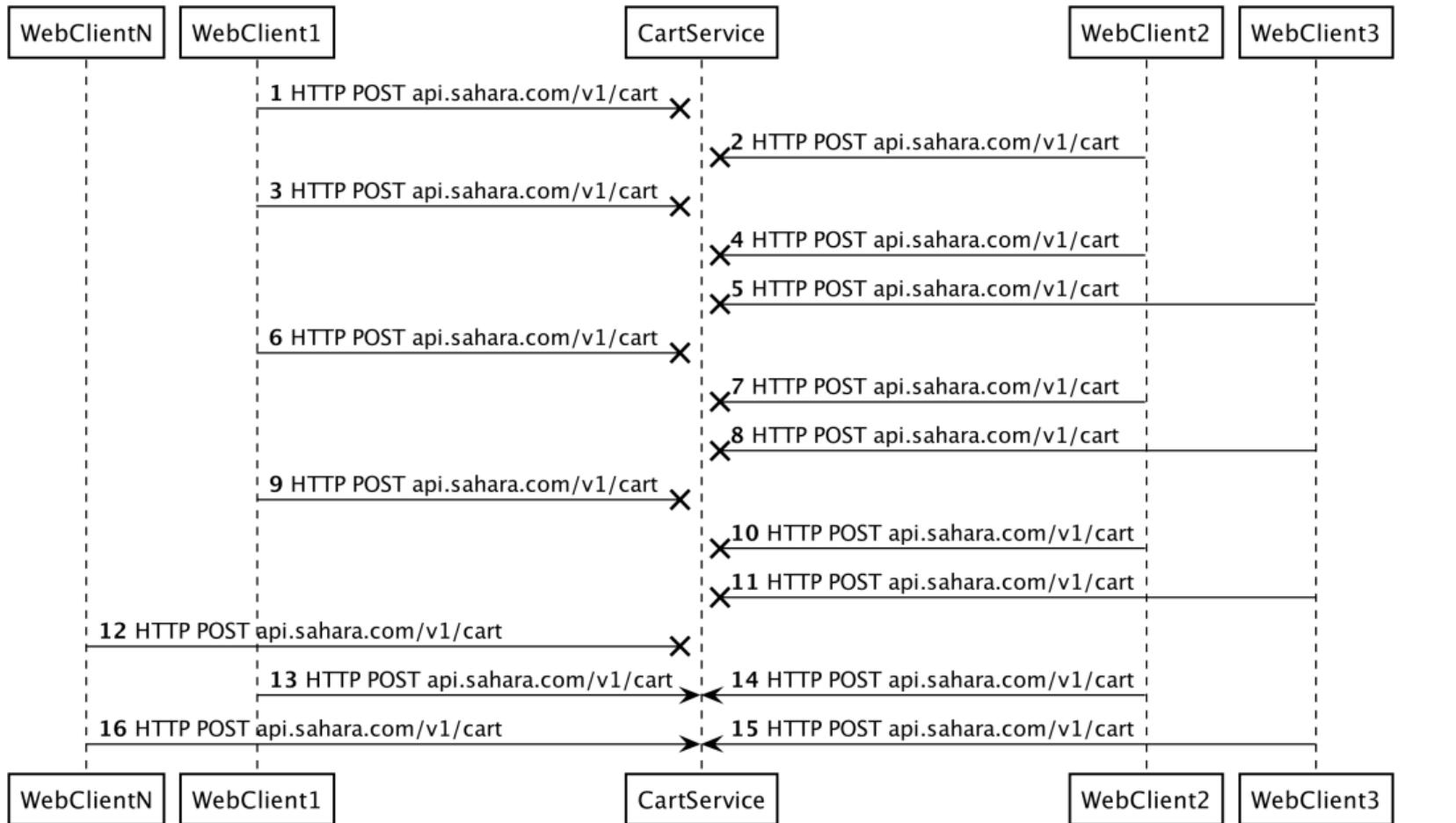
The network is reliable







Solve it by resending it

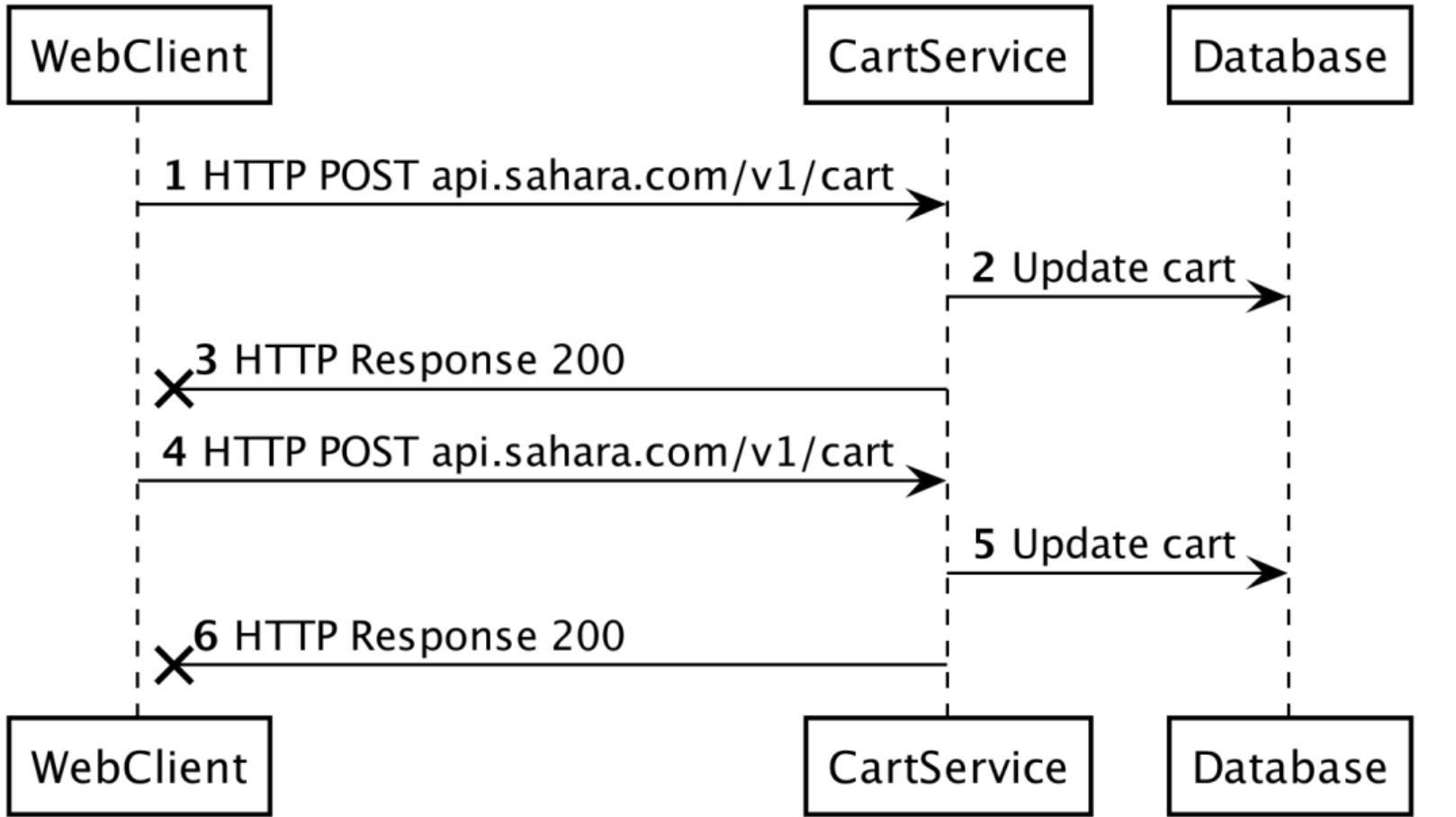


If the service goes down and all clients are re-trying, the service is in for a shock when it comes back, we solve this with *exponential backoff*

## Exponential backoff

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





Causes duplicate actions, problem for ordering/payments



Use tokens to prevent duplicates.

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

Be mindful when designing distributed systems. Network call much slower than local call.

Fallacy #3

## Bandwidth is infinite

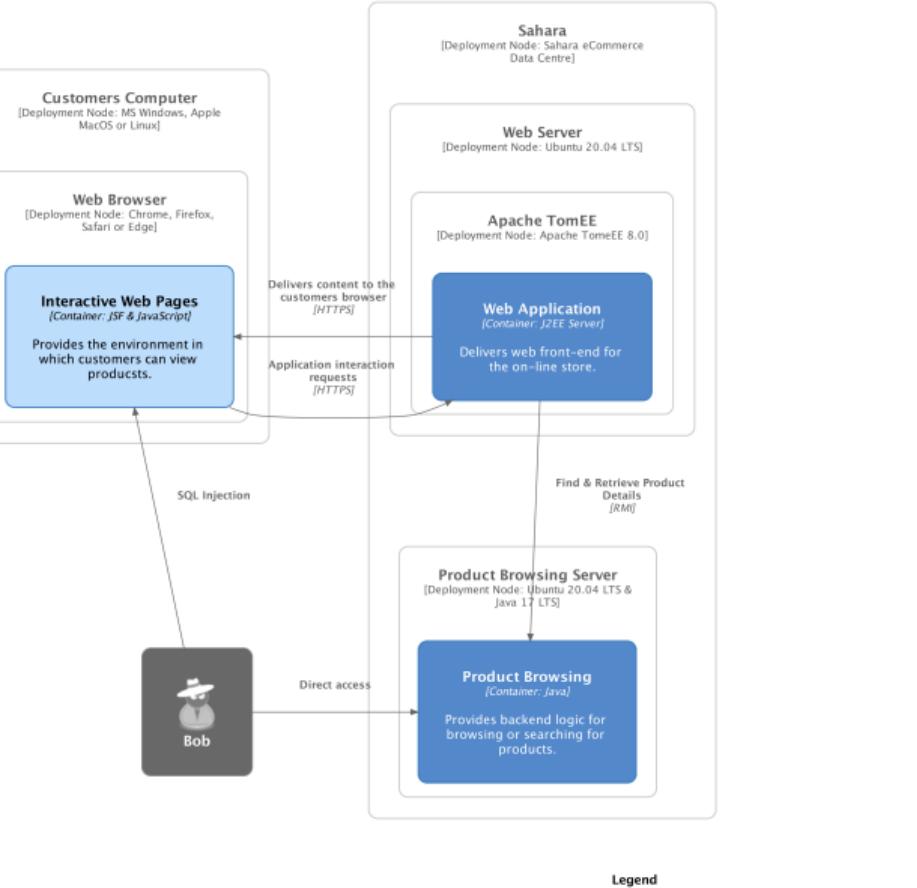
Similar to previous fallacy, be mindful, distributed calls clog up network.

Fallacy #4

The network is secure



# Authentication only occurs when entering Sahara data centre



Bad actor gets access via one insecure node, network is compromised. Practice defence in depth.

Fallacy #5

The topology never changes

Topology changes all the time, cloud has just made this easier.  
Don't rely on static IPs. Don't assume consistent latency.

Fallacy #6

**There is only one administrator**

## Scenario

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- Sunday night users start complaining.
- There have been no deployments since Friday.
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- Who do you talk to?

Things spontaneously break. Who can help you?

Fallacy #7

**Transport cost is zero**

Remember

Distributed systems are *hard*.

Remember

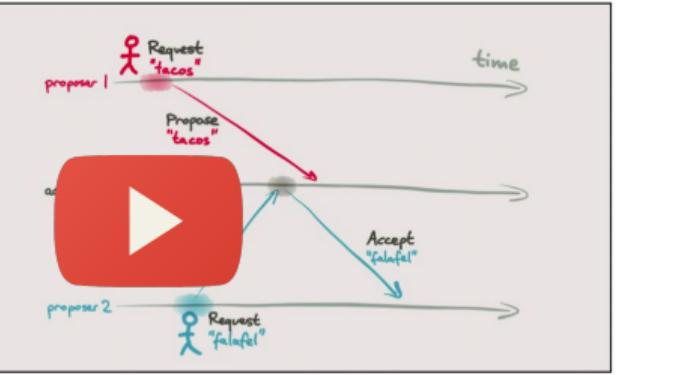
Distributed systems are often *not your friend*.

Can often introduce more problems than they solve

When you need to, prove it



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## Programming Research Group at Oxford in 1982

## Previously in CSSE6400...

**Simplicity** For a distributed system



**Reliability** Independent services



**Scalability** Coarse-grained services



Previously in CSSE6400...

Reliability Independent services



Question

What makes software *reliable*?

Perhaps software that always works?

'Working' software

**Satisfies the functional requirements**

## 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*

John von Neumann built fault tolerant hardware in the 50s.

Problem

Individual computers fail *all the time*

10-50 years hard-drive lifetime. 10,000 disks will fail daily.

Solution

Spread the risk of faults over *multiple computers*

## 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.

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- Why is this software somewhat reliable?
- Any individual service can go down and the rest still work.
- Can we do better?
- Can a service go down but have that service still work?

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Simplicity For a distributed system



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Question

Who has used *auto-scaling*?

## Auto-scaling Terminology

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

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**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

User defined method to determine whether an instance is *healthy*.

Auto-scaling

## An example



# Product service keeps going down



We might expect product service to have a much higher load than other services

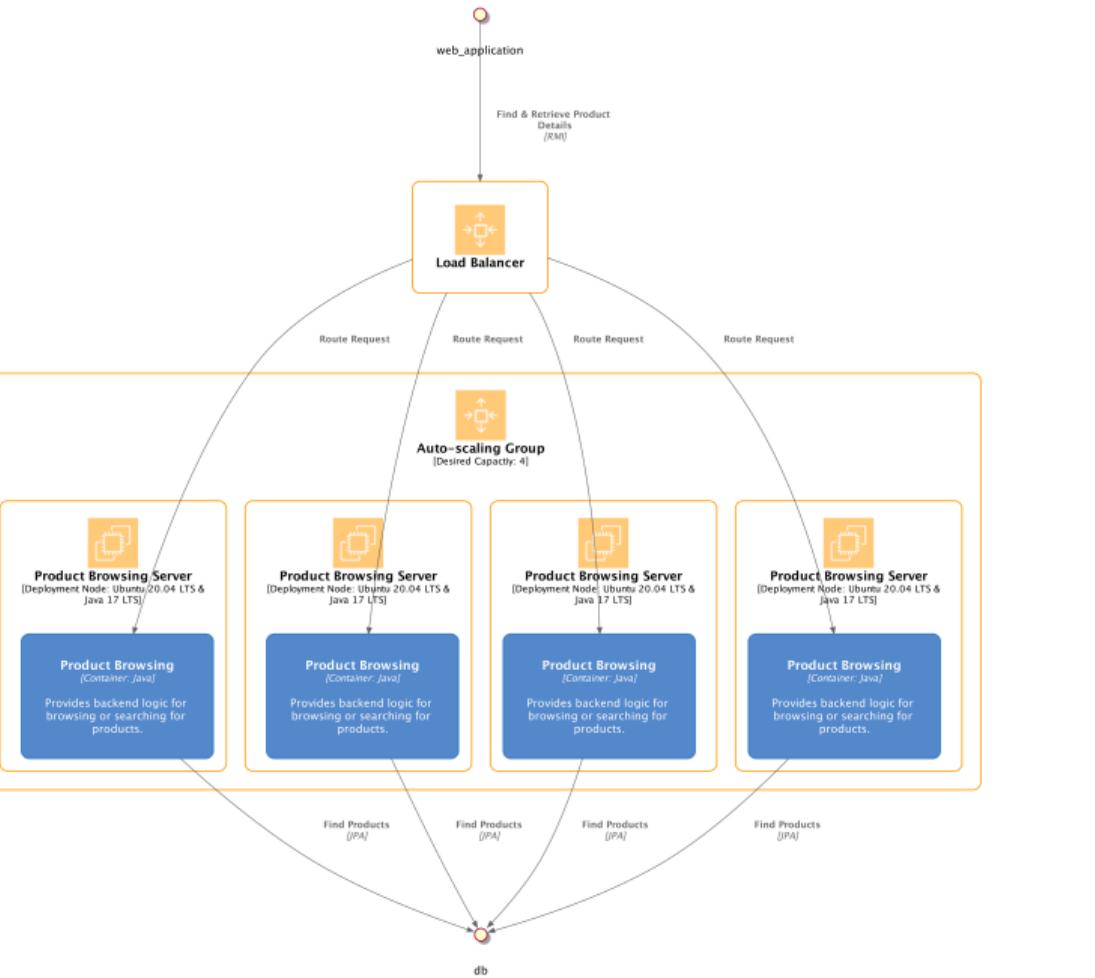




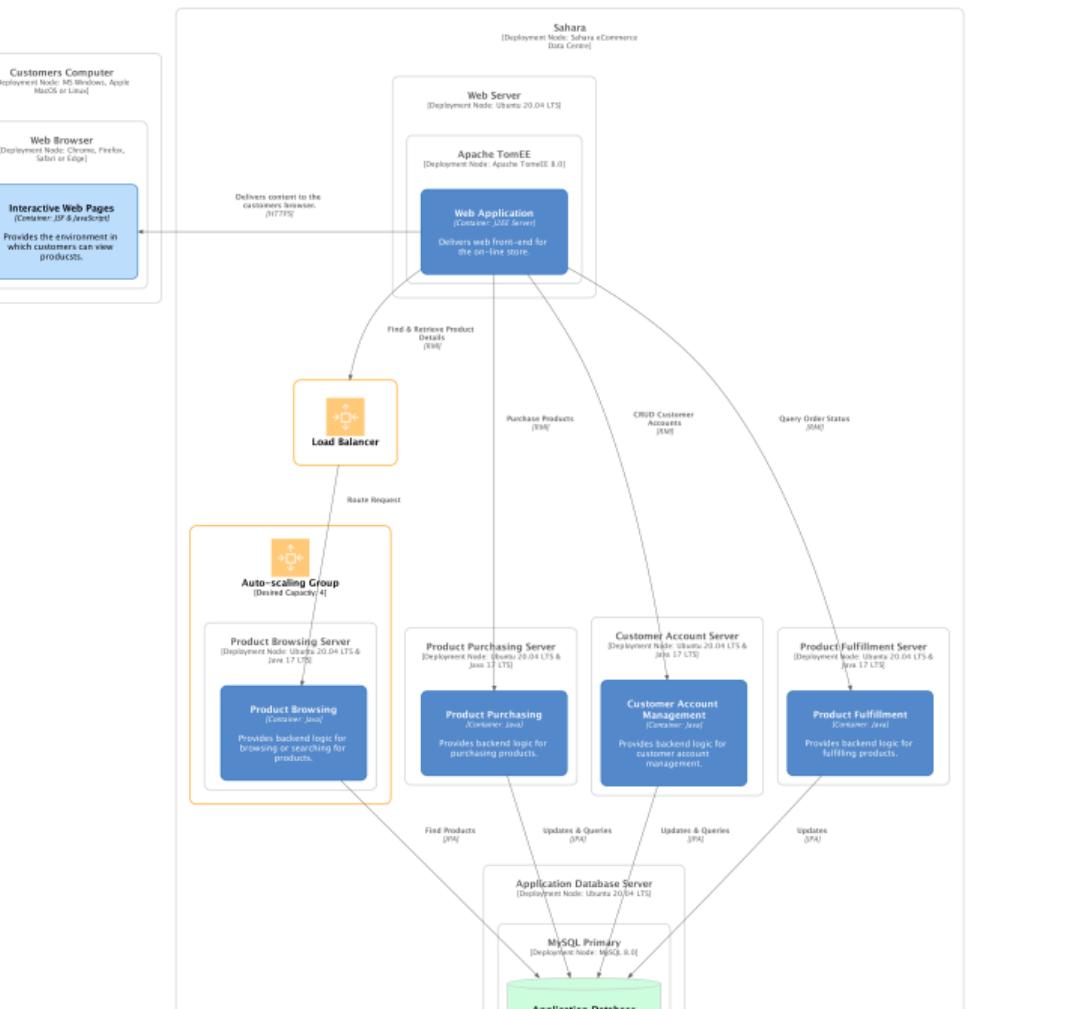
Use an auto-scaling group to replicate the service



## What's the problem?



Traffic was all sent through the one instance, load balancer routes to all



## In Summary

Simplicity

Reliability

Scalability

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

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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*.

*database is a bottle-neck* is foreshadowing