

# Distributed Computing I

## *Software Architecture*

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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



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Let's revisit these attributes

Previously in CSSE6400...

Simplicity *For a distributed system*



This condition is doing a lot of work

Previously in CSSE6400...

Simplicity



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

## *§ Fallacies*

*Question*

What is a *fallacy*?

*Definition 1.* Fallacy

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

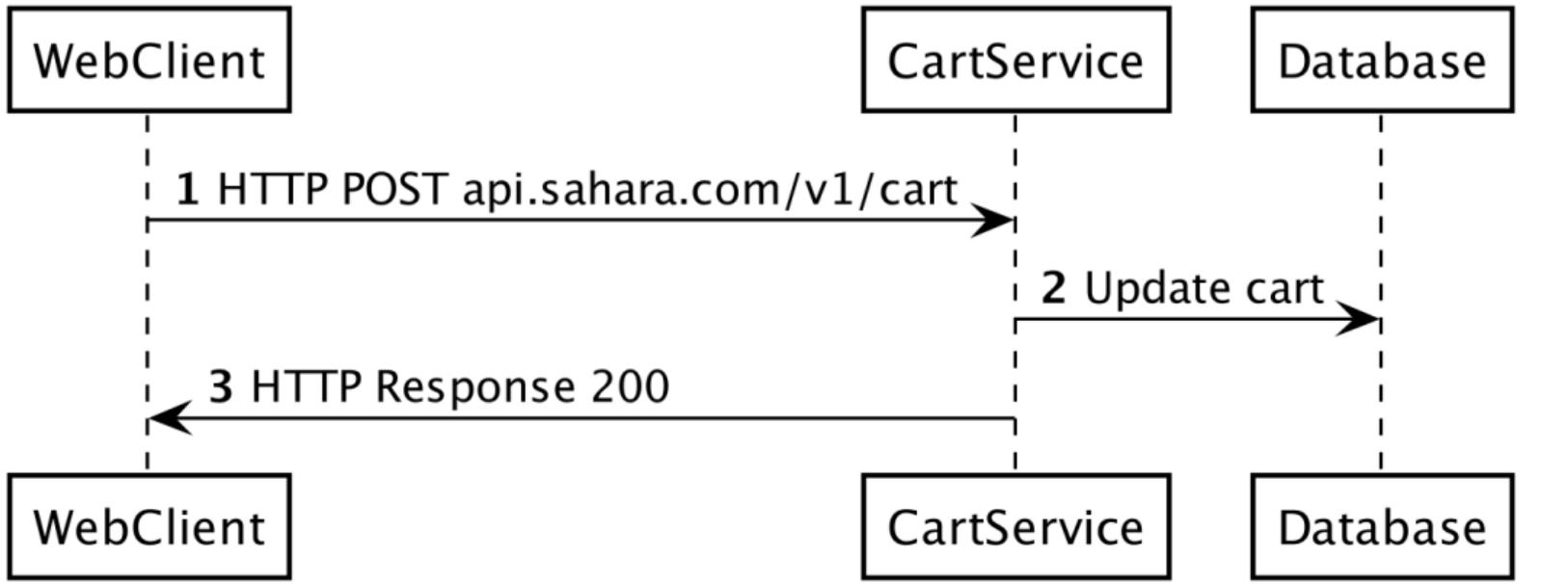
*A few reasons for complexity*

## The Fallacies of *Distributed Computing*

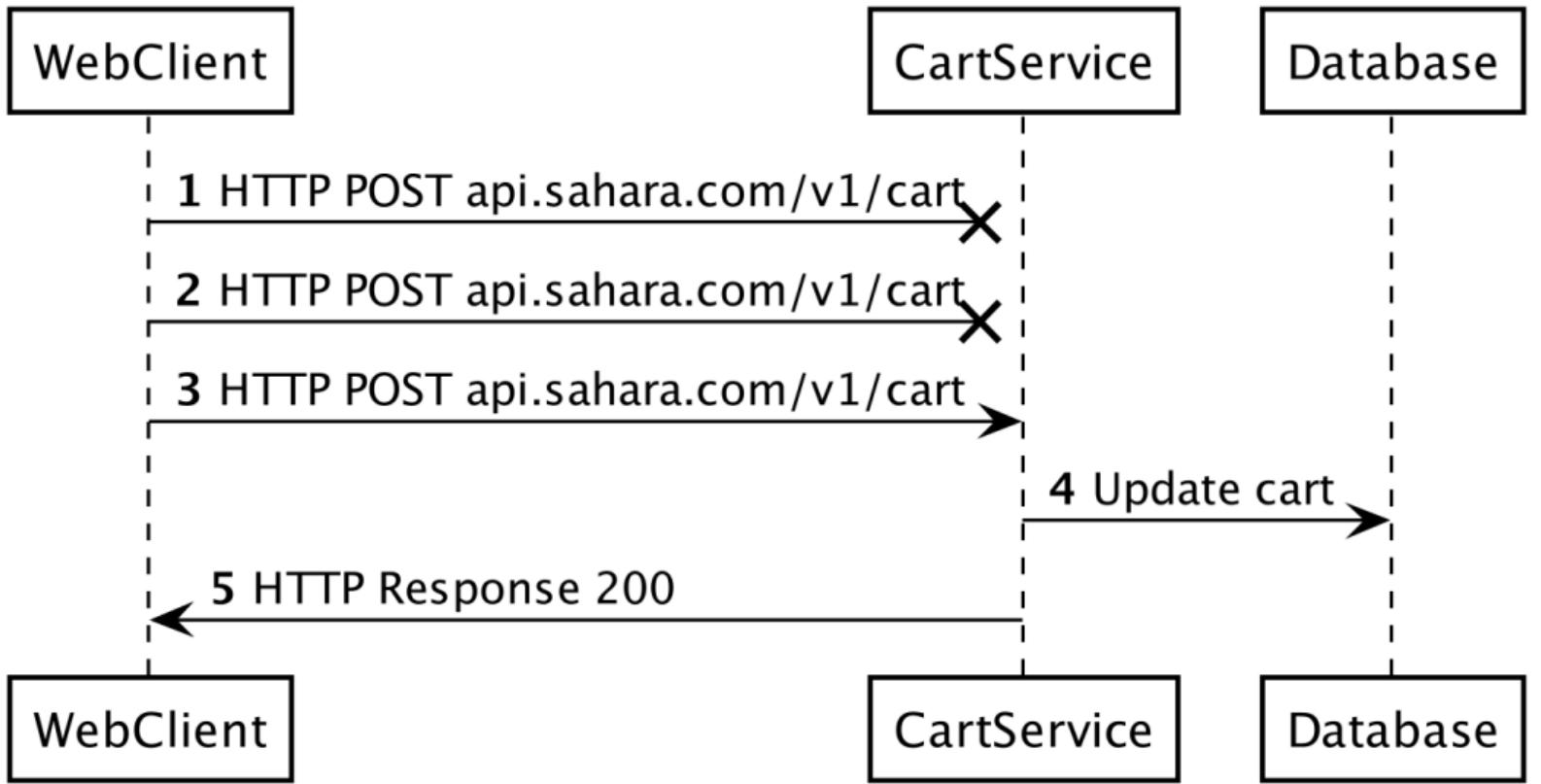
Sun Microsystems in 1994, primarily accredited to Peter Deutsch  
(doy-ch)

*Fallacy #1*

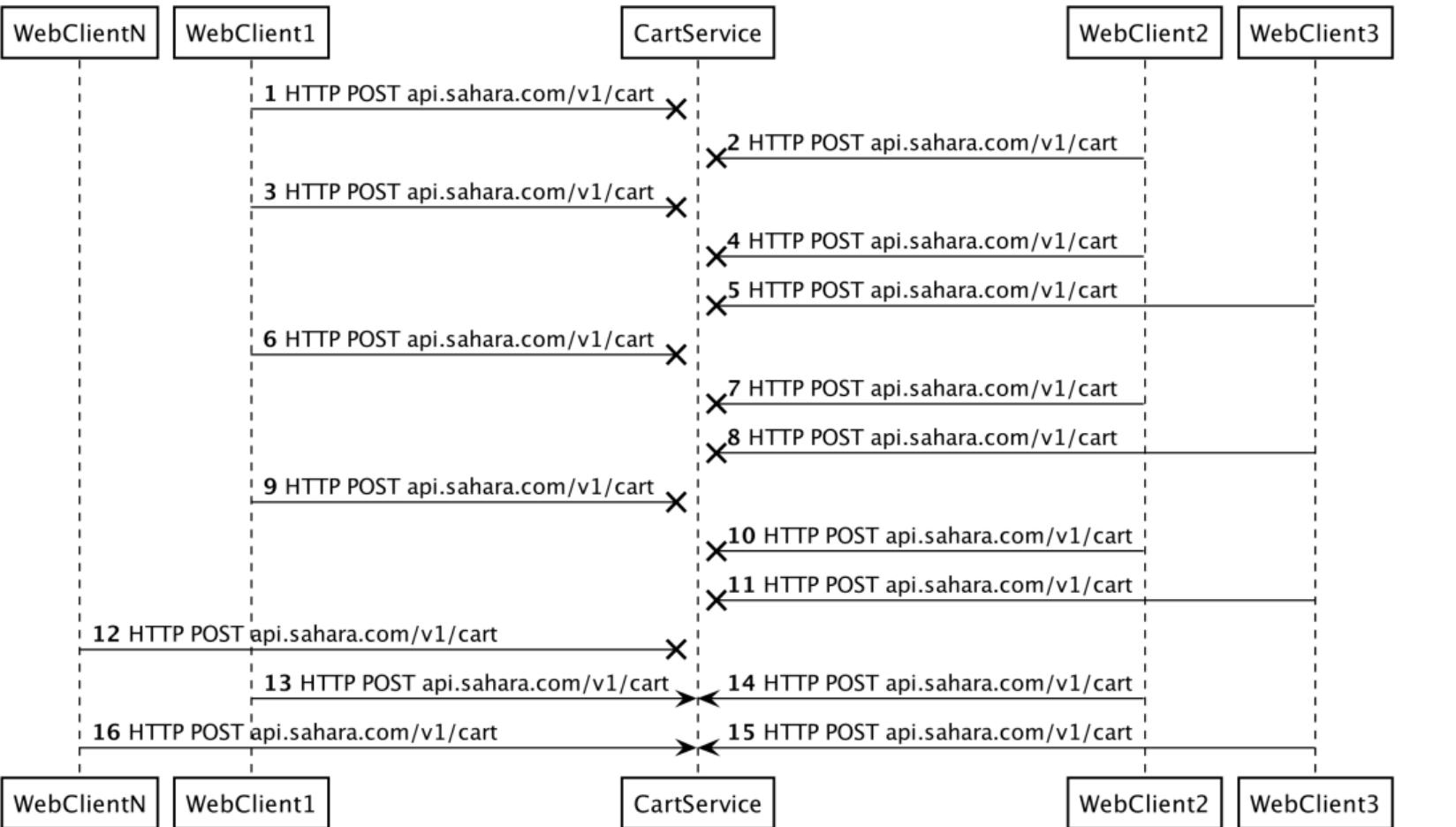
The network is reliable







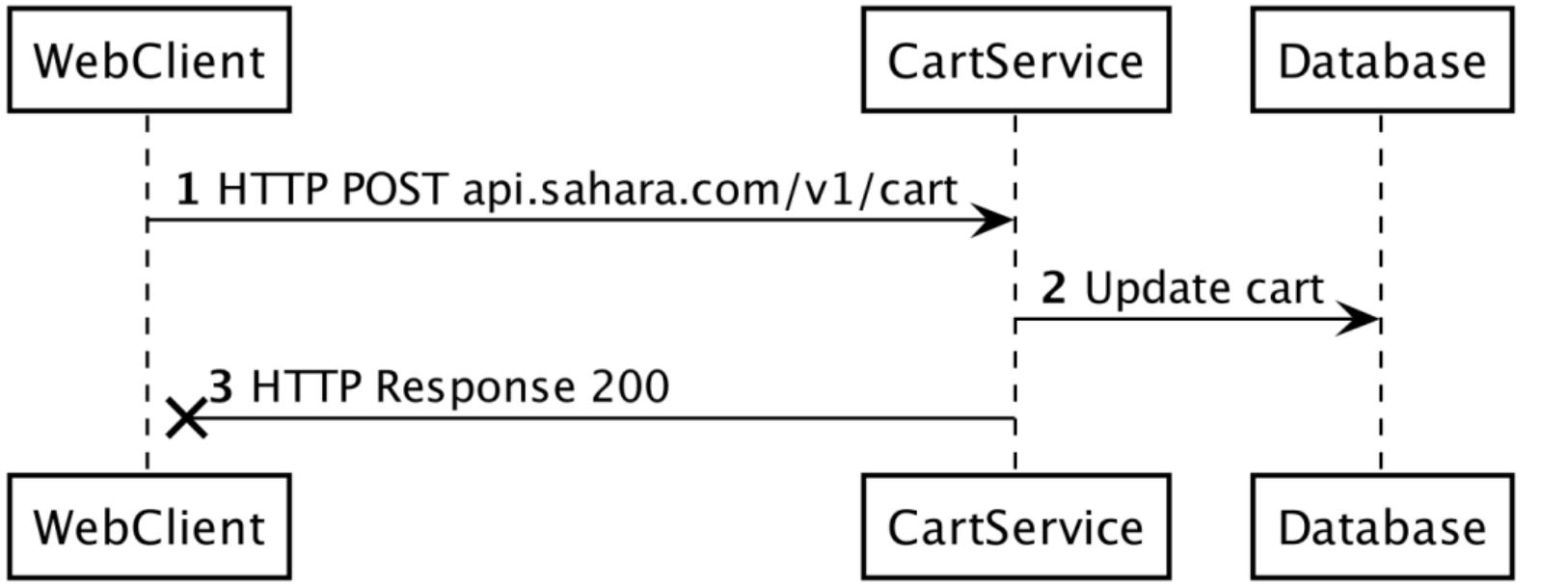
Solve it by resending it

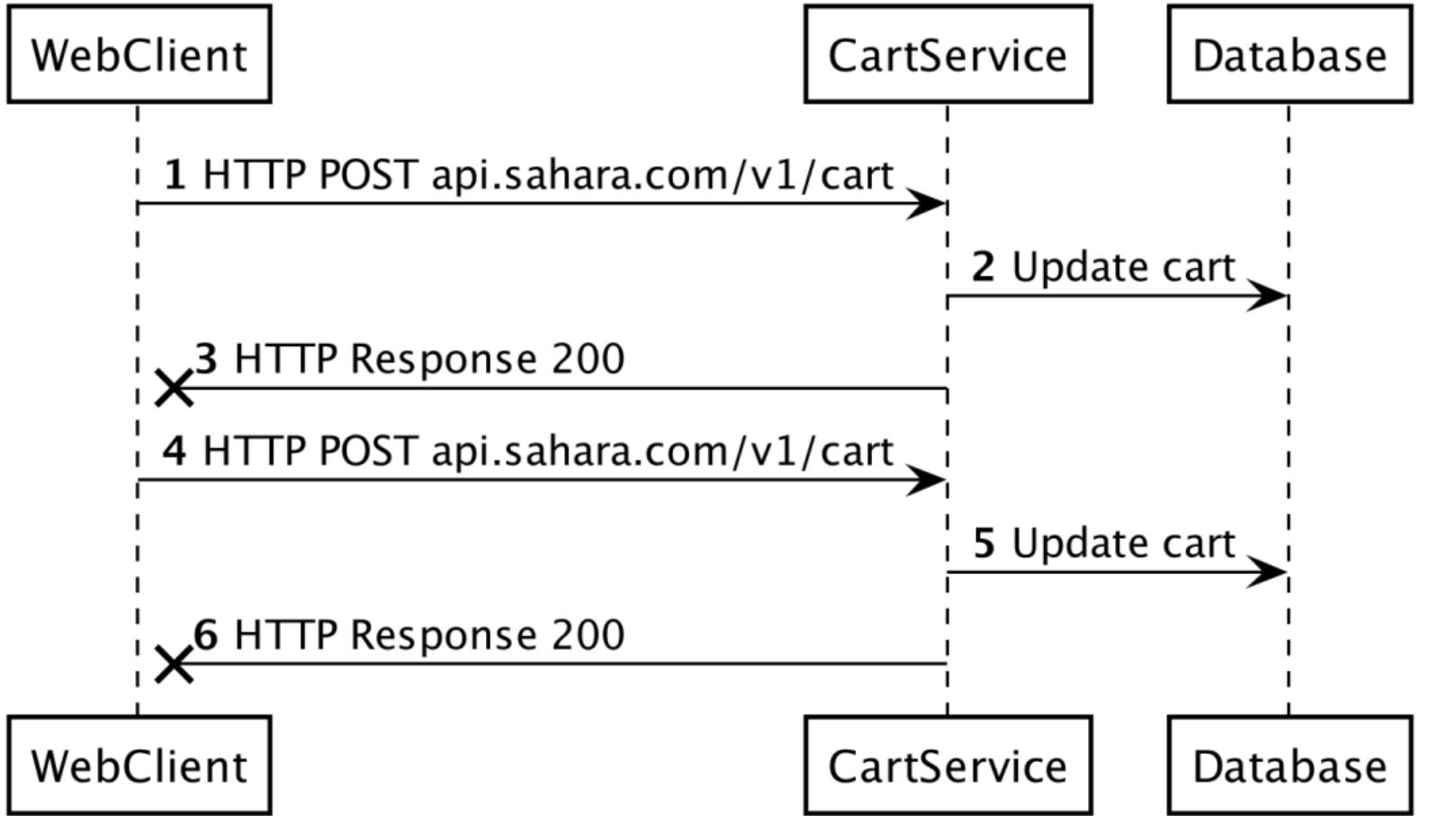


If the service goes down and all clients are re-trying, the service is in for a shock when it comes back, we solve this with *exponential backoff*

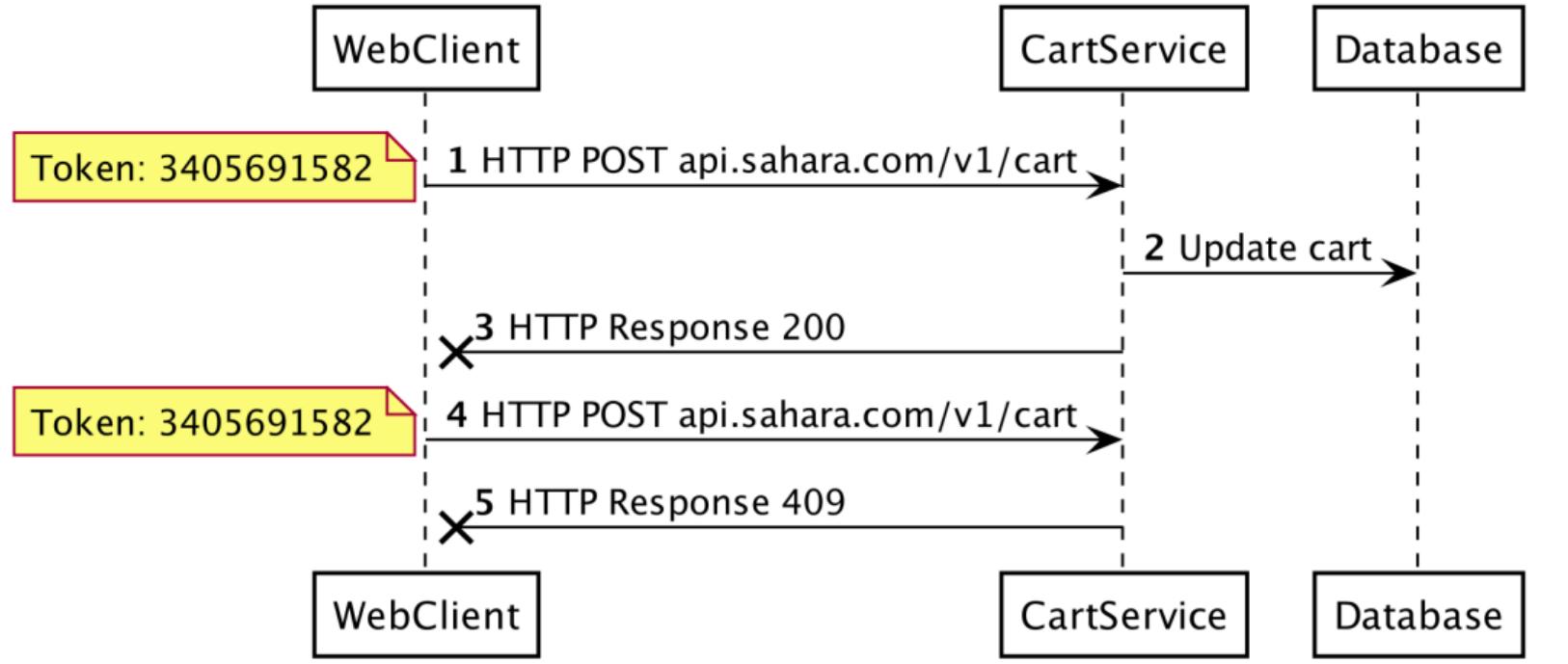
## Exponential backoff

```
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_RETRIES)
```





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 then local call.

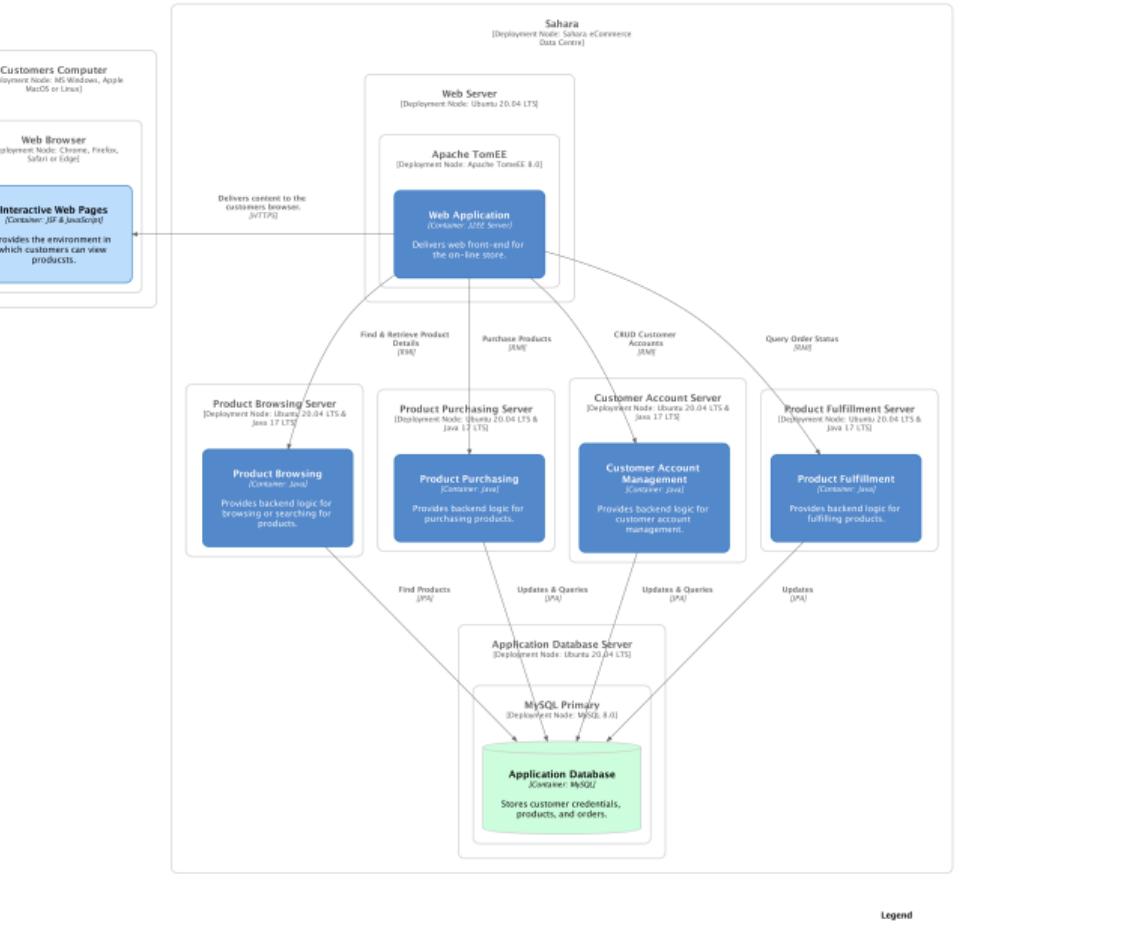
*Fallacy #3*

Bandwidth is infinite

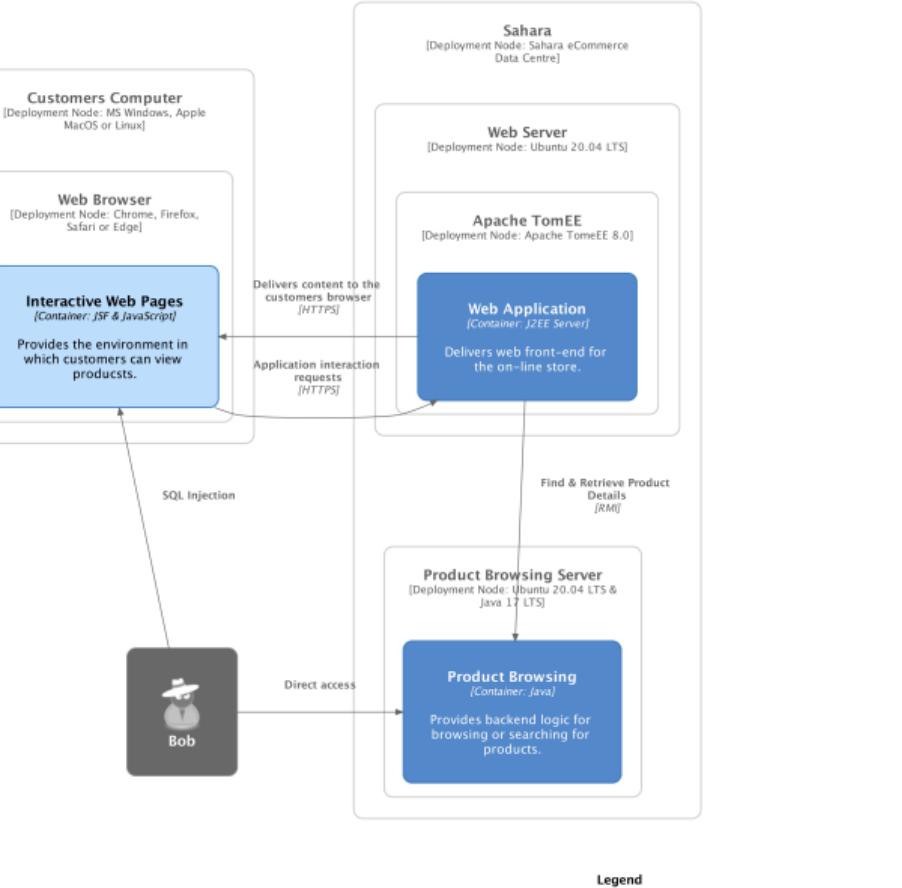
Similar to previous fallacy, be mindful, distributed calls clog up network.

*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*

- Deployments are banned on the weekend.

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- Deployments are banned on the weekend.
  - Sunday night users start complaining.
  - There have been no deployments since Friday.
  - You can still access the system.
  - Who do you talk to?
- Things spontaneously break. Who can help you?

*Fallacy #7*

Transport cost is zero

*Remember*

Distributed systems are *hard*.

*Remember*

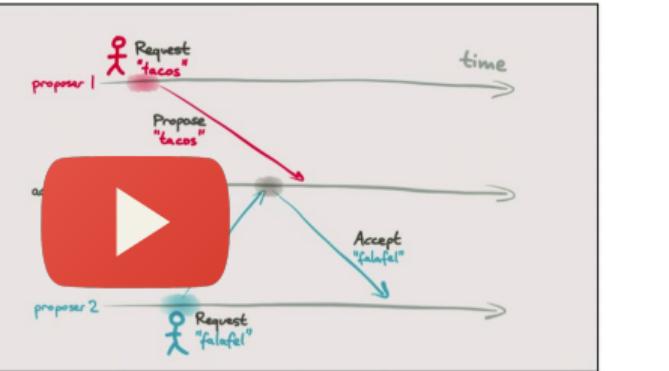
Distributed systems are often *not your friend*.

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

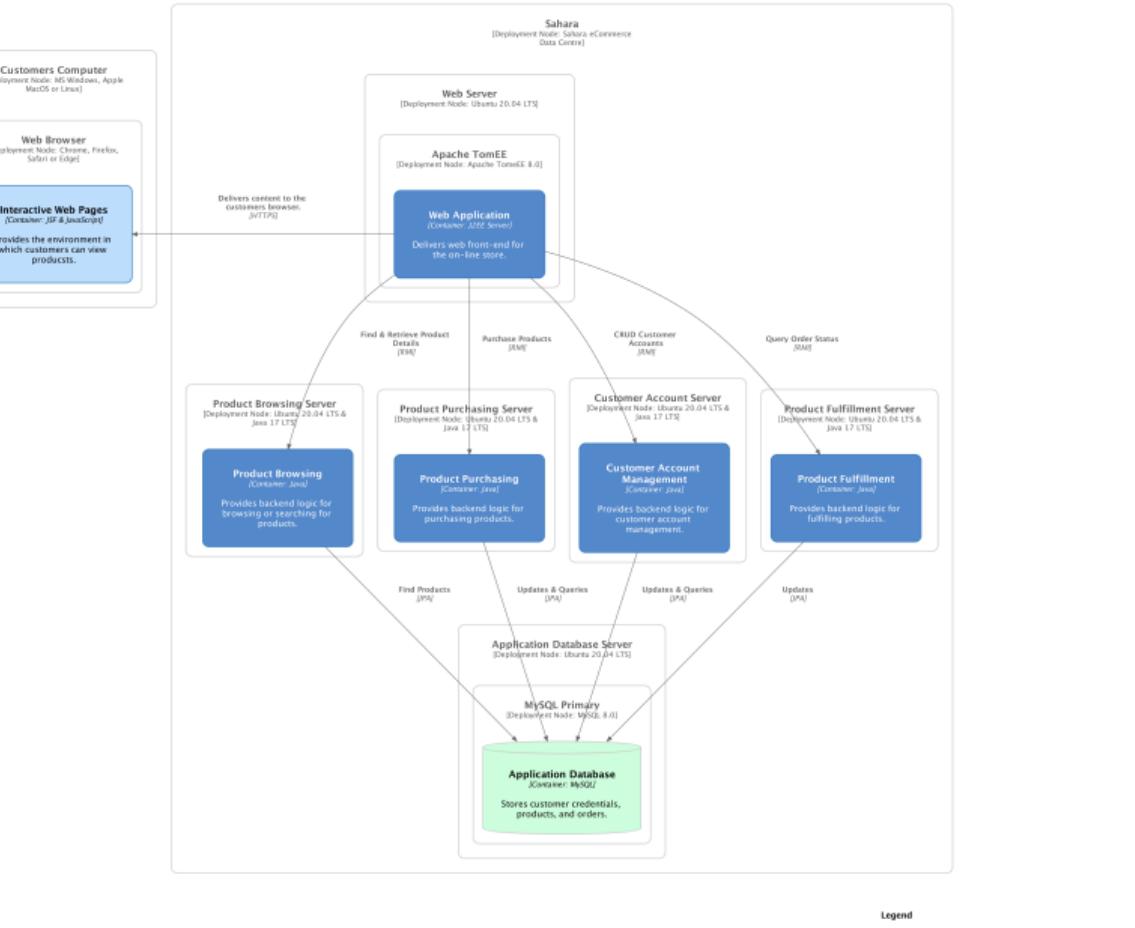
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Of course, there are other reasons you might want run software on multiple computers.



- 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*

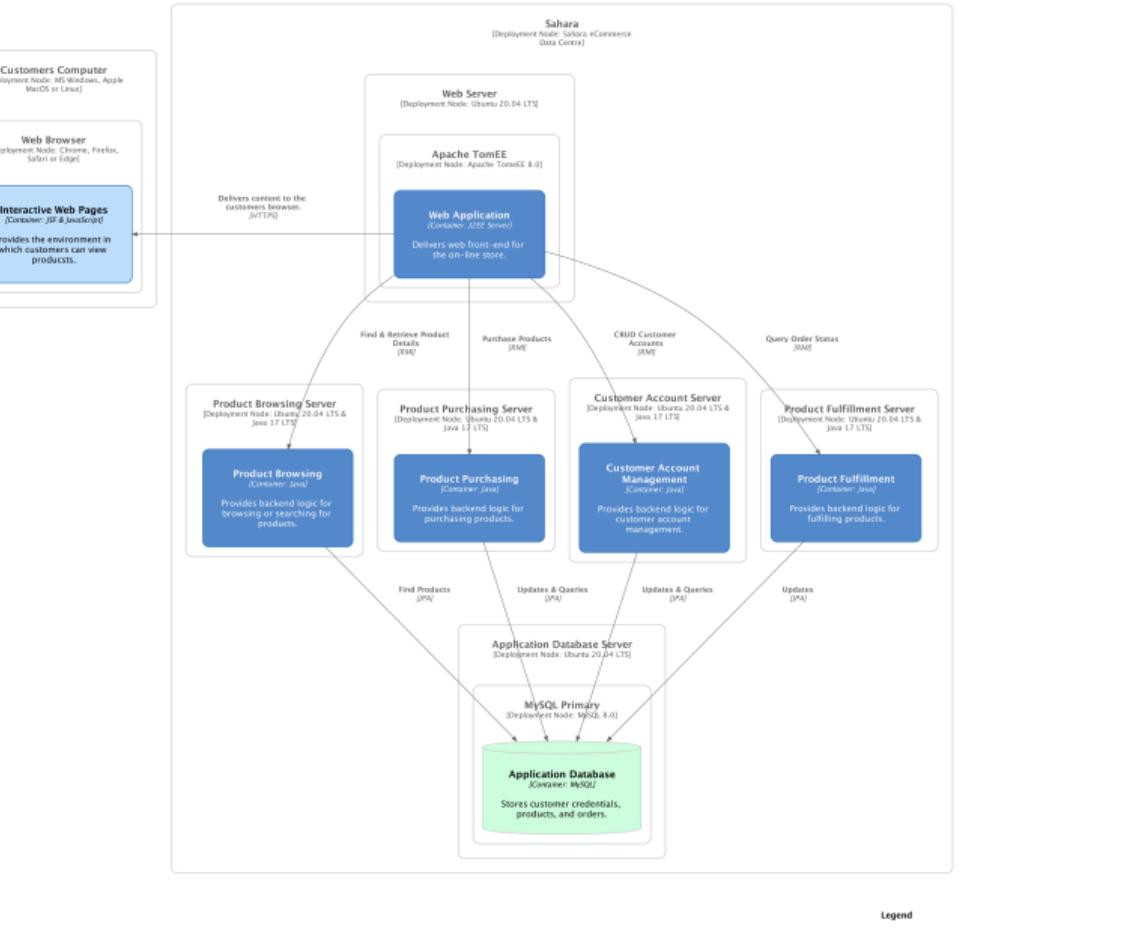
Desired Capacity Amount of *healthy* instances we want to have in an auto-scaling group.

### *Health check*

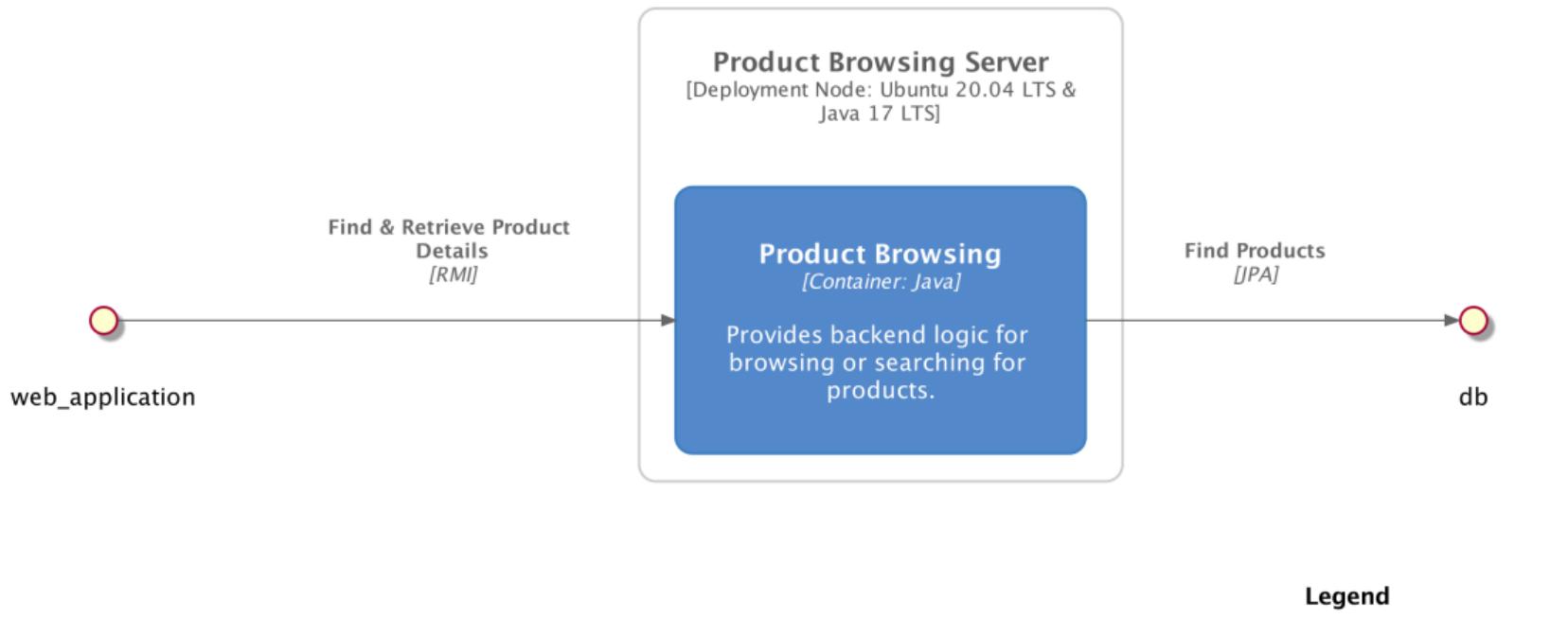
User defined method to determine whether an instance is *healthy*.

## *Auto-scaling*

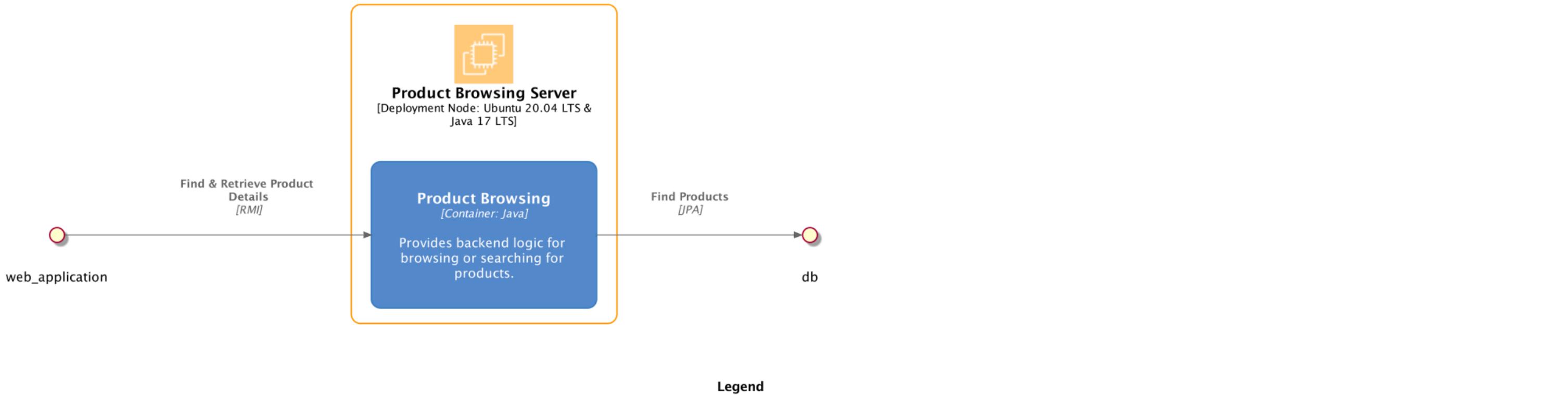
An example

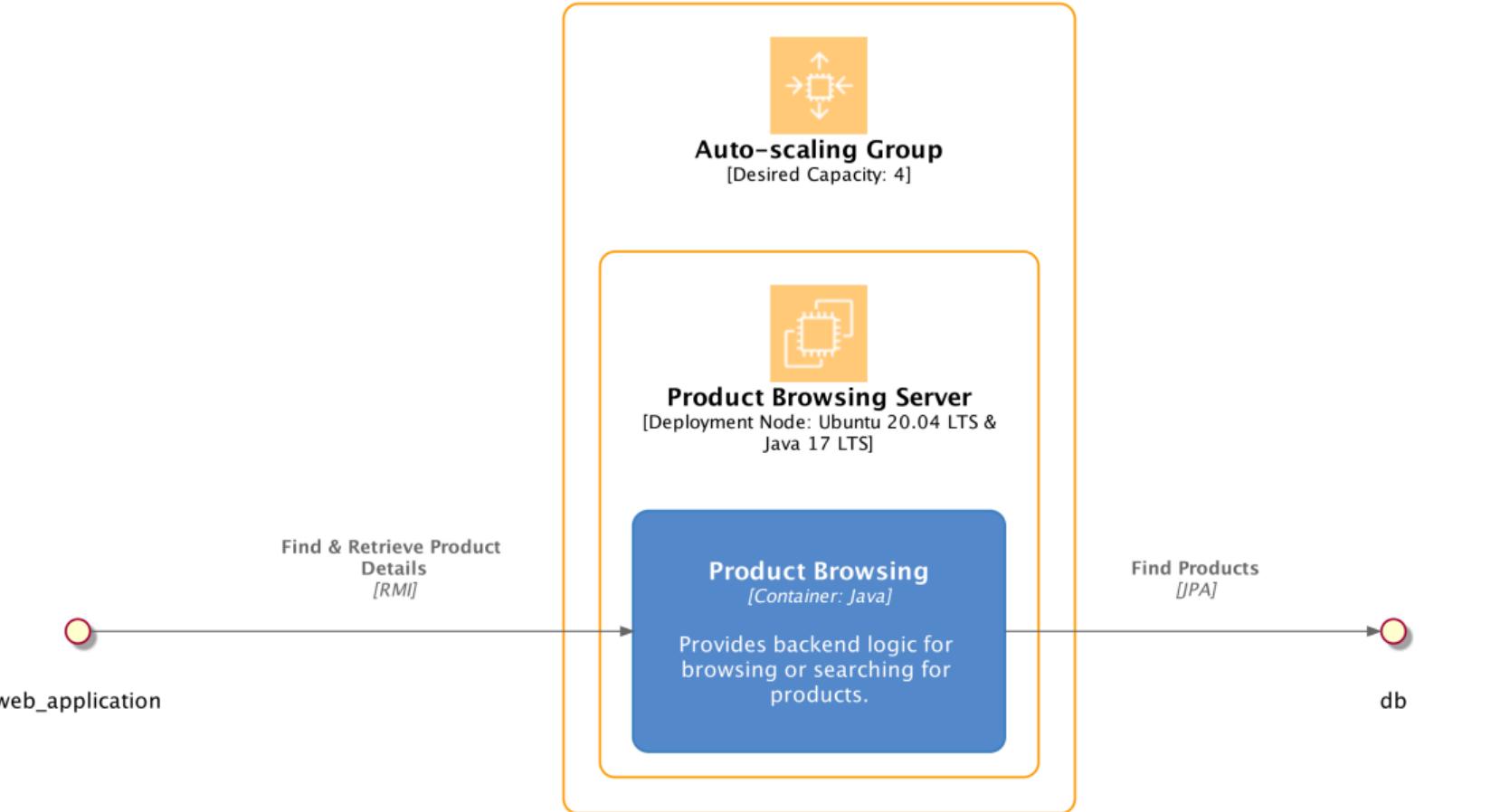


Product service keeps going down

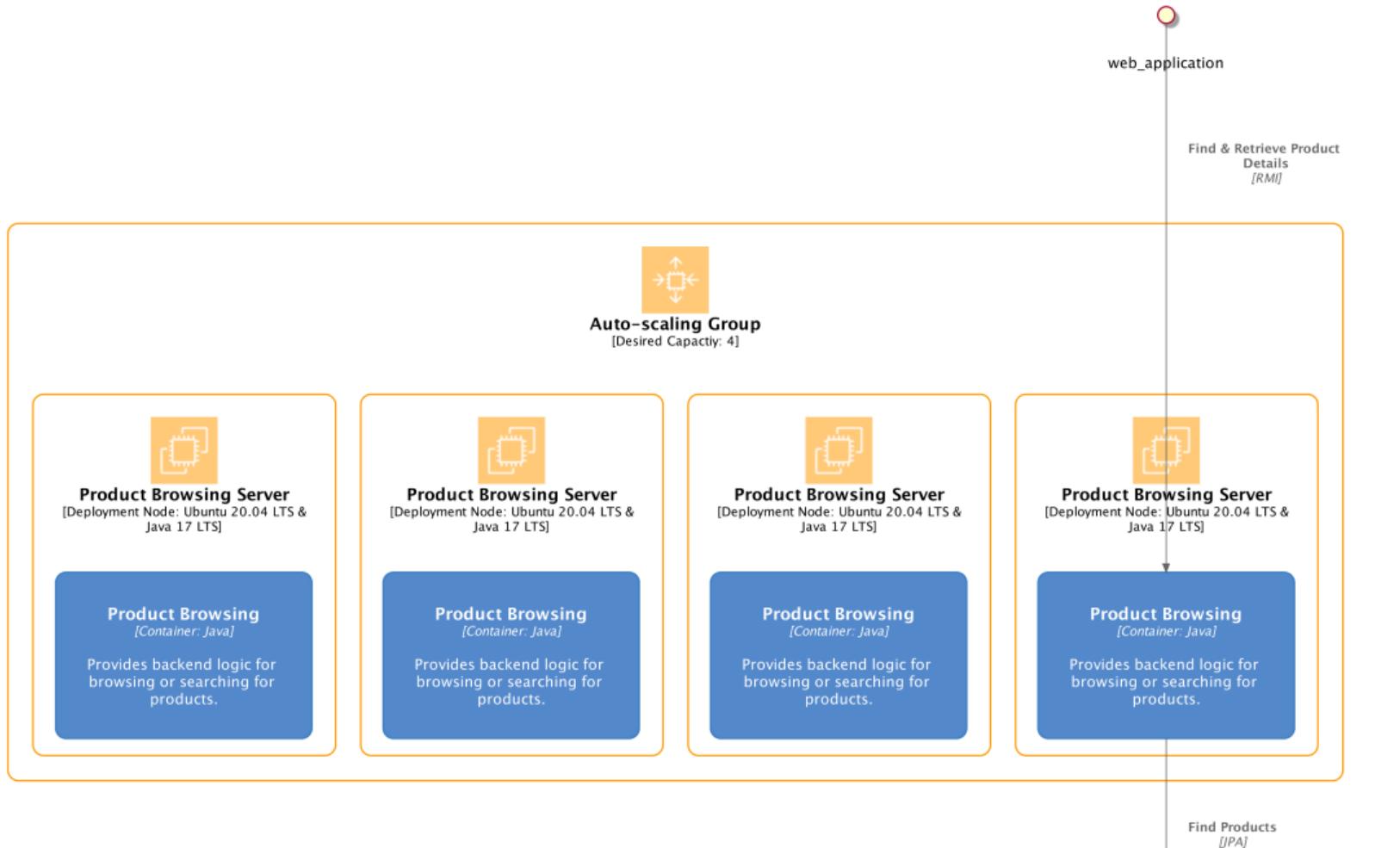


We might expect product service to have a much higher load than other services

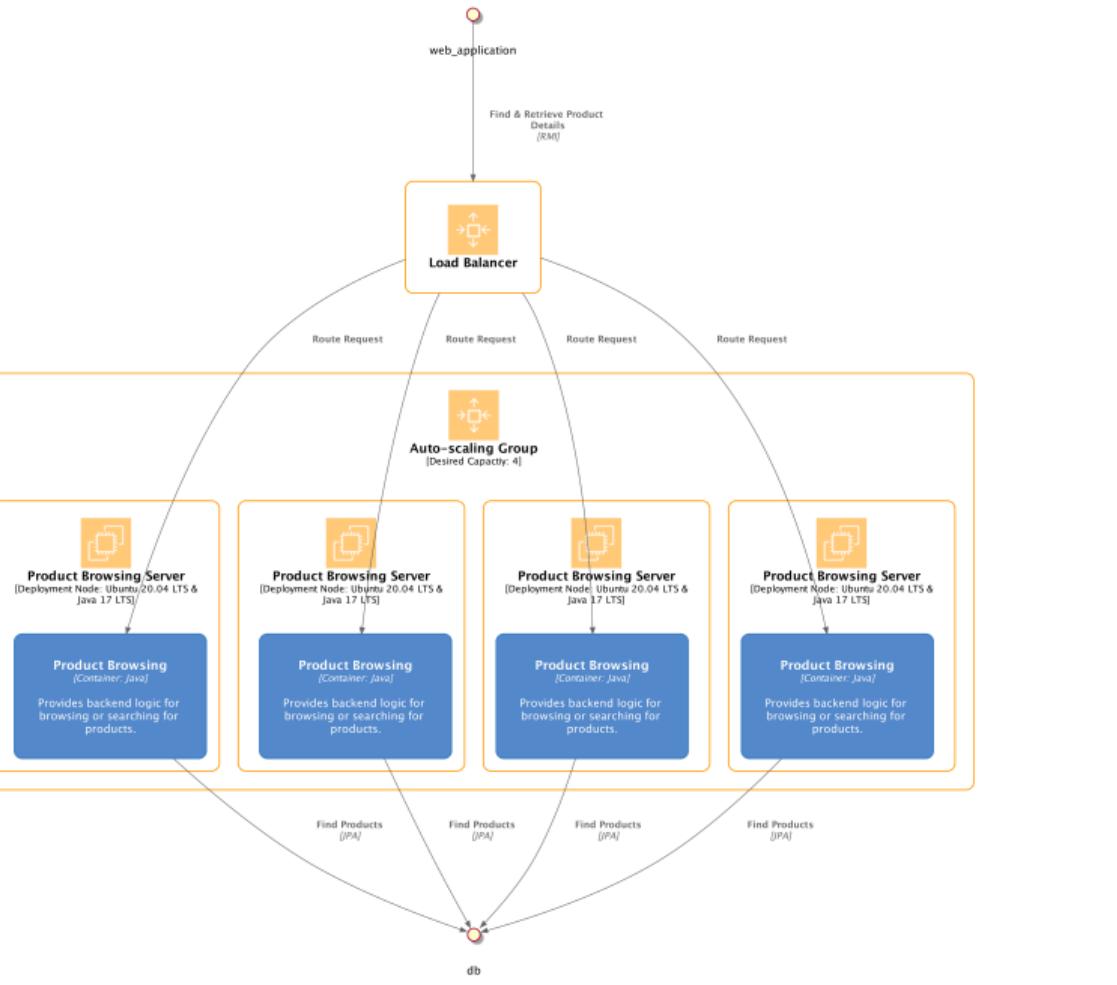




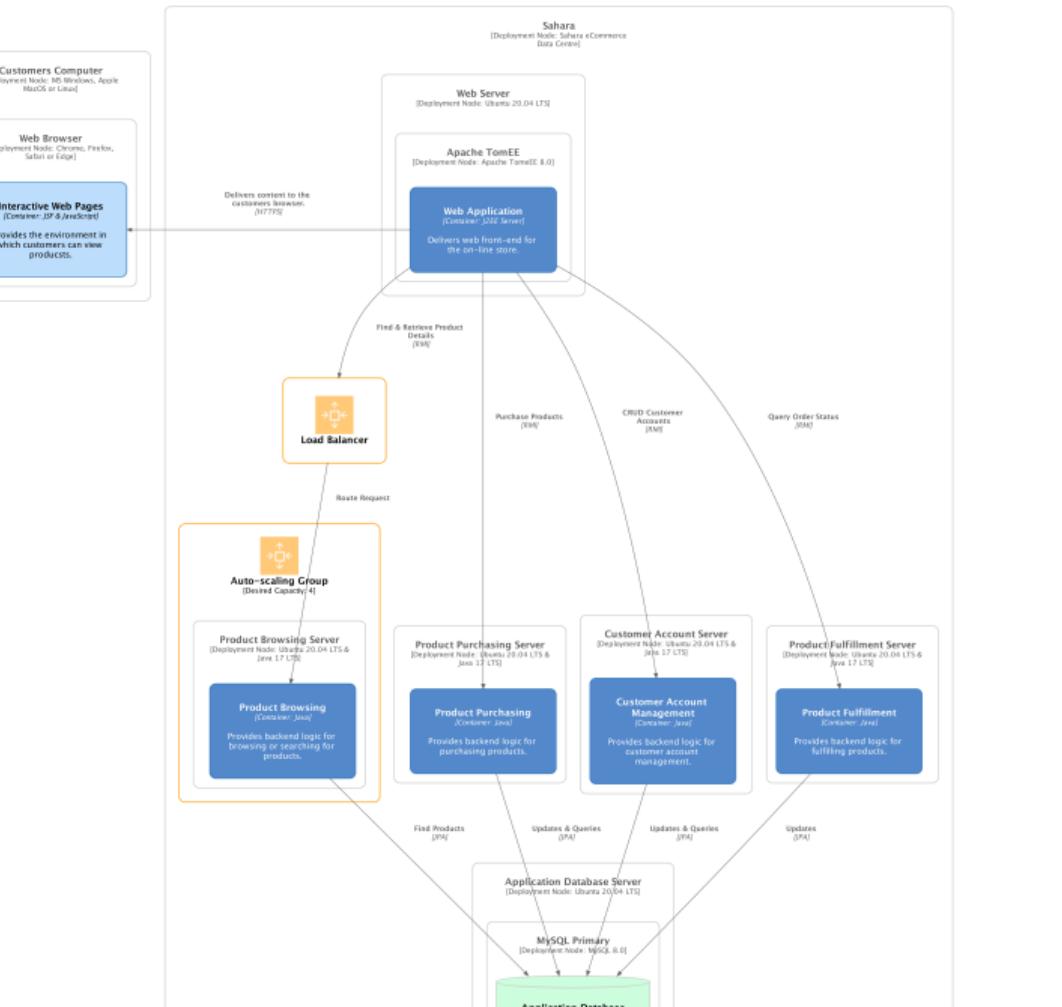
Use an auto-scaling group to replicate the service



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