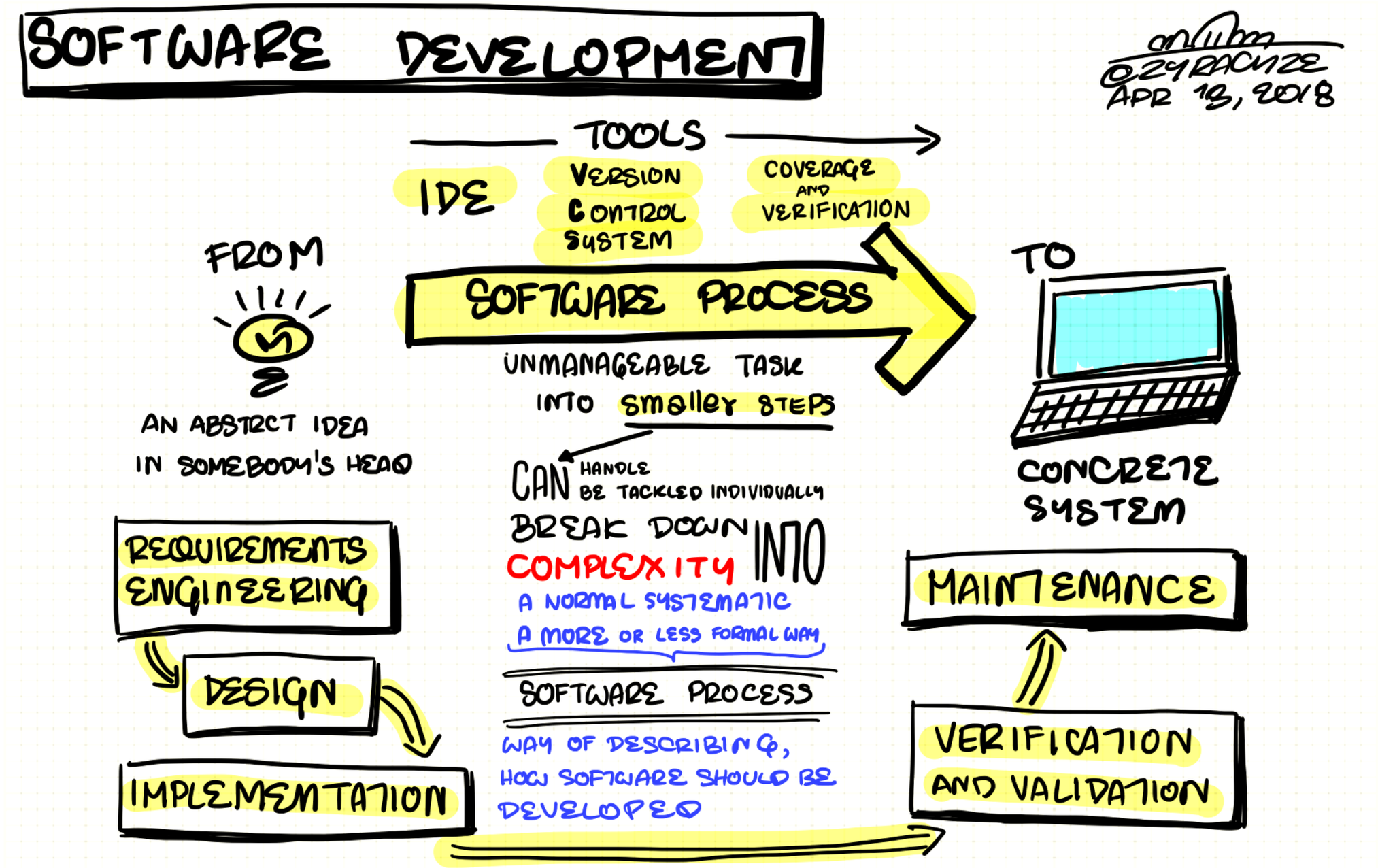
สยามชำนาญกิจ
SIAM CHAMNAN KIT

# Performance Testing


# Performance testing

# Software Development Life Cycle

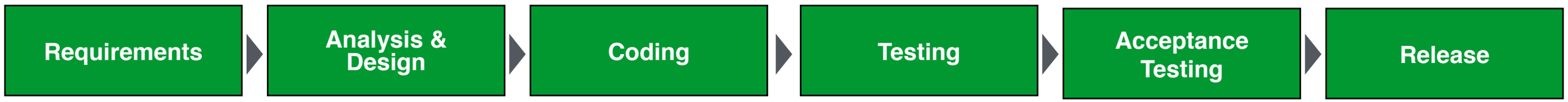



FROM : SOFTWARE DEVELOPMENT PROCESS - UDACITY

Silo with poor communication and collaboration

Requirements change

Don’t understand business domain and requirements

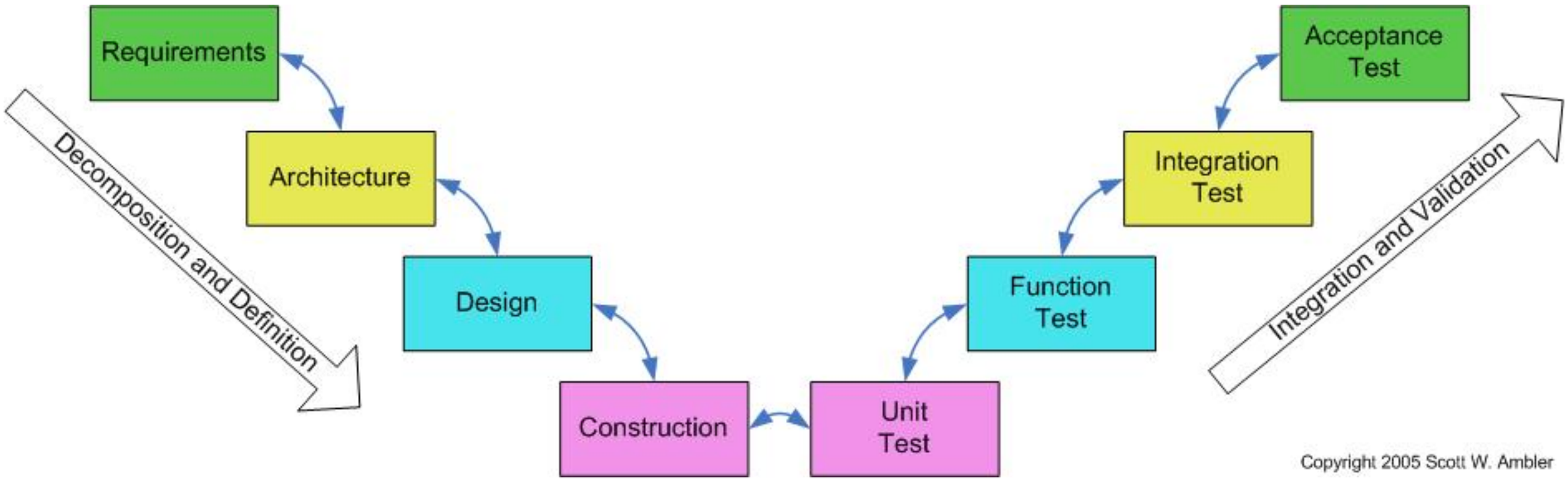



Testing at the end

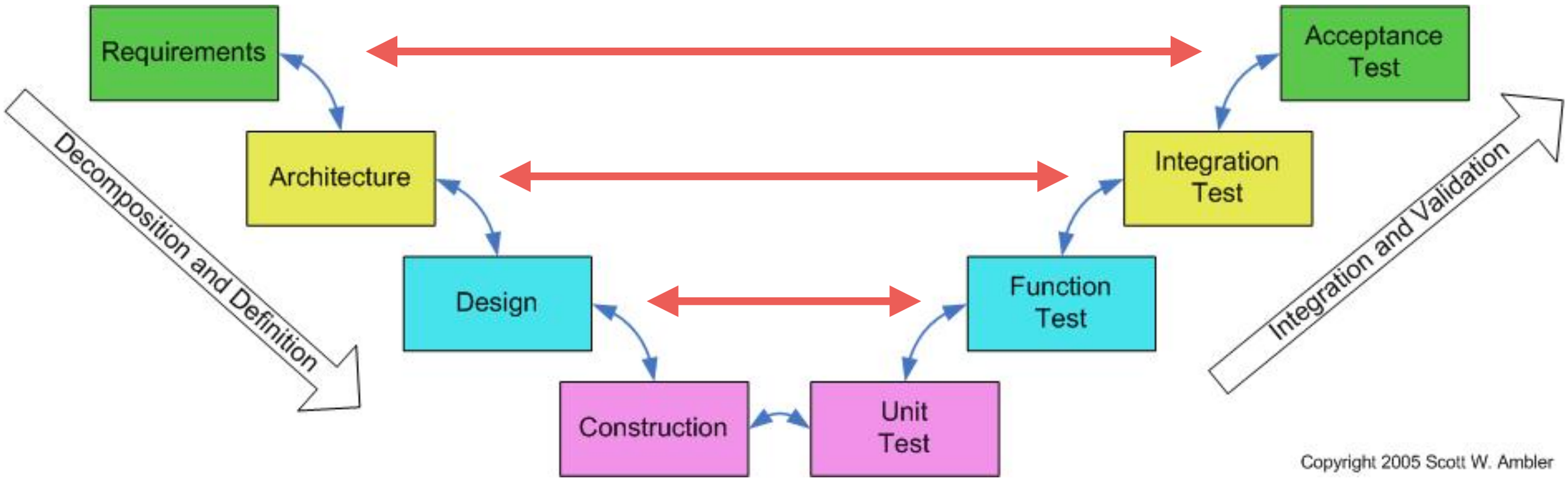
Tester don’t involved early

Only tester take responsibility

# V Model

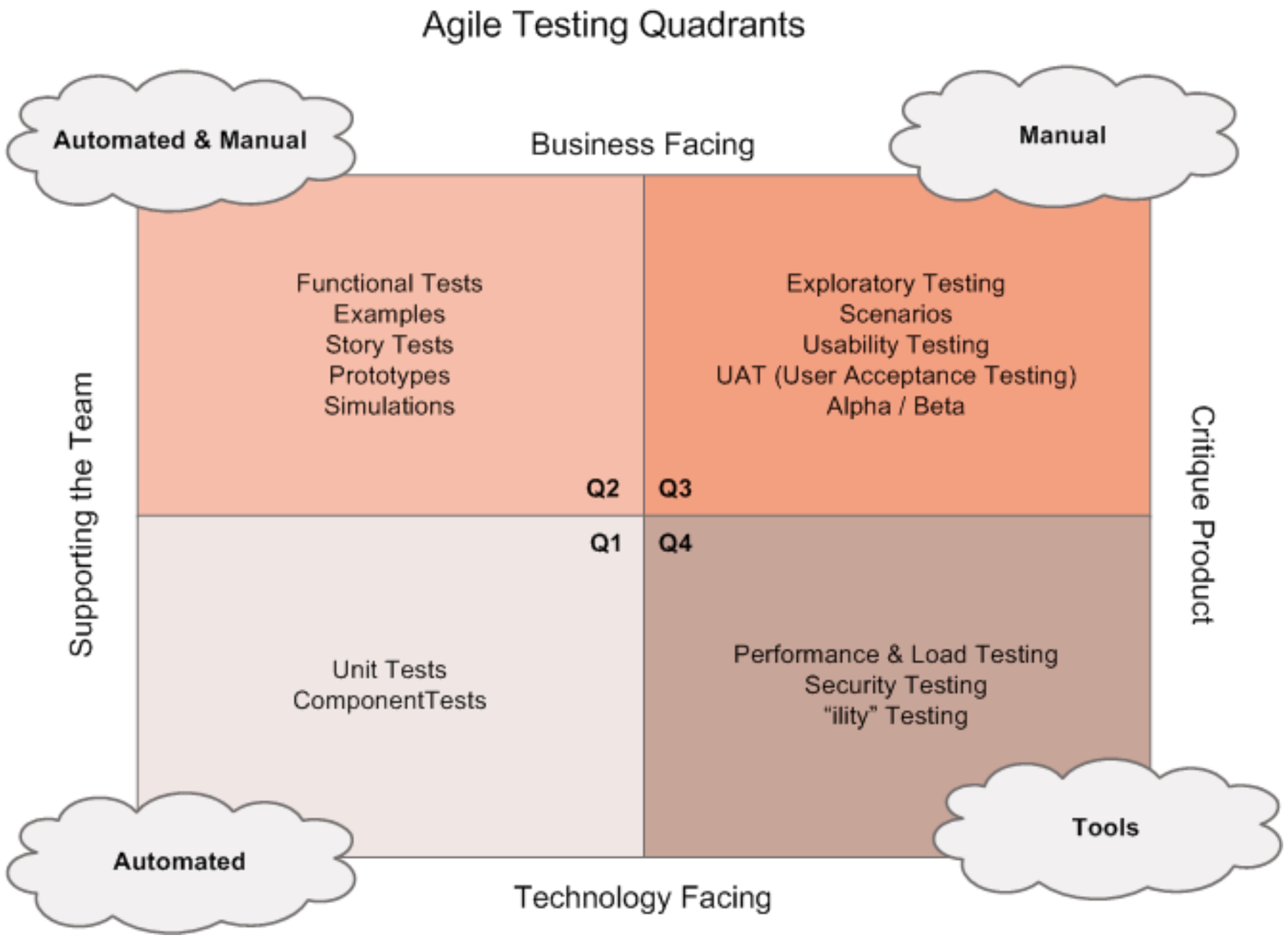


# V Model

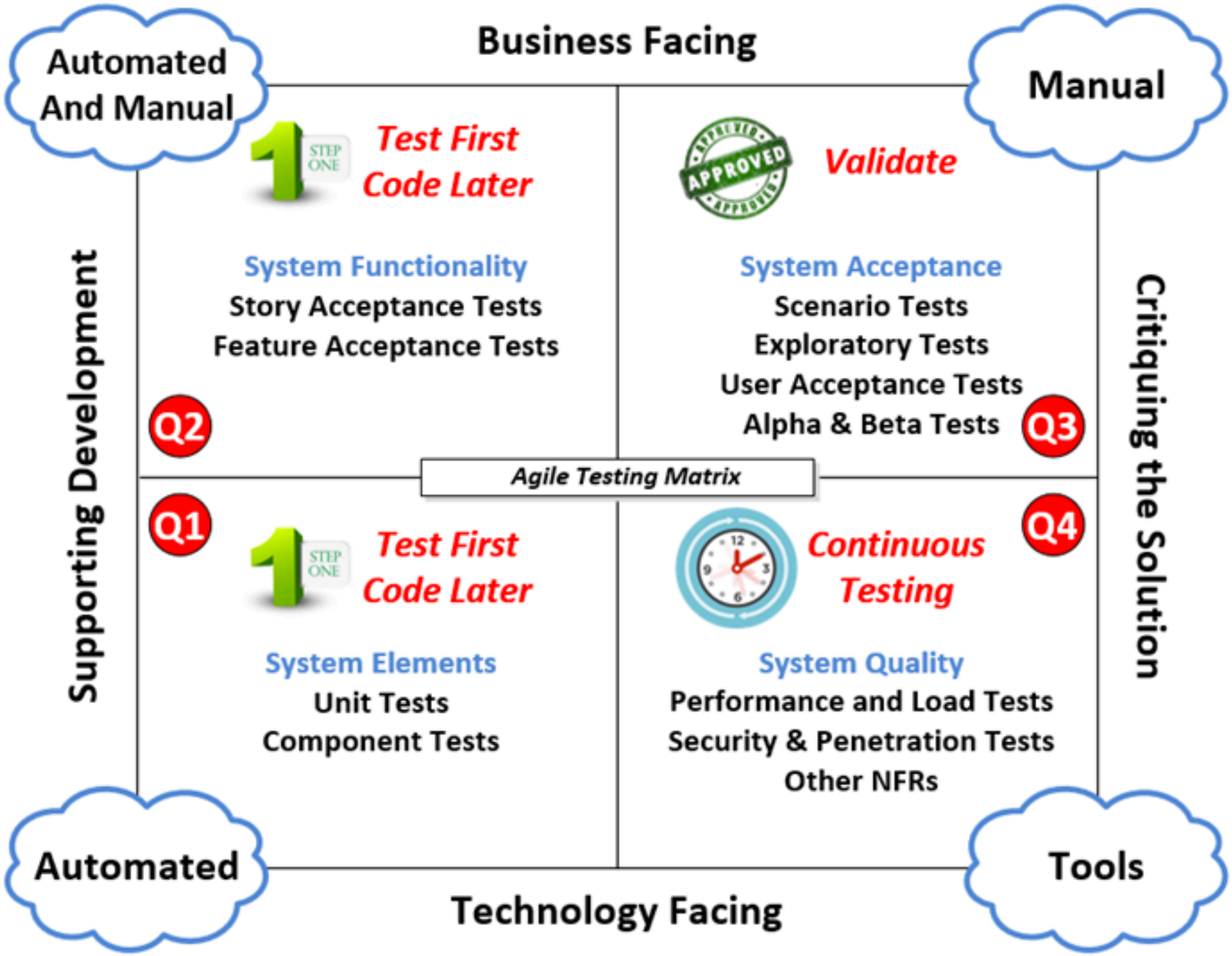


# Types of testing

# Agile Testing Quadrant



# Agile Testing Quadrant



# When performance testing ?

# At the end !!

# Before release !!

# Simplify testing and start early

# When performance testing ?

Design phase
Development phase
Deployment phase

# Why do performance testing ?

# Questions ?

# Questions ?

How many end users will the application need to support at release ?

After 6 months, 12 months, 2 years ?

# Questions ?

Where will these users be located, and how will they connect to the application?

# Questions ?

How many of these users will be concurrent at release?

After 6 months, 12 months, 2 years ?

# Lead to more questions

# Questions ?

How many and what specification of servers will I need for each application tier ?

# Questions ?

Where should these servers be hosted ?

# Questions ?

What sort of network infrastructure do I need to provide ?

# Think about
# Capacity and scalability

# Impact on Performance and Availability

# Non Functional Requirements (NFRs)

# Essential for NFRs (1)

Designing an appropriate **performance test environment**

Setting realistic and appropriate **performance targets**

Identifying and scripting the **business-critical use cases**

# Essential for NFRs (2)

Providing **test data**

Creating a **load model**

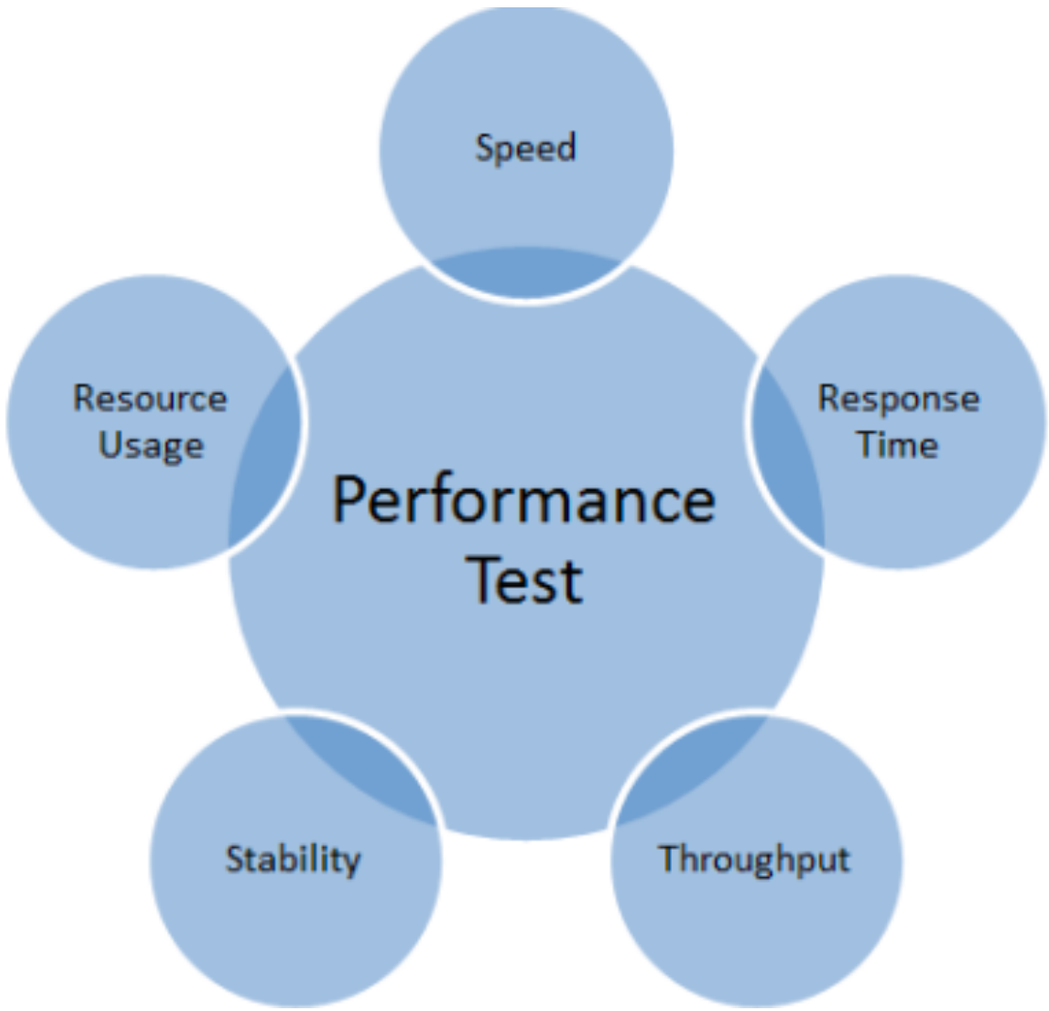
Ensuring accurate performance test design

Identifying the **KPIs**

# Fast is better

# Why do performance testing ?

Stability
Responsiveness



# Stability ?

No response
Incomplete response
Inconsistent experience
User may never come back !!

# Responsiveness ?

User get frustrated
Negative feelings about system
Users may leave

# Summary

Identify problems early
Reduce development cycle
Produce better quality system
Produce better scalable system
Prevent revenue and creditability loss
Enable planing for the future

# Summary

Ensure the system meets performance expectation

Expose more bugs (memory leak, CPU)

# Cost and benefits of Performance testing

# Costs ?

Test creation time
Resources to run tests
Users may leave

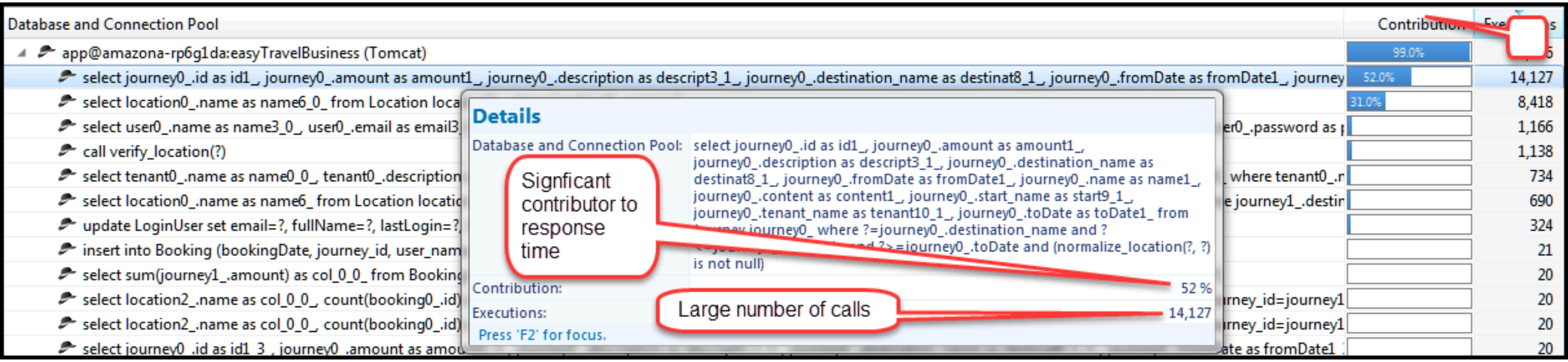
# Benefits ?

Found issues early (not in production)
Impact of issues

# Make sure app is ready

High data presentation
Poorly performing SQL
Large number of app network round-trips
Undetected app errors

# Example of the bad SQL



# Must allocate enough time to performance test

# Performance test time ?

Prepare test environment
Create load injectors
Identify and script of use cases
Identify and create test data
Unexpected problems

# What Performance testing ?

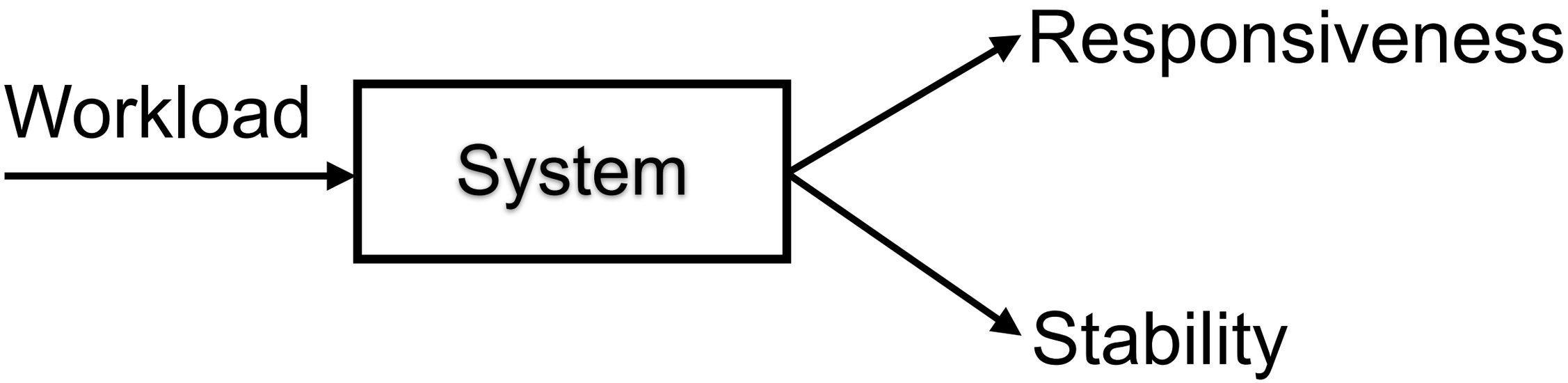
# What ?

"**Performance testing** is in general
a testing practice performed to determine how
a system performs in terms of **responsiveness**
and **stability** under a particular **workload**."

— Wikipedia —

# Performance testing

The way we load or stress the system



# Responsiveness ?

How **quickly** an application **responds** when asked to do something

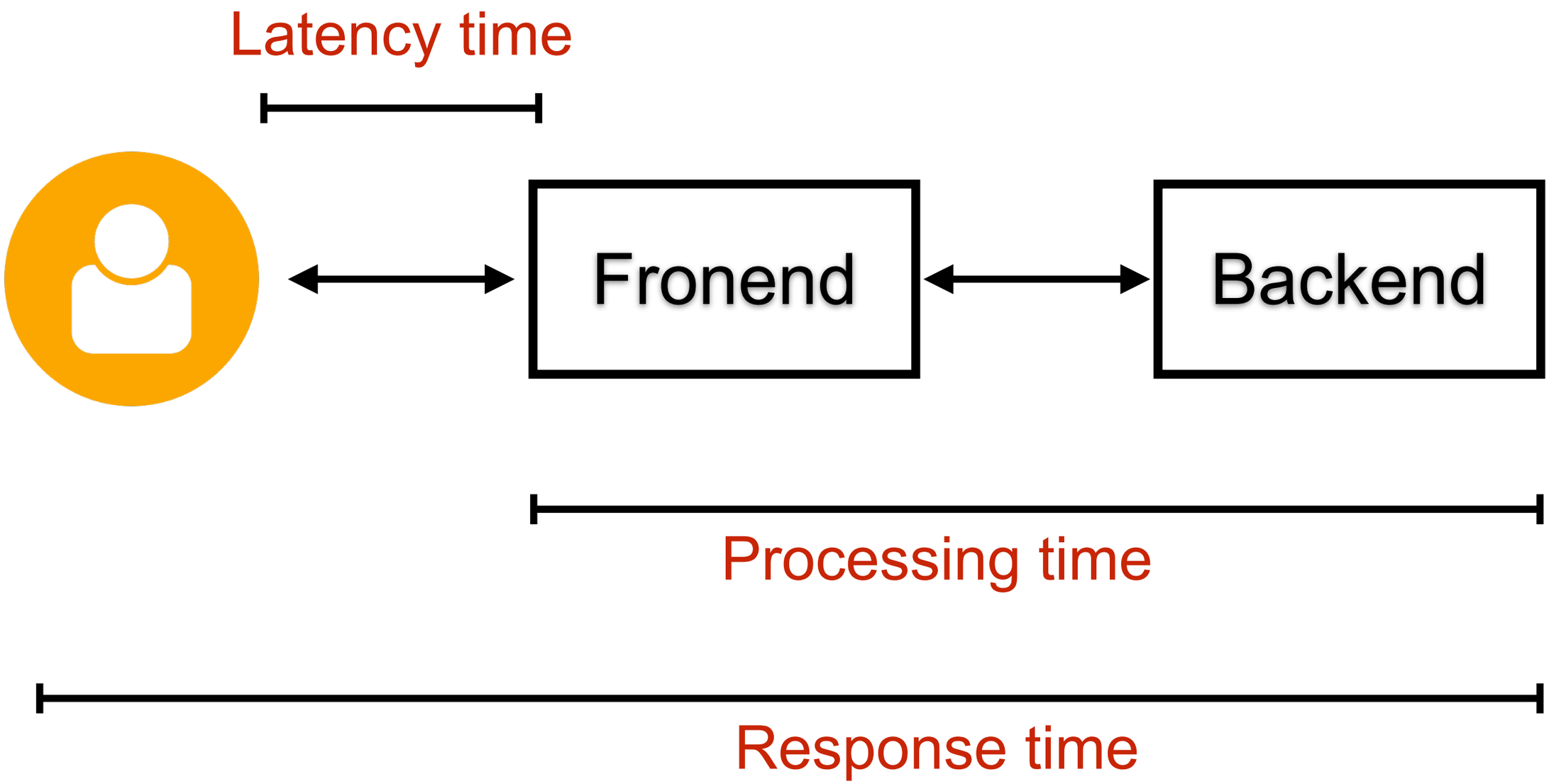
# Stability ?

How **consistent** or **reliable** the application is

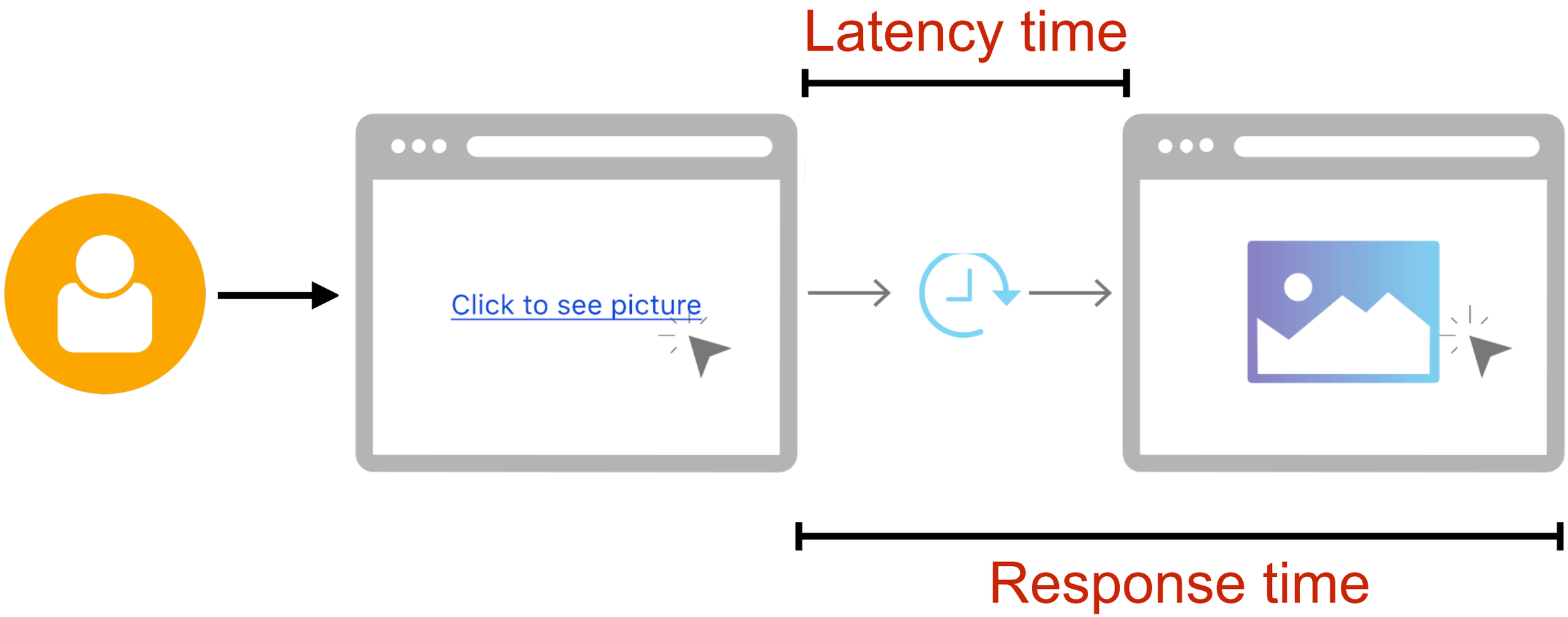
# Response metrics

Average response time
Peak response time
Error rate

# Latency vs Response time



# Latency vs Response time




Response time = Latency time + **Processing time**

# Response time

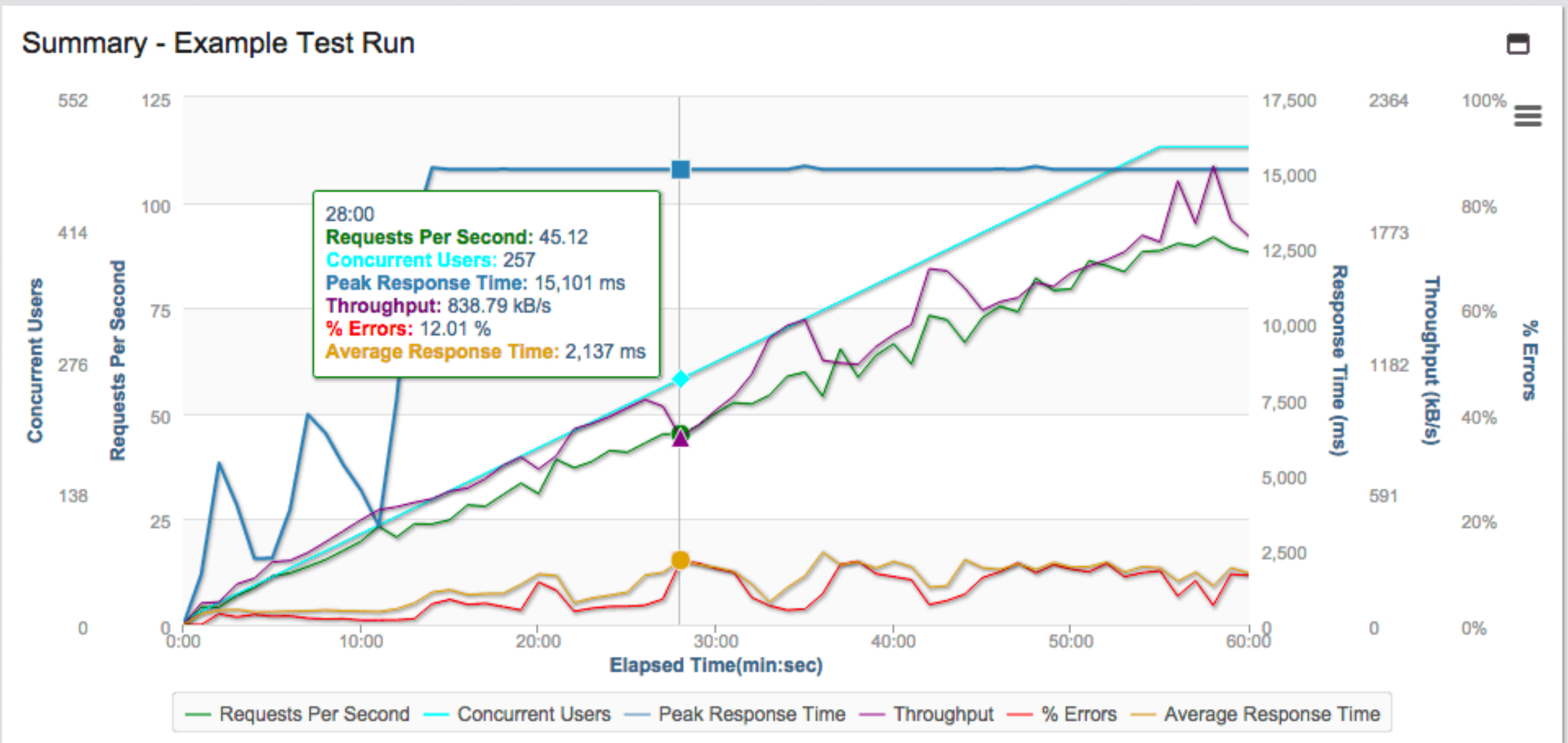
Time to First byte

Time to Last byte

# Volume measurements

Concurrent users
Requests per second
Throughput

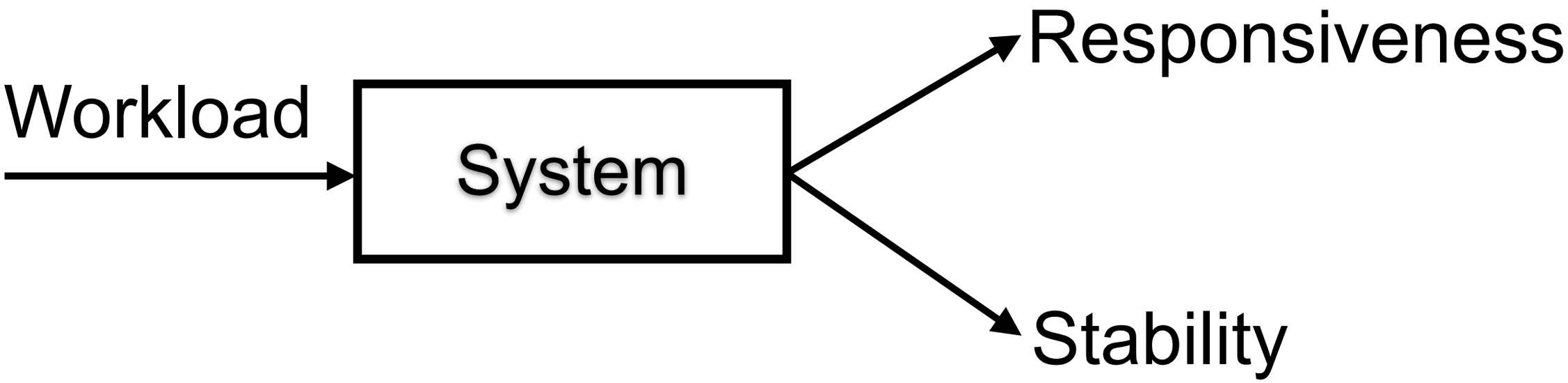
# Example



# Workload

# Workload ?

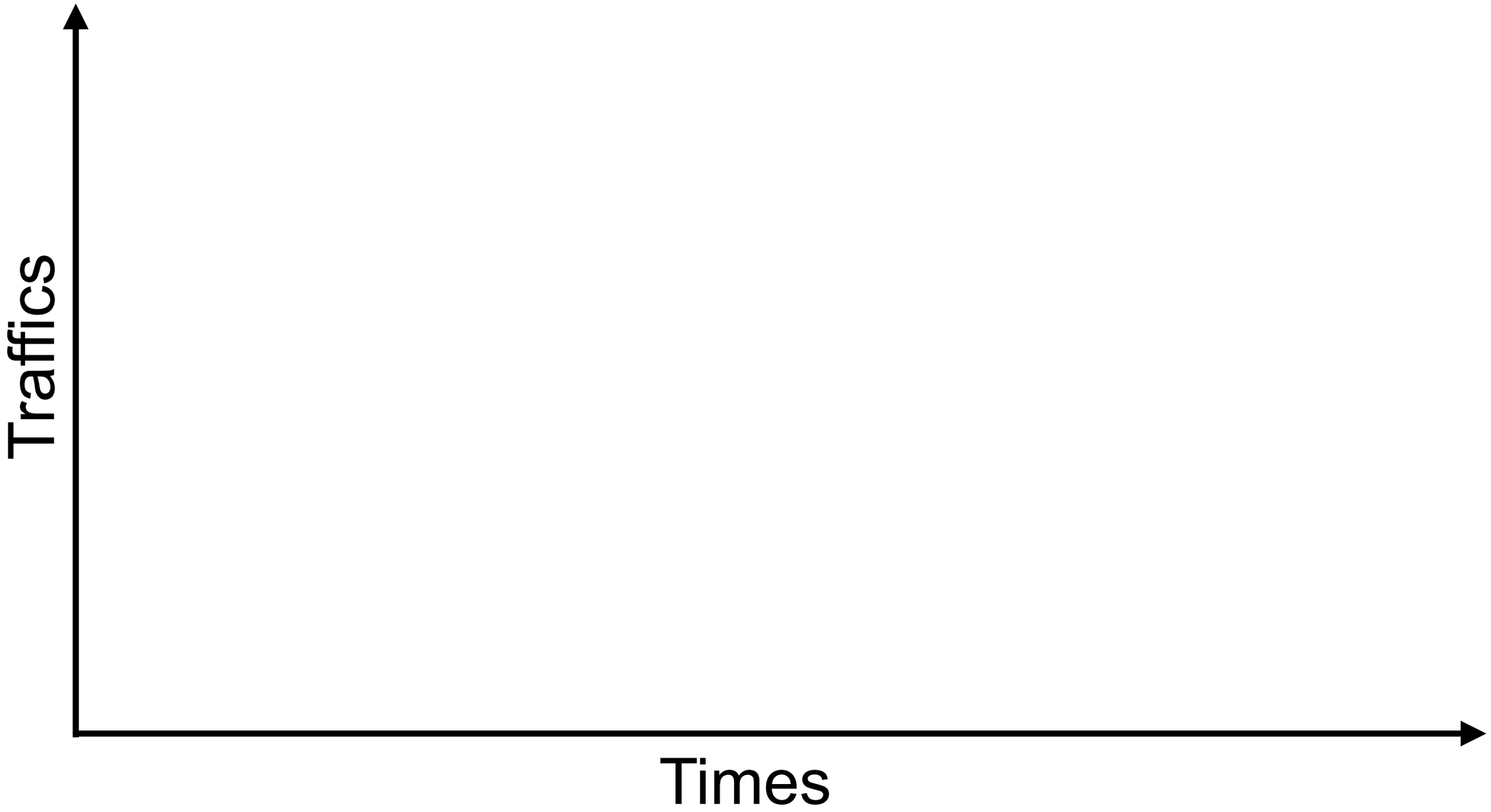
The way we load or stress the system



# Workloads ?

Load testing
Stress testing
Endurance/soak testing
Spike testing
Scalability testing

# Workloads ?



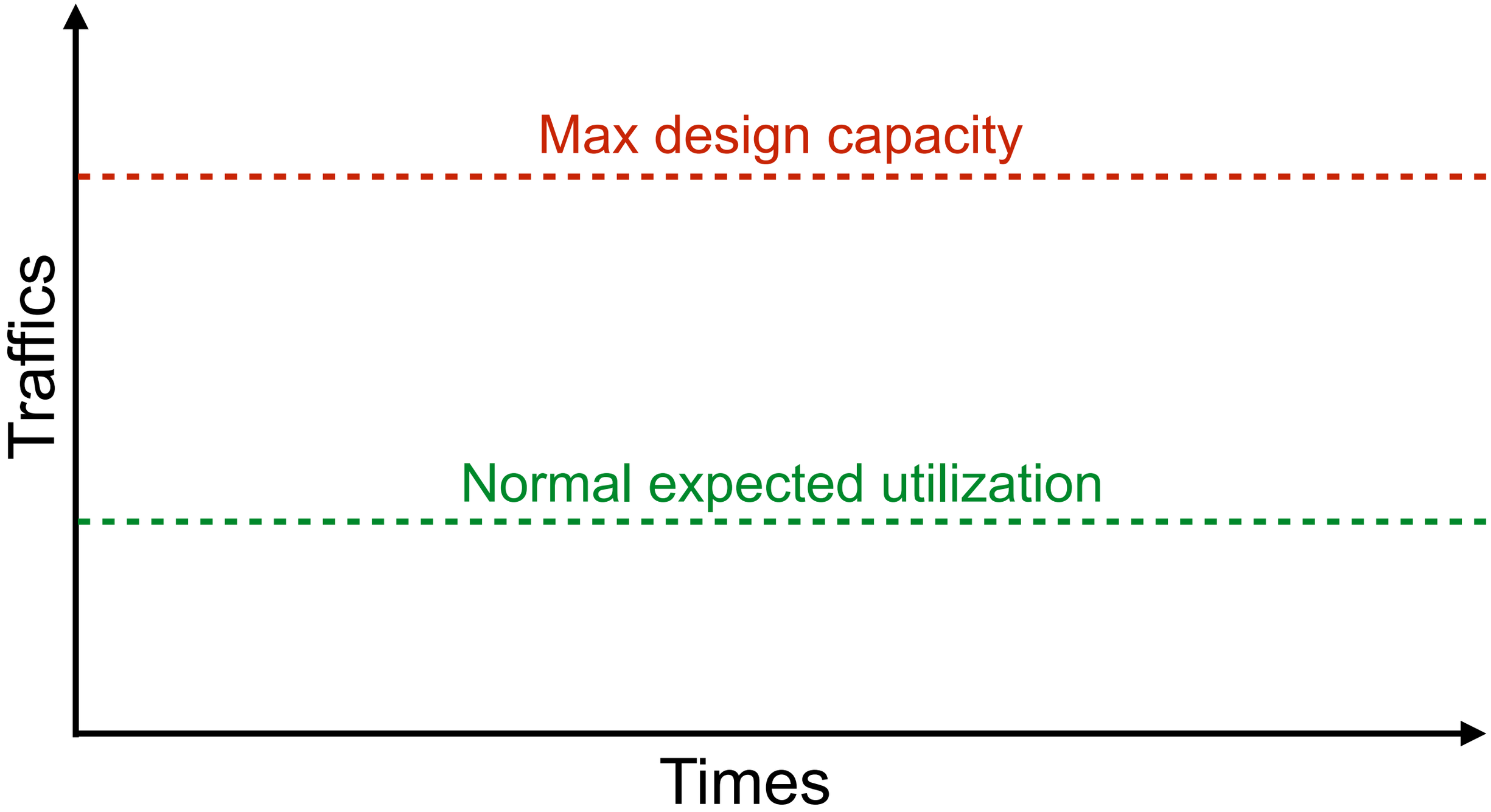
# Load testing ?

Understand the behaviour of system under **specific expected load**

Concurrent, transaction, duration

Identify **bottleneck** in application and hardware

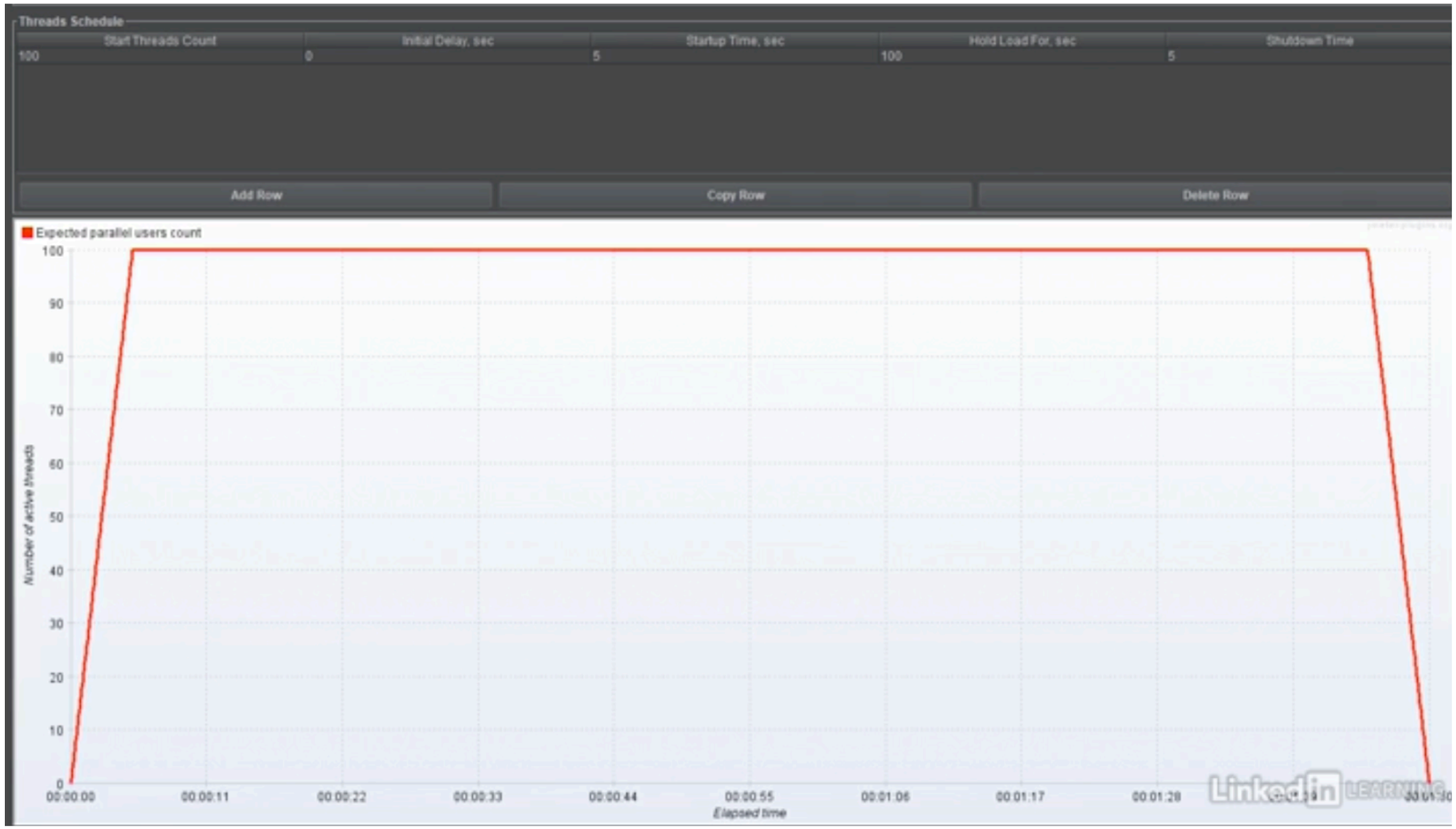
# Load testing



# Types of load testing

# Basic load

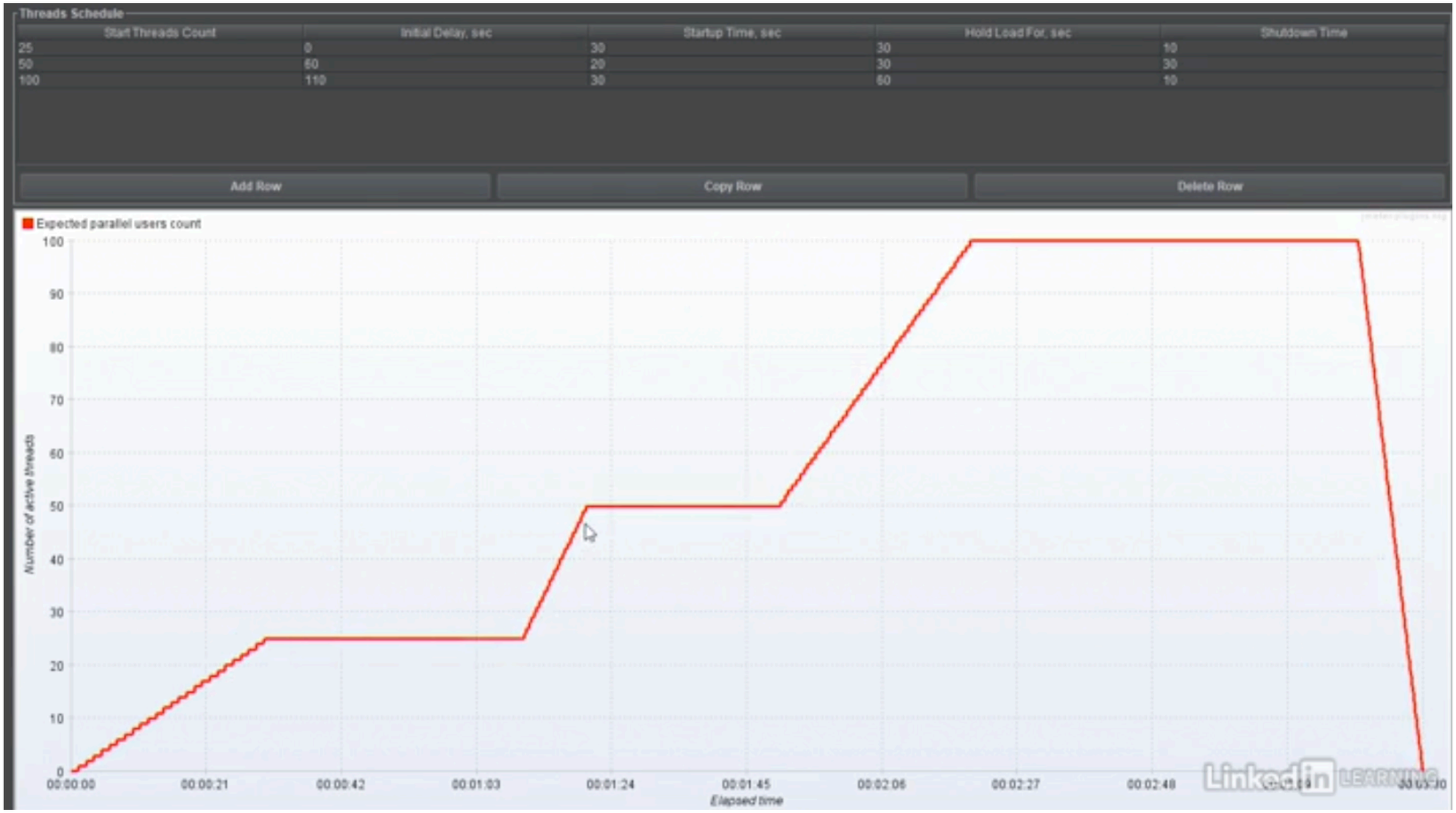
## Certain number of users



# Ramp up

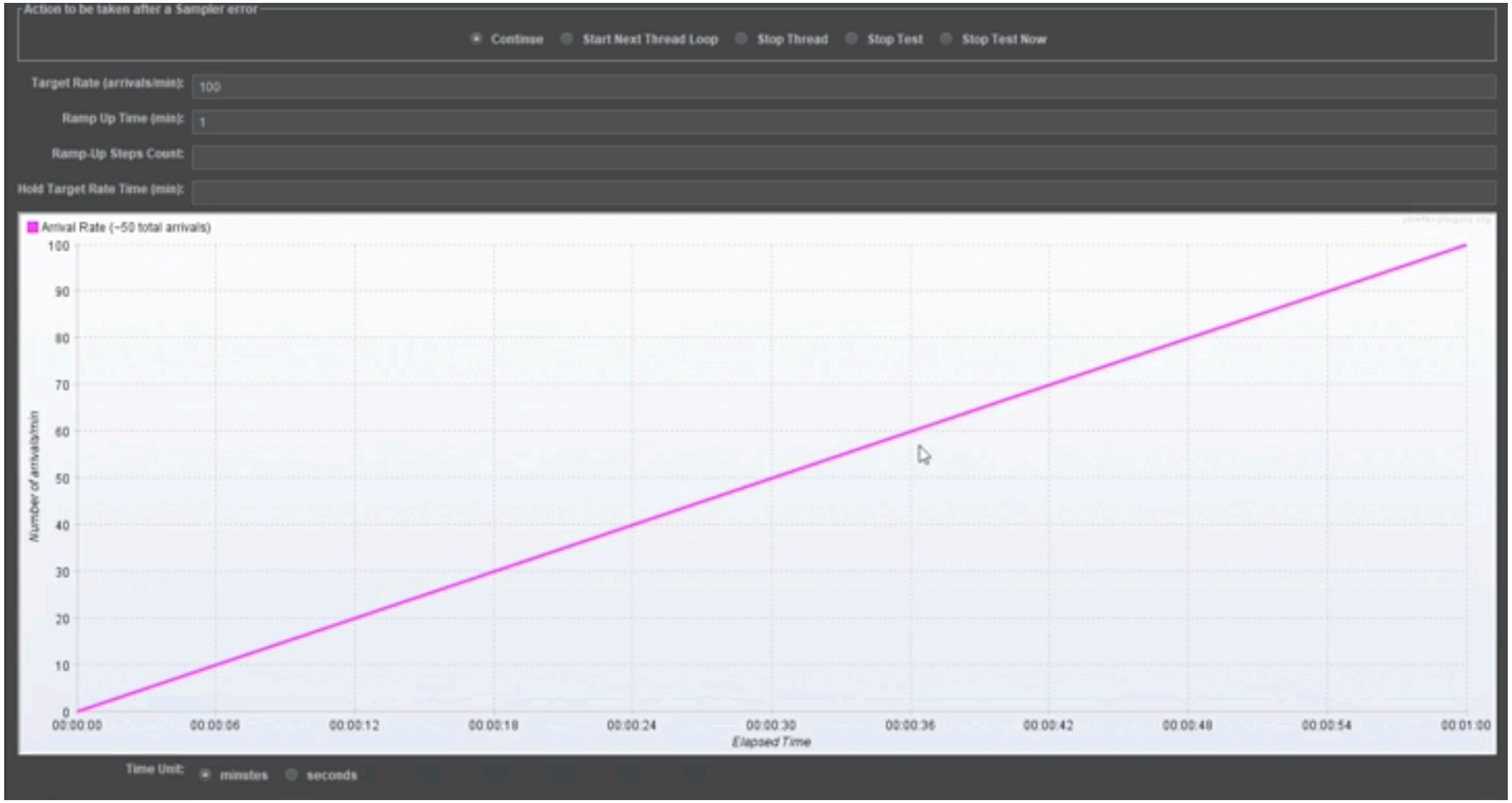
Understand how to system response to increased loads overtime

# Multi-step ramp up



# Random load

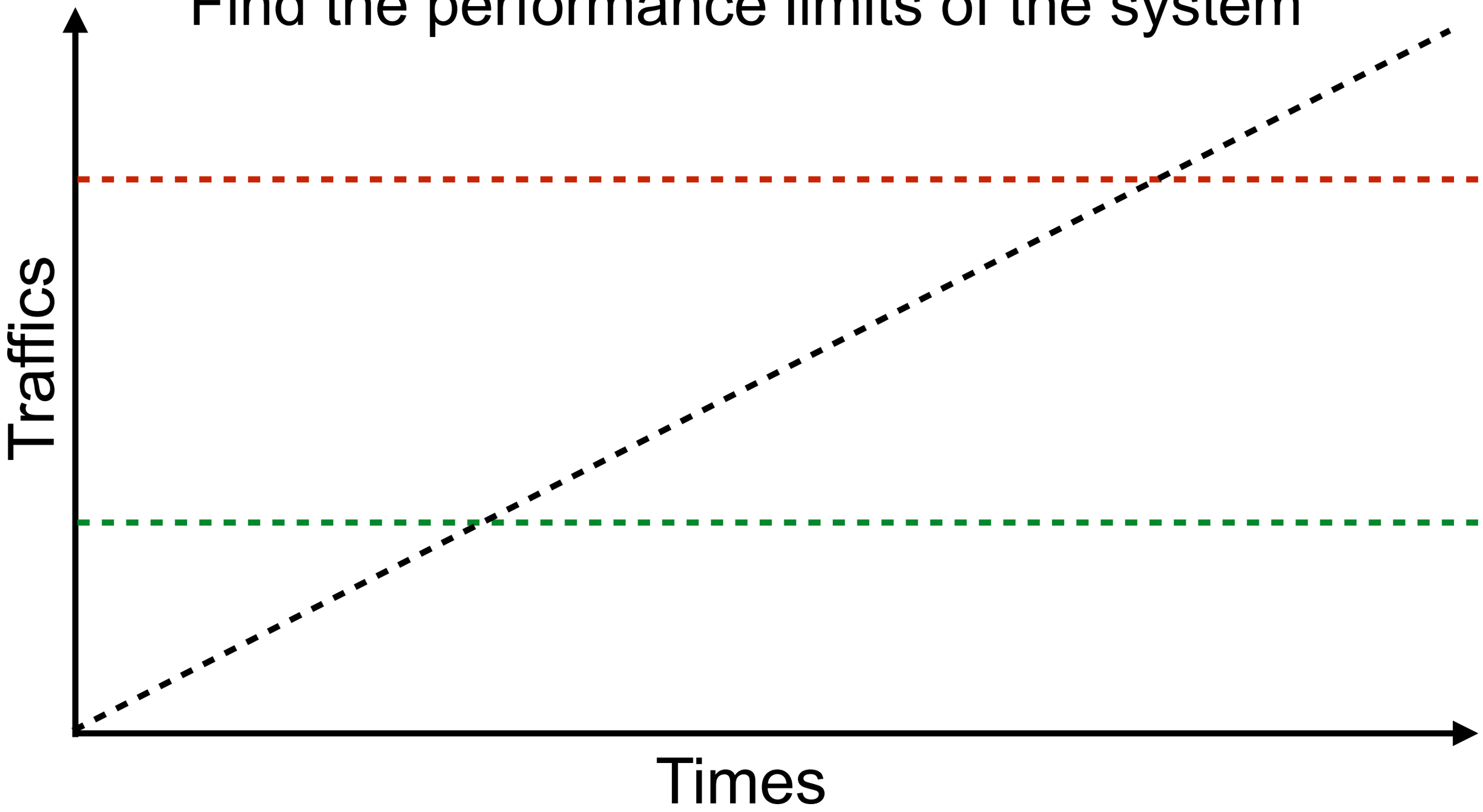
# Linear load



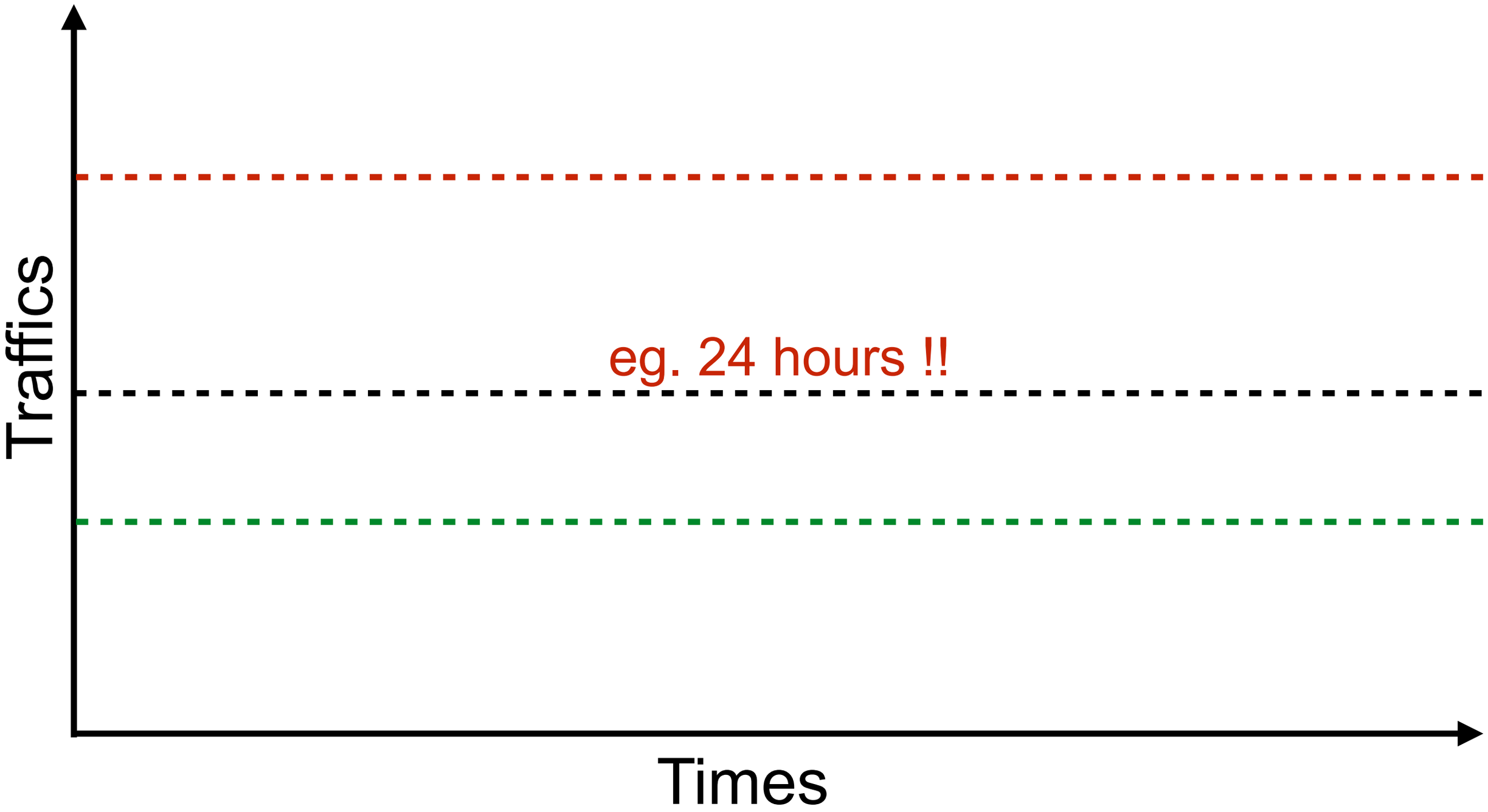
# Exponential load

# Stress testing

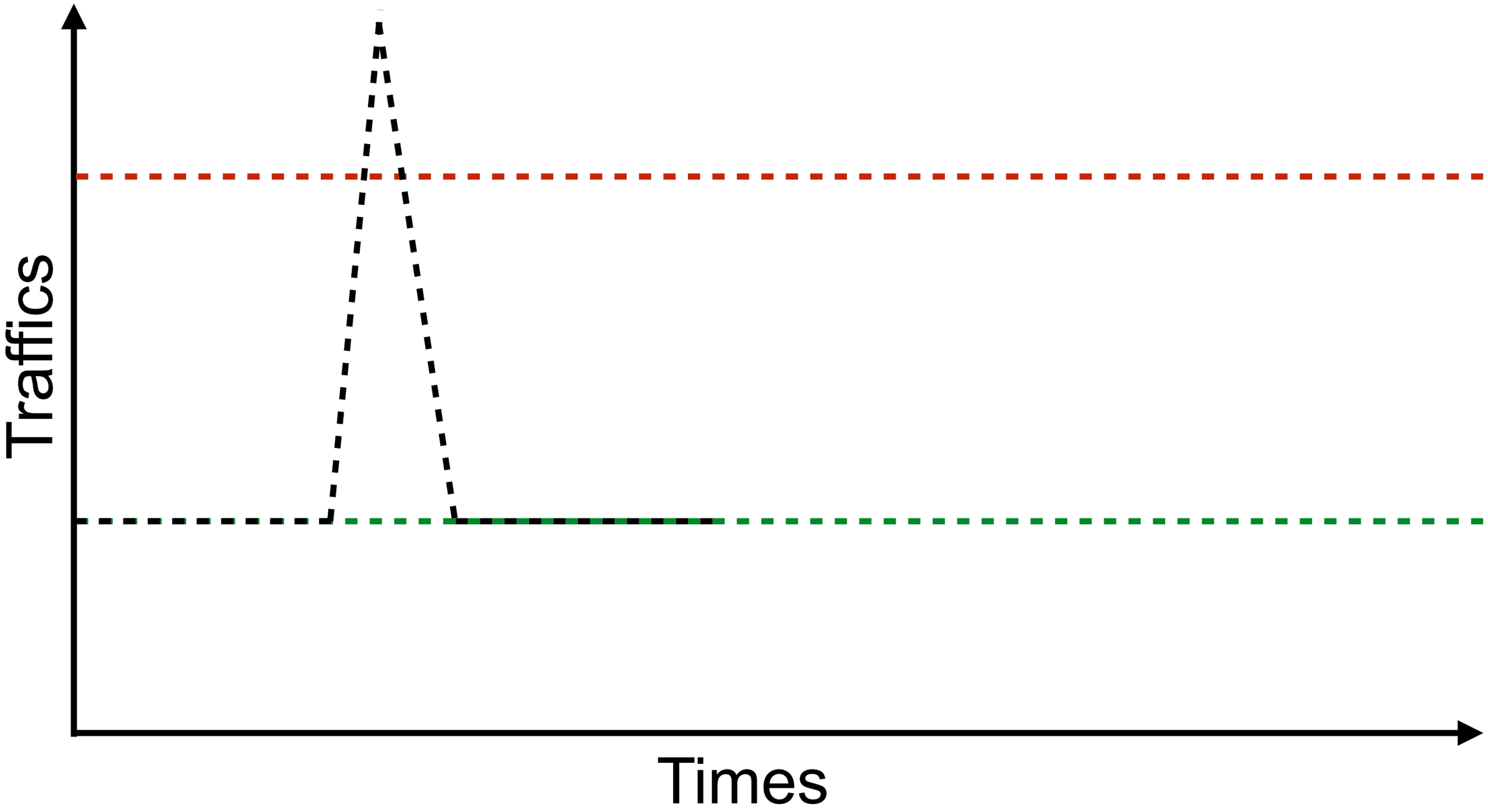
Find the performance limits of the system



# Endurance/soak testing

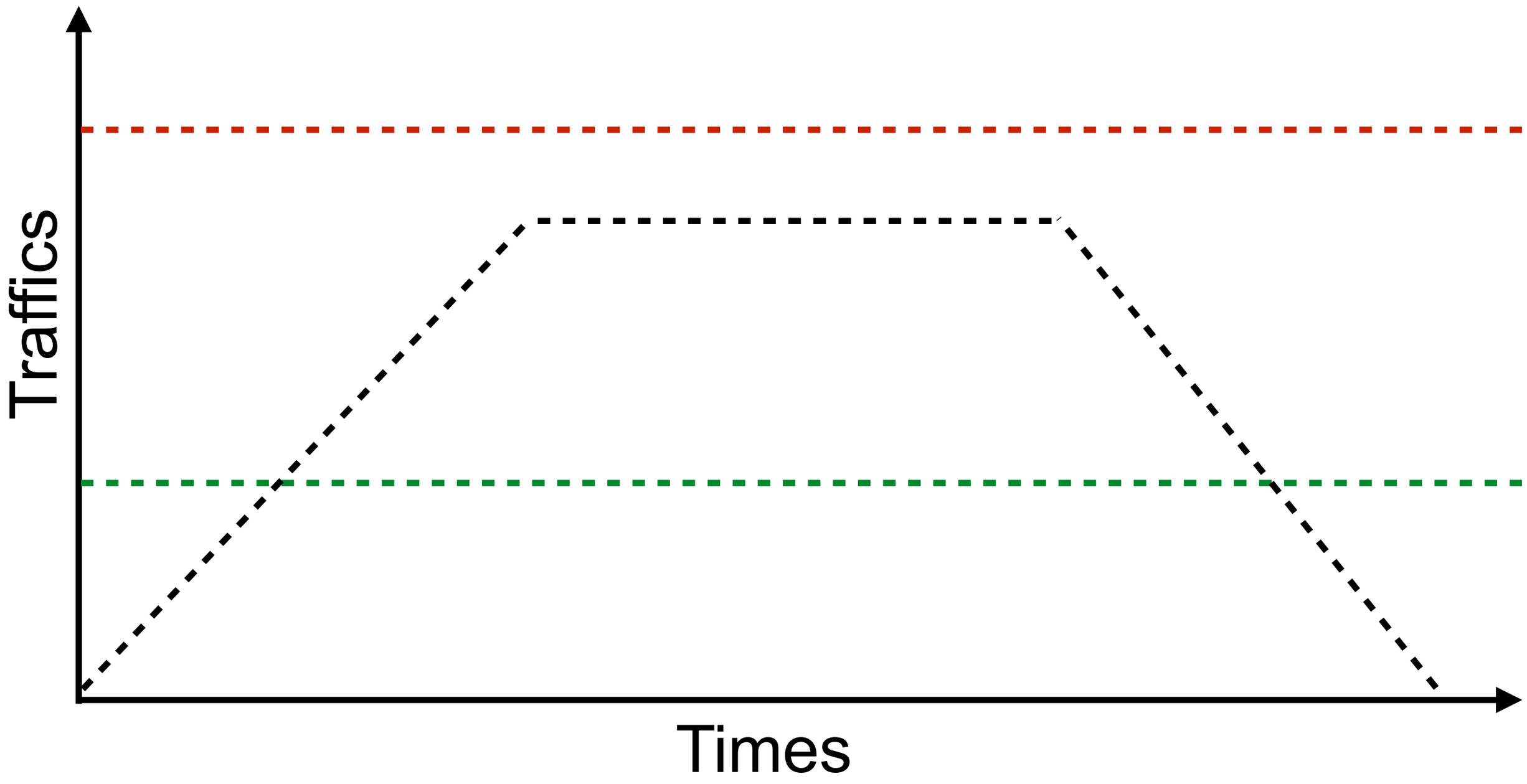


# Spike testing



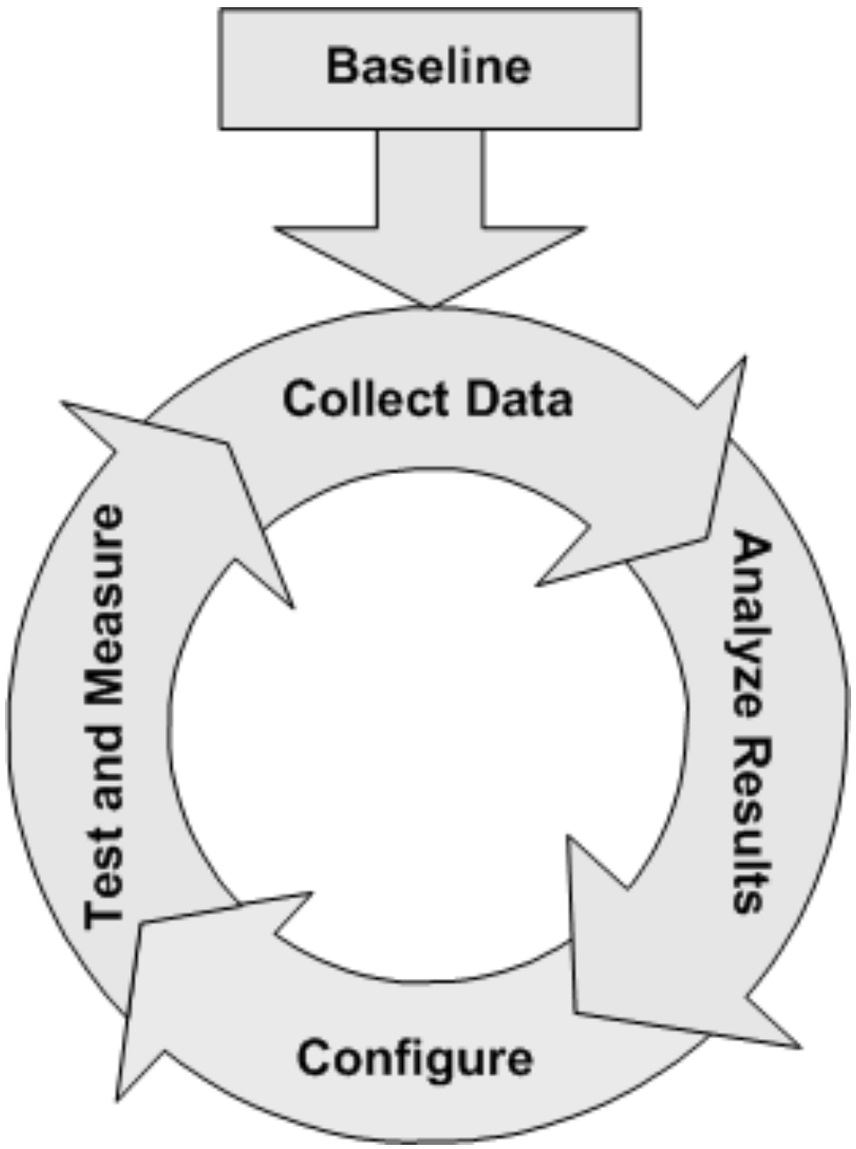
# Peak load testing

Simulate busy period (End of month payroll cut-off)



# Tuning section

# Tuning



# Tuning process for Database

Identify
Gather
Tune
Monitor
Repeat

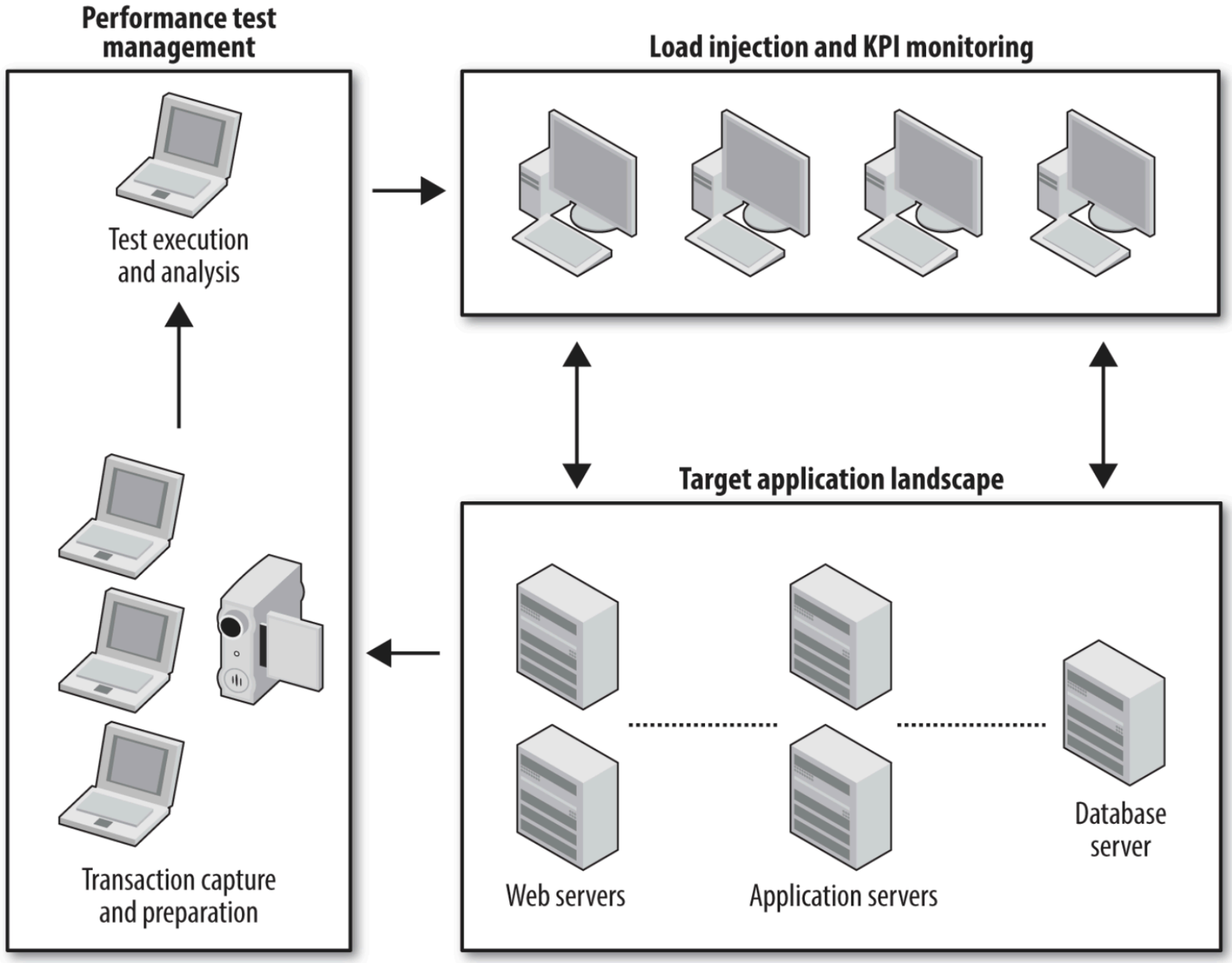
# Performance testing process

| Identify acceptance criteria | Identify test environment | Plan and design test scenarios | Prepare test environment | Record test scenarios | Run test scenarios | Analyse test results | Perform tuning and change configuration |
|---|---|---|---|---|---|---|---|

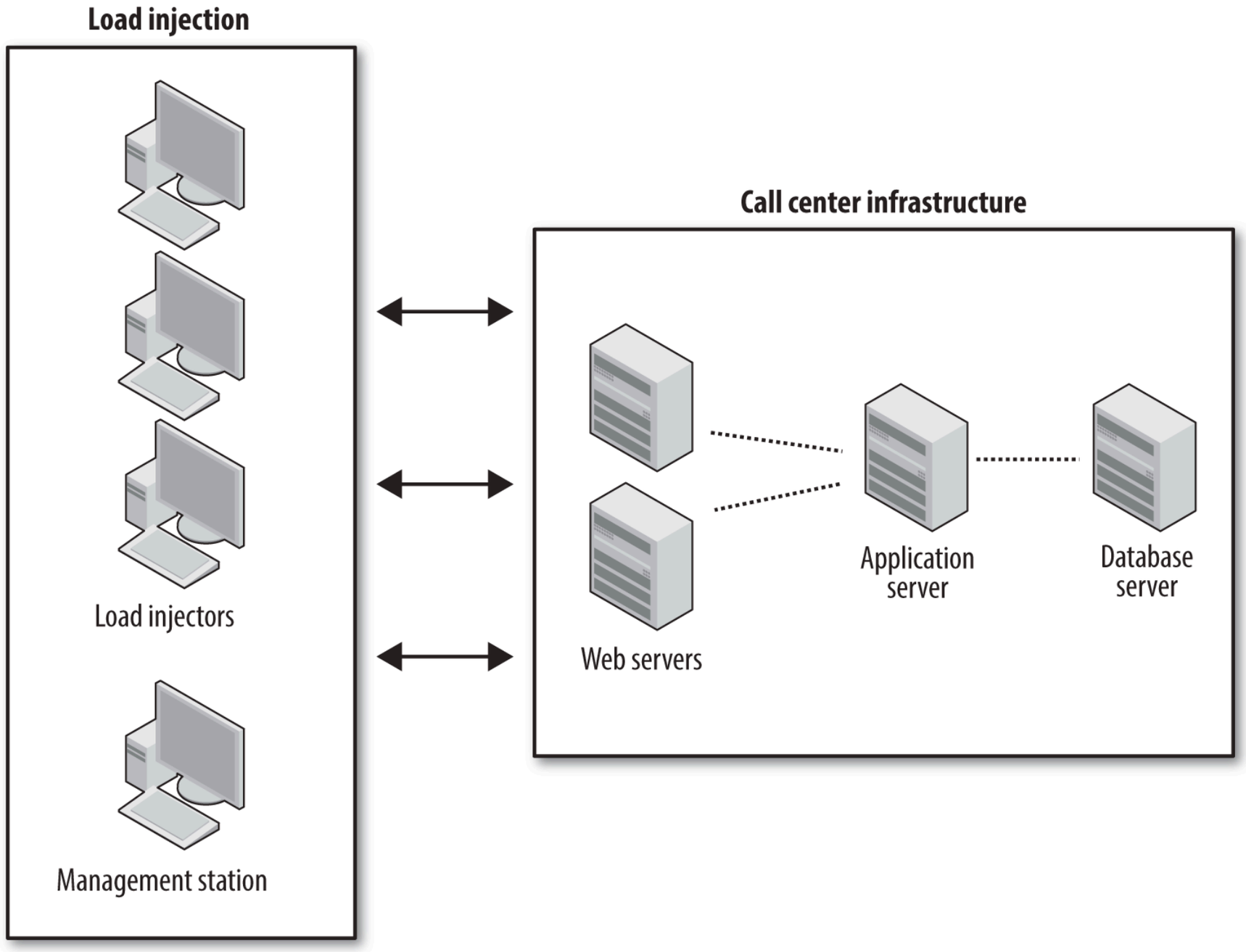
# Approach

Non-functional requirements captures
Performance test environment build
Use cases scripting
Performance test scenario build
Performance test execution
Collect data
Analyse and report

# Performance testing architecture

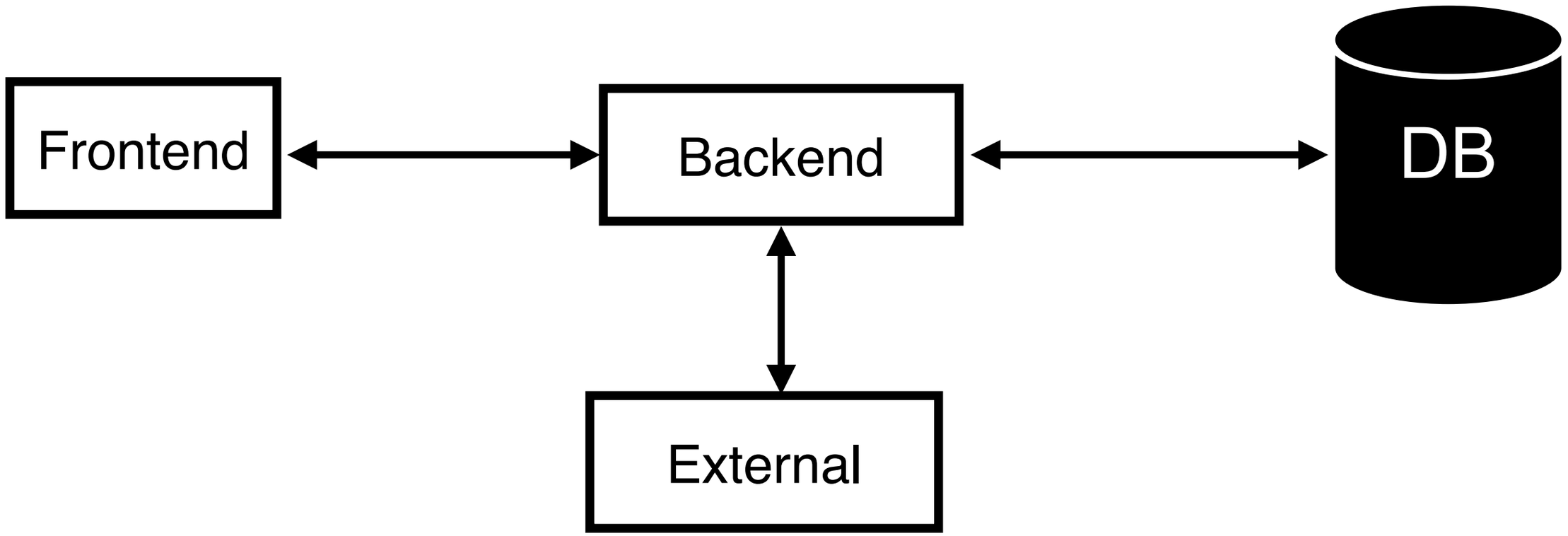


# Example

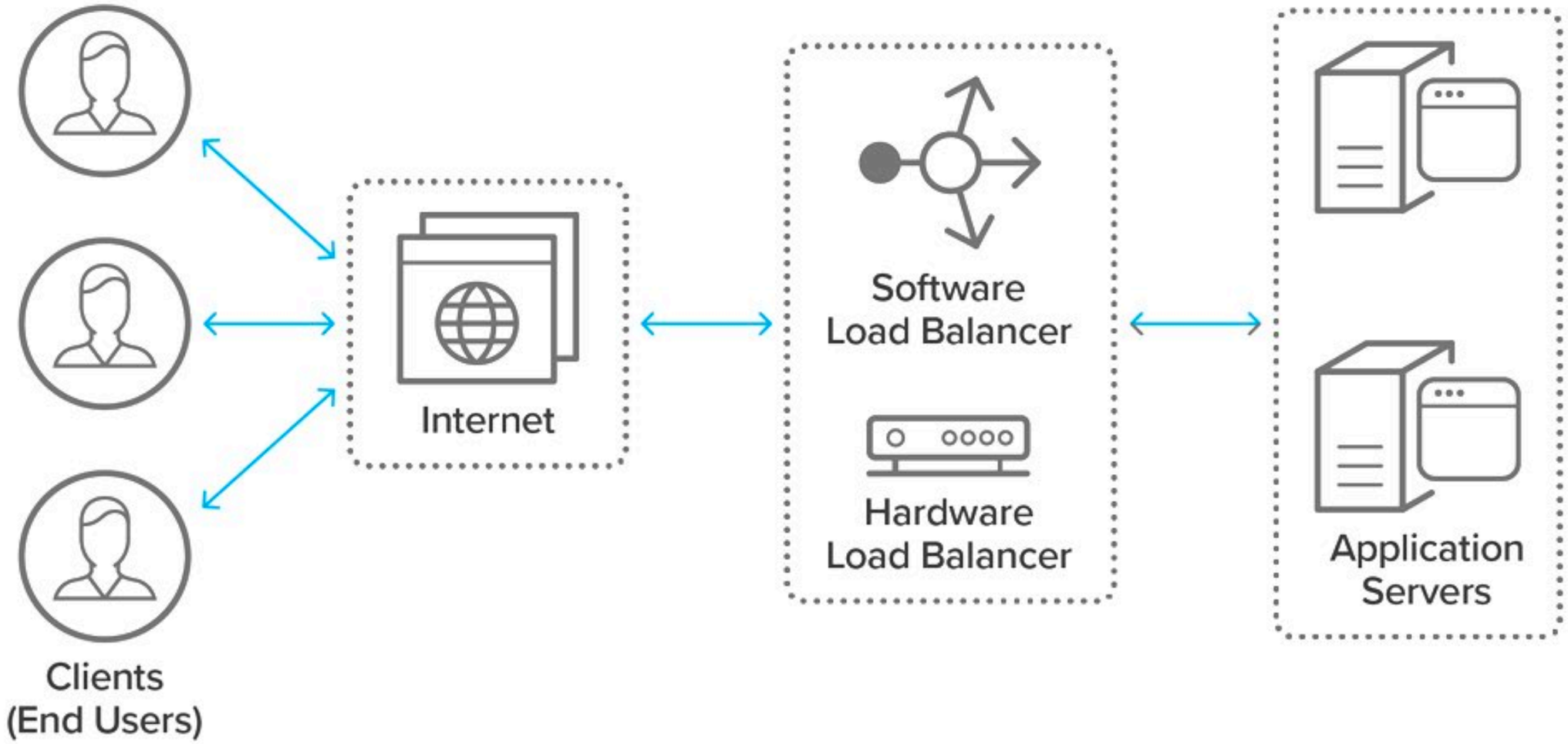


# Architecture of system ?

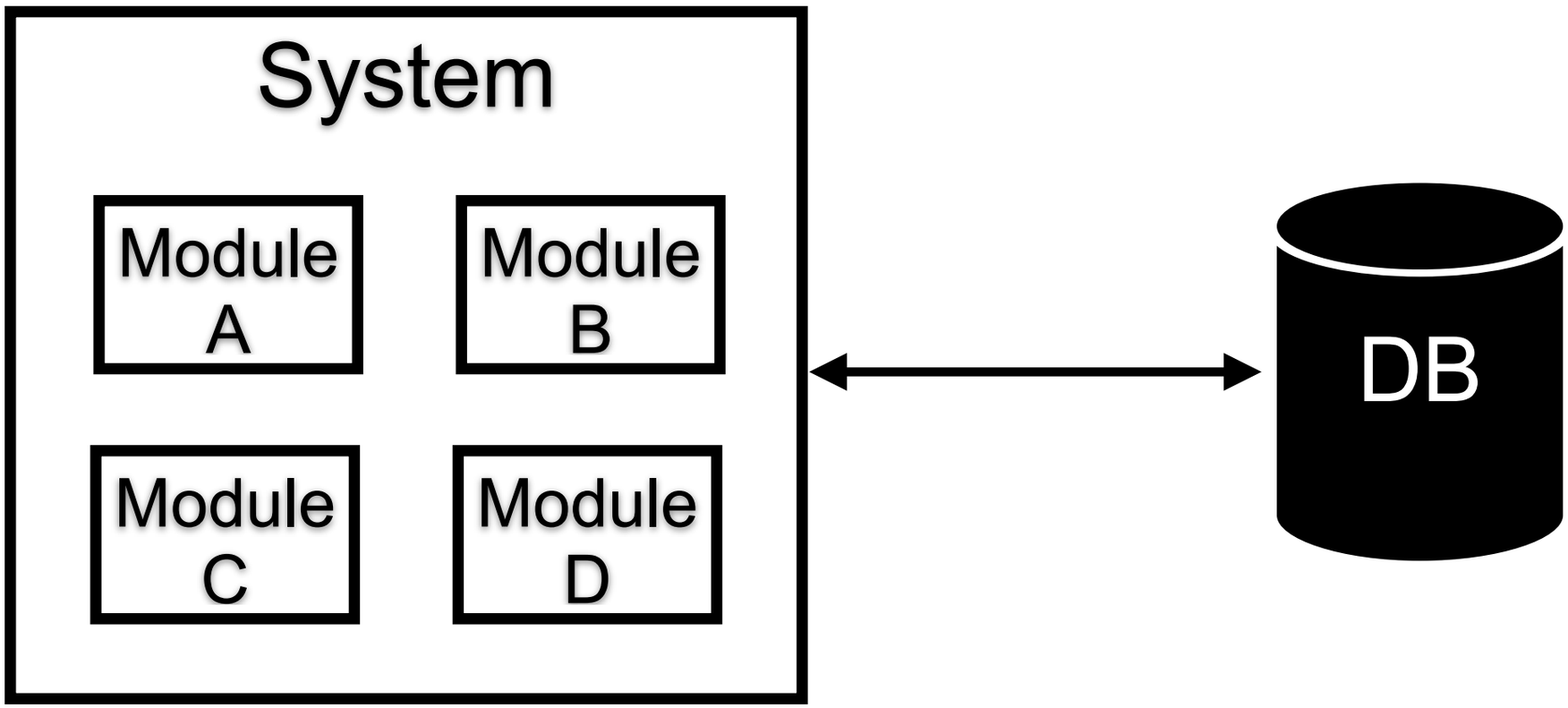
# Architecture



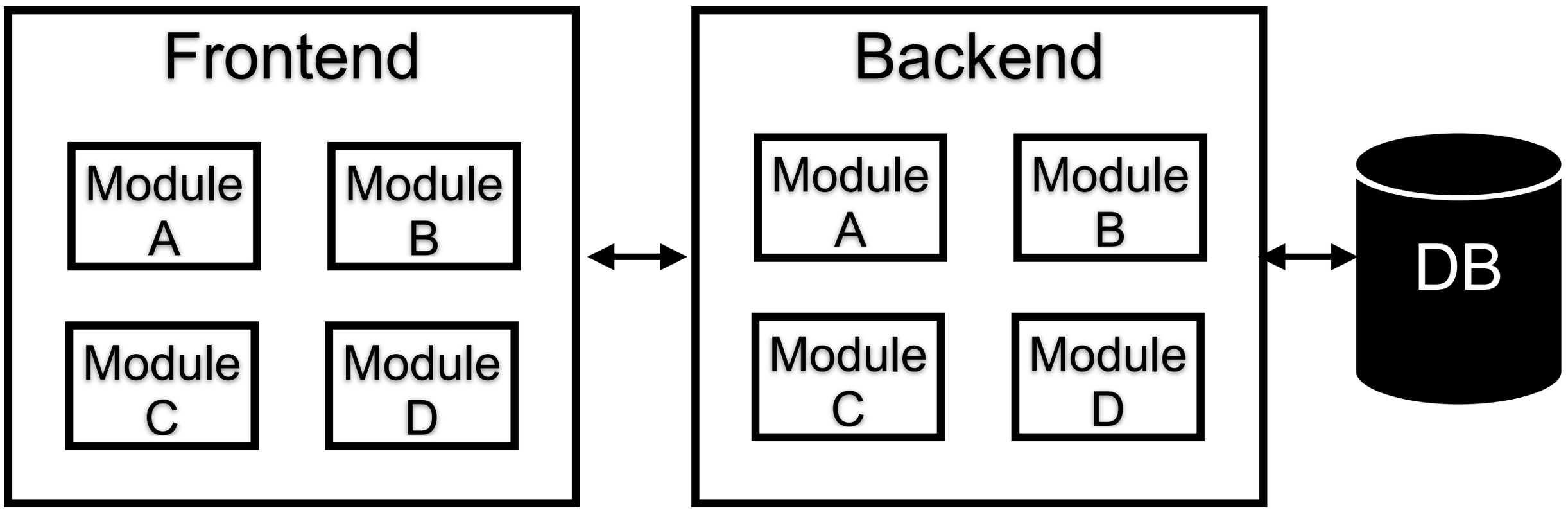
# Architecture



# Monolith

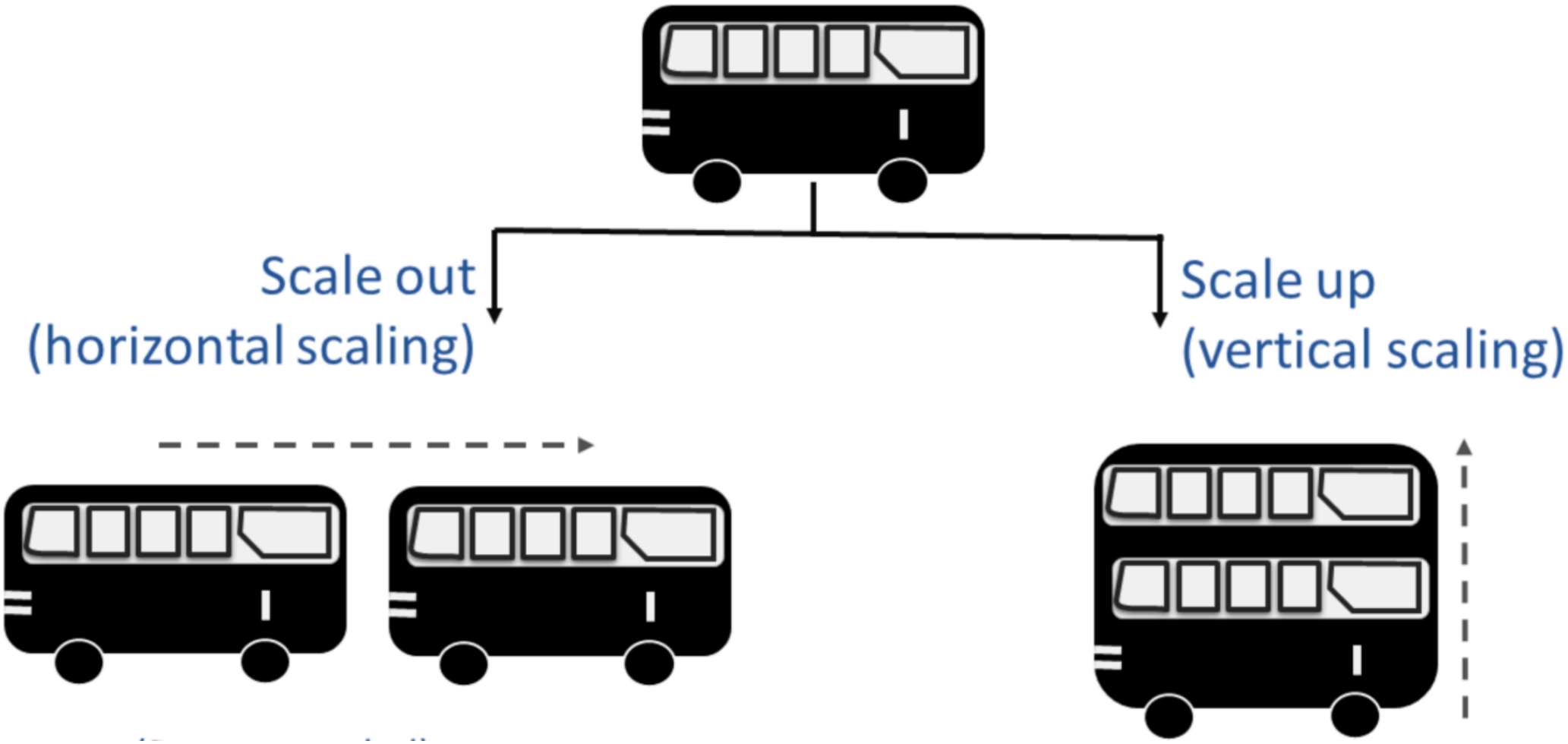


# N-Tier

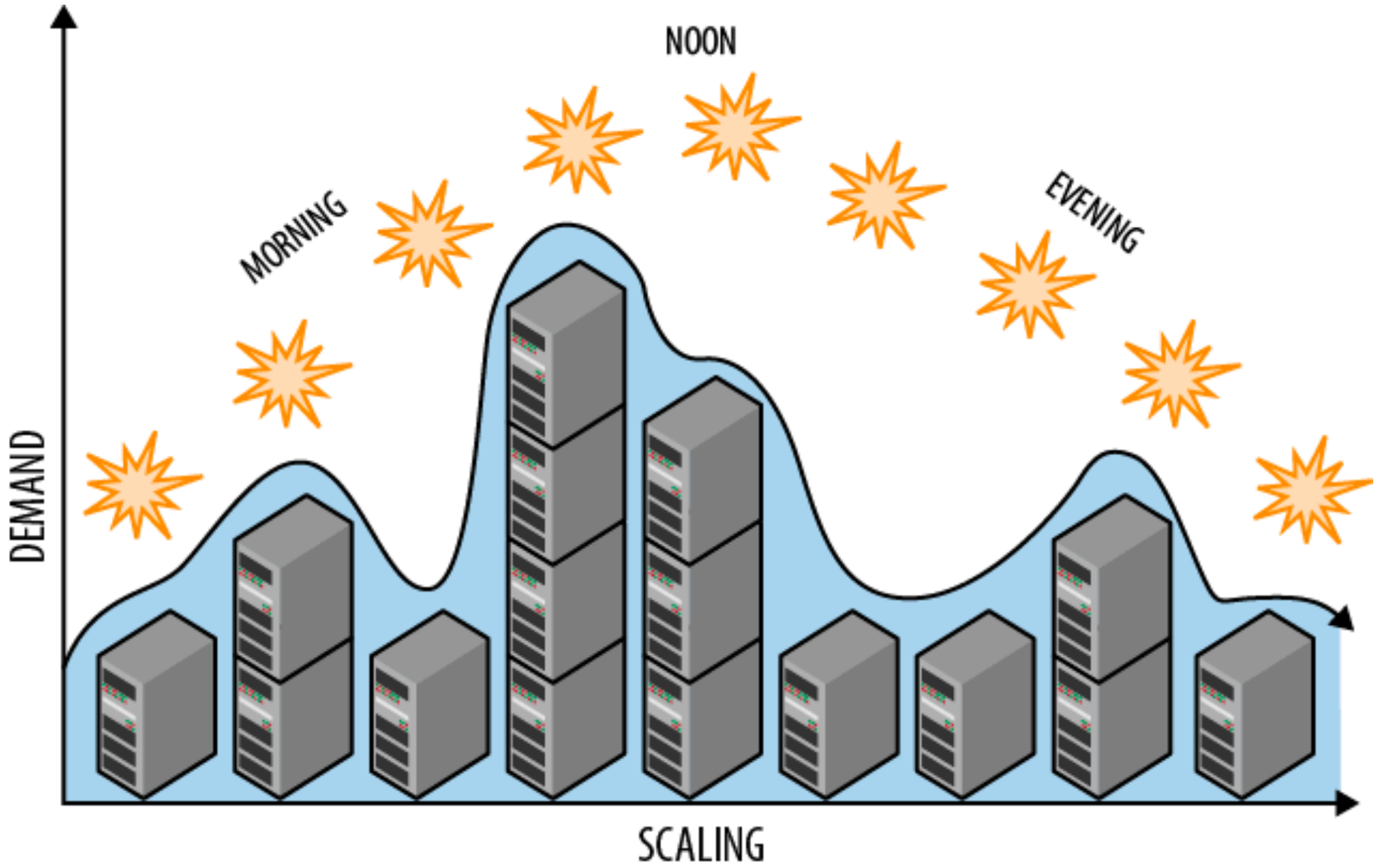


# How to scale ?

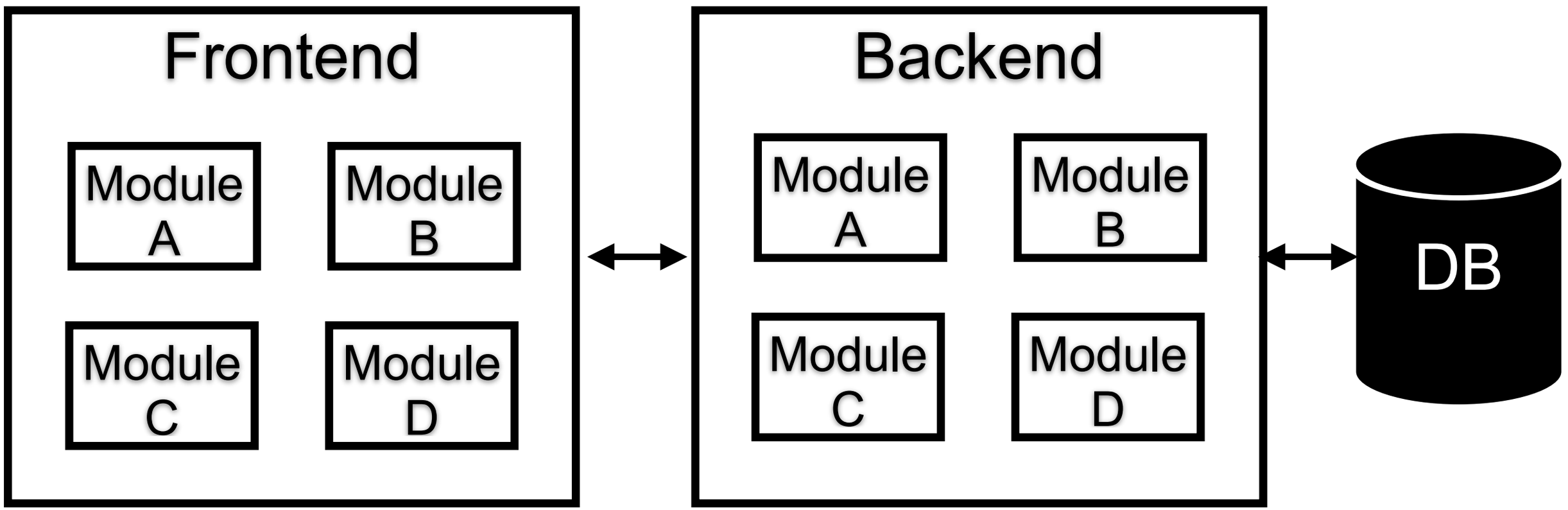
# Scaling



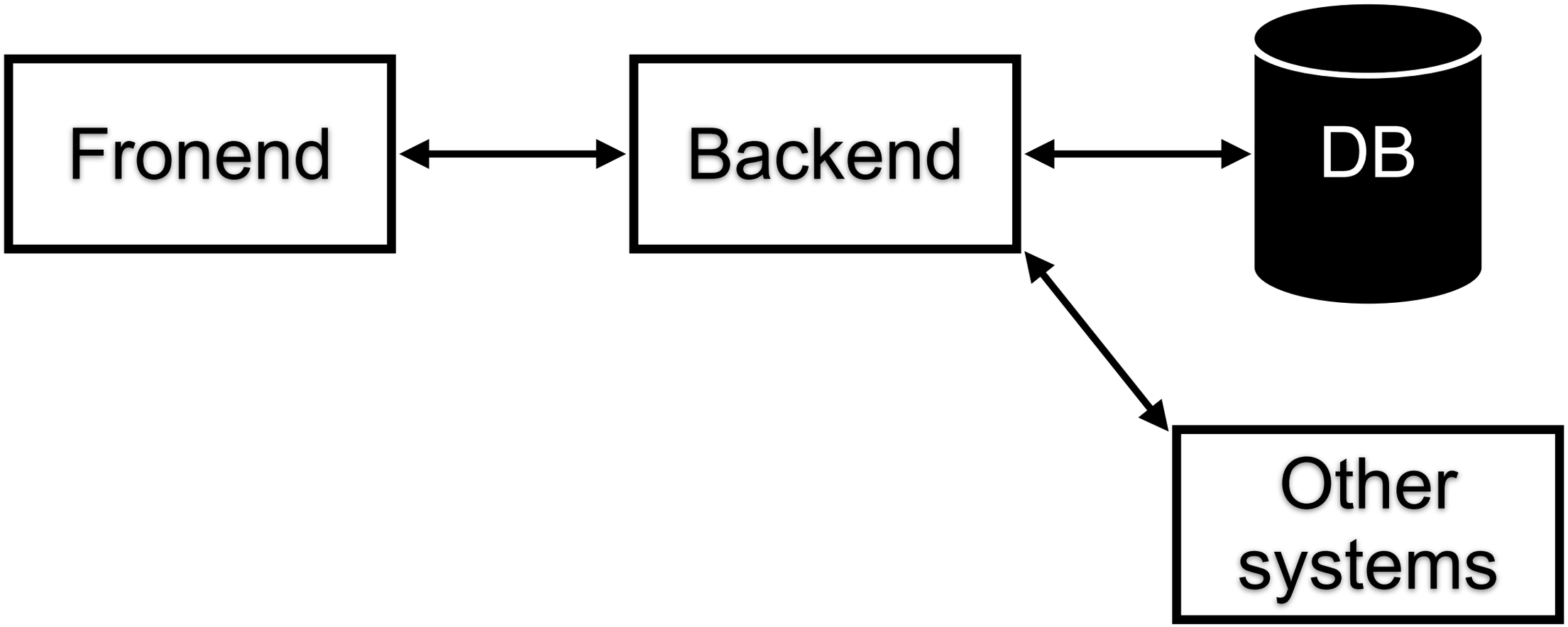
# Elastic Scaling



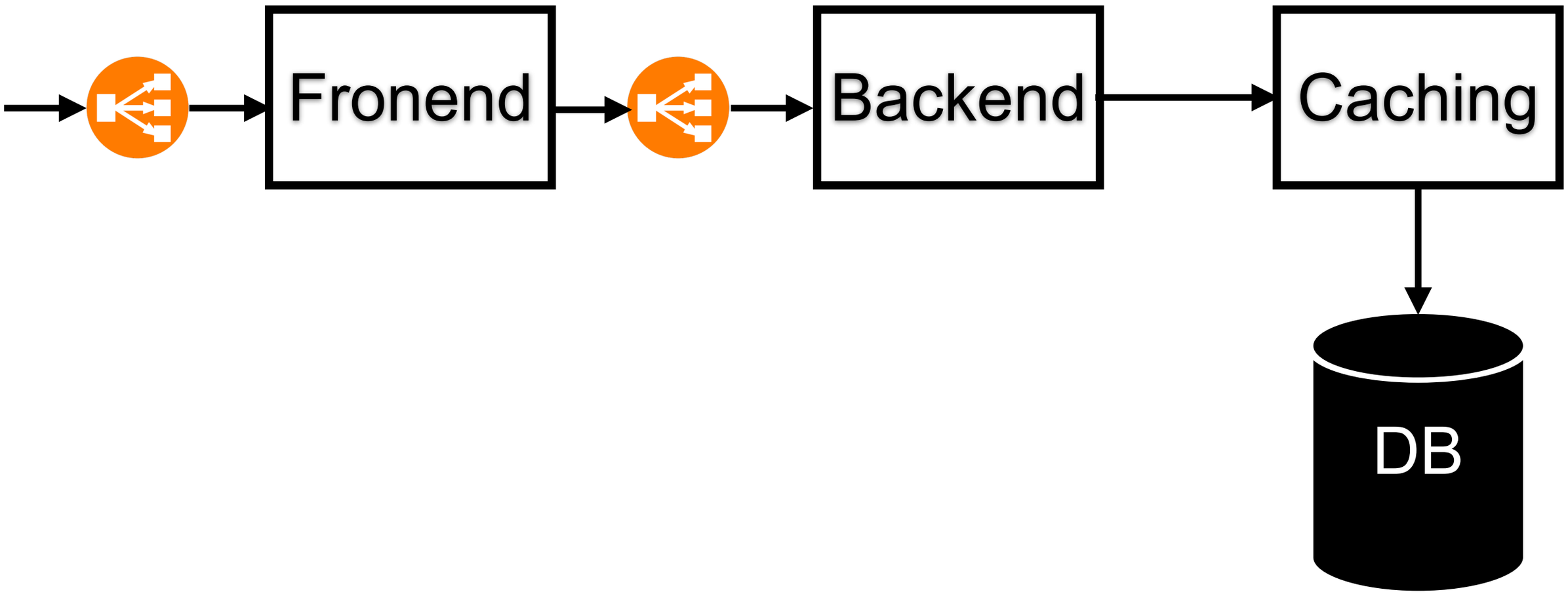
# How to scale ?



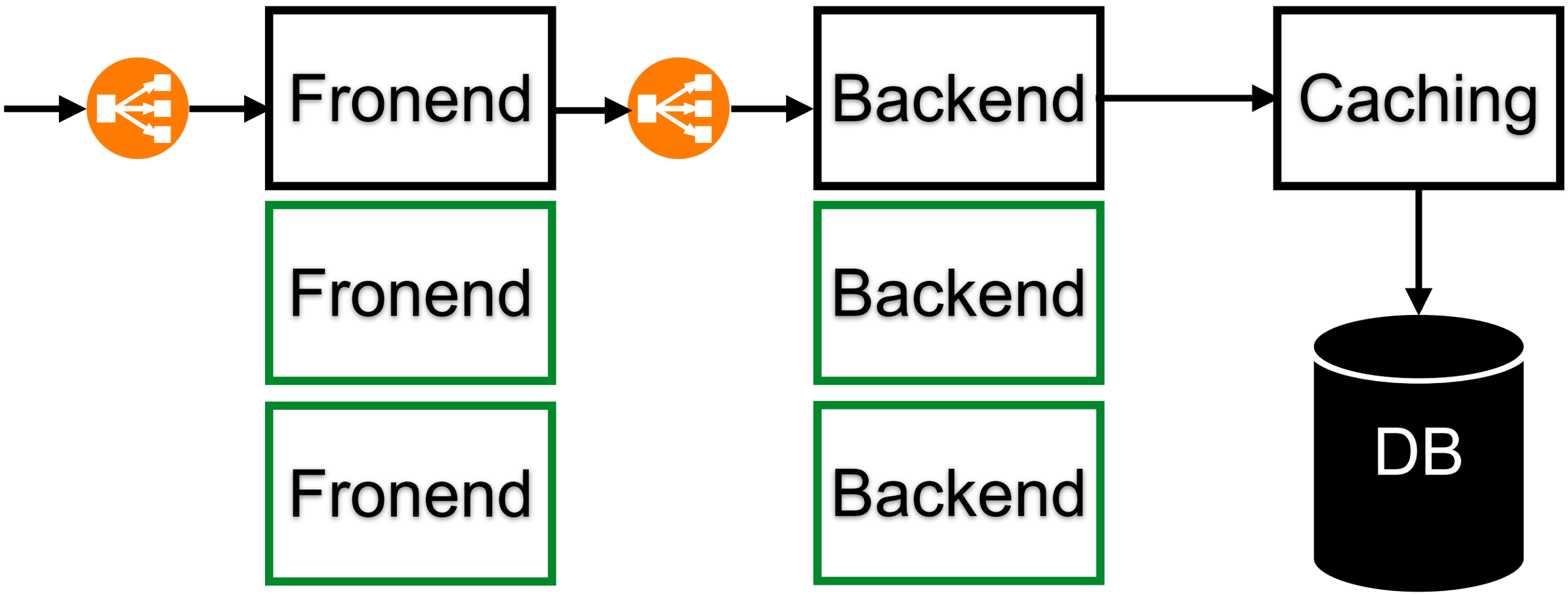
# Redesign architecture ?



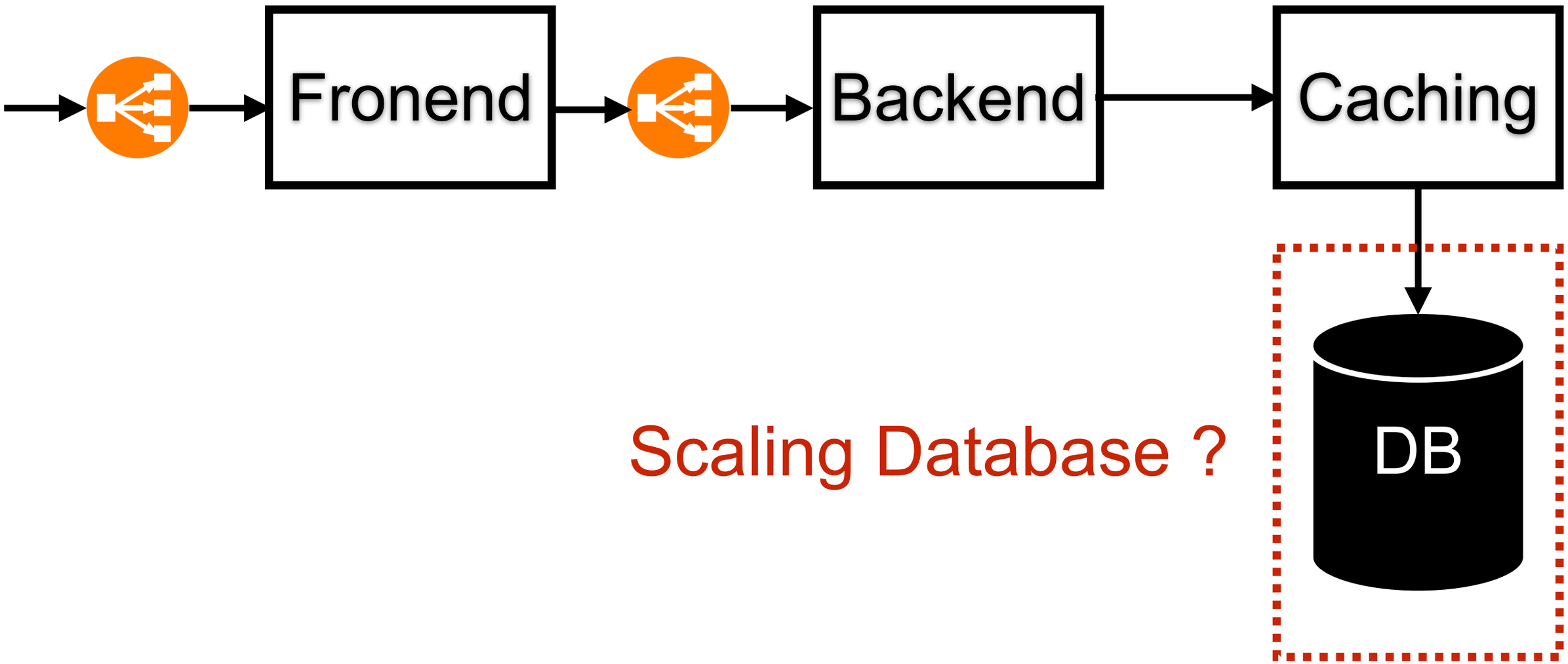
# Redesign architecture ?



# Redesign architecture ?

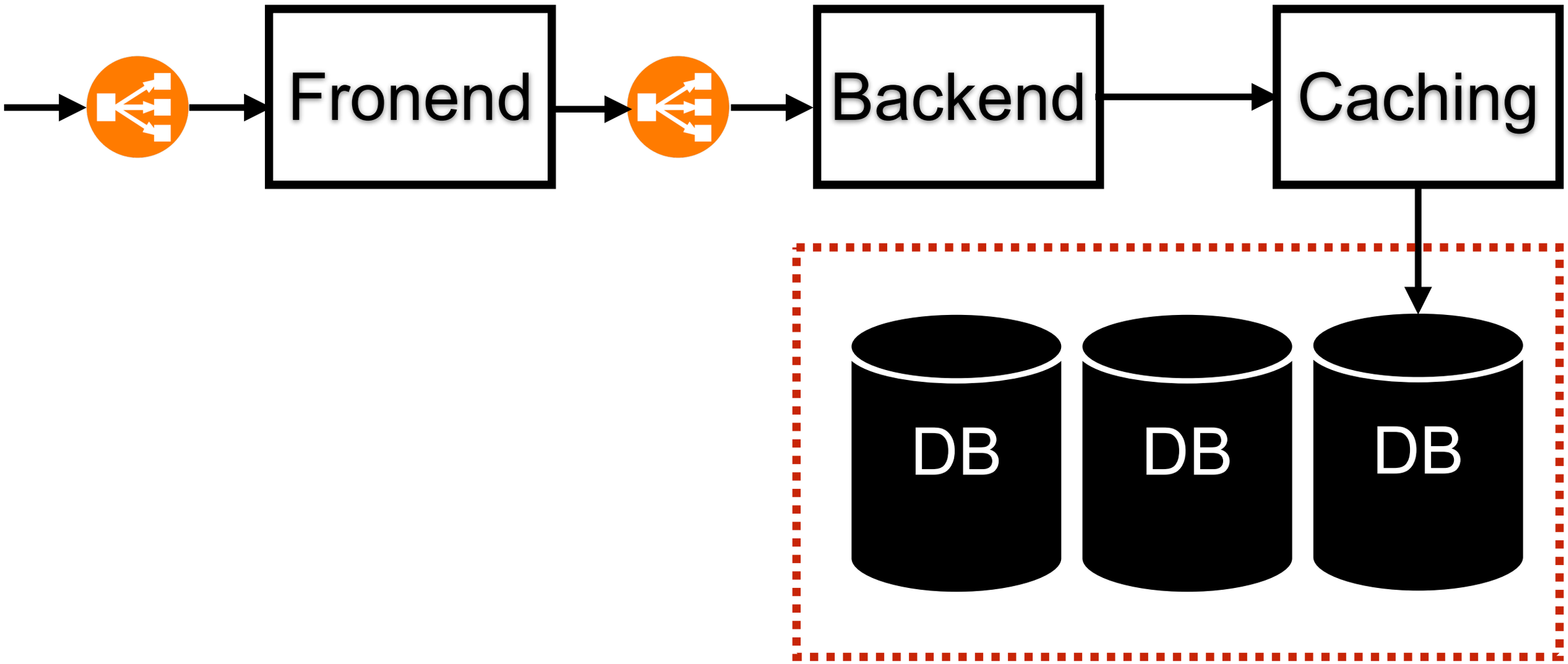


# Redesign architecture ?

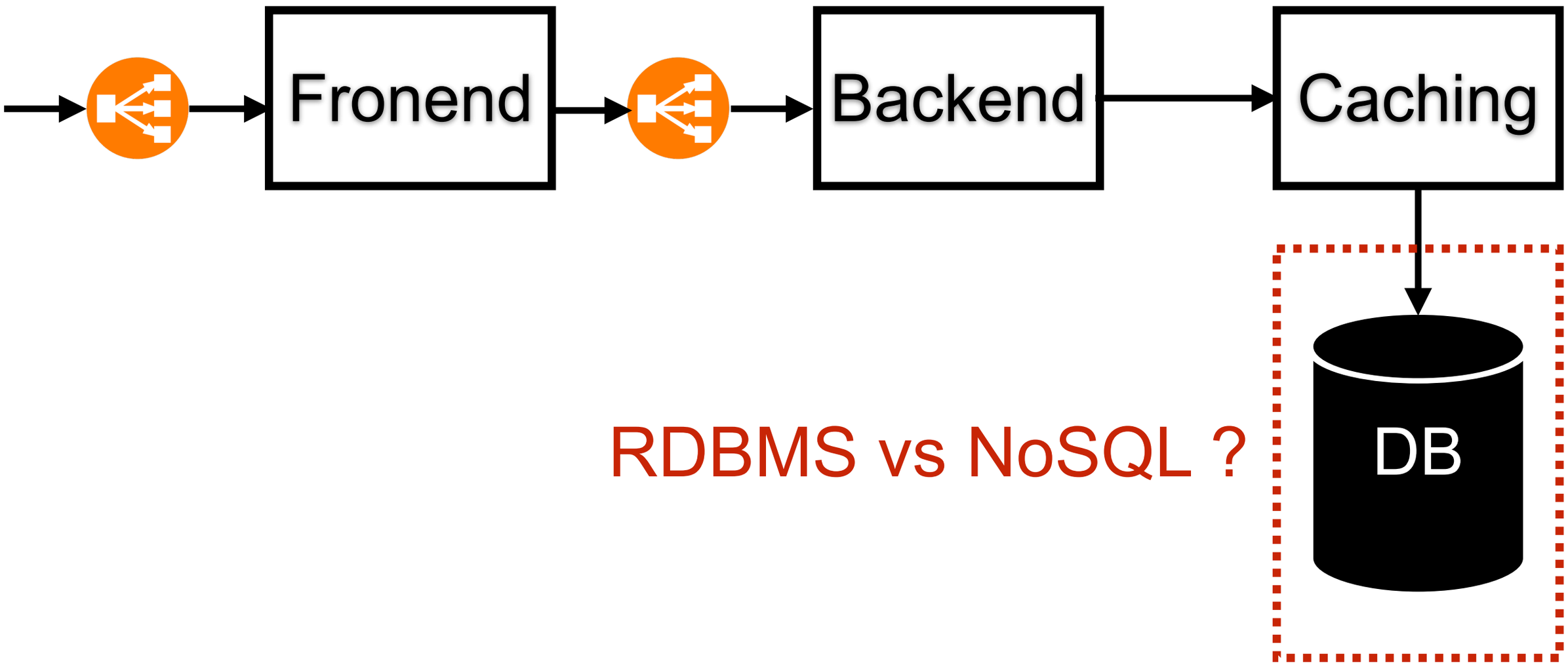



Scaling Database ?

# Redesign architecture ?



# Redesign architecture ?




RDBMS vs NoSQL ?

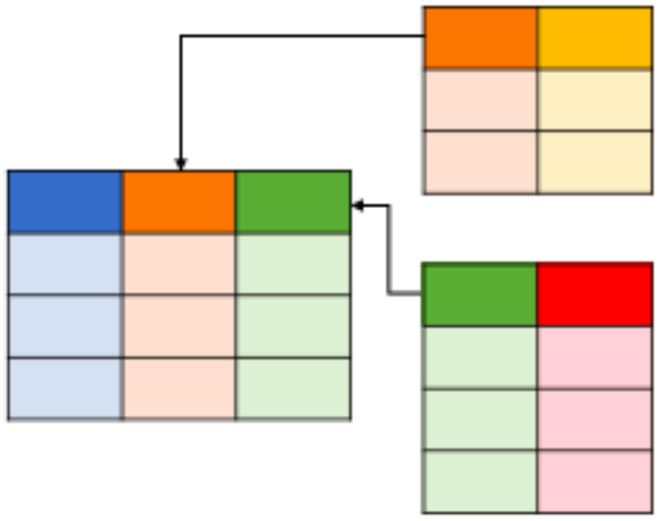
# Database model ?

| Rank | | | DBMS | Database Model |
|---|---|---|---|---|
| Apr 2020 | Mar 2020 | Apr 2019 | | |
| 1. | 1. | 1. | Oracle | Relational, Multi-model |
| 2. | 2. | 2. | MySQL | Relational, Multi-model |
| 3. | 3. | 3. | Microsoft SQL Server | Relational, Multi-model |
| 4. | 4. | 4. | PostgreSQL | Relational, Multi-model |
| 5. | 5. | 5. | MongoDB | Document, Multi-model |
| 6. | 6. | 6. | IBM Db2 | Relational, Multi-model |
| 7. | 7. | ↑ 8. | Elasticsearch | Search engine, Multi-model |
| 8. | 8. | ↓ 7. | Redis | Key-value, Multi-model |
| 9. | ↑ 10. | ↑ 10. | SQLite | Relational |
| 10. | ↓ 9. | ↓ 9. | Microsoft Access | Relational |

https://db-engines.com/en/ranking

# Database model

## SQL DATABASES

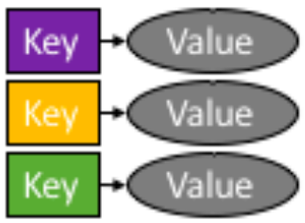


Relational

## NoSQL DATABASES

Column

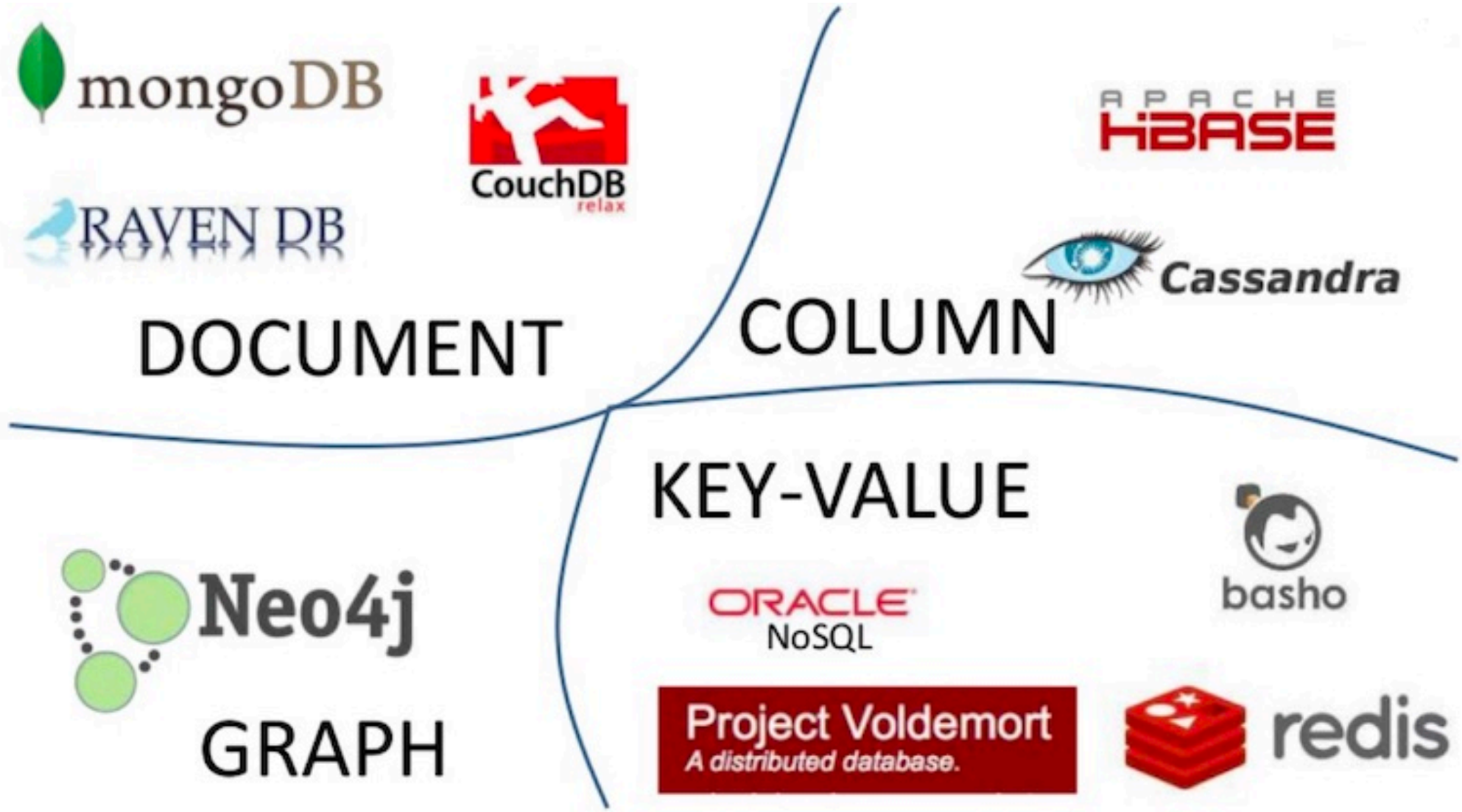
Graph




Key-Value

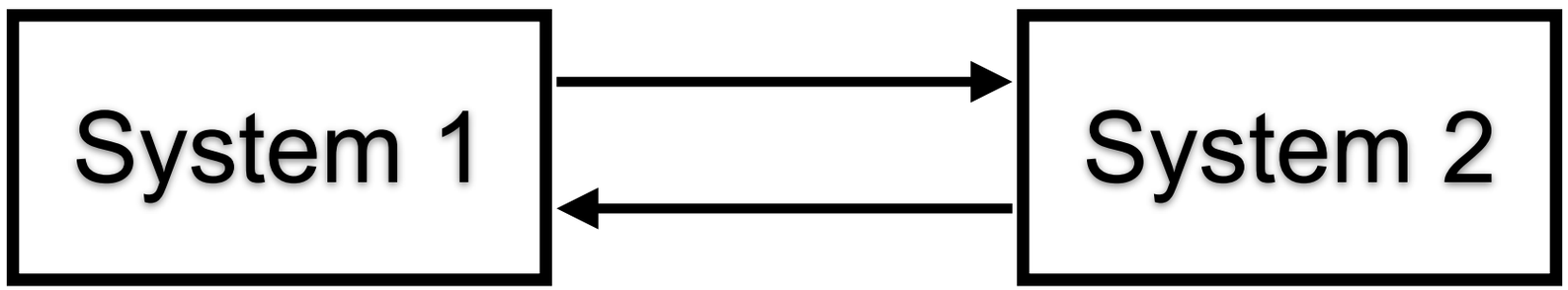
Document

# NoSQL



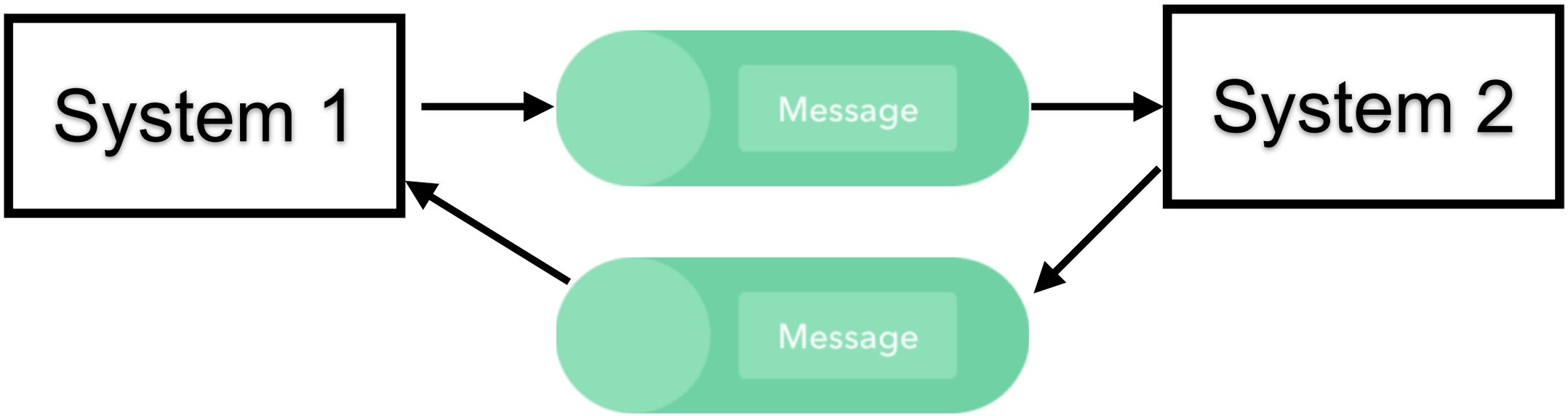
# Redesign architecture ?

Synchronous communication



# Redesign architecture ?

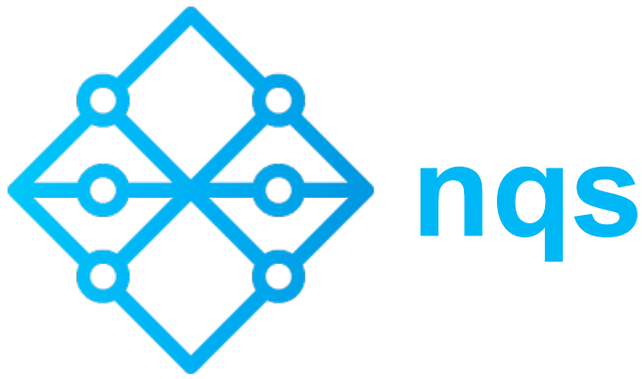
Asynchronous communication



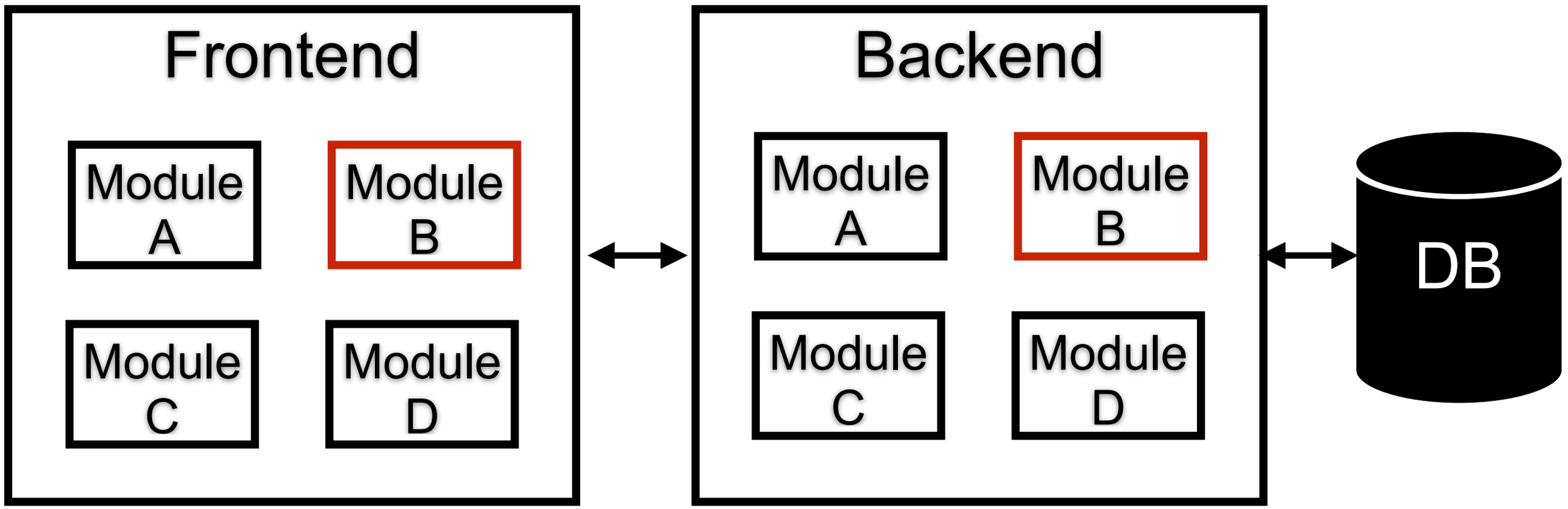
# Messaging system



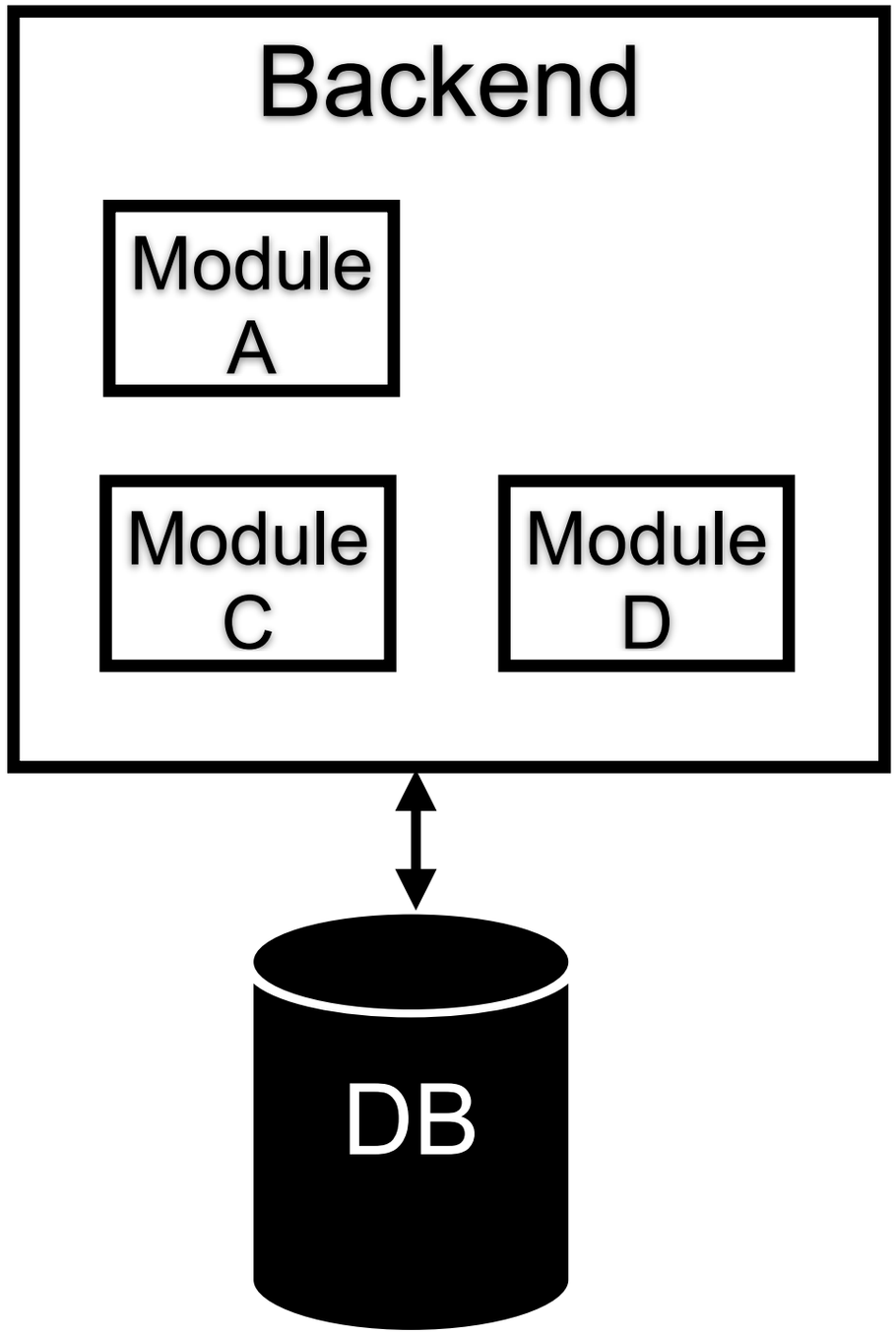


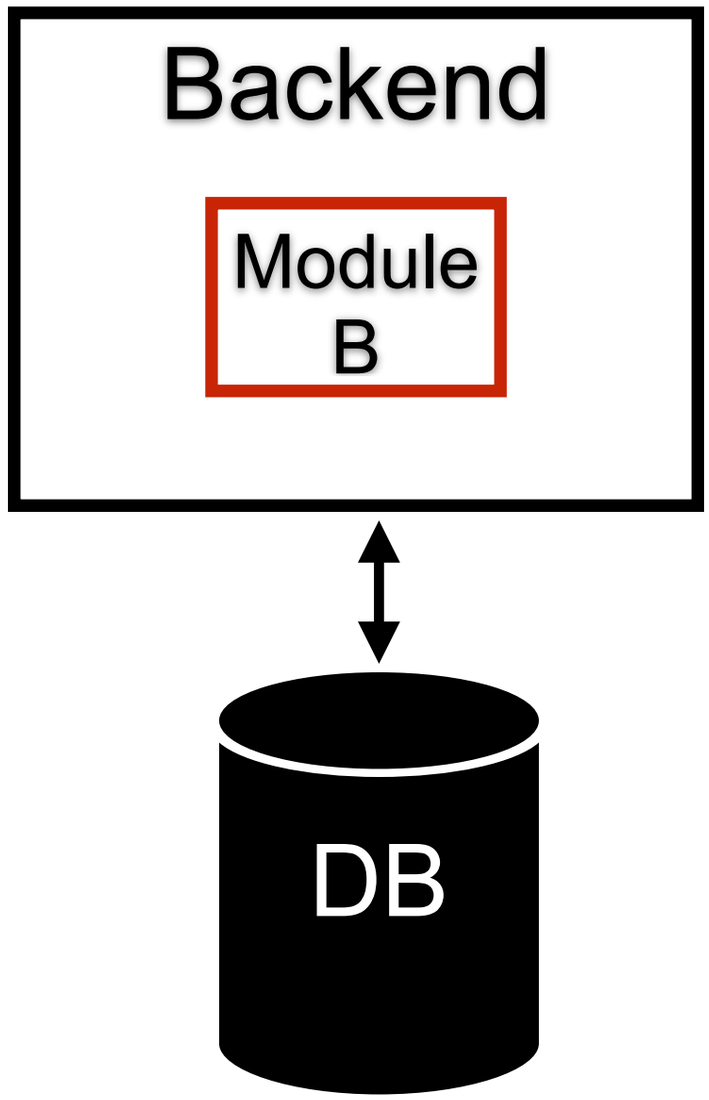


# How to scale ?



# Split to new service



# 12 factor app

THE TWELVE-FACTOR APP

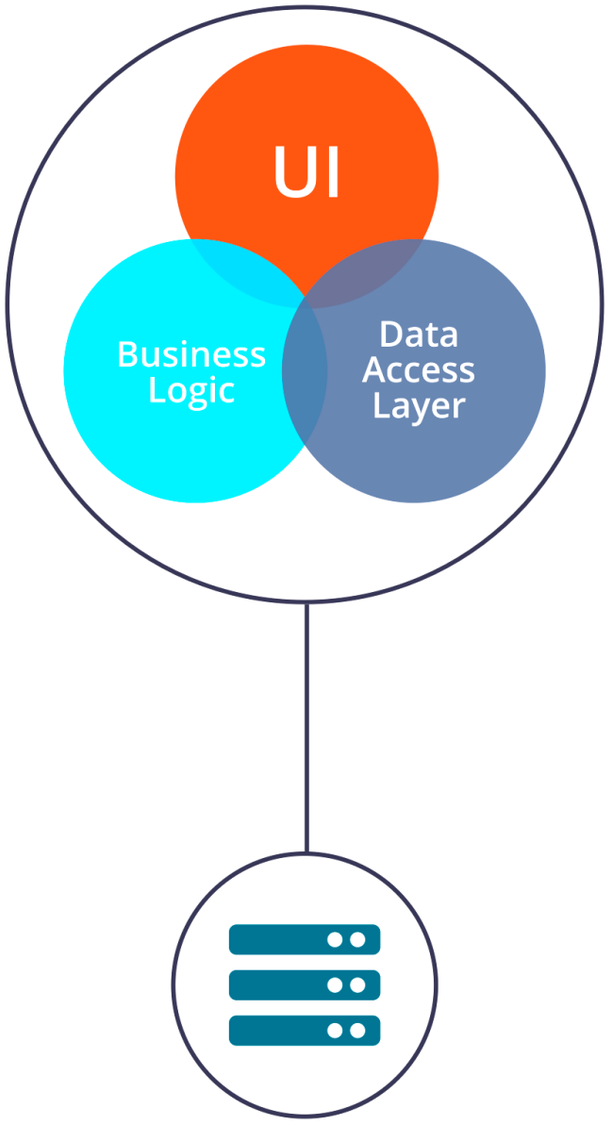
## INTRODUCTION

In the modern era, software is commonly delivered as a service: called *web apps*, or *software-as-a-service*. The twelve-factor app is a methodology for building software-as-a-service apps that:

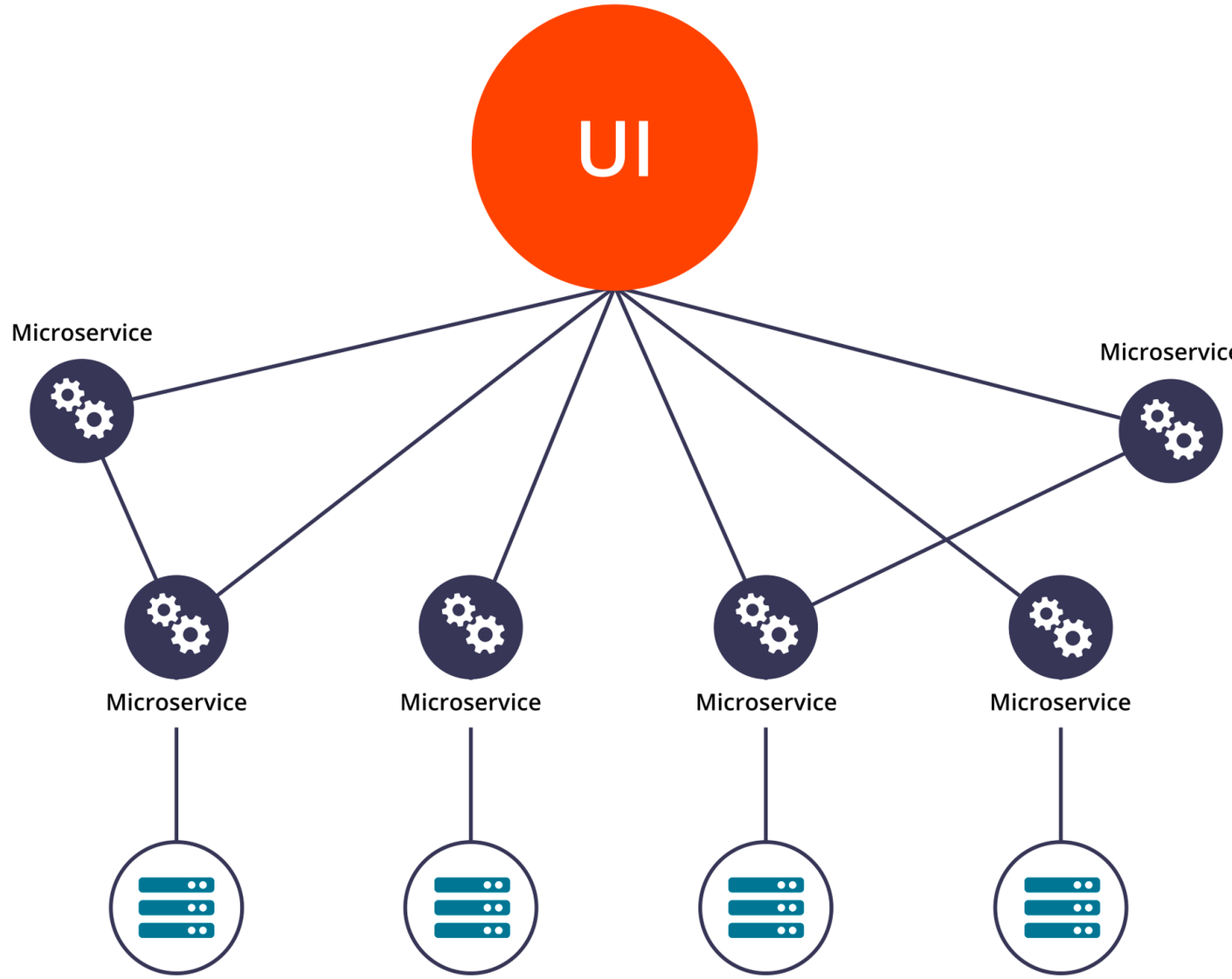
- Use **declarative** formats for setup automation, to minimize time and cost for new developers joining the project;
- Have a **clean contract** with the underlying operating system, offering **maximum portability** between execution environments;
- Are suitable for **deployment** on modern **cloud platforms**, obviating the need for servers and systems administration;
- **Minimize divergence** between development and production, enabling **continuous deployment** for maximum agility;
- And can **scale up** without significant changes to tooling, architecture, or development practices.

https://12factor.net/

# Microservices




Monolithic Architecture




Microservice Architecture

# Scalability testing for your architecture

# Scalability testing ?

Compute resource allocated based on dynamic demand

Low usage => small server

Increases usage => growing server size

Test your architecture

# What to check for in scalability testing ?

Too few resources

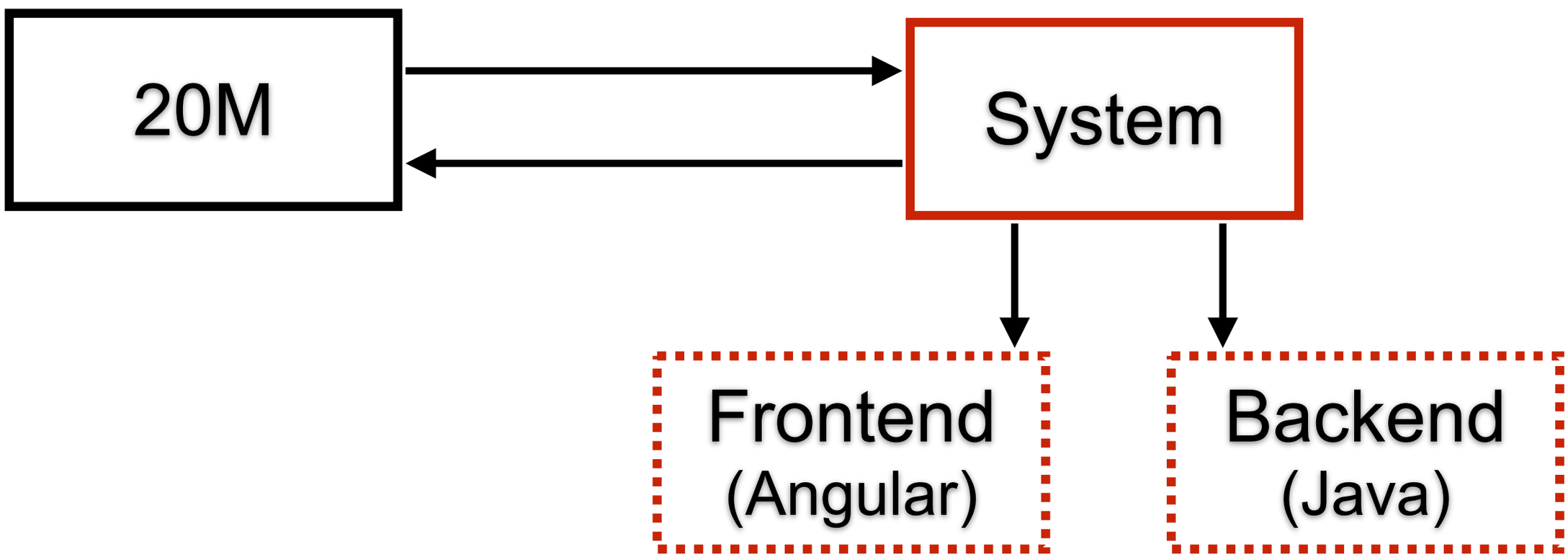
Too many resources

Frequently changing resource allocation

# Use cases

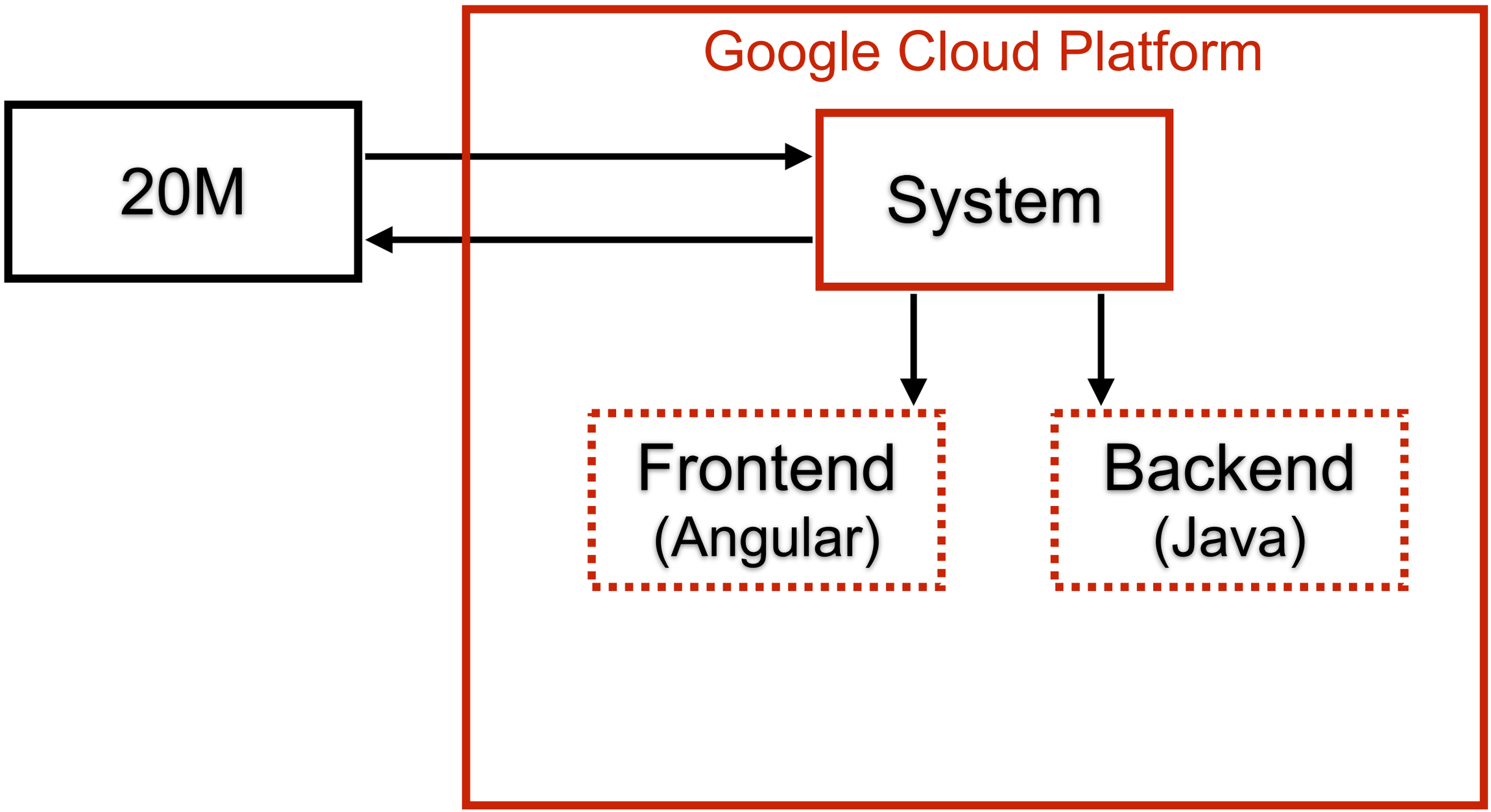
# Architecture ?

**20M** connections waiting to register….



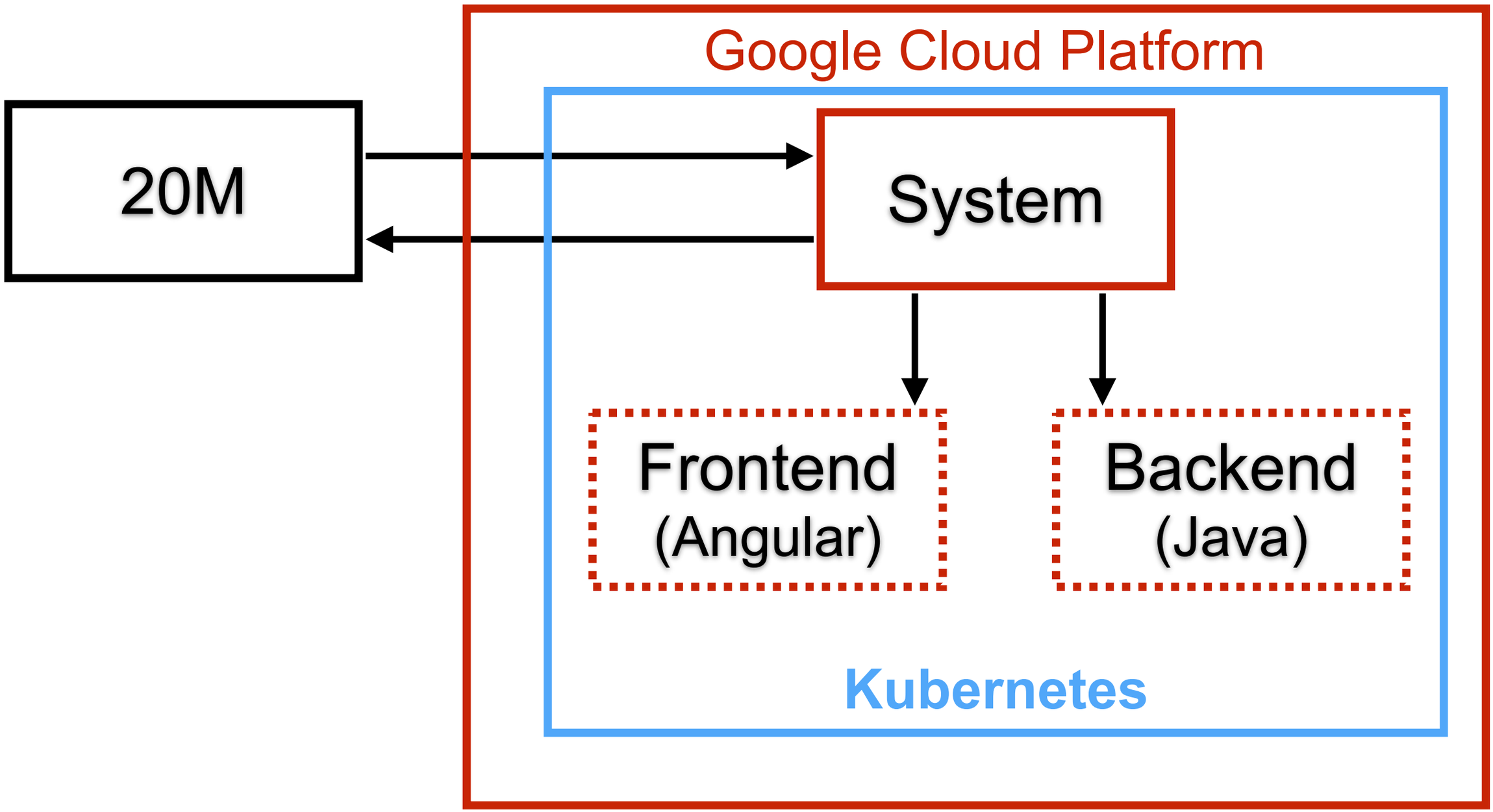
# Architecture ?

## Infrastructure at Google Cloud platform



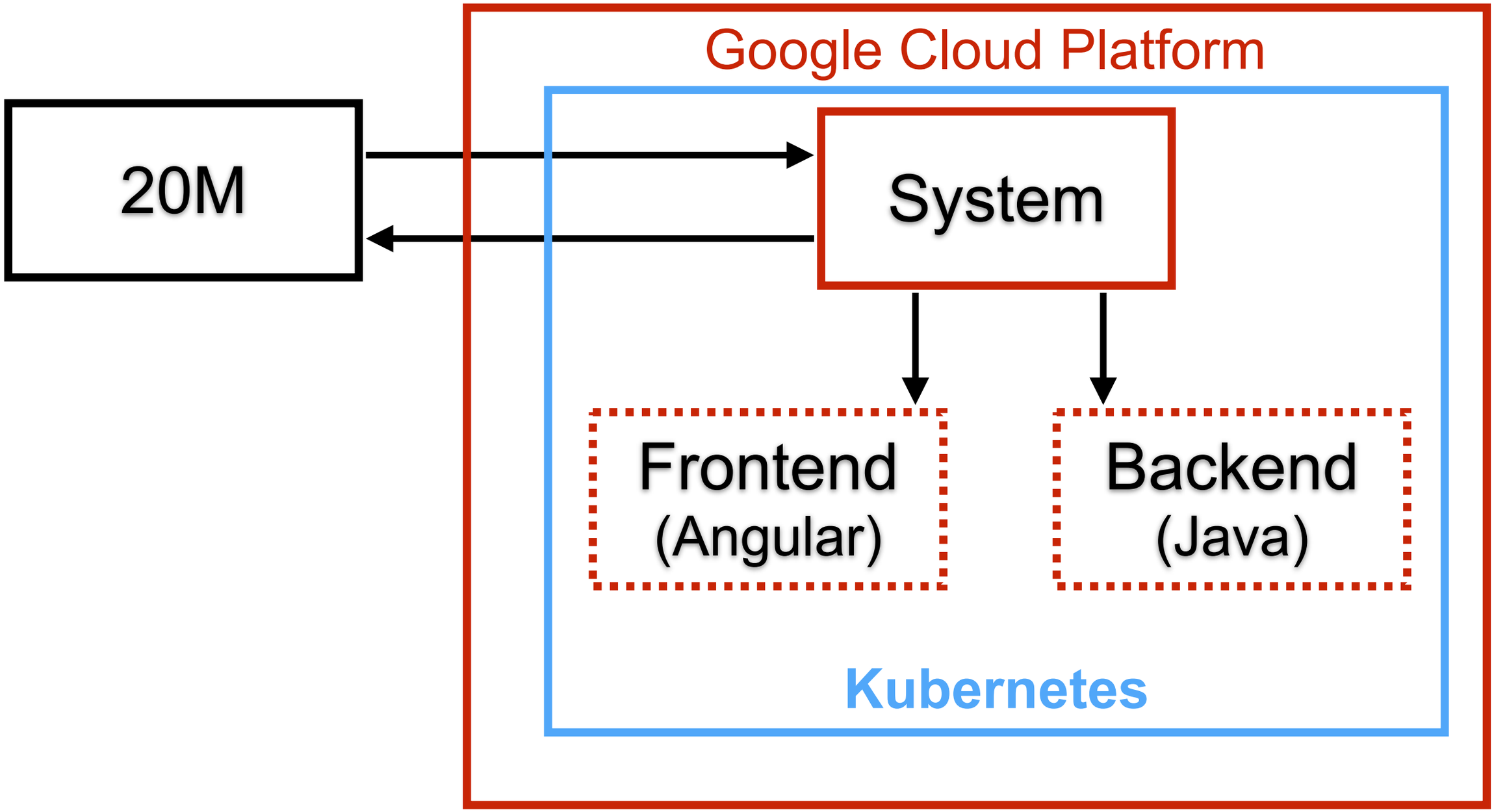
# Architecture ?

## Manage with Kubernetes (K8S)



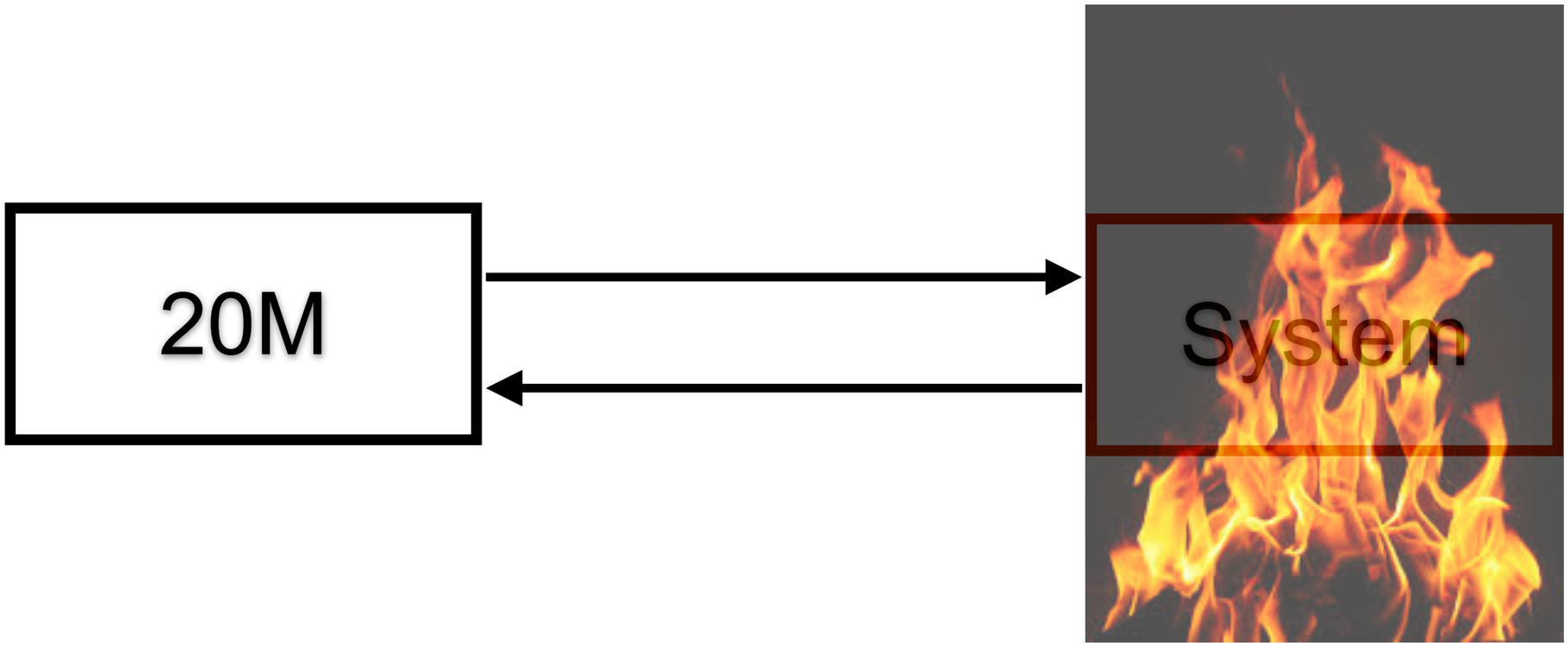
# Architecture ?

## Kubernetes and Horizontal Pods Autoscaling (HPA)



# 10 minutes after open system !!

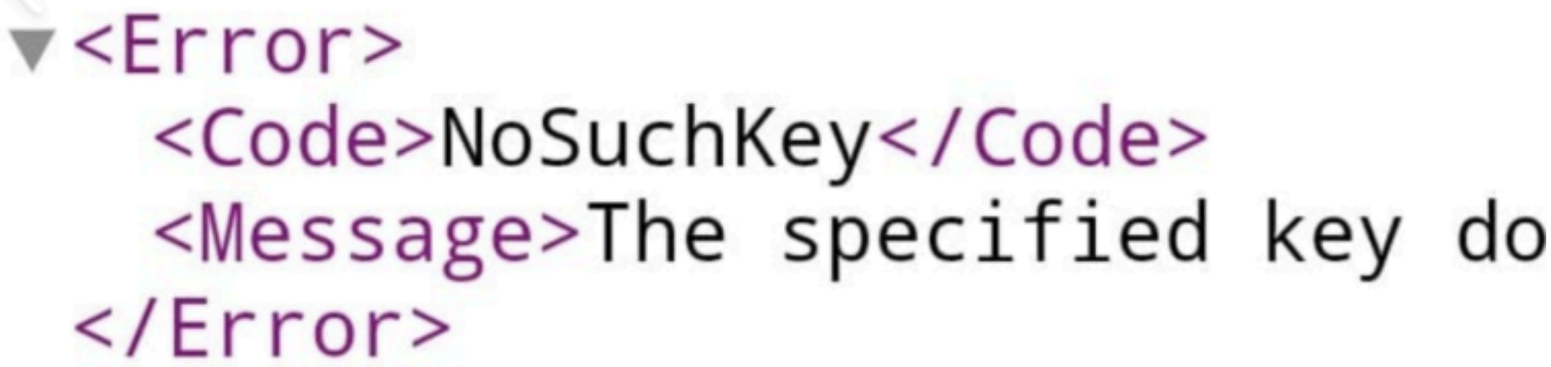
**20M** connections come to system !!



# 10 minutes after open system !!

# 10 minutes after open system !!

This XML file does not appear to



# 10 minutes after open system !!

**Error: Server Error**

**The server encountered a temporary error and could not complete your request.**

**Please try again in 30 seconds.**

# Restart ?

# Reset all system

# Discuss about business process !!

# Fixed

# Deploy service-by-service

# Monitoring system

# Manual scaling

# Repeat …

Monitoring system

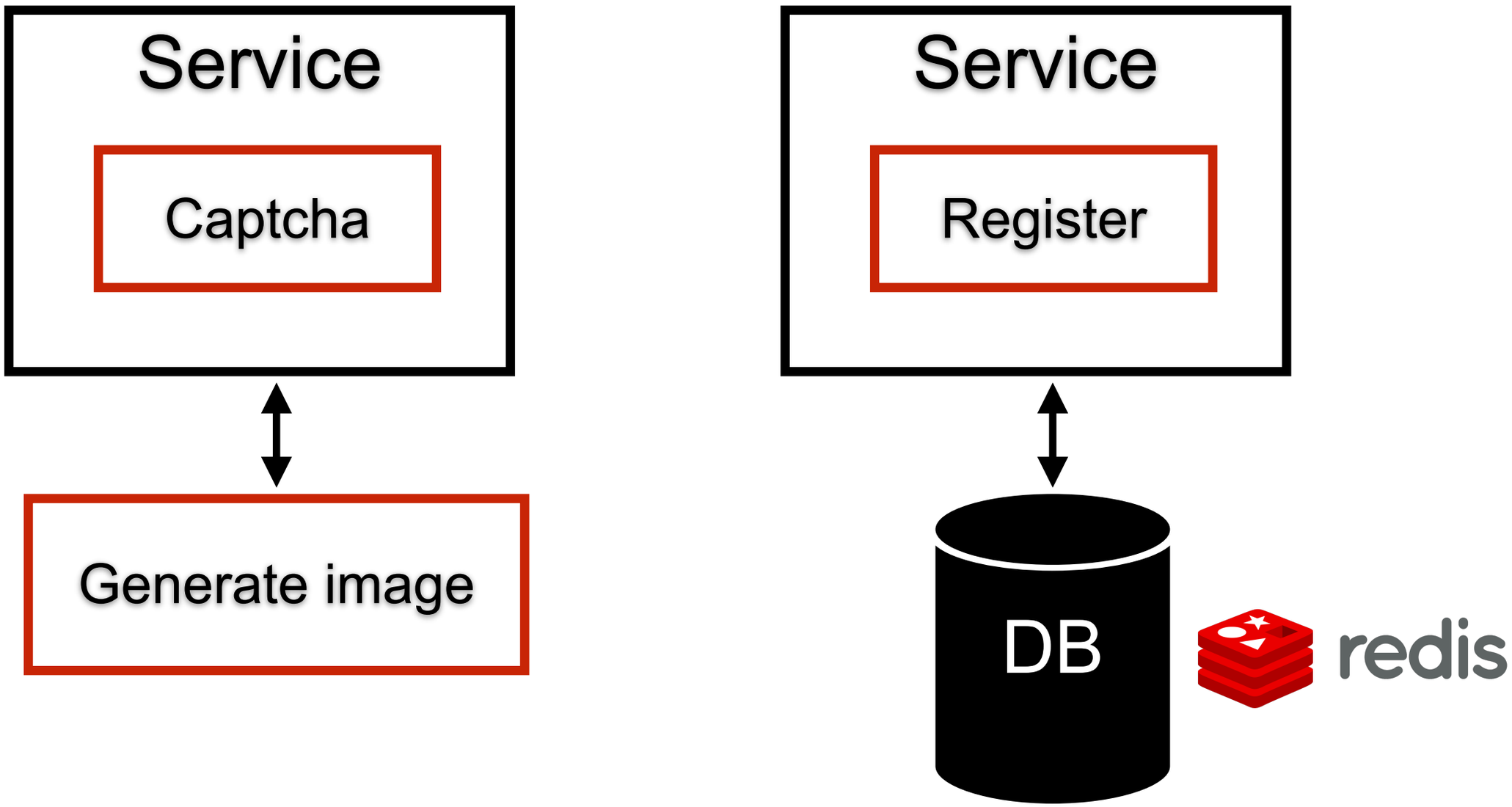
Deploy service-by-service

Monitoring system

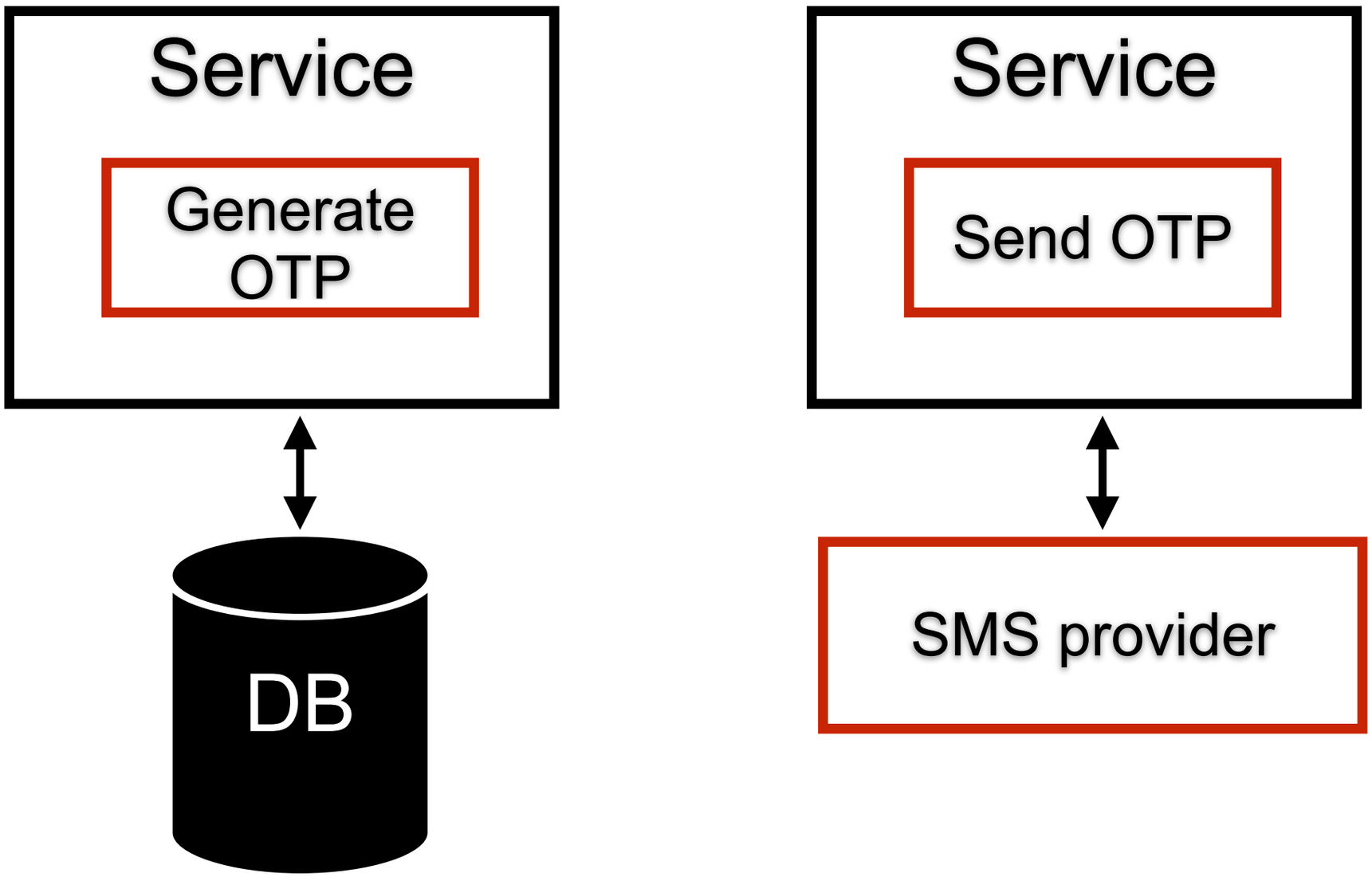
Manual scaling

Repeat …

# Split to new service



# Split to new service



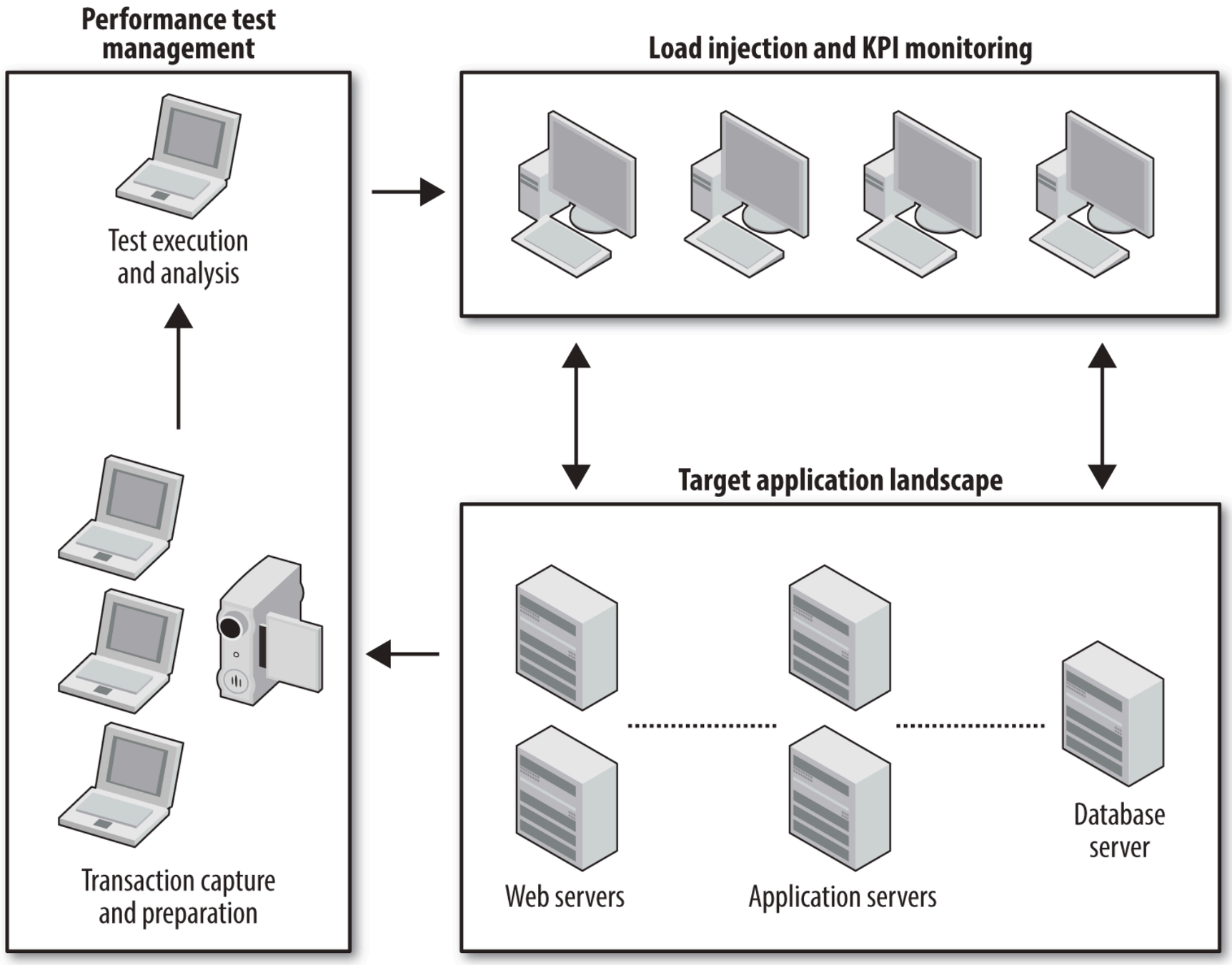
# Tools

# How to choose the testing tool ?

# Performance testing tool !!

Scripting module
Test management module
Load injectors
Analysis module
Optional module

# Performance testing tool !!



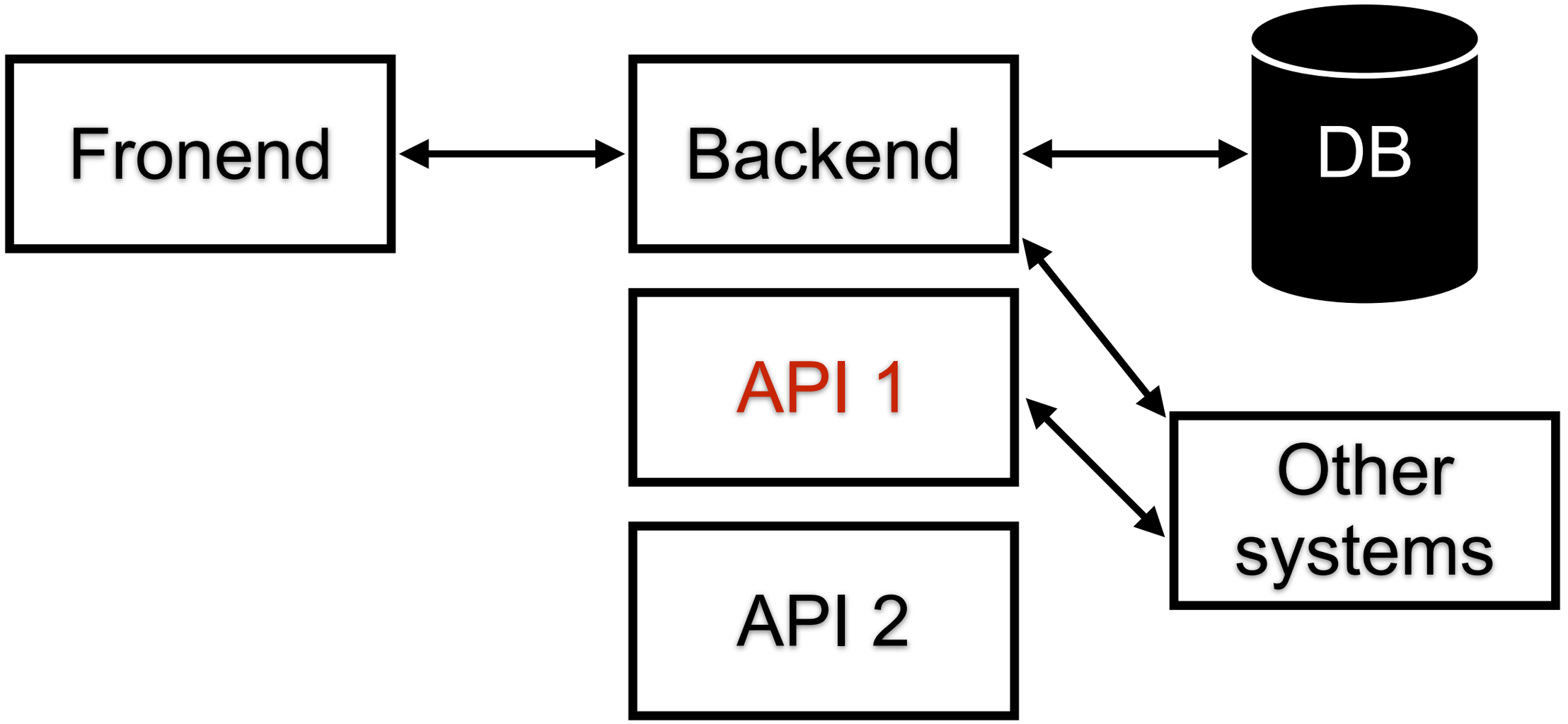
# How to choose ?

Protocol support
Licence model
Scripting effort
Solution vs load testing tool
In-house vs outsource
Software-as-a-Service (SaaS)

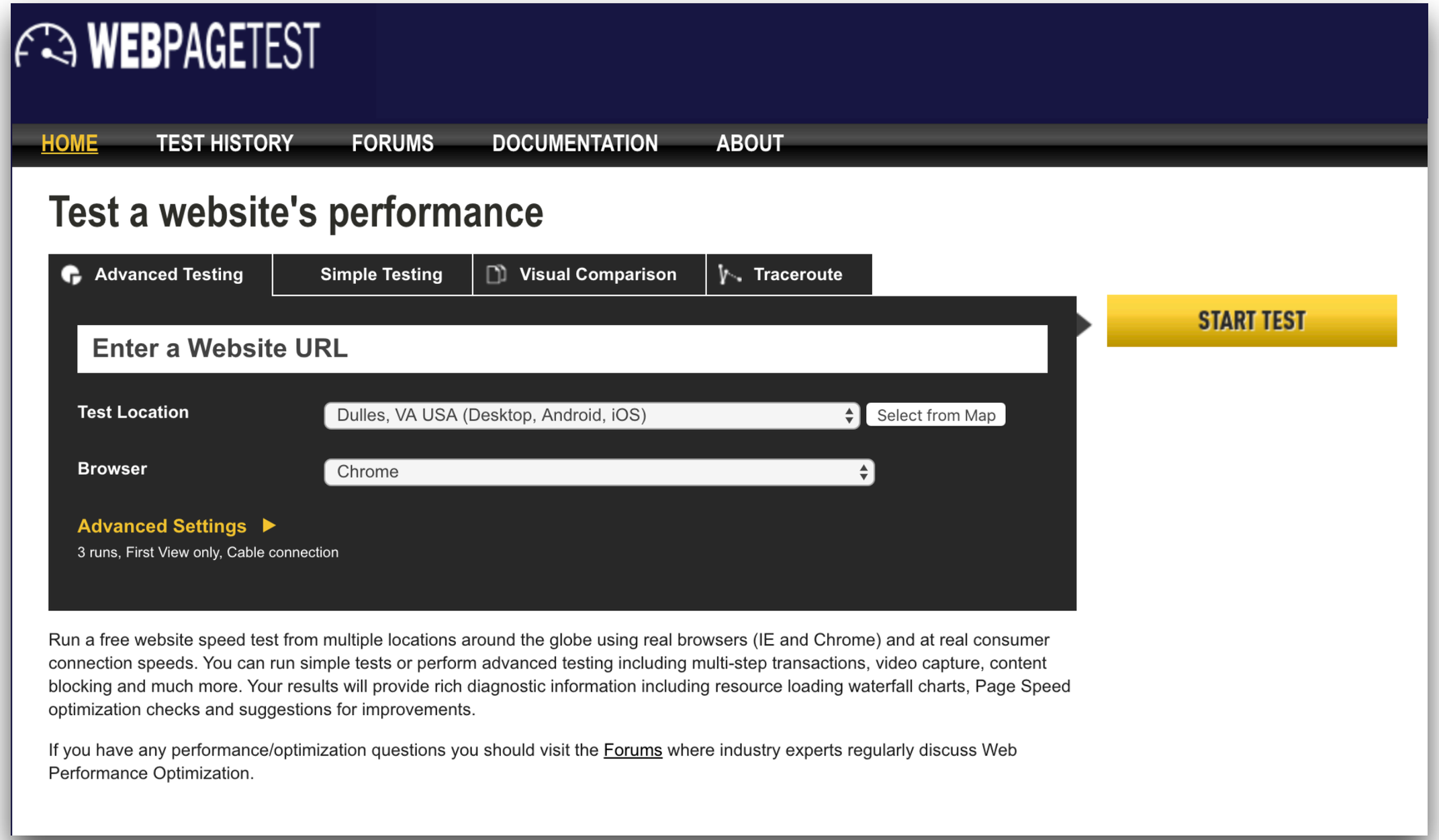
# Try to PoC (Proof of Concept)

# Effective performance testing
# Must use Automation

# Start with goals ?



# How responsive a webpage ?

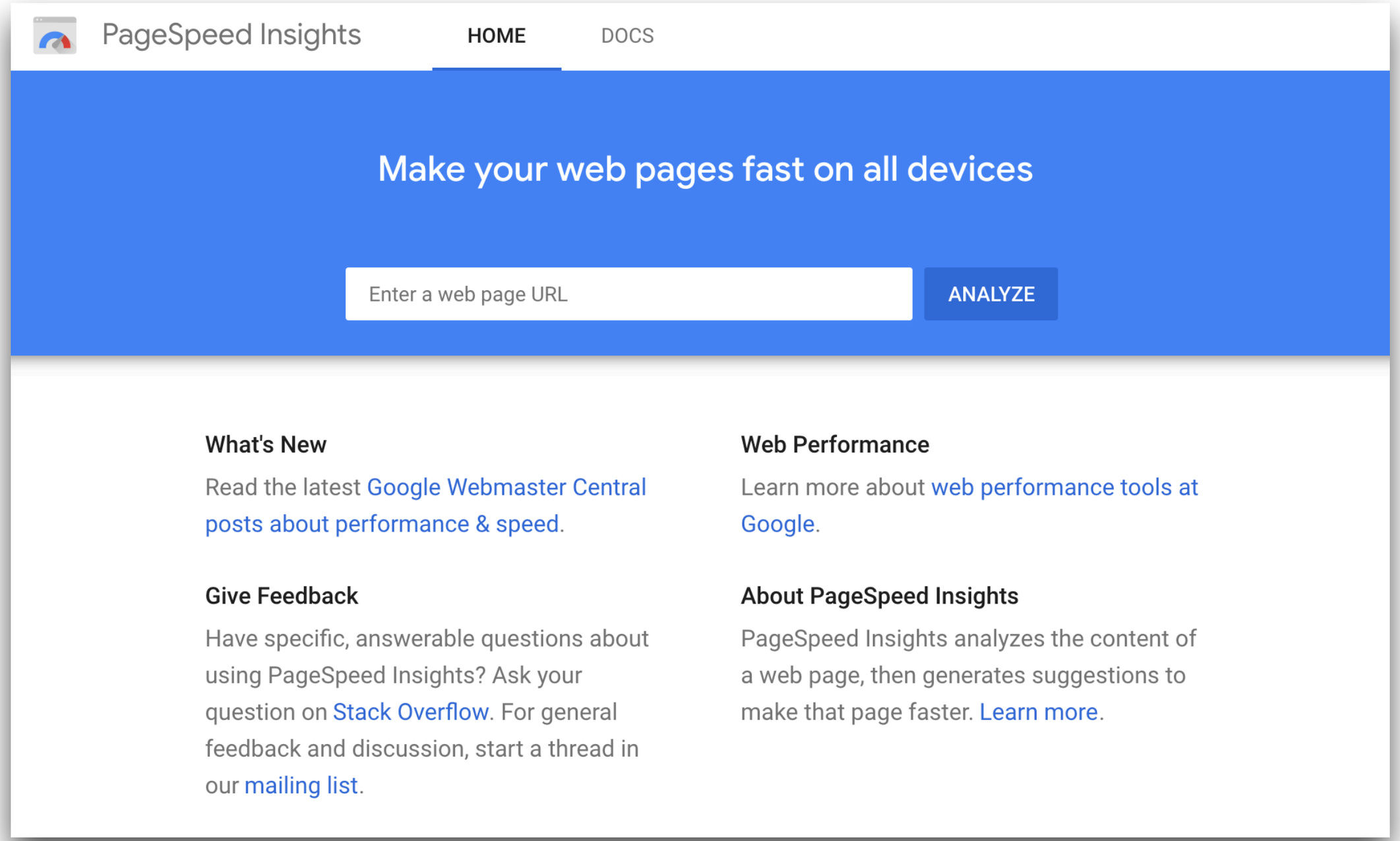



https://www.webpagetest.org/

# How responsive a webpage ?

https://www.webpagetest.org/

# How responsive a webpage ?

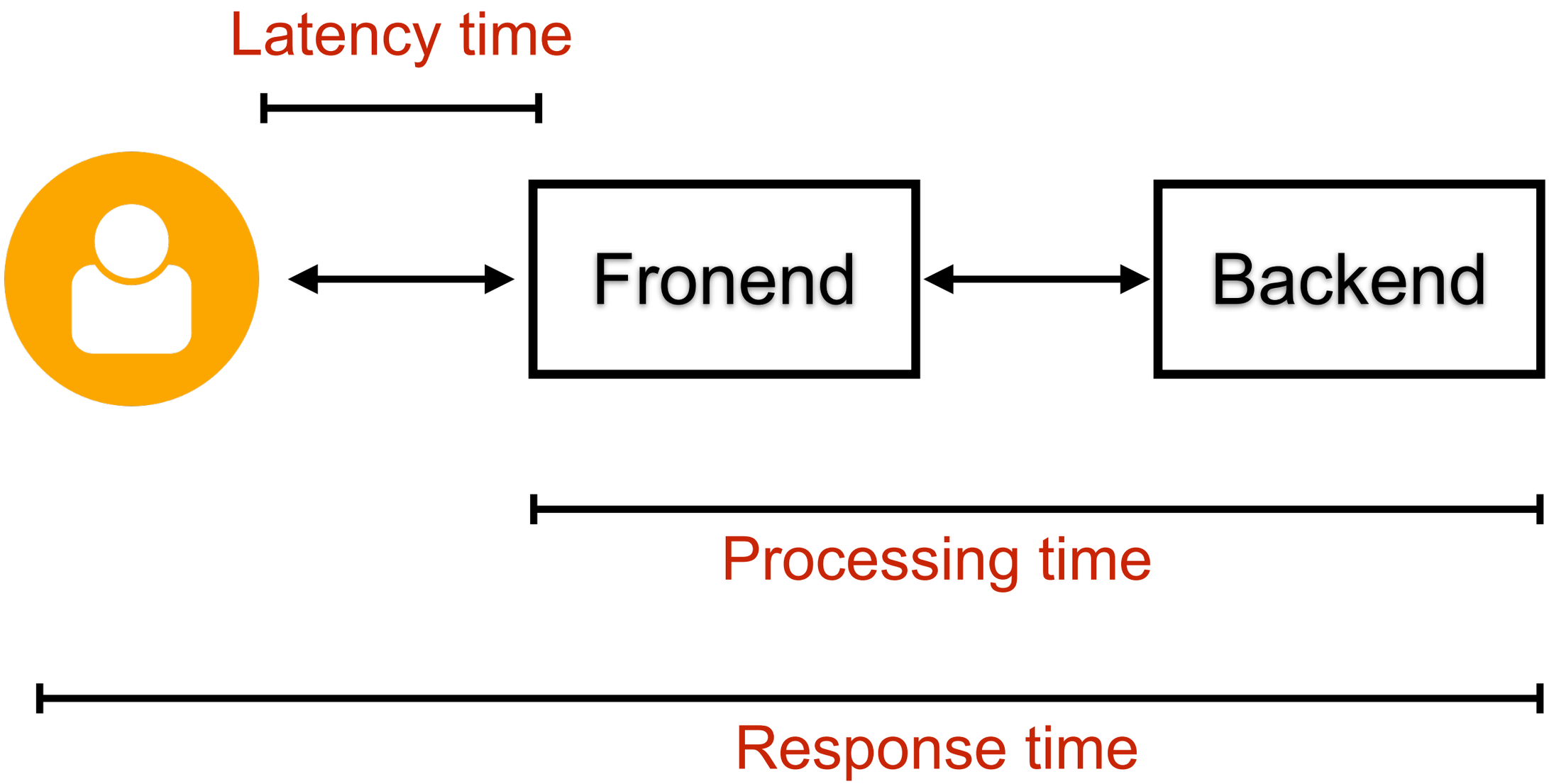



https://developers.google.com/speed

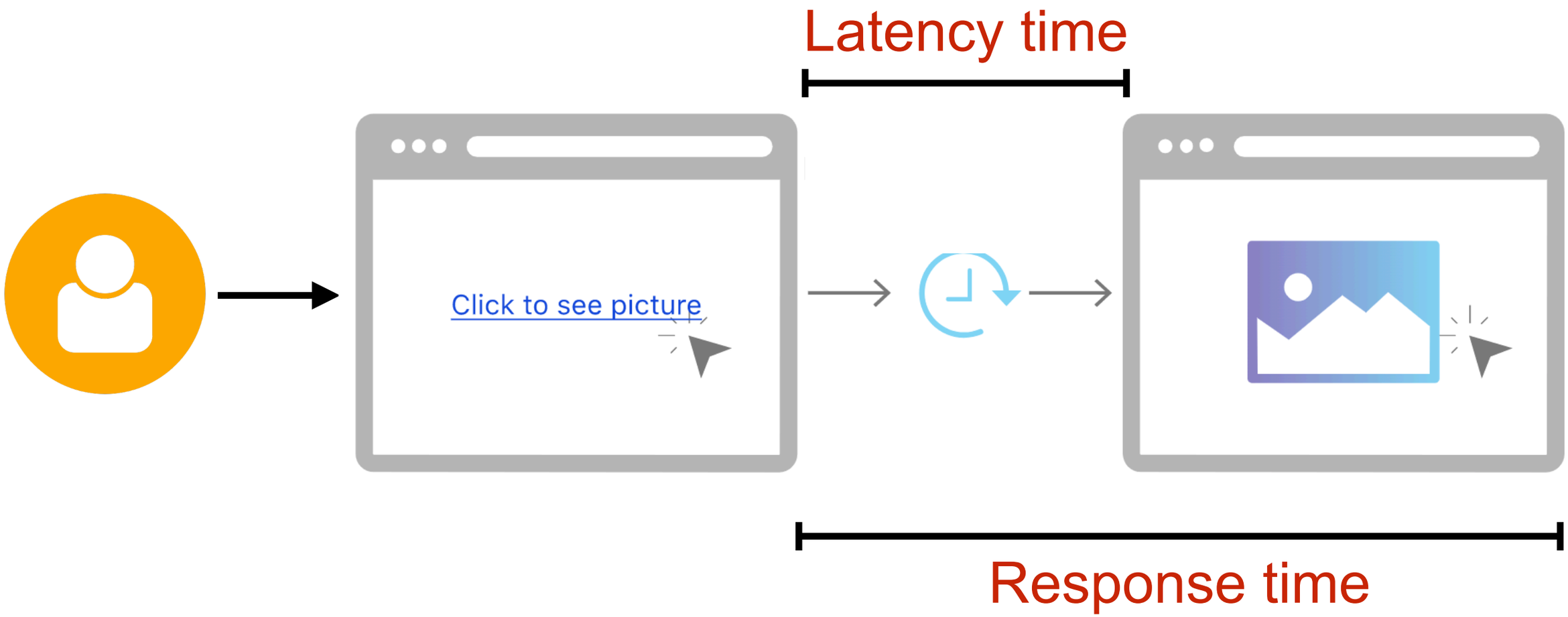
# Non-code performance issue

Latency
Network speed
Human perception

# Latency ?



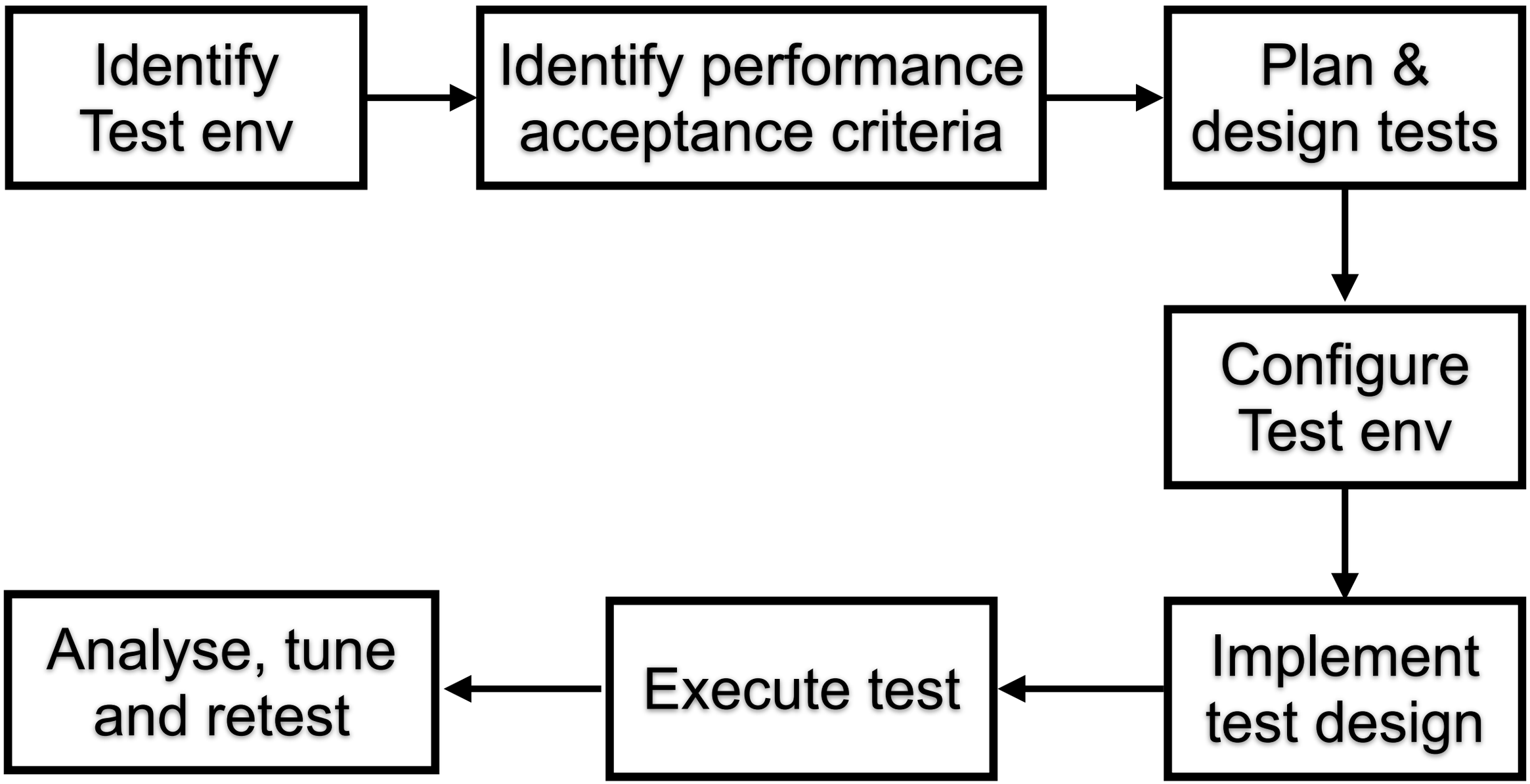
# Latency vs Response time



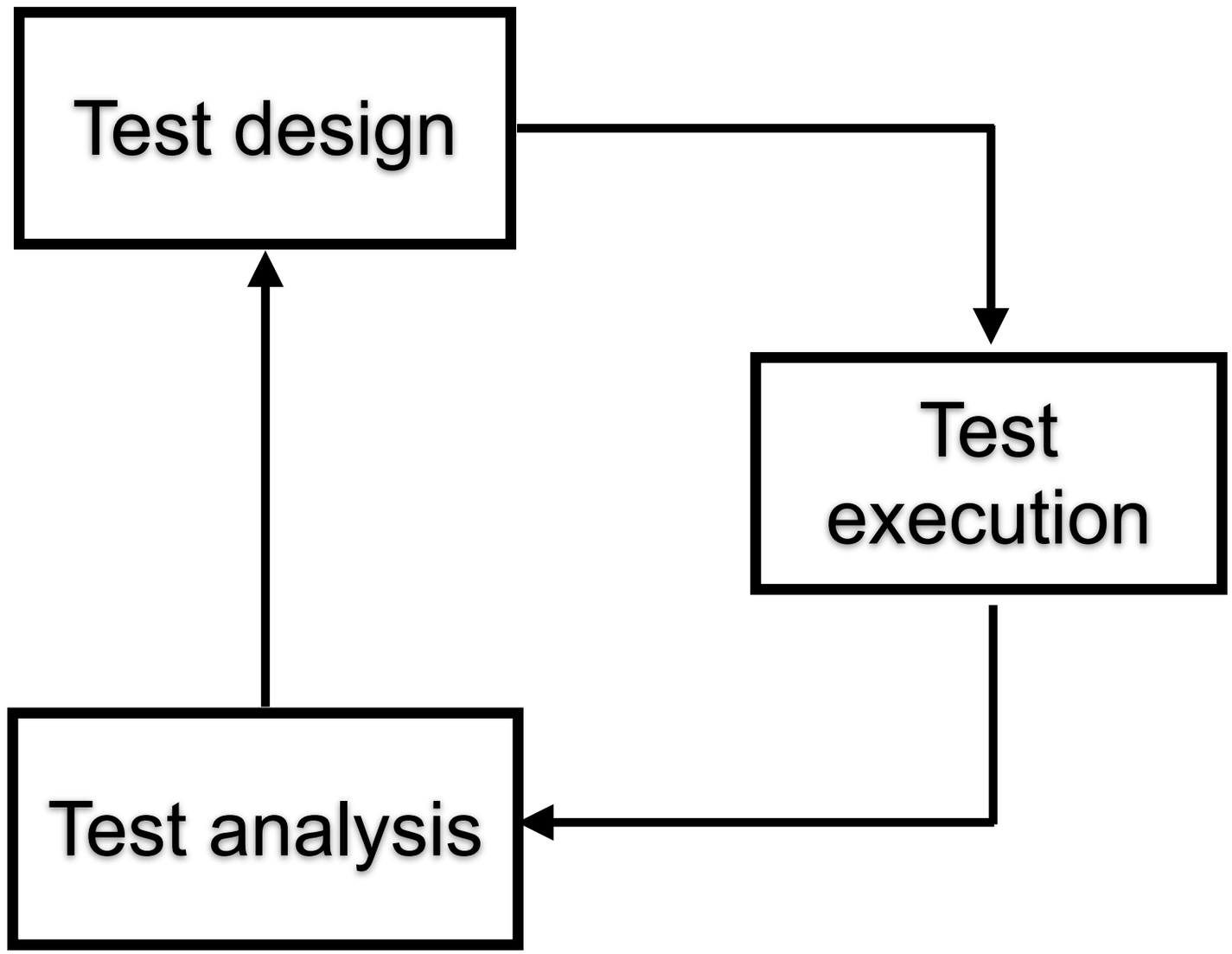

Response time = Latency time + **Processing time**

# Performance testing process

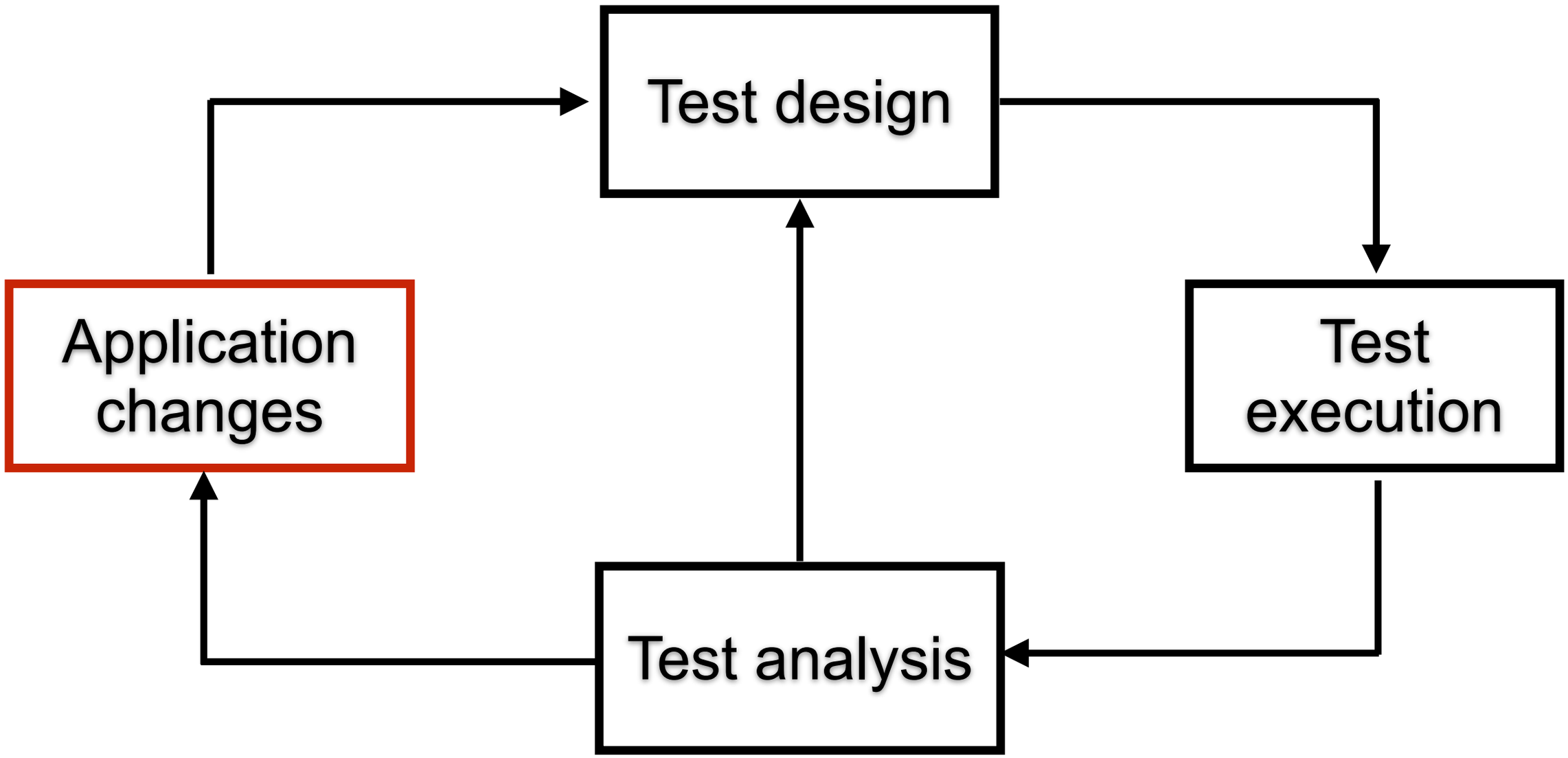
# Process



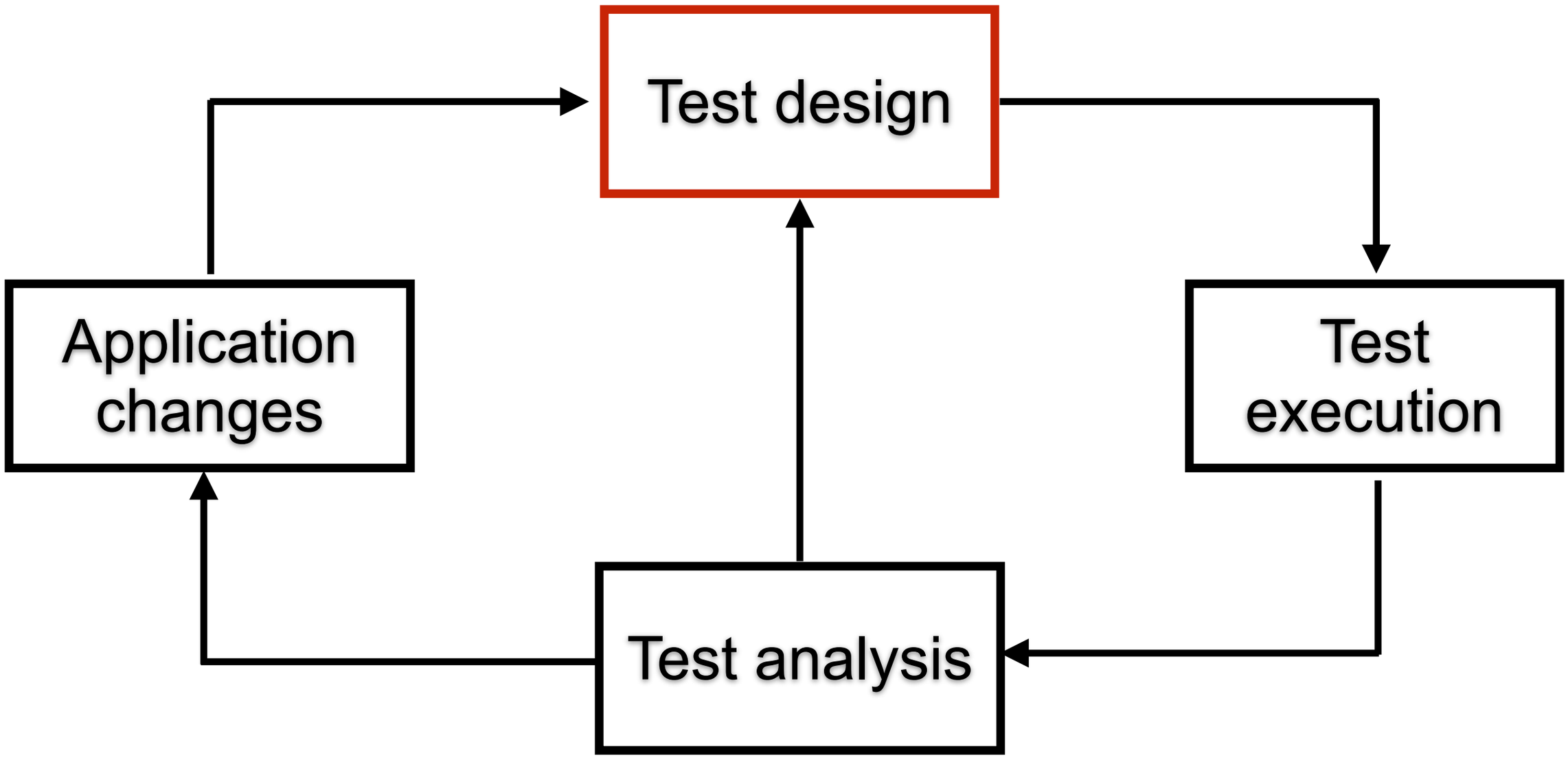
# Testing process



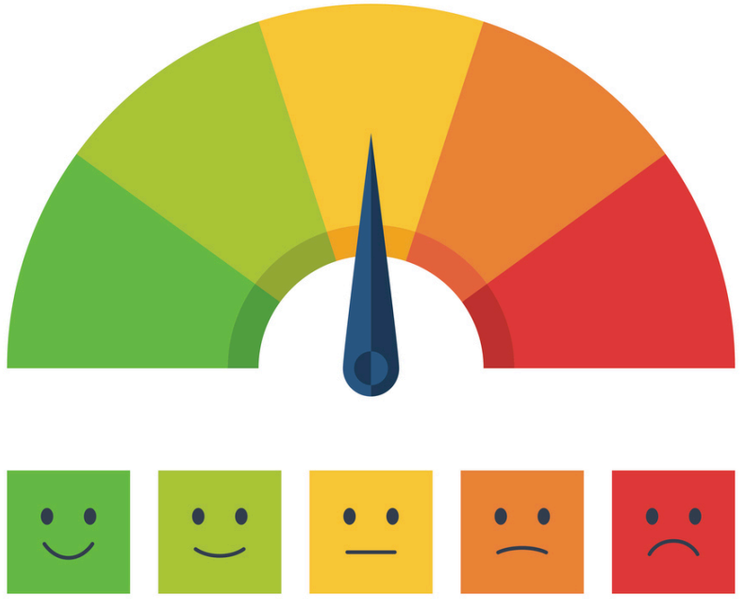
# Testing process



# Start with design



# What to measure ?



# Measure timing

What times are you checking ?
Help you understand the user’s experience ?
What questions you are trying to answer ?
Every time when you need ?

# Measure stability

**Errors ?**

Understand and compare error rates
Find in logs (app/server logs)

# Measure stability

**Server-side ?**

CPU, memory, I/O usage

Queued requests and thread utilization

# Measure analytics

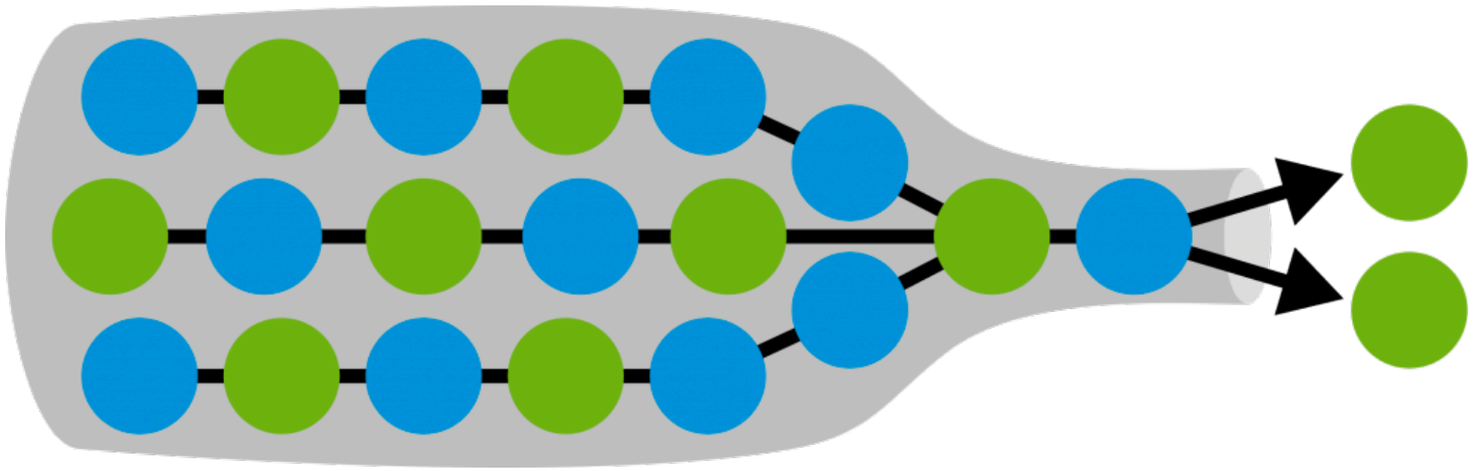
## Instrumentation

Consider performance metrics on production

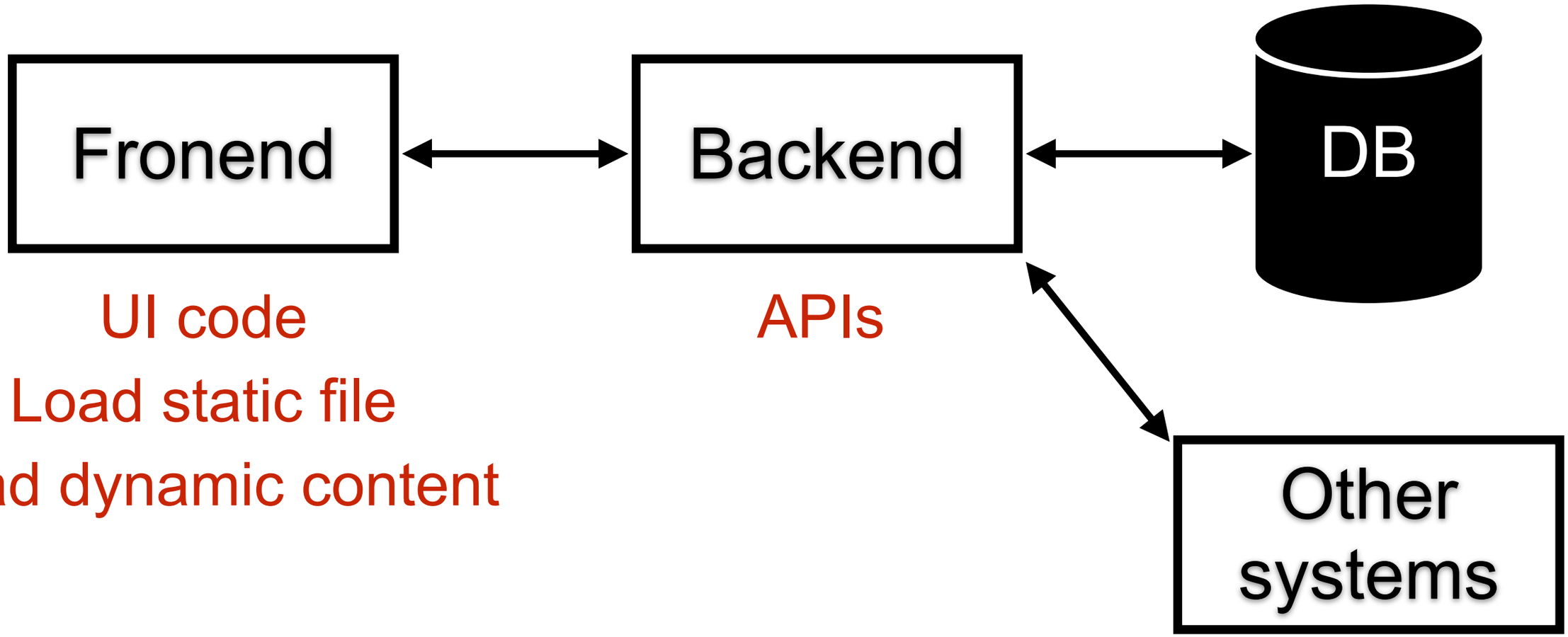
Discover popular actions

*“Understand performance impact that user care about”*

# Understand bottleneck



# Find valuable problems




UI code

Load static file

Load dynamic content

APIs

# Potential bottlenecks

CPU, memory, file I/O
Third-party application
Network latency
Design issue

# Monitoring results

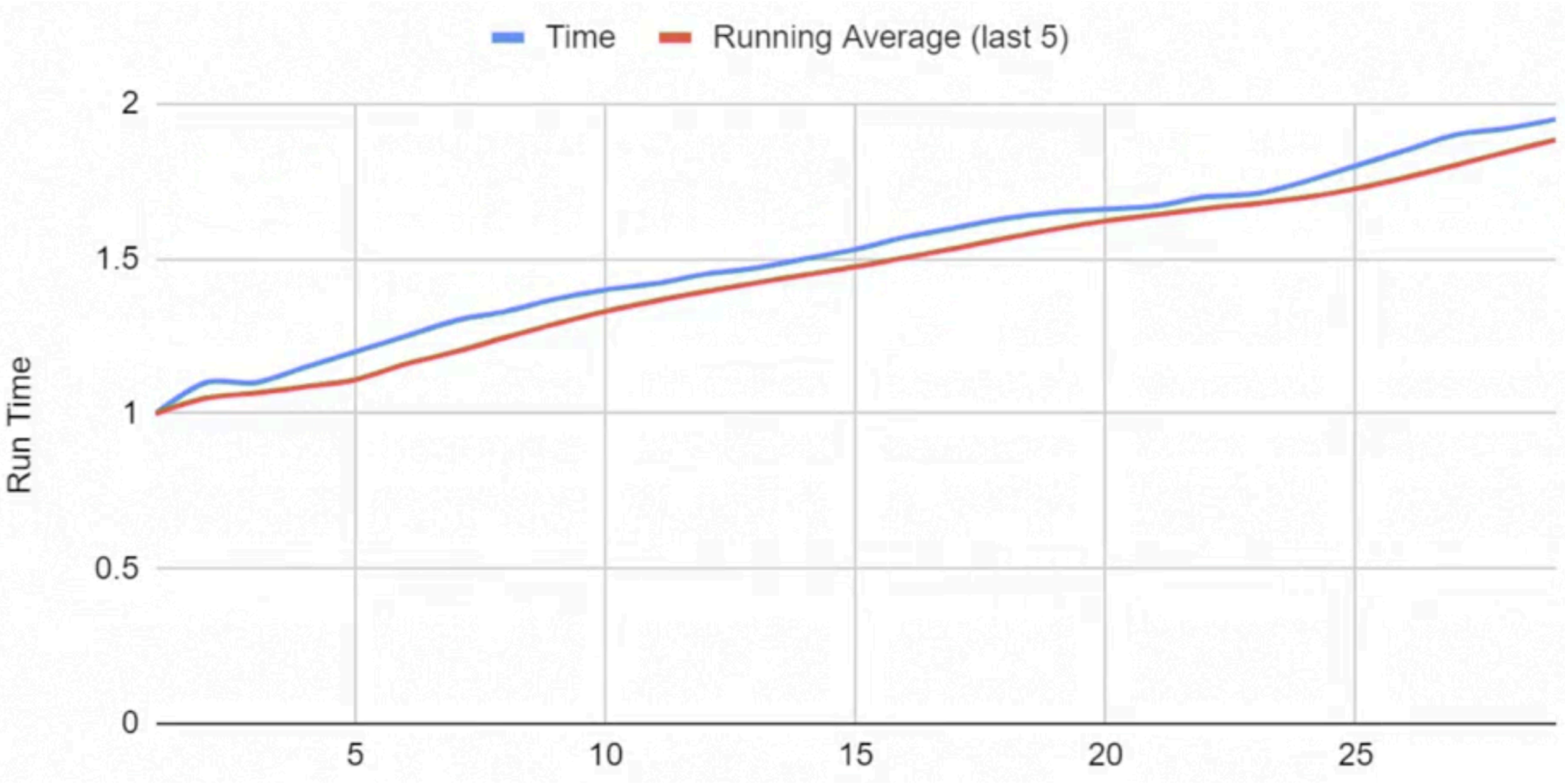
# Challenge !!

How do we **know** when system have issues or slowdown ?

Performance results have a lot of **variation**

# Good or bad ?

# Good or bad ?

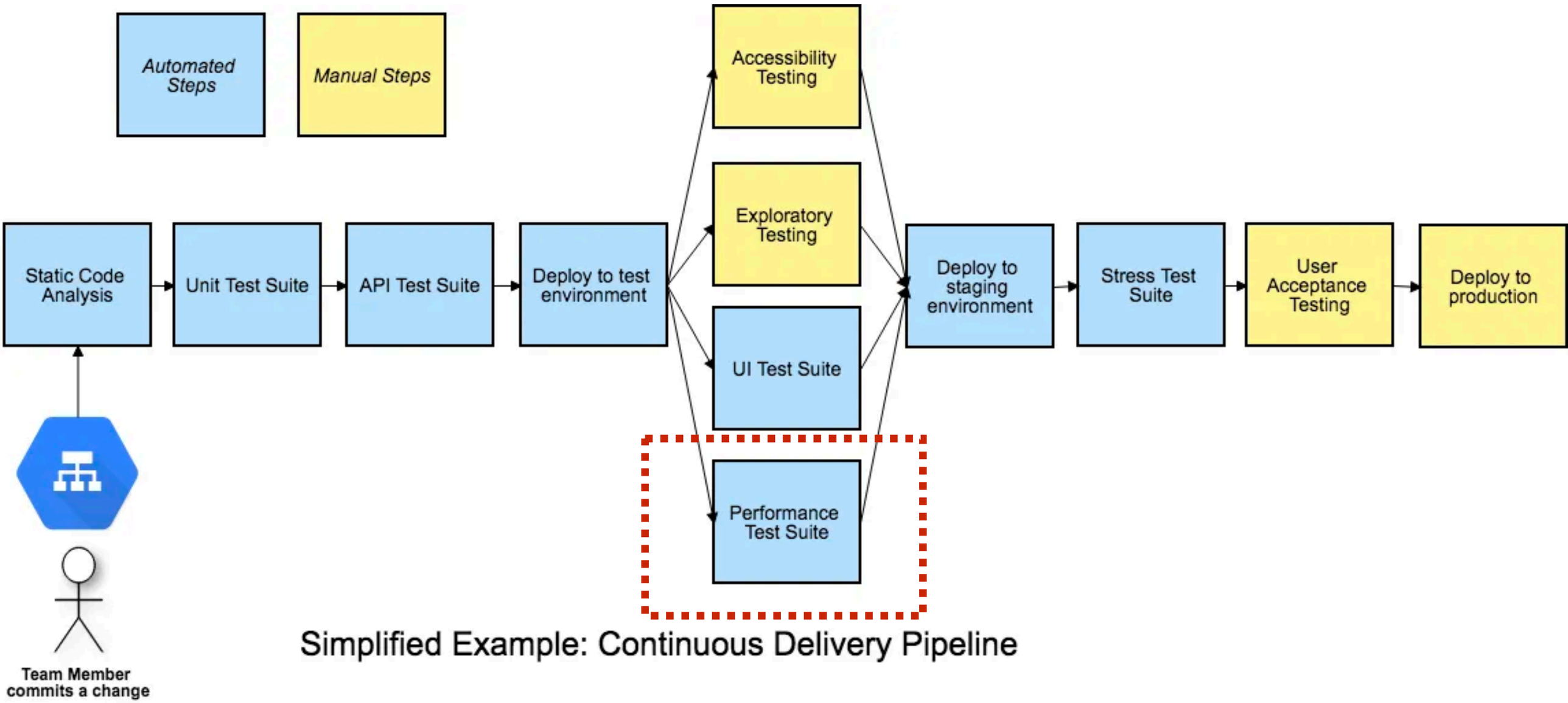


# Good monitoring

Check more than on performance indicator
Have alerts be actionable
Account for test variation

# Pipeline

# Pipeline




Simplified Example: Continuous Delivery Pipeline

# Tools

# Performance test tools

ApacheBench

ARTILLERY.IO

Drill

Gatling

HEY

APACHE JMeter™

k6

LOCUST

Siege

A distributed Load Testing Tool TSUNG

Wrk

https://k6.io/blog/comparing-best-open-source-load-testing-tools

# Goad

Goad is an AWS Lambda powered, highly distributed, load testing tool built in Go for the 2016 Gopher Gala.

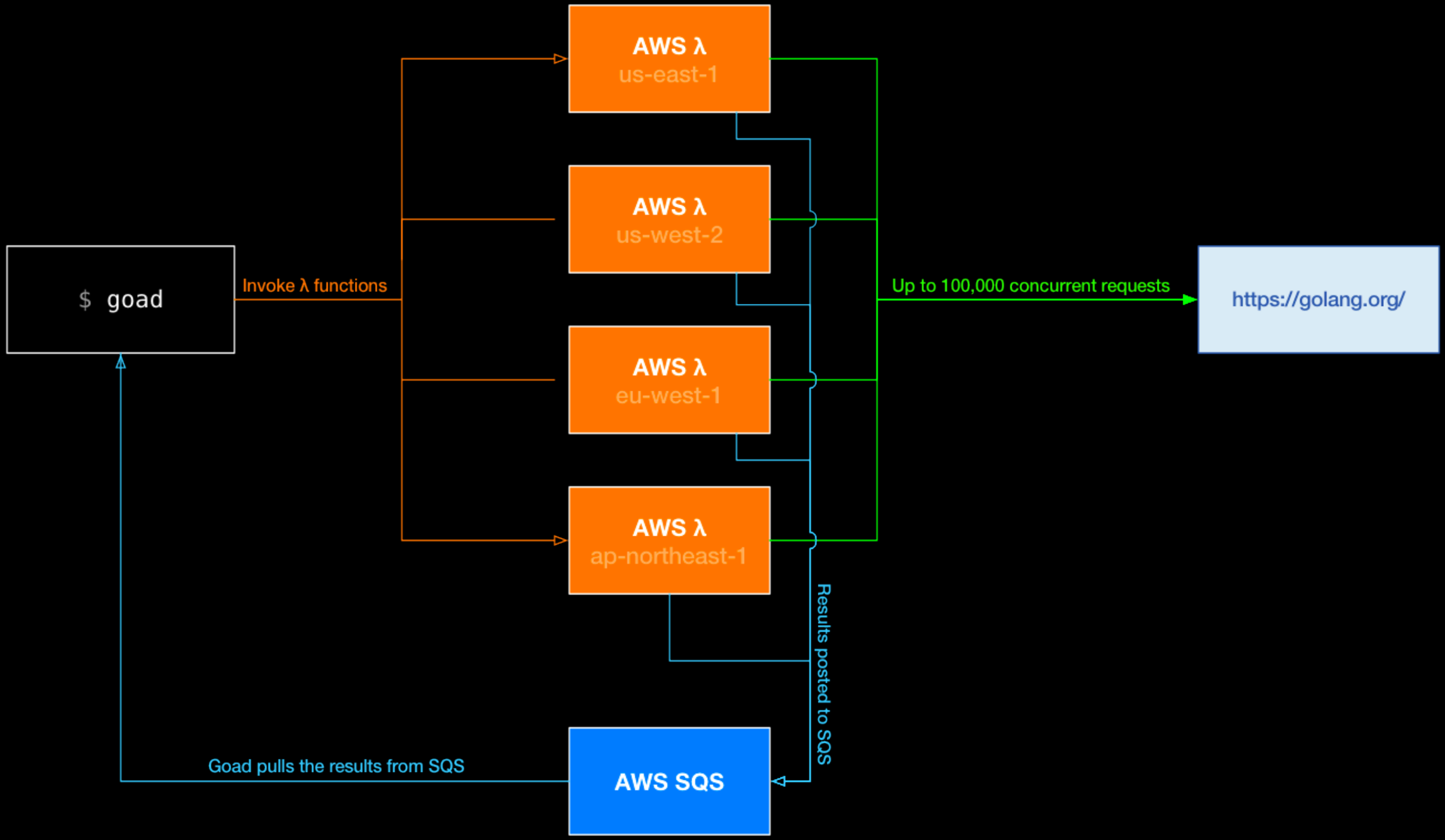
**Go + Load ⇒ Goad**

Downloads for macOS, Linux, and Windows

or get the source code from GitHub

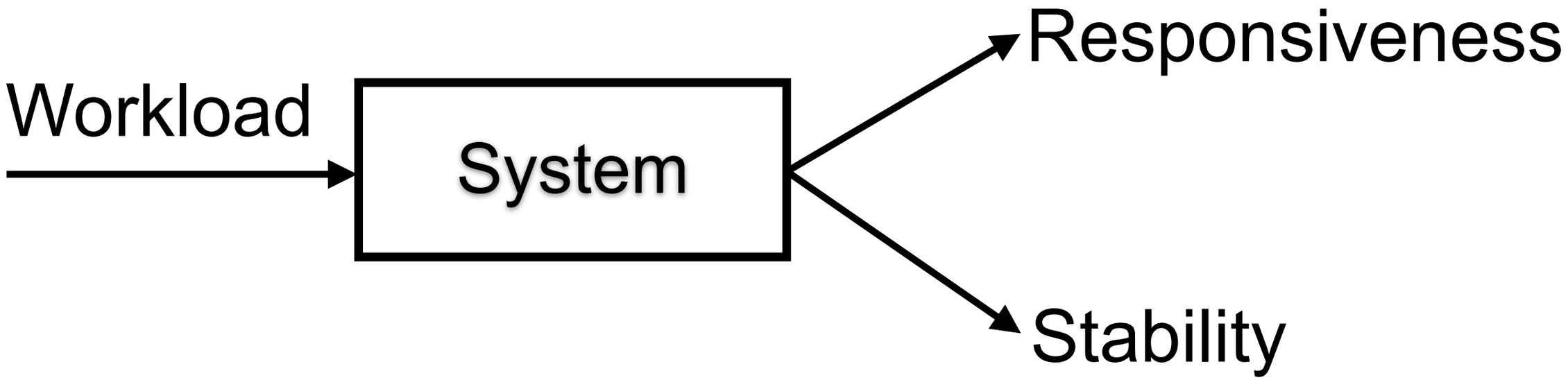
G O A D

https://goad.io/

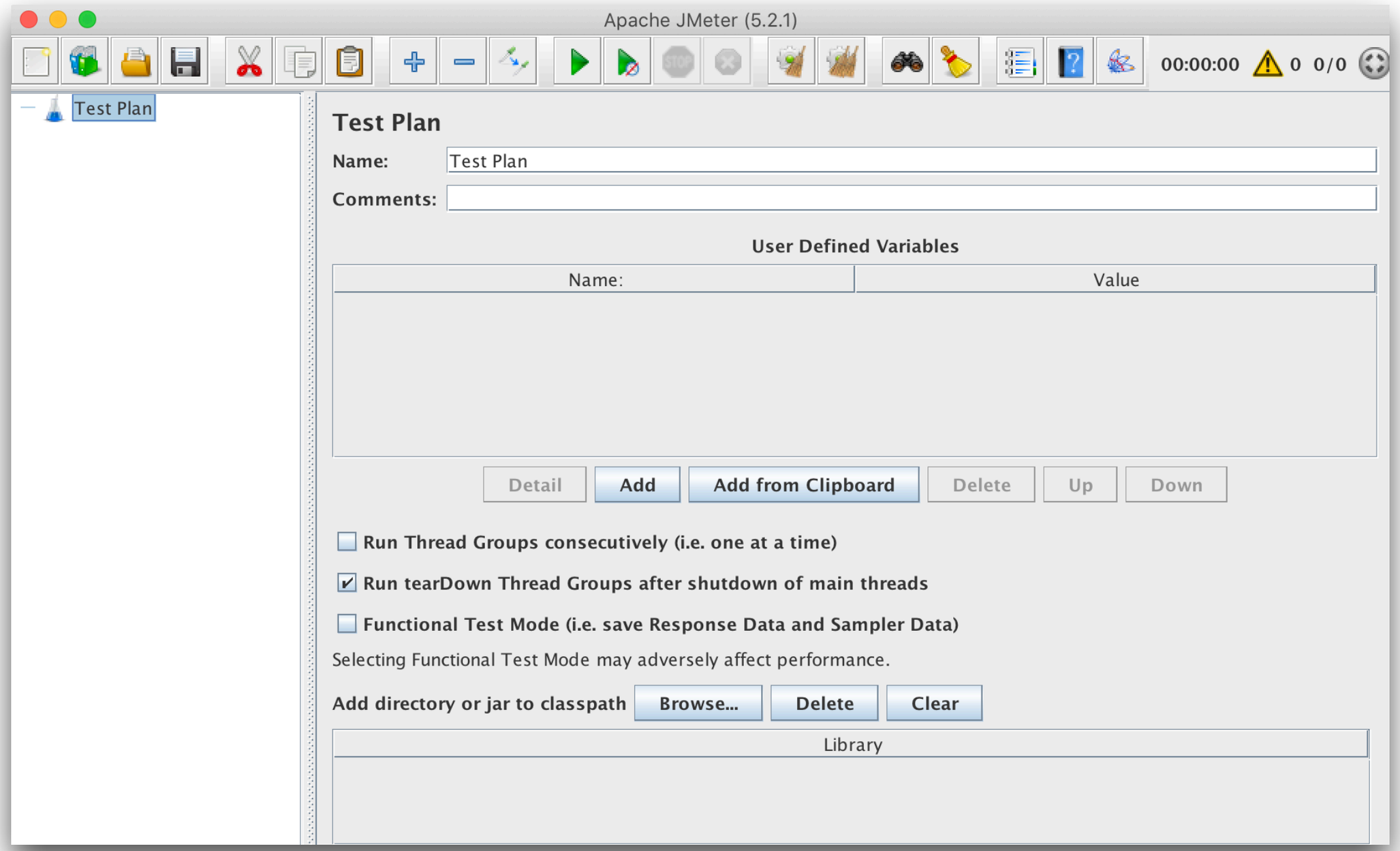


# JMeter workshop

# Create workload with JMeter



# JMeter




https://jmeter.apache.org/

# JDK (8, 11, 12)



https://openjdk.java.net/

# JMeter plugins

JMeter Plugins

jmeter-plugins.org

Every load test needs some sexy features!

NEW Online JMX Editor

Install | Browse Plugins | Documentation | Usage Statistics | Support Forums | JMX Editor | Star

## Custom Plugins for Apache JMeter™

APACHE JMeter™

This project is an independent set of plugins for Apache JMeter, the popular Open-Source load and performance testing tool.

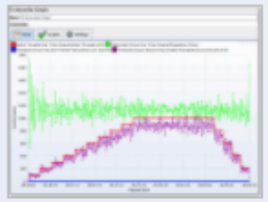
This catalogue lists plugins available for use with Plugins Manager. If you're first time here, consider installing Plugins Manager into your JMeter.

*Items found: 82*

Search...

### Composite Timeline Graph

Graph that is able to show several other graphs data in single place



ID: jpgc-graphs-composite

Users: 10197

Download Versions: 2.0

Maven Artifact: kg.apc:jmeter-plugins-graphs-composite:2.0

### Dummy Sampler

Debugging sampler that just generates result as you specified. Very convenient to debug your complex scripts

ID: jpgc-dummy

Users: 17628

Download Versions: 0.1, 0.2, 0.3, 0.4

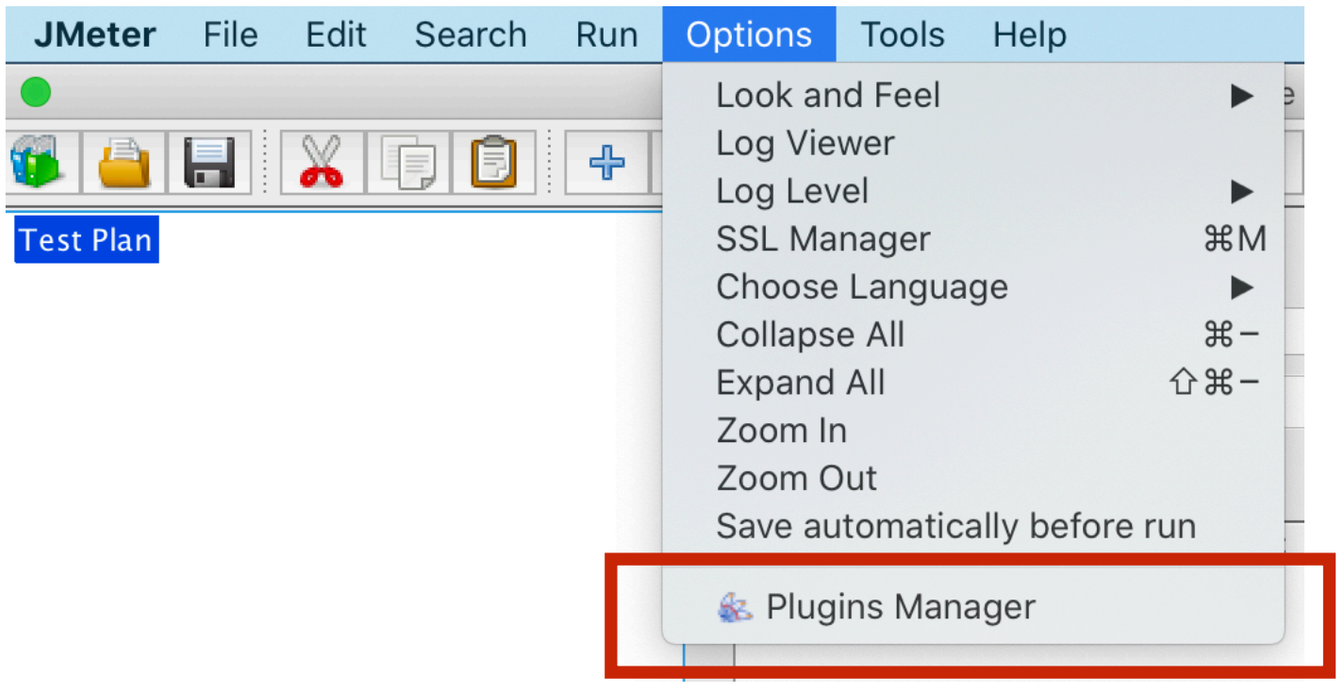
Maven Artifact: kg.apc:jmeter-plugins-dummy:0.4

https://jmeter-plugins.org/

# JMeter plugins

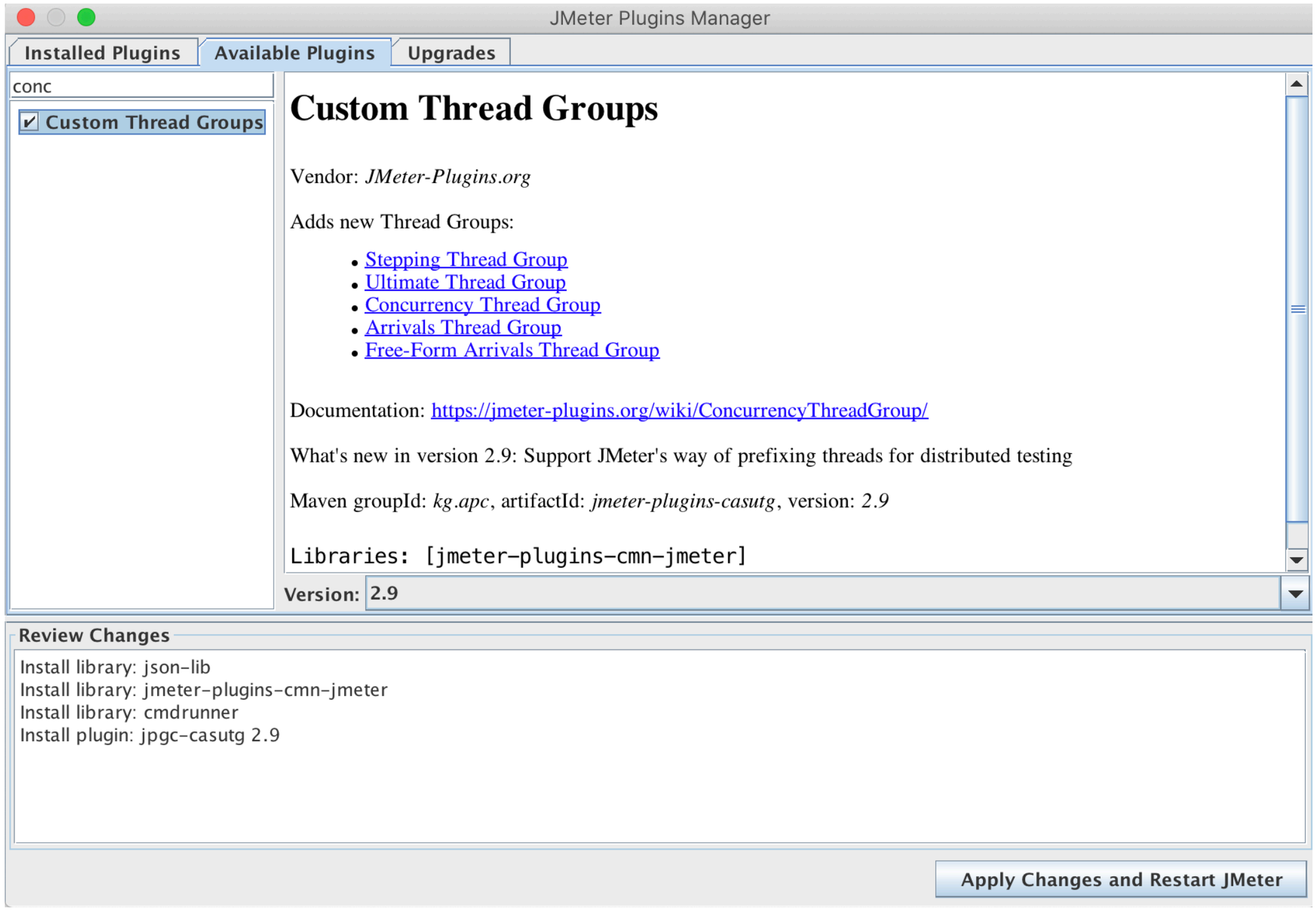
Copy jar file to **$JMETER_HOME/lib/ext**

Restart JMeter

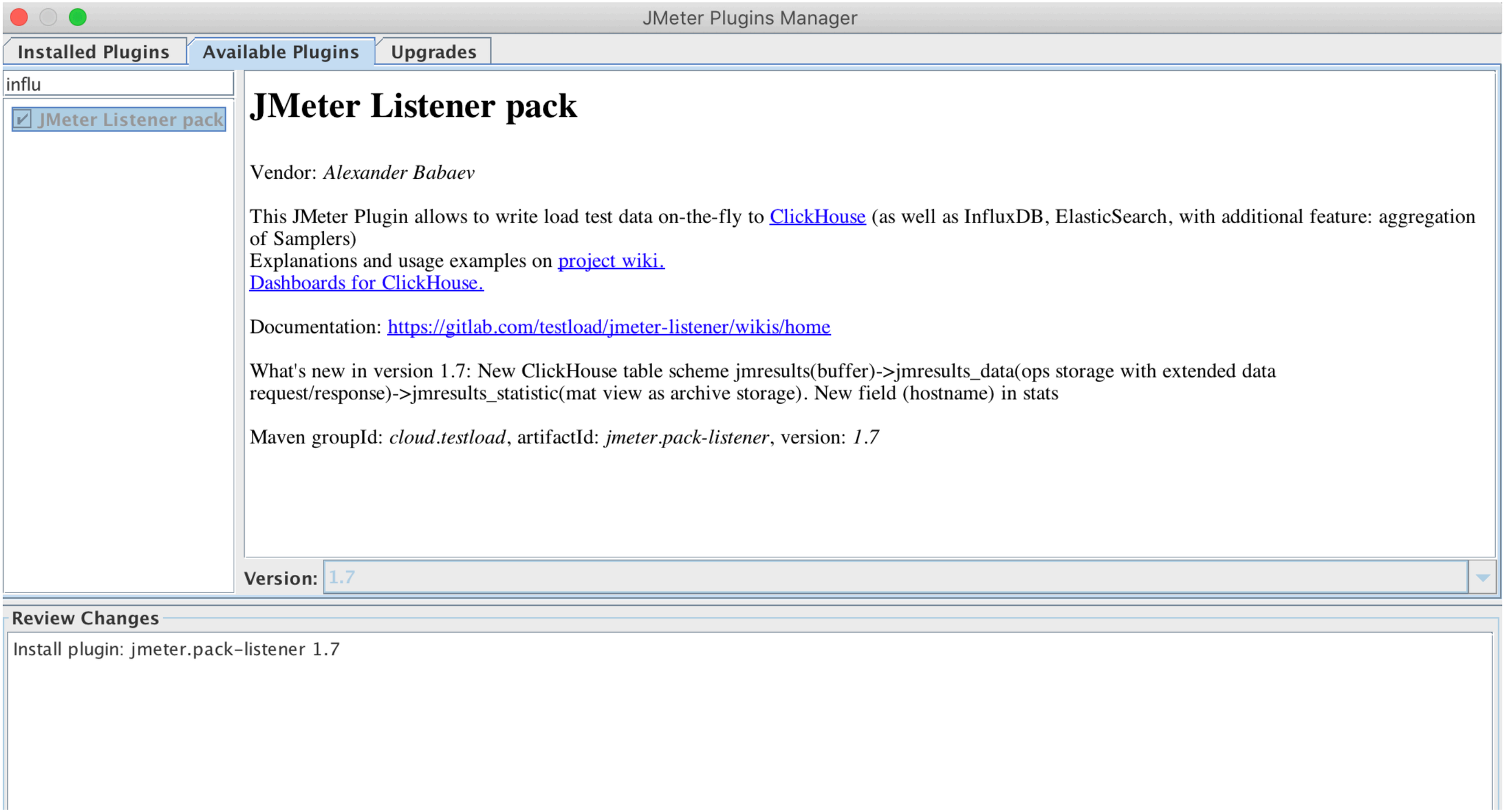



https://jmeter-plugins.org/

# Custom Thread Groups



# JMeter listener pack

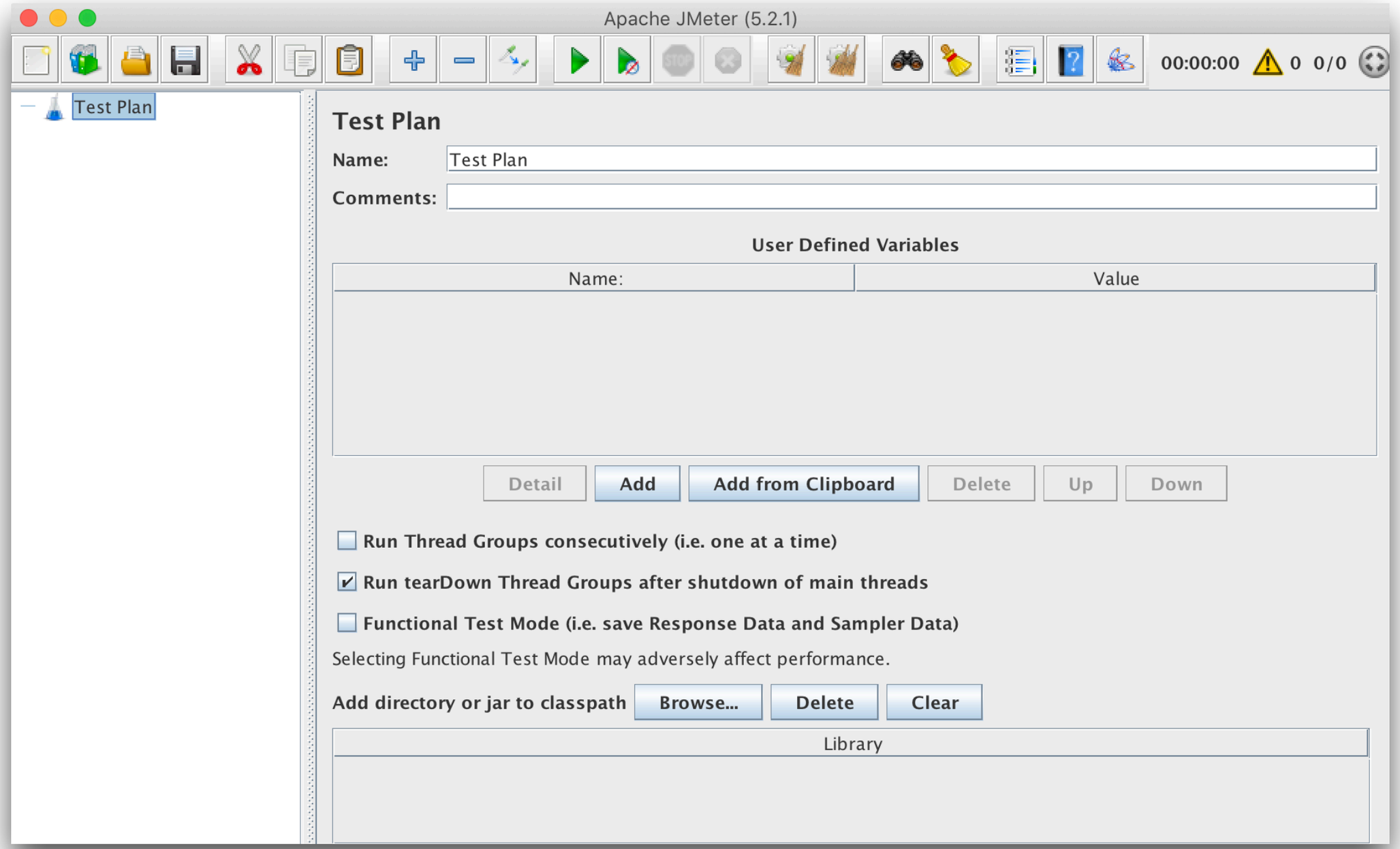


# Demo with JMeter

# Basic elements of JMeter

**Test plan**
**Thread Group**
**Sampler**
**Listener**
Config Element
Logic controller
Assertions
Pre/post processor

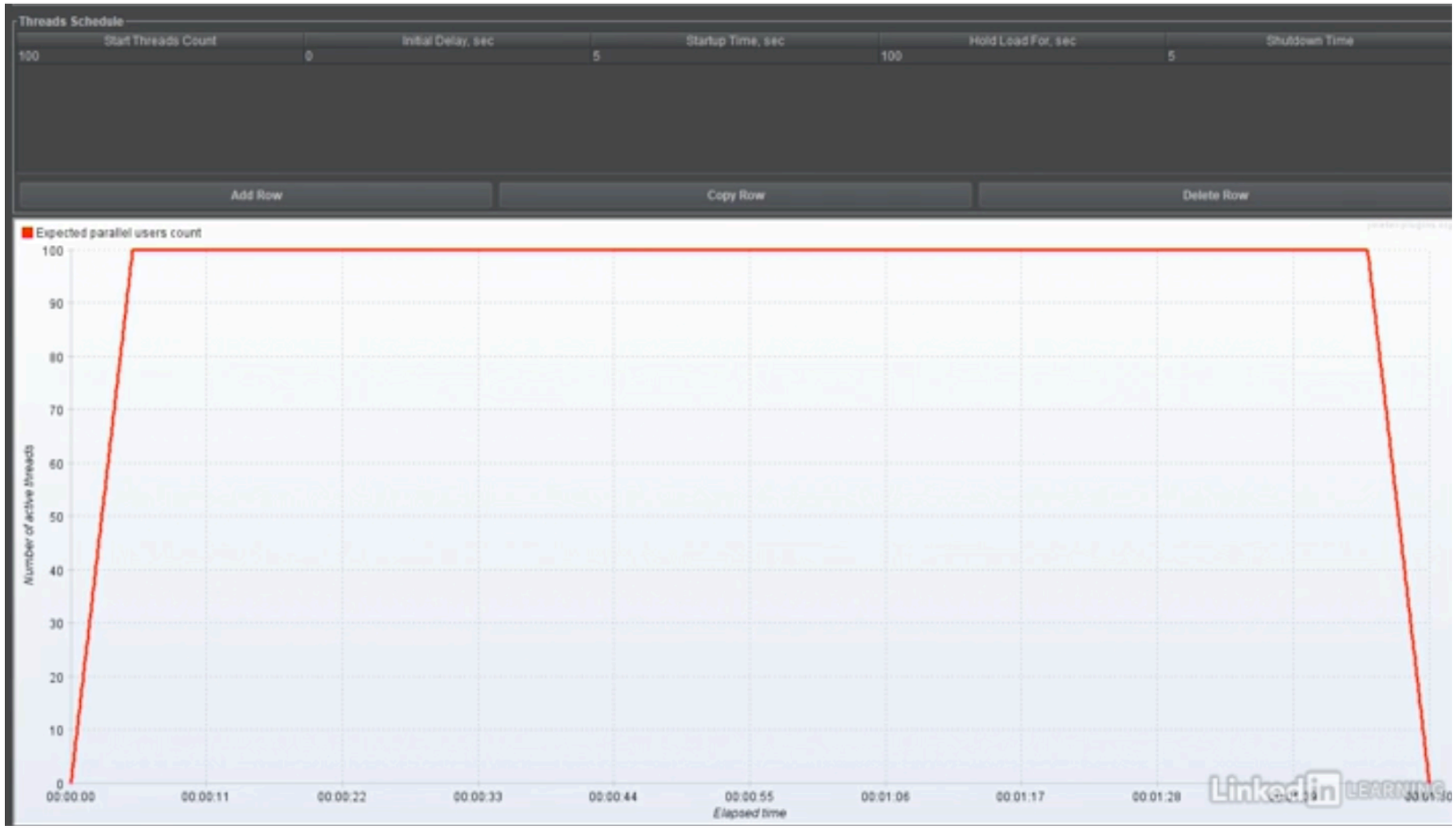
# Let’s start



# Workshop with Thread Group

# Basic load

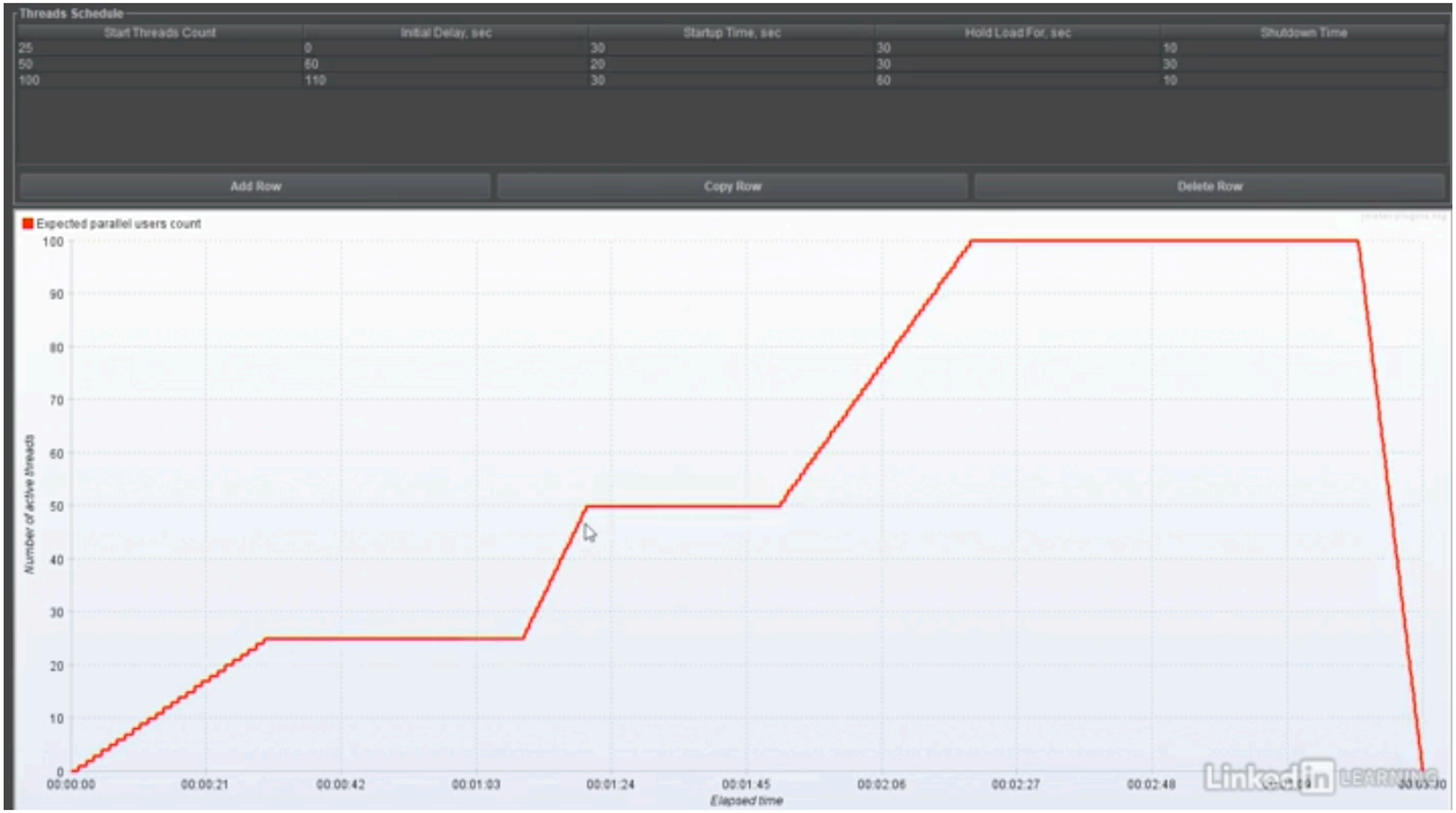
## Certain number of users



# Ramp up

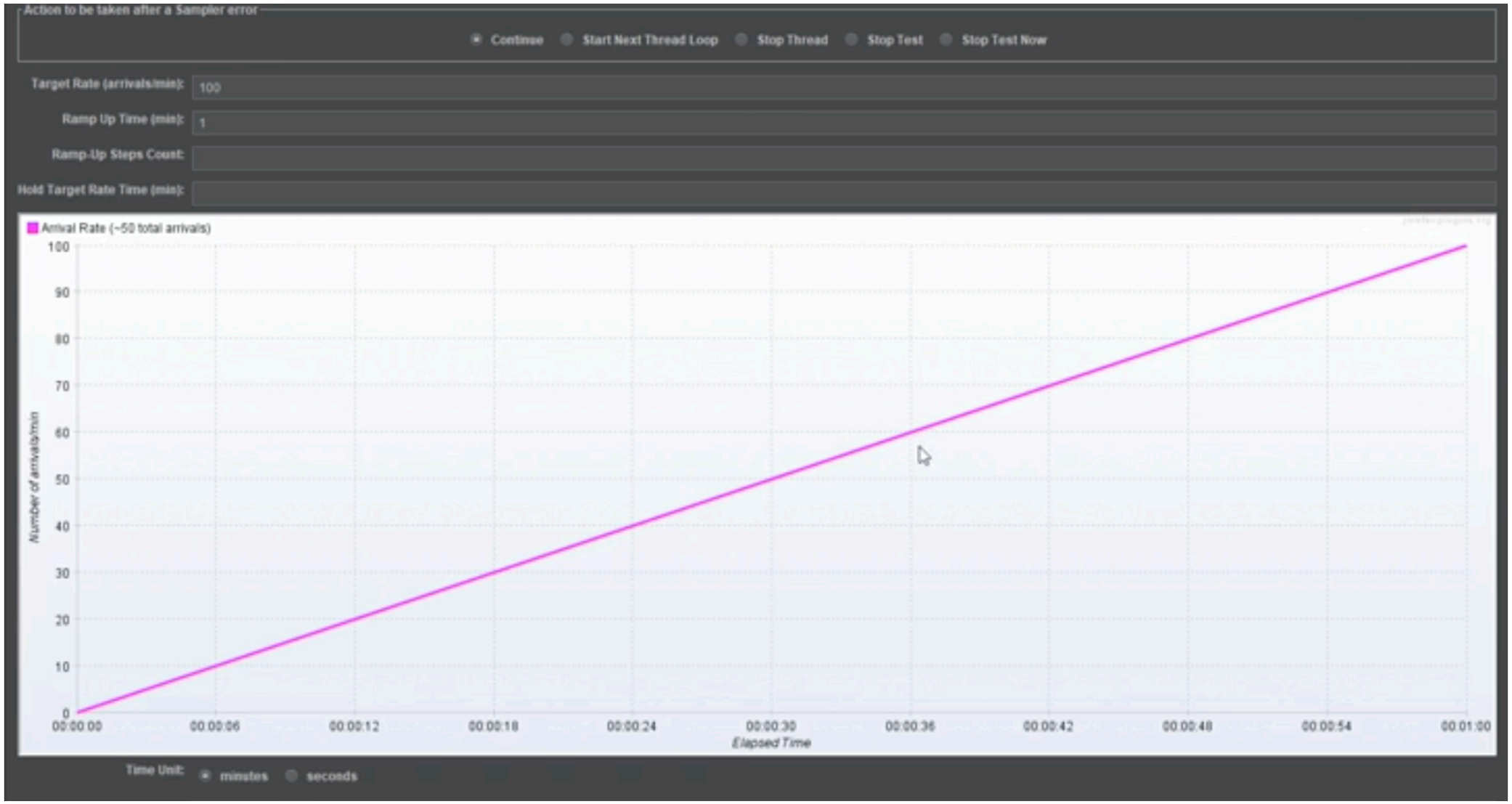
Understand how to system response to increased loads overtime

# Multi-step ramp up



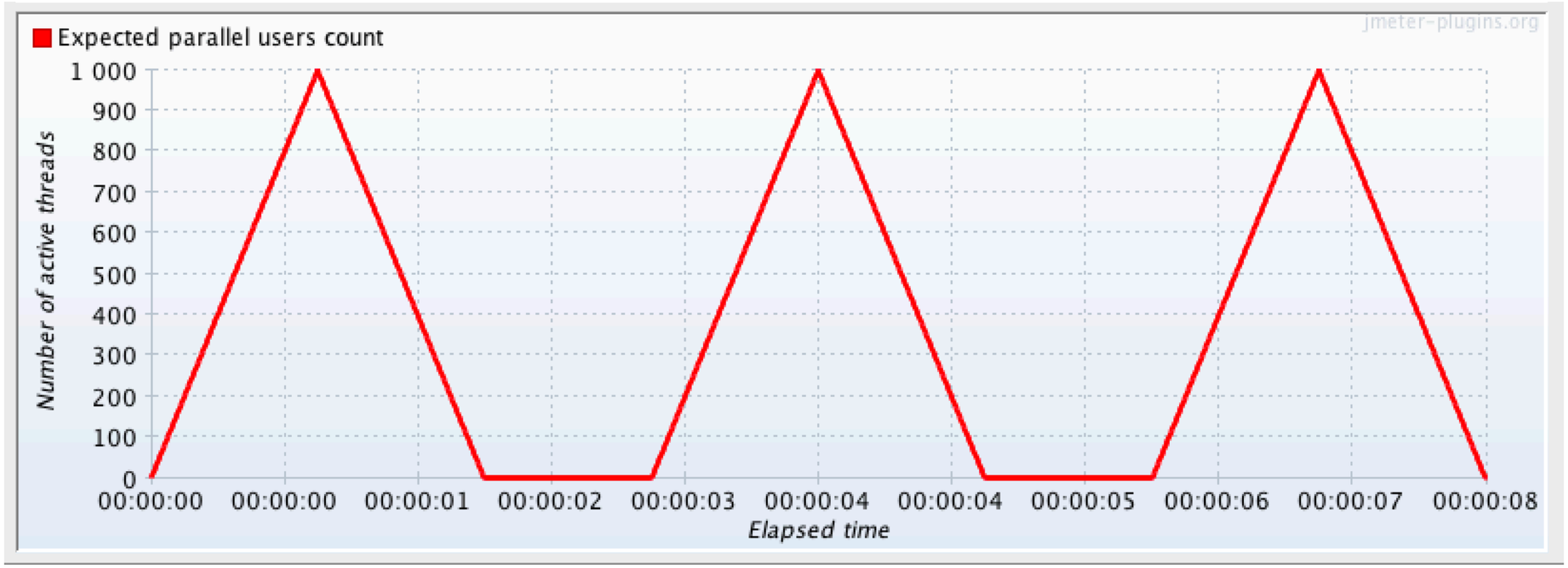
# Random load

# Linear load



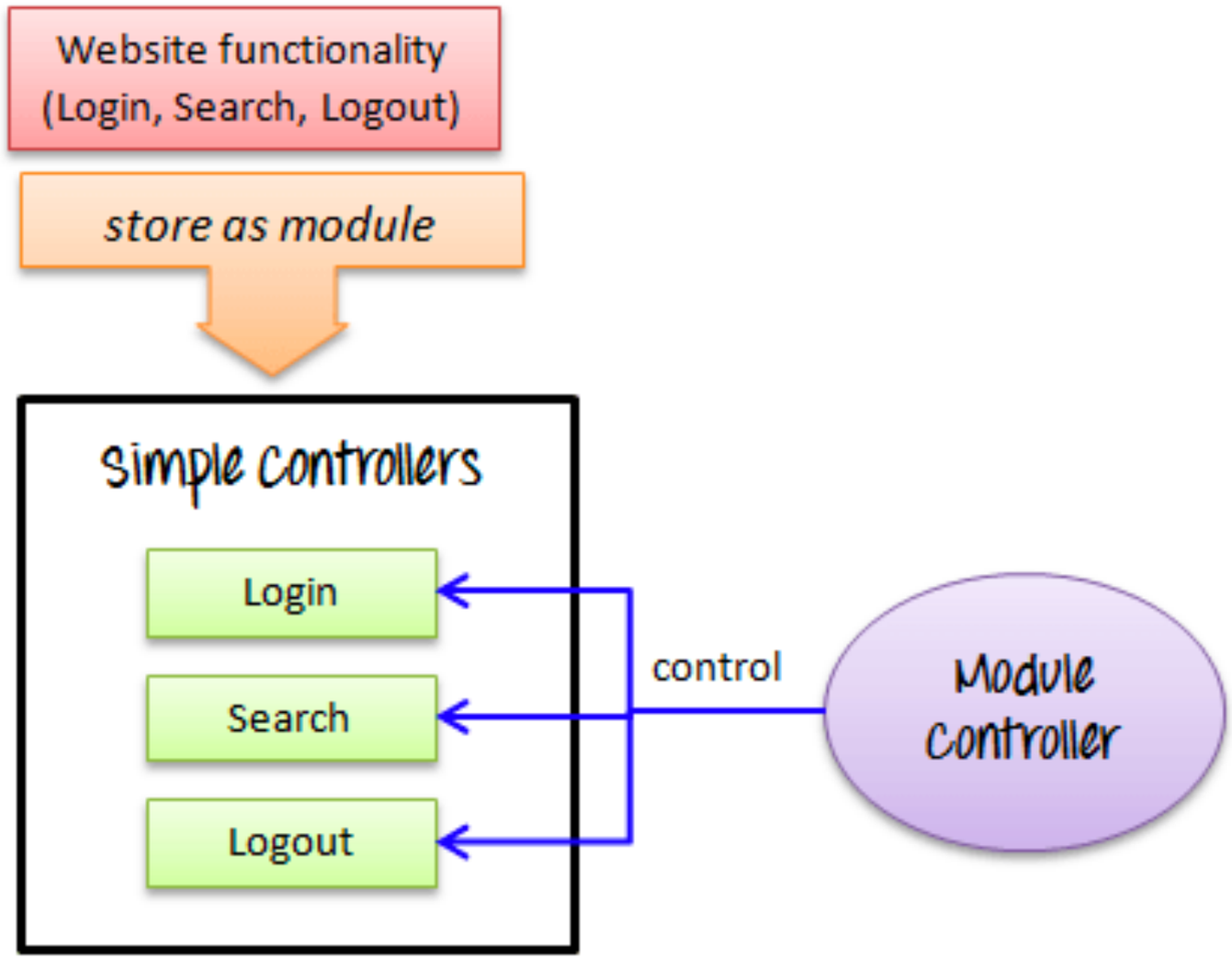
# Exponential load

# Quiz



# Workshop with HTTP Request

# Run in sequence with controller



# Working with Data

# Working with data (CSV)

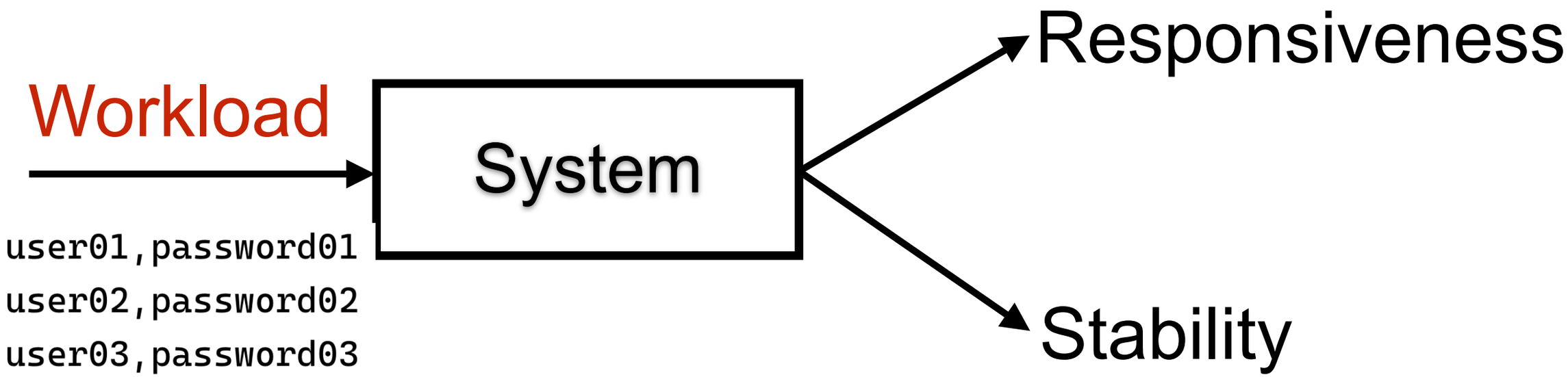
```
user01,password01
user02,password02
user03,password03
user04,password04
user05,password05
```

# Working with data (CSV)

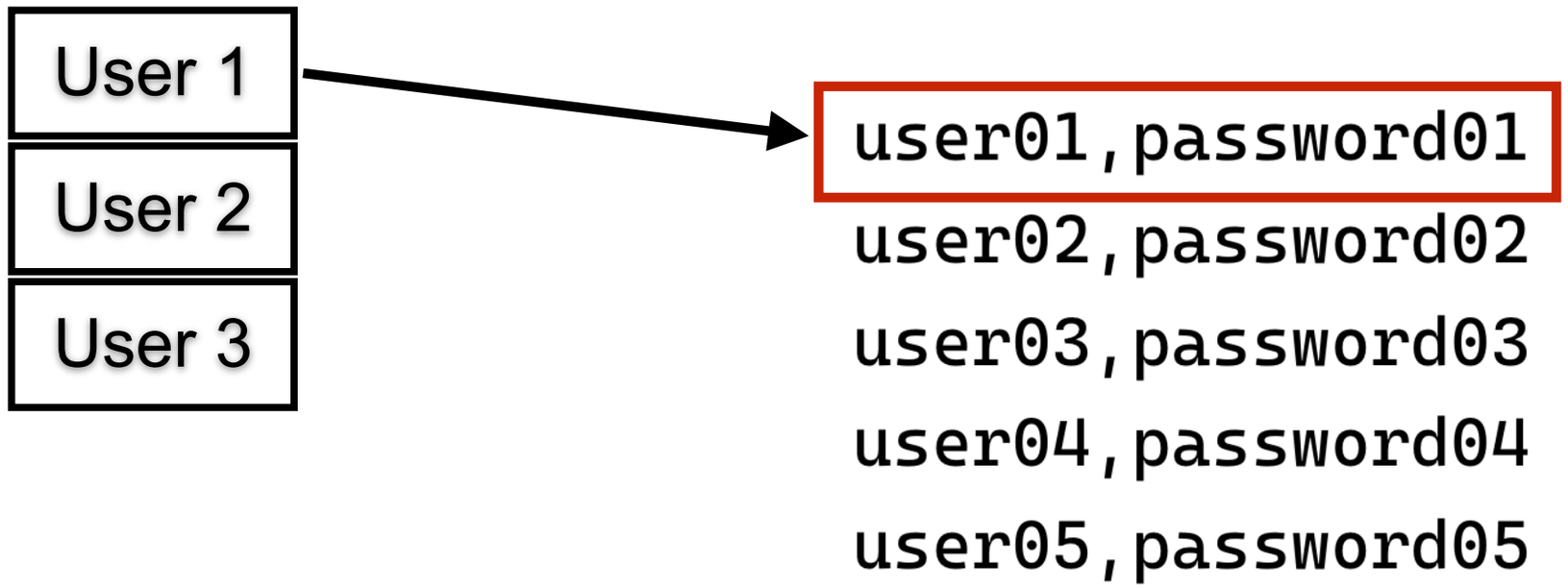
username password

```
user01,password01
user02,password02
user03,password03
user04,password04
user05,password05
```

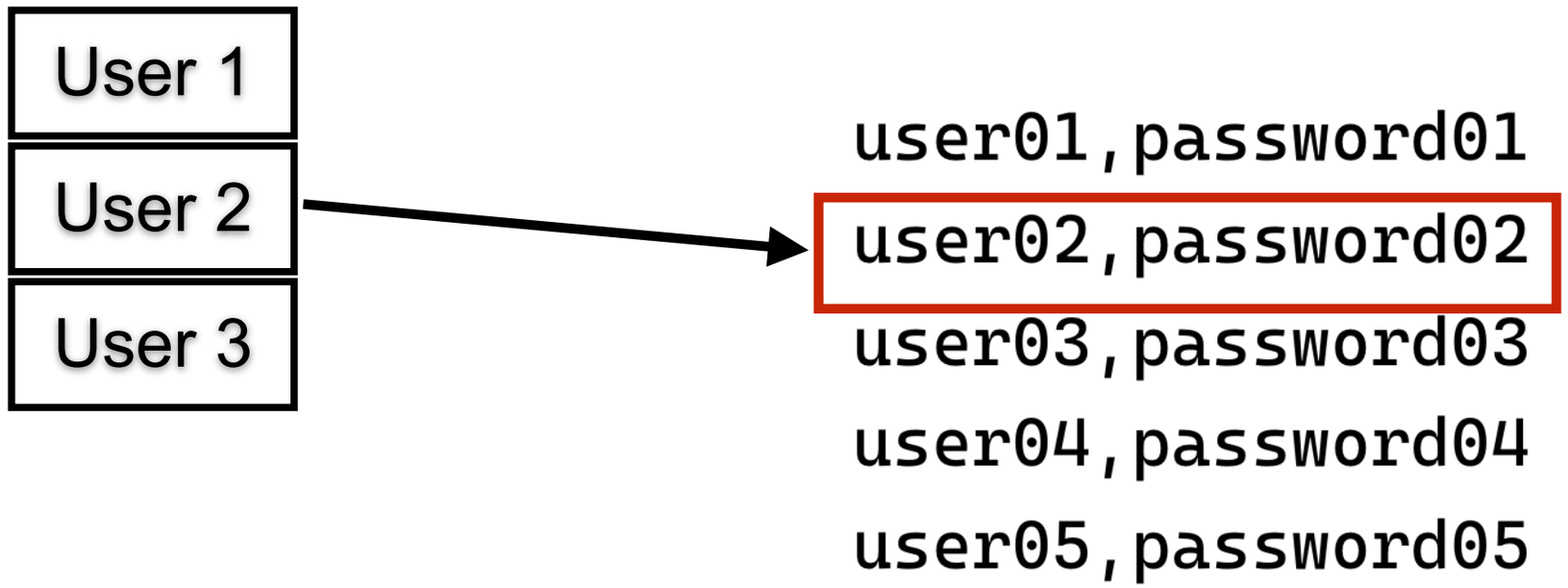
# Create workload with JMeter



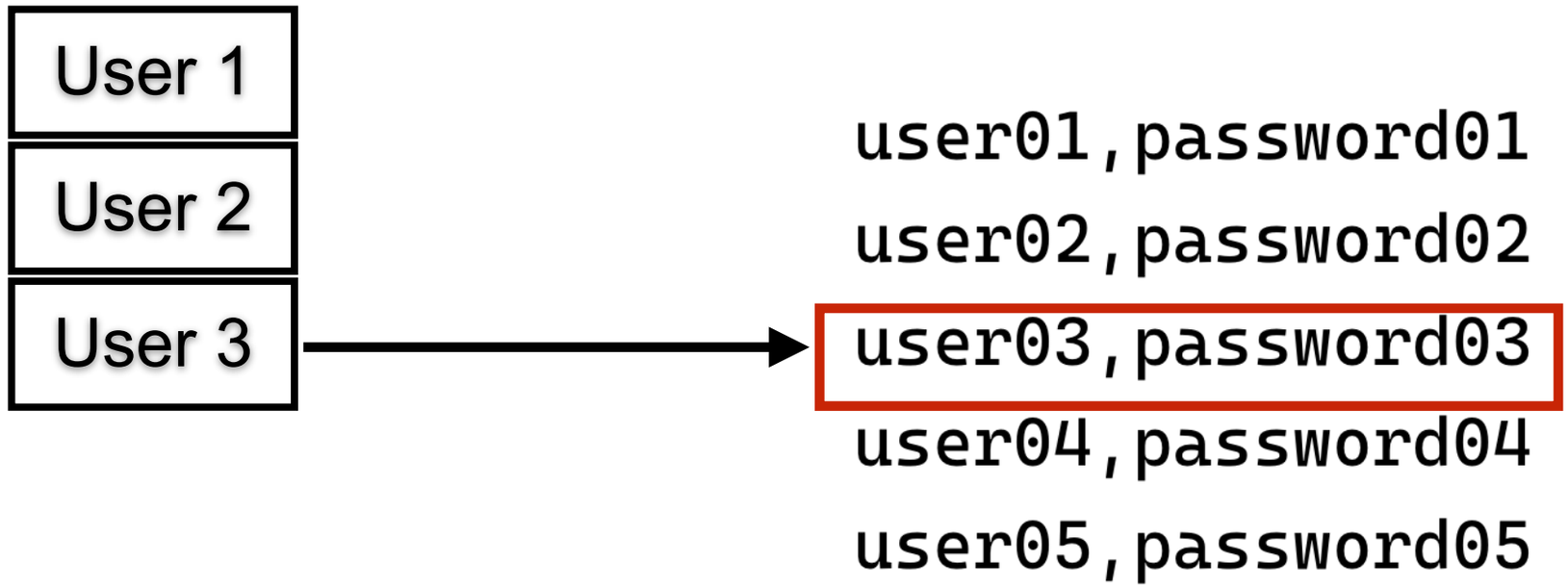
# Working with data (CSV)



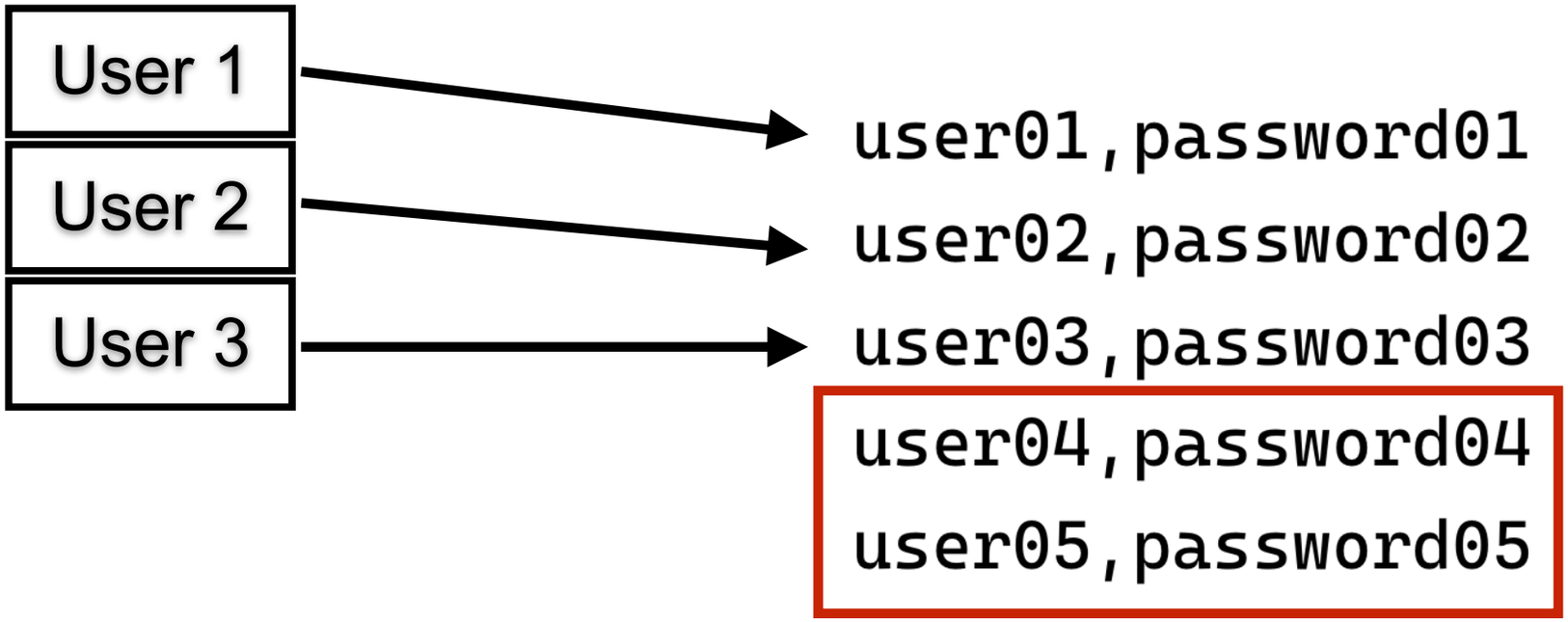
# Working with data (CSV)



# Working with data (CSV)



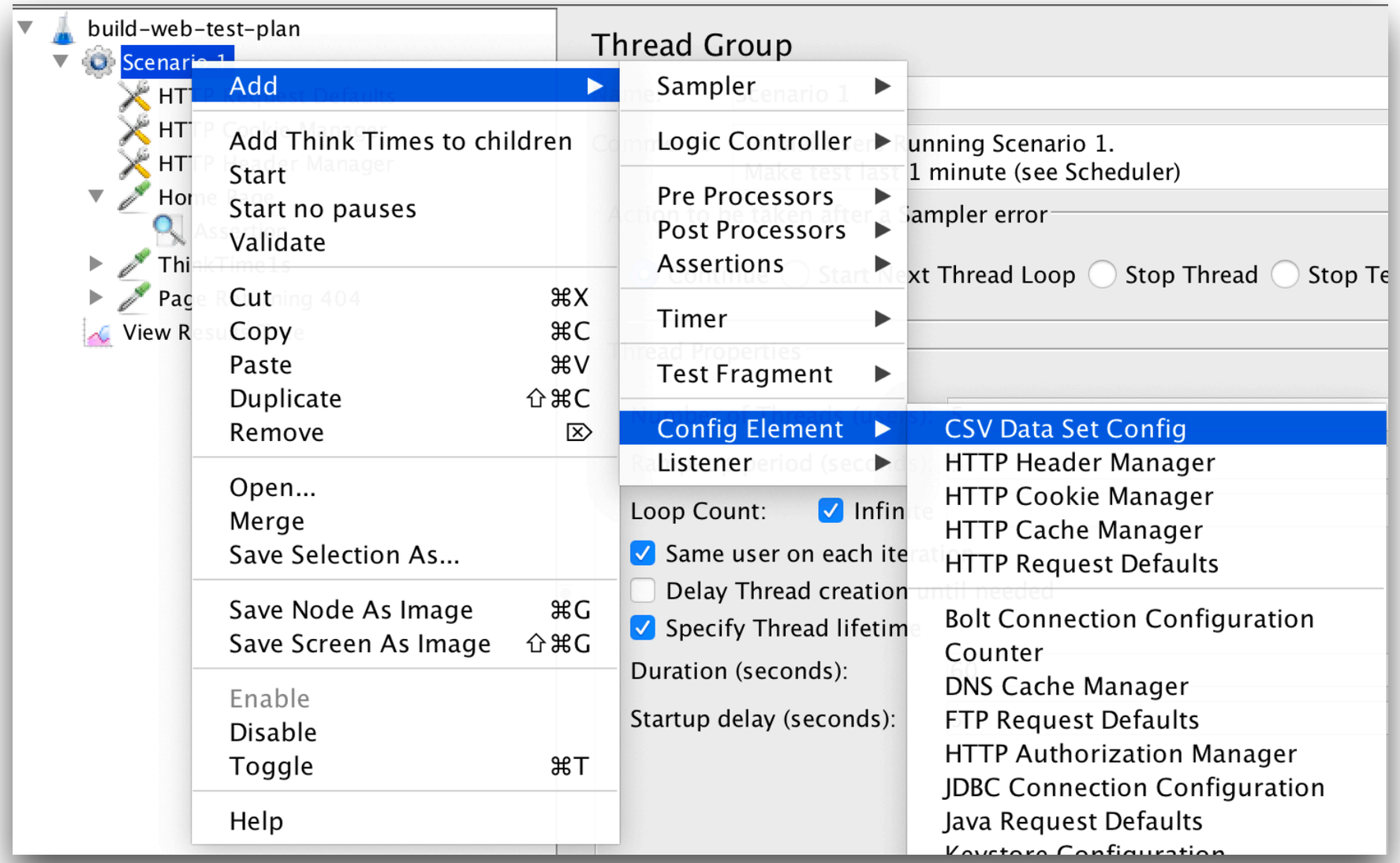
# Working with data (CSV)



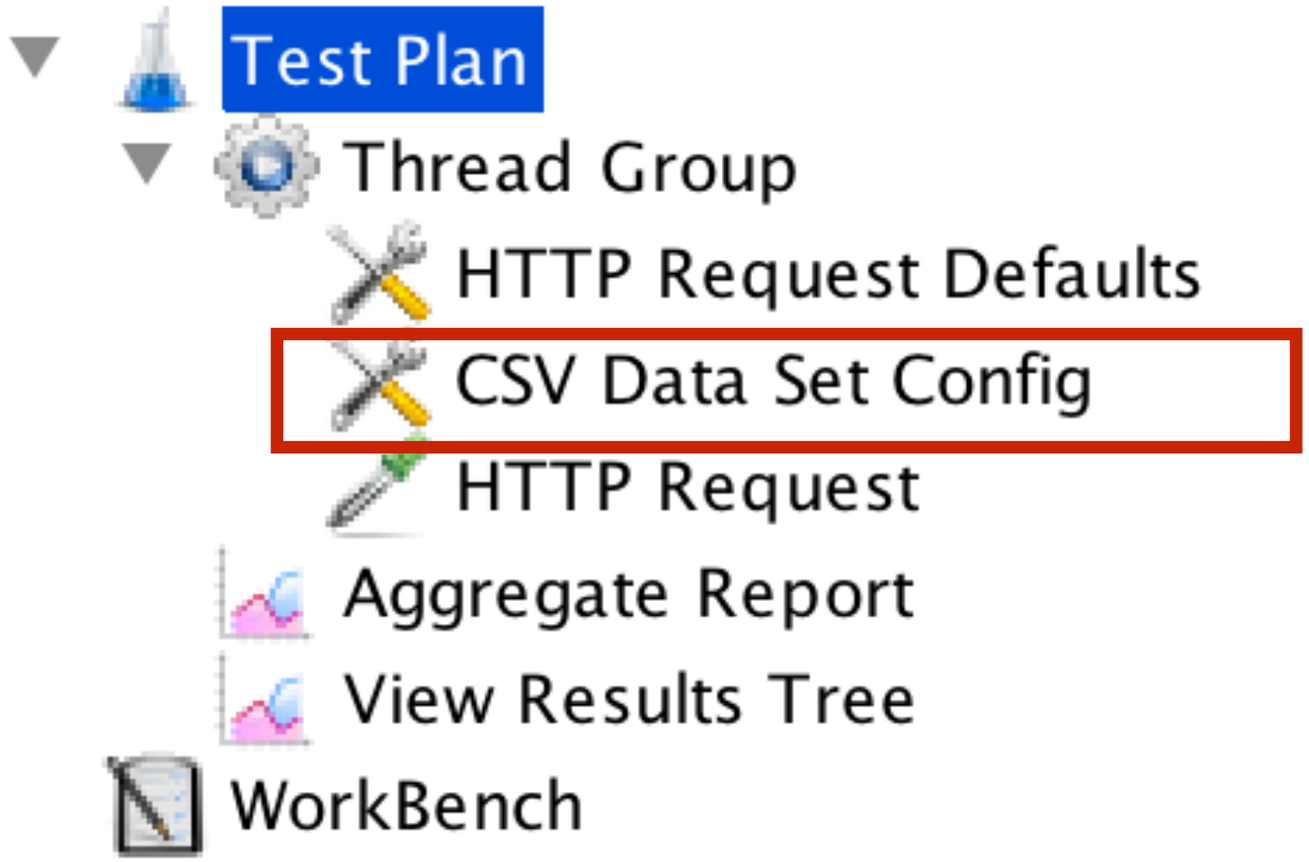

ไม่ถูกใช้งาน !!

# Working with data (CSV)

## Add -> Config Element -> CSV Data Set Config



# Working with data (CSV)



# Working with data (CSV)

CSV Data Set Config

Name: CSV Data Set Config

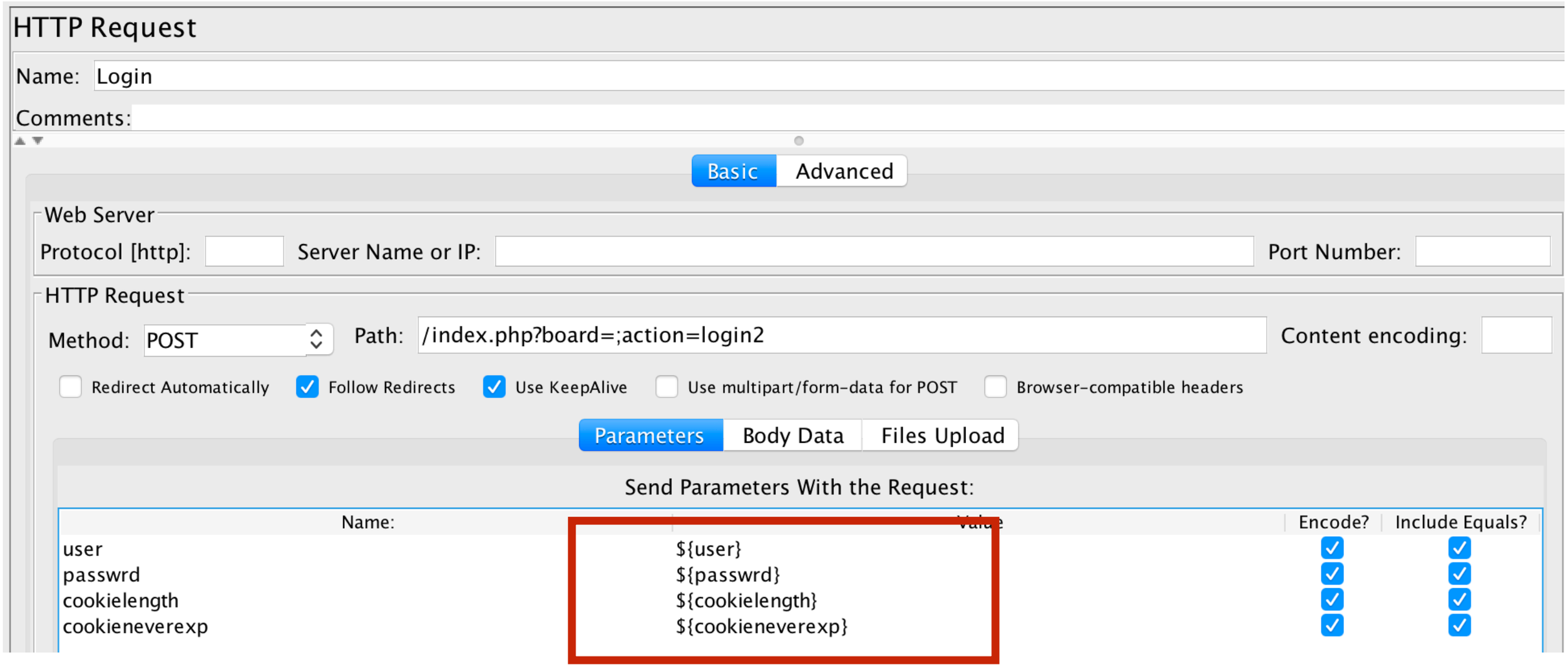
Comments:

Data Source

Configure the CSV Data Source

| | |
|---|---|
| Filename: | D:\Job\JMeter\csv_data.txt |
| File encoding: | |
| Variable Names (comma-delimited): | user,passwrd,cookielength,cookieneverexp |
| Ignore first line (only used if Variable Names is not empty): | False |
| Delimiter (use '\t' for tab): | , |
| Allow quoted data?: | True |
| Recycle on EOF ?: | True |
| Stop thread on EOF ?: | False |
| Sharing mode: | All threads |

# Working with data (CSV)




## ${Variable Name}

# Run in command-line

$jmeter -n -t ***[jmx file]***
  -l ***[results file]***
  -e -o ***[Path to web report folder]***

[results file] = CSV file
[path to web report folder] = Name of folder

# Run in command-line

## 1.4.4 CLI Mode (Command Line mode was called NON GUI mode)

For load testing, you must run JMeter in this mode (Without the GUI) to get the optimal results from it. To do so, use the following command options:

**-n**
This specifies JMeter is to run in cli mode

**-t**
[name of JMX file that contains the Test Plan].

**-l**
[name of JTL file to log sample results to].

**-j**
[name of JMeter run log file].

**-r**
Run the test in the servers specified by the JMeter property "**remote_hosts**"

**-R**
[list of remote servers] Run the test in the specified remote servers

**-g**
[path to CSV file] generate report dashboard only

**-e**
generate report dashboard after load test

**-o**
output folder where to generate the report dashboard after load test. Folder must not exist or be empty

The script also lets you specify the optional firewall/proxy server information:

**-H**
[proxy server hostname or ip address]

**-P**
[proxy server port]

https://jmeter.apache.org/usermanual/get-started.html#non_gui

# HTML Report

Apache JMeter Dashboard

- Dashboard
- Charts
- Customs Graphs

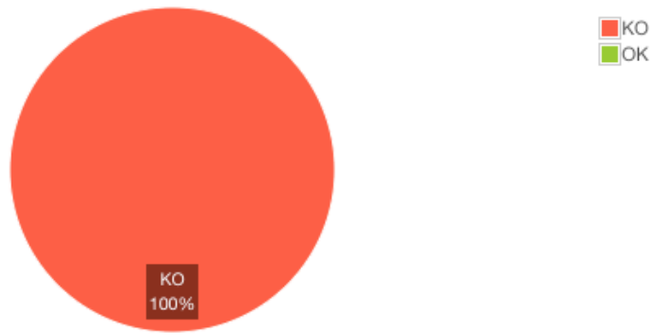
## Test and Report information

| | |
|---|---|
| Source file | "result.csv" |
| Start Time | "4/16/20, 9:37 AM" |
| End Time | "4/16/20, 9:38 AM" |
| Filter for display | "" |

## APDEX (Application Performance Index)

| Apdex | T (Toleration threshold) | F (Frustration threshold) | Label |
|---|---|---|---|
| **0.000** | **500 ms** | **1 sec 500 ms** | **Total** |
| 0.000 | 500 ms | 1 sec 500 ms | Login Page |

## Requests Summary

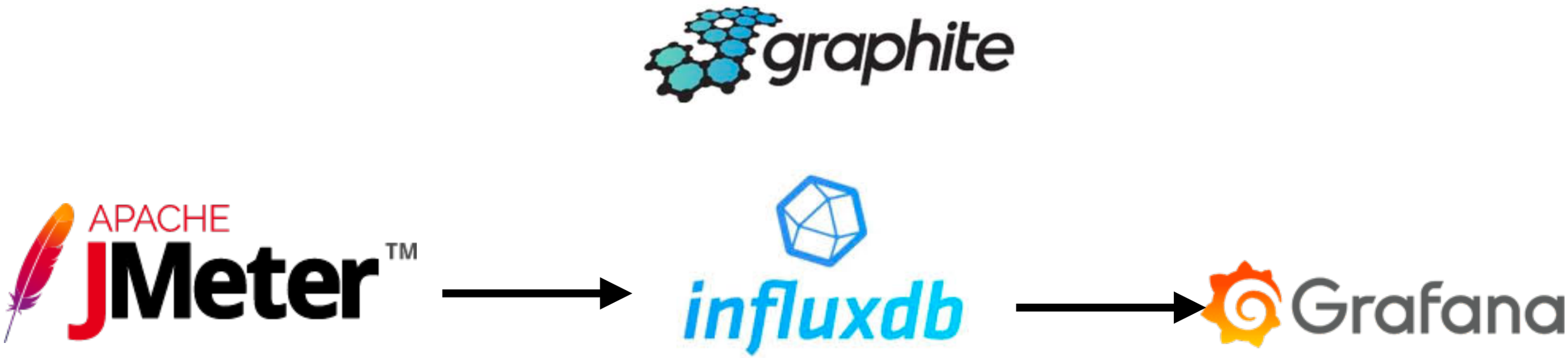



## Statistics

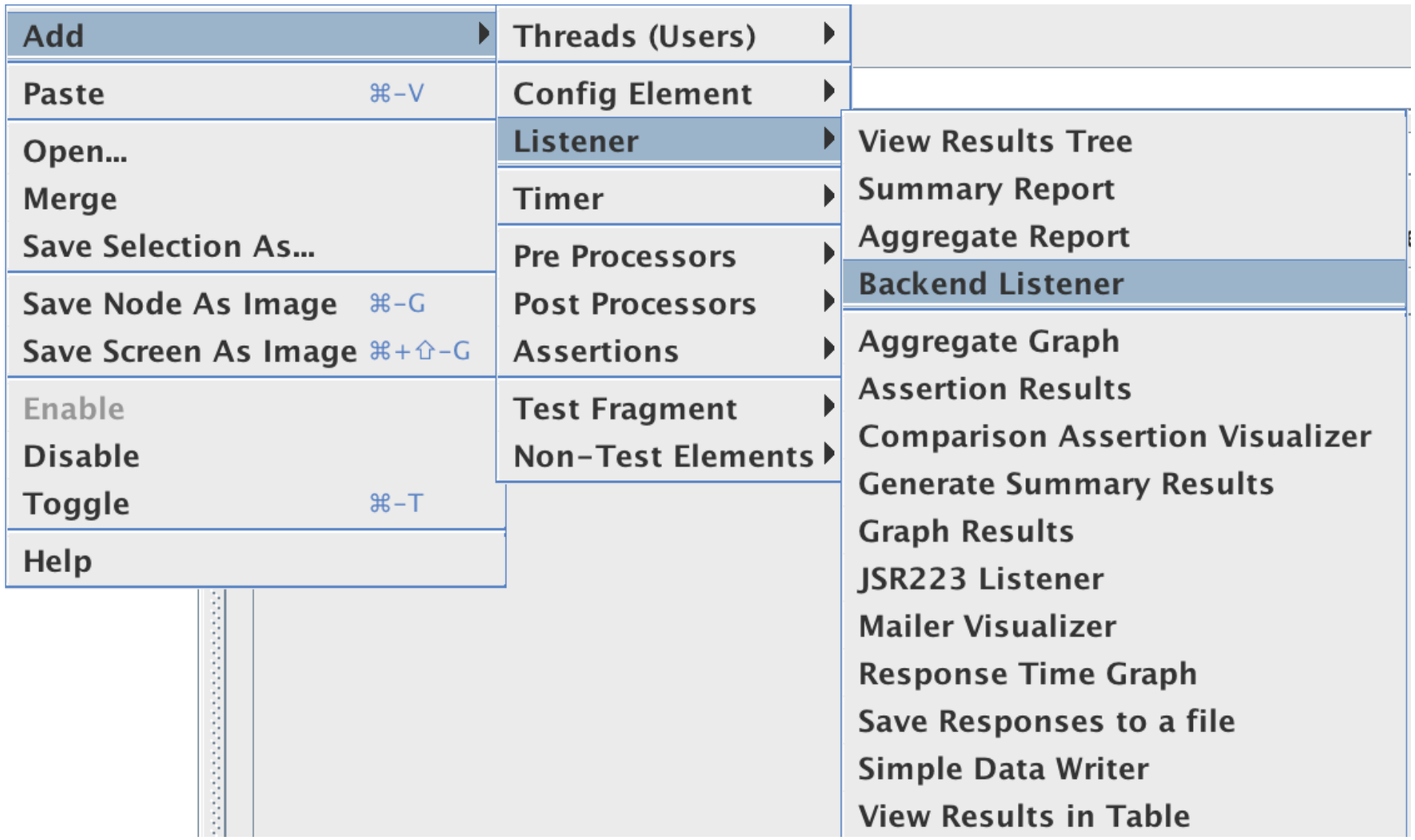
# Realtime result with JMeter

https://jmeter.apache.org/usermanual/realtime-results.html

# Realtime result with JMeter




# Backend listener



# Backend listener

**Backend Listener**

**Name:** Backend Listener

**Comments:**

**Backend Listener implementation** org.apache.jmeter.visualizers.backend.influxdb.InfluxdbBackendListenerClient

- cloud.testload.jmeter.ClickHouseBackendListenerClient
- cloud.testload.jmeter.ElasticSearchBackendListenerClient
- cloud.testload.jmeter.InfluxDBBackendListenerClient
- cloud.testload.jmeter.InfluxDBImportFileClient
- org.apache.jmeter.visualizers.backend.graphite.GraphiteBackendListenerClient
- org.apache.jmeter.visualizers.backend.influxdb.InfluxdbBackendListenerClient

**Async Queue size** 5000

| | |
|---|---|
| influxdbMetricsSender | |
| influxdbUrl | |
| application | application name |
| measurement | jmeter |
| summaryOnly | false |
| samplersRegex | .* |
| percentiles | 99;95;90 |
| testTitle | Test name |
| eventTags | |

# Backend listener

**Backend Listener**

**Name:** Backend Listener

**Comments:**

**Backend Listener implementation** org.apache.jmeter.visualizers.backend.influxdb.InfluxdbBackendListenerClient

**Async Queue size** 5000

**Parameters**

| Name: | Value |
|---|---|
| influxdbMetricsSender | org.apache.jmeter.visualizers.backend.influxdb.HttpMetricsSender |
| influxdbUrl | http://localhost:8086/write?db=jmeter |
| application | application_name |
| measurement | jmeter |
| summaryOnly | false |
| samplersRegex | .* |
| percentiles | 99;95;90 |
| testTitle | Test name |
| eventTags | |

influxdbUrl = http://localhost:8086/write?db=jmeter

# Grafana report

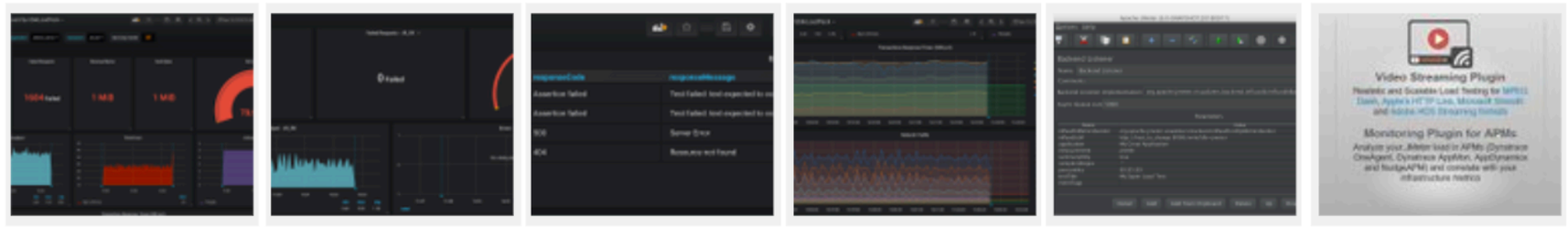
## *Apache JMeter Dashboard using Core InfluxdbBackendListenerClient*

by Philippe M.

**DASHBOARD**

Monitor your Apache JMeter load test in real time with InfluxDB and Grafana. Get overall summary, errors details and particular transaction response times.
Last updated: 2 years ago

Overview | Revisions | Reviews



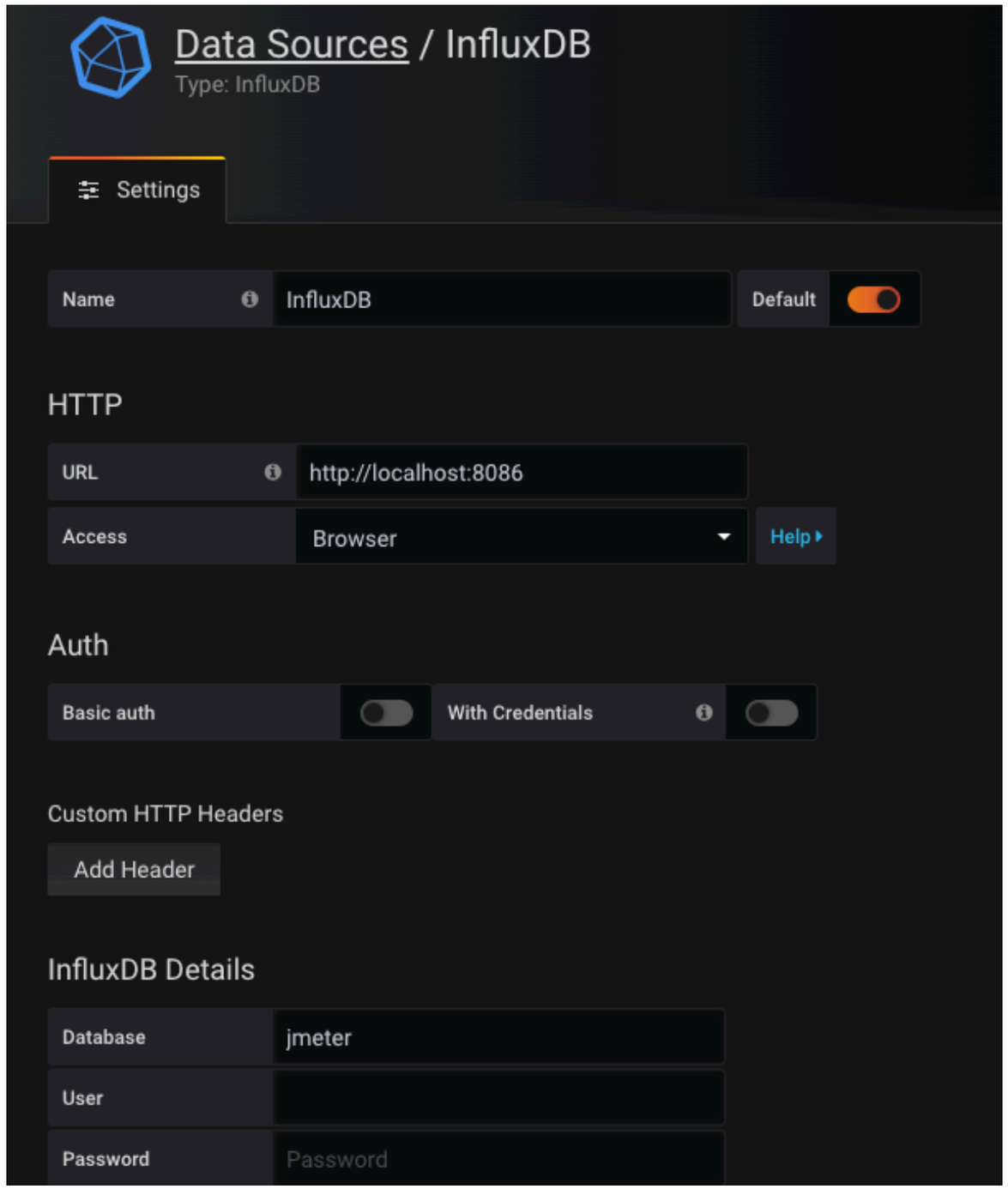

This dashboard requires Apache JMeter 5 and upper versions. It shows overall statistics and you can zoom on one particular transaction. In order to use it you need to use JMeter Backend Listener and select InfluxdbBackendListenerClient.

**Setup:**

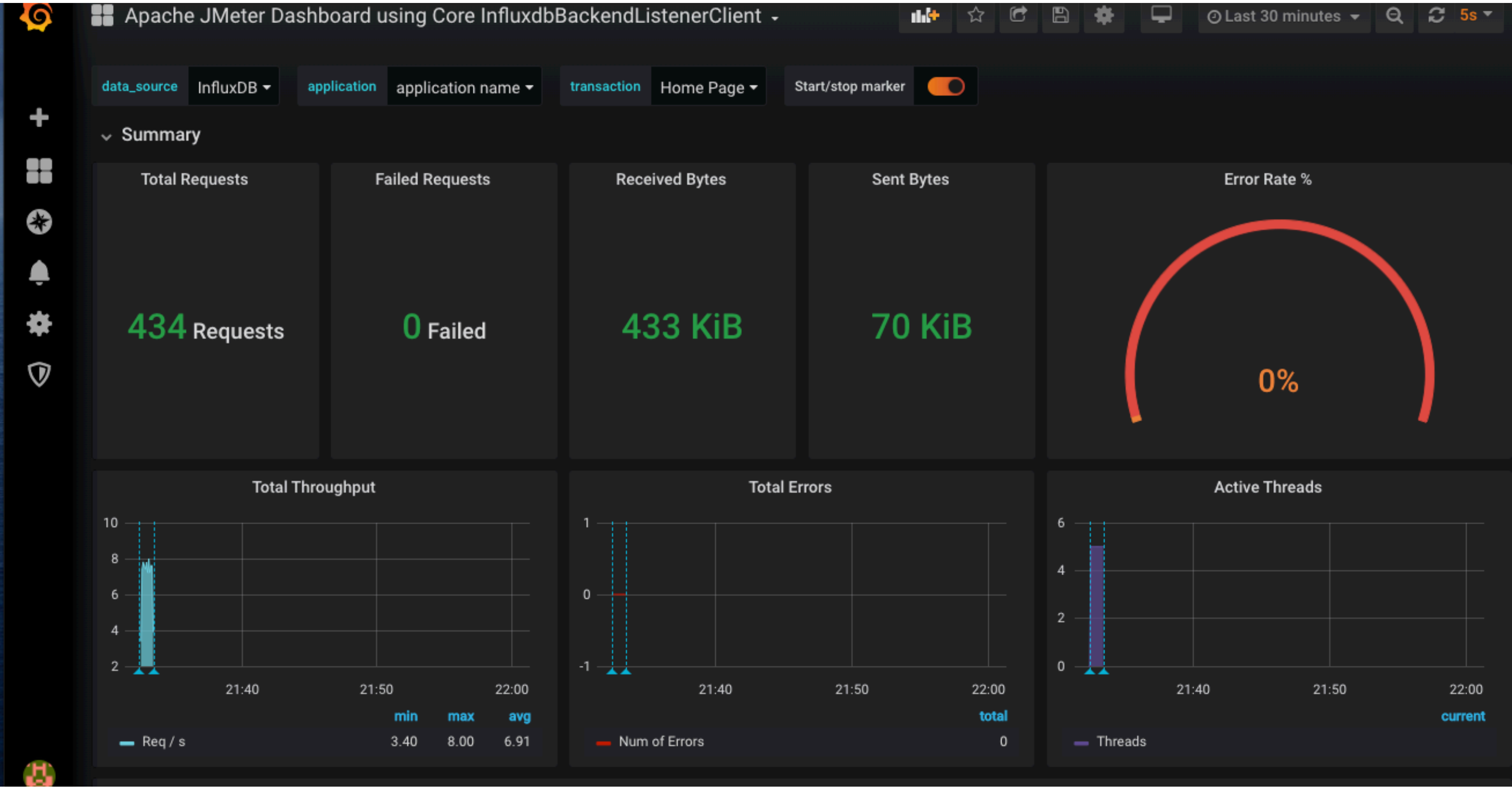
- Add Backend Listener to your test plan (Add → Listener → Backend Listener) and select org.apache.jmeter.visualizers.backend.influxdb.HttpMetricsSender
- Provide in the Parameters table the InfluxDB settings, provide a name for the test, and specify which samplers to record.

https://grafana.com/grafana/dashboards/5496

# Grafana report



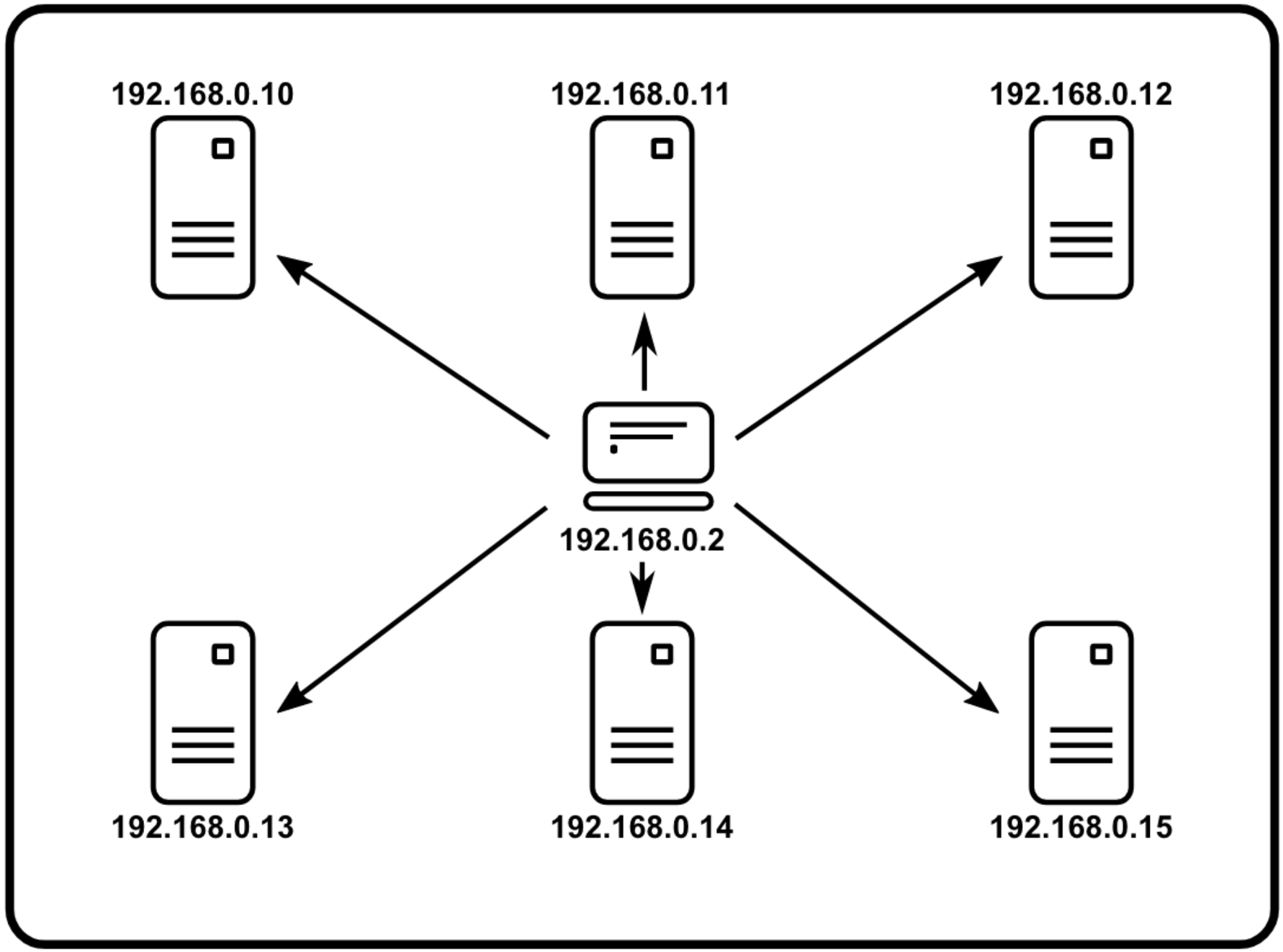
# Grafana report



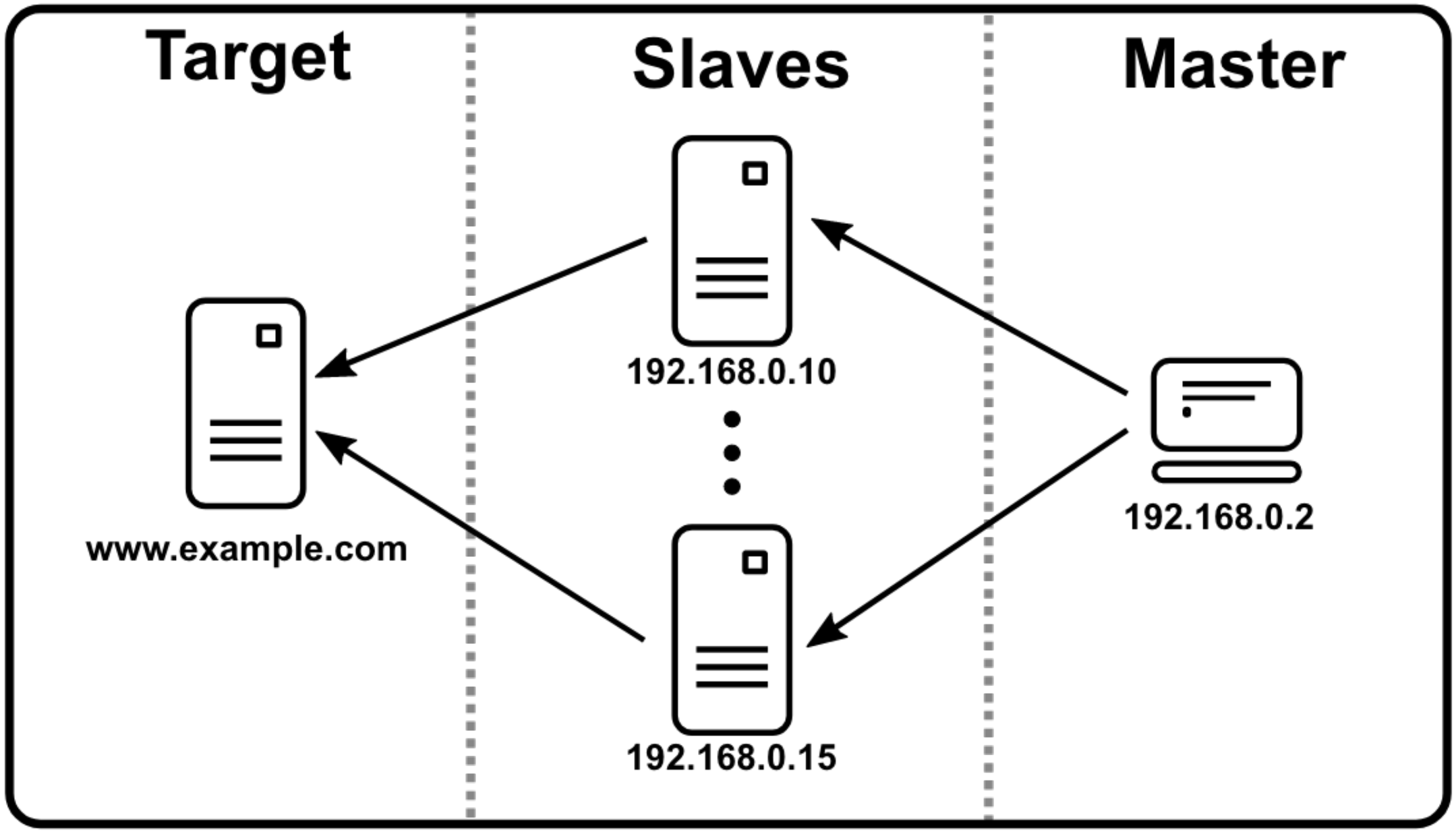
# Distributed testing

https://jmeter.apache.org/usermanual/jmeter_distributed_testing_step_by_step.html

# Distributed testing



# Architecture

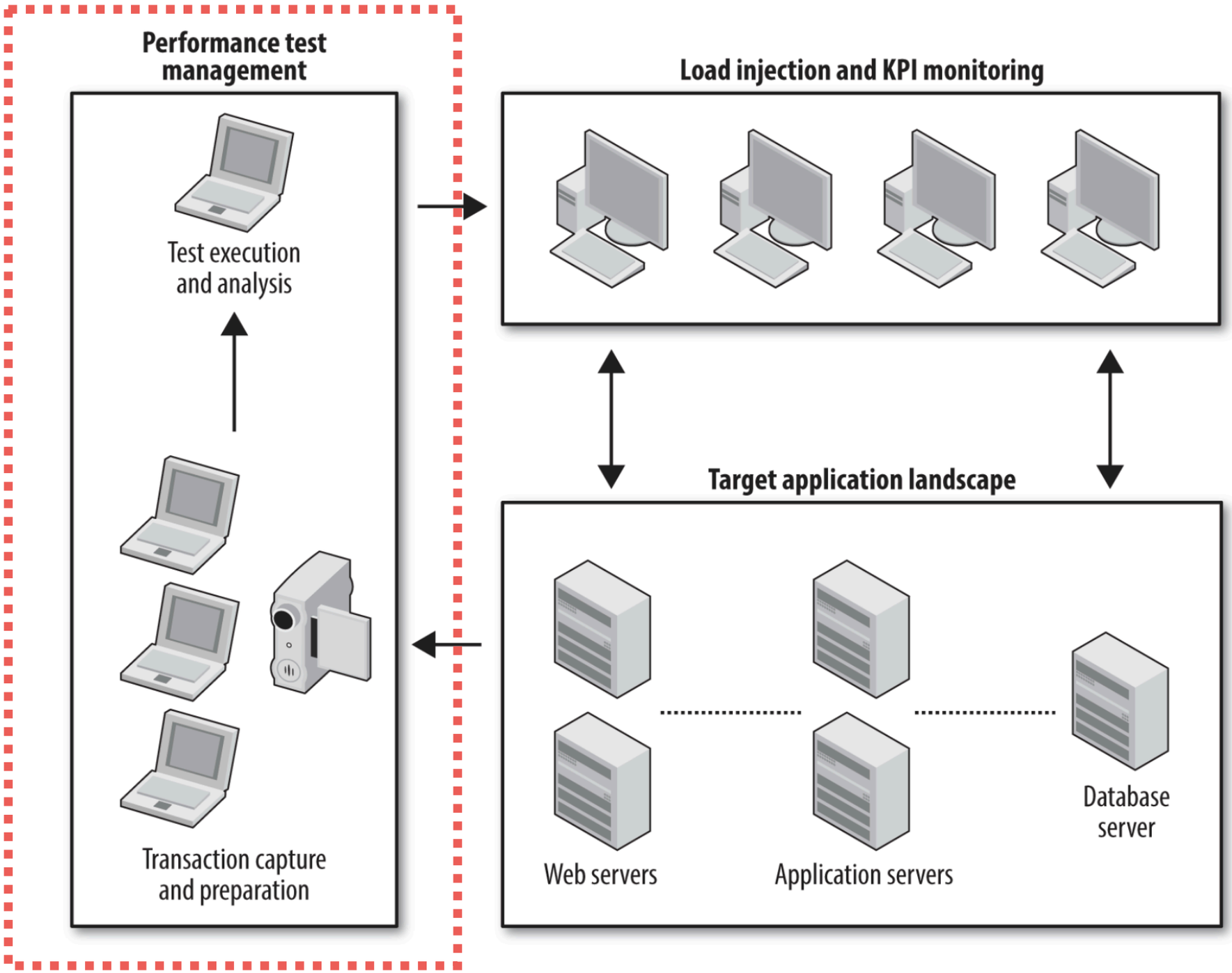


# Recording testing

https://jmeter.apache.org/usermanual/jmeter_distributed_testing_step_by_step.html

# Interpret result of testing

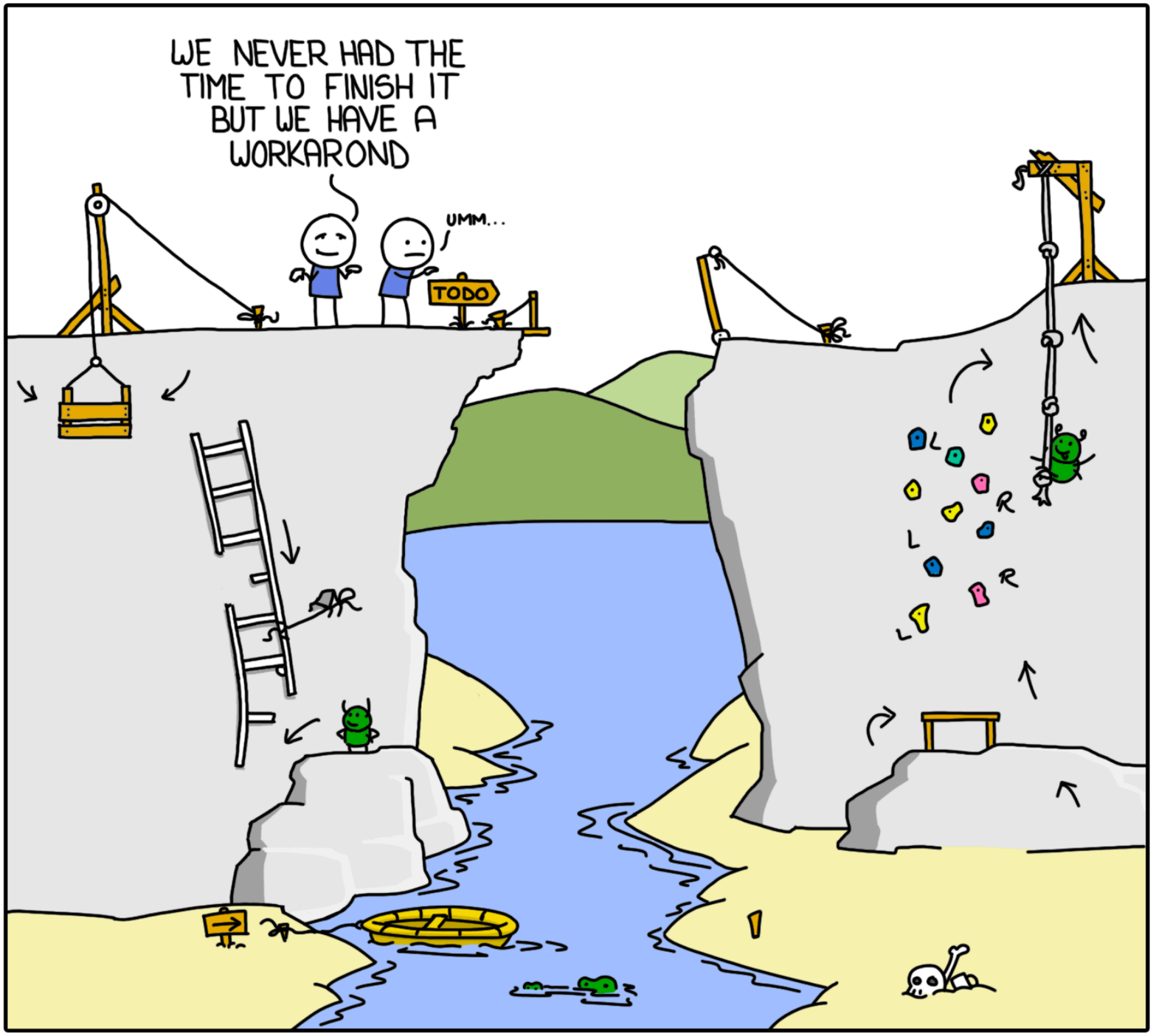
# Performance testing architecture



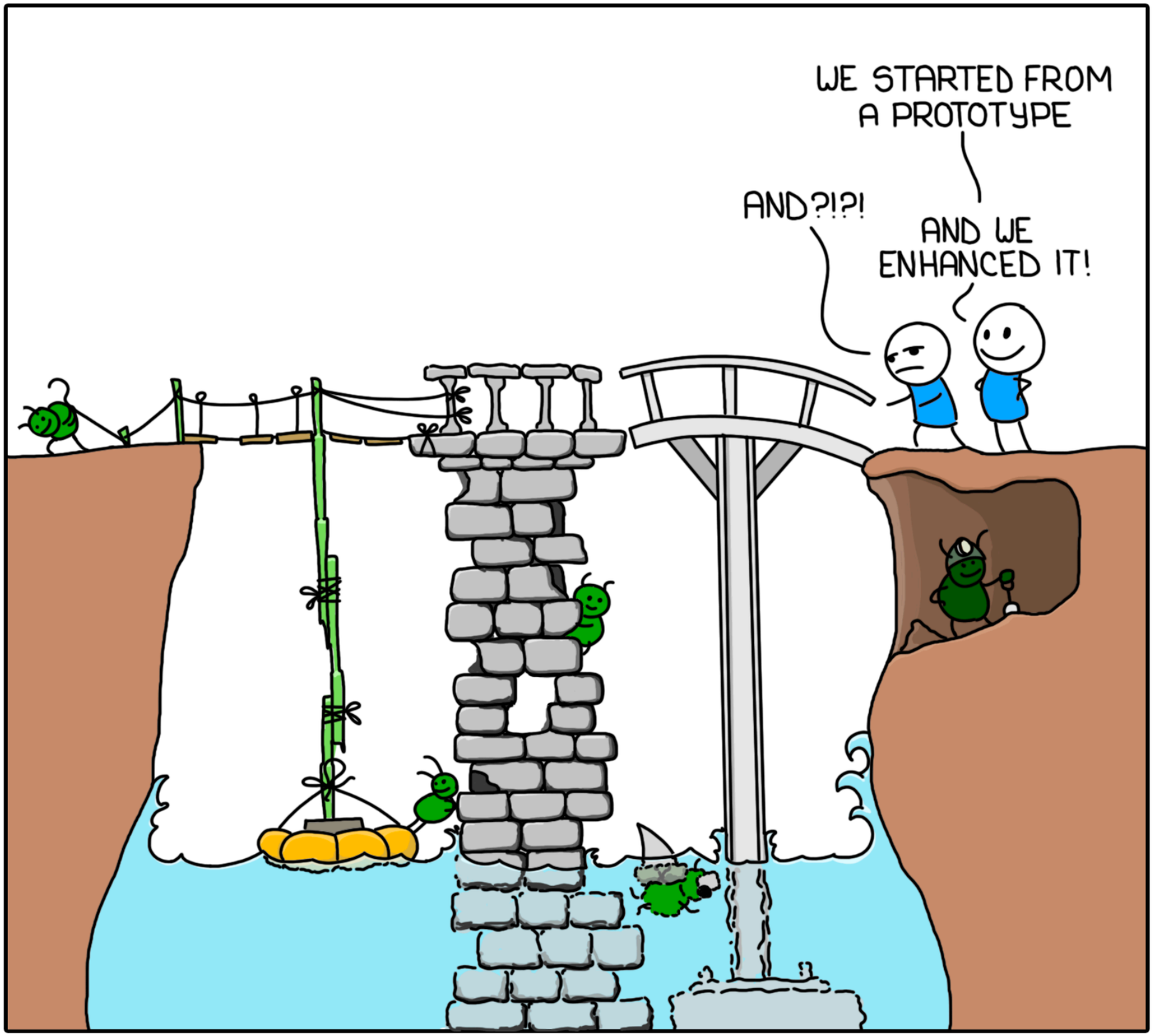
# Goals

**Root-cause** analysis
Method of problem solving

# WORKAROUND



# PRODUCTION READY



# Analysis process

Real-time analysis
Post-test analysis

# Types of result/outputs

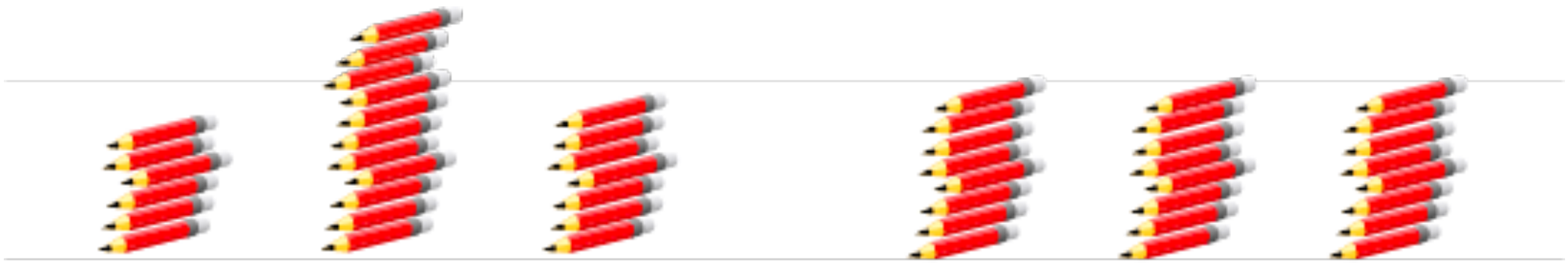
Statistic
Response time measurement
Throughput and capacity
Server KPI performance
Network KPI performance

# Statistic

Mean and median
Standard deviation
Normal distribution
Percentile
Response time distribution

# Mean

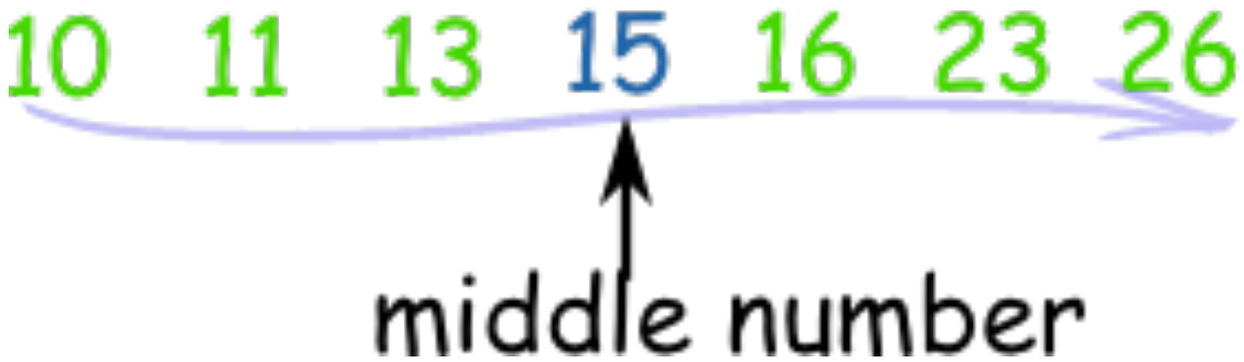
Average of the numbers



6 + 11 + 7 = 8 + 8 + 8

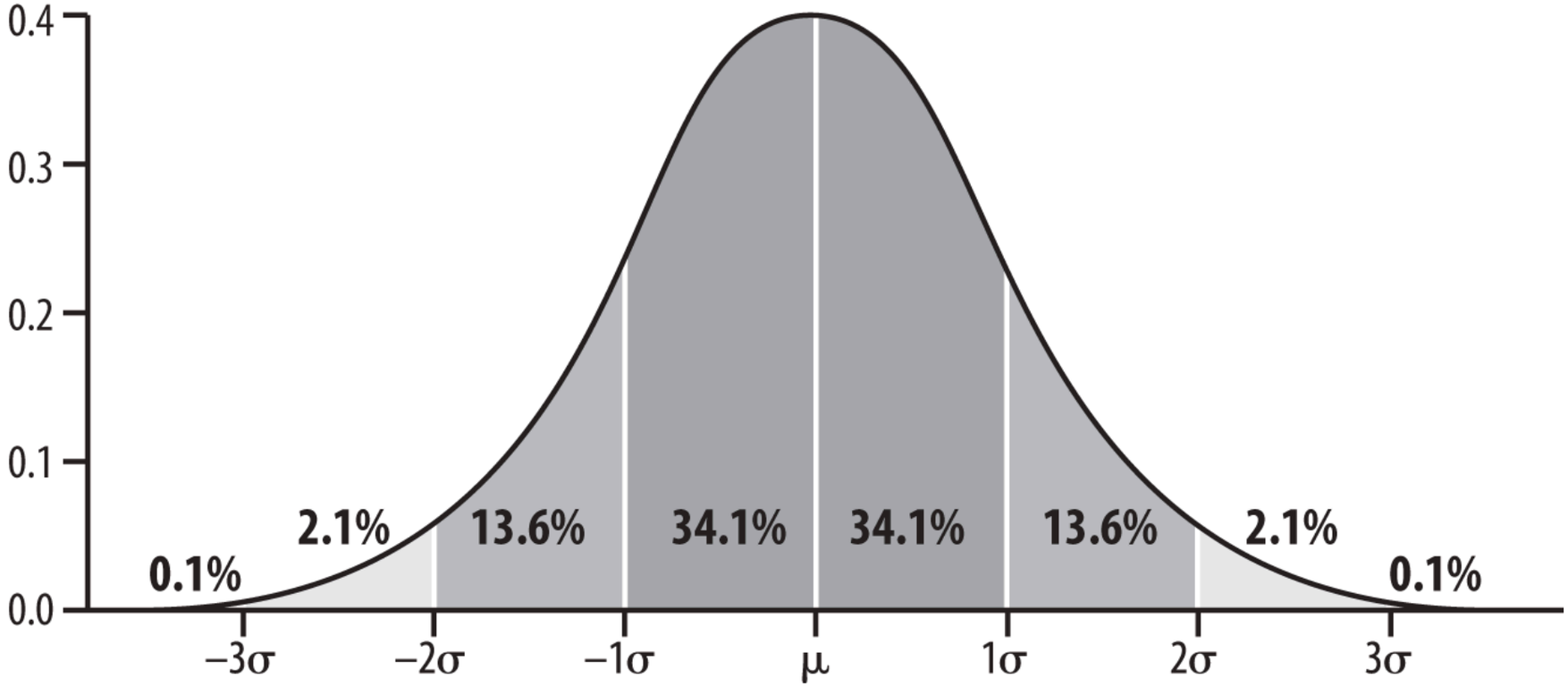
# Median

the "middle" of a sorted list of numbers.



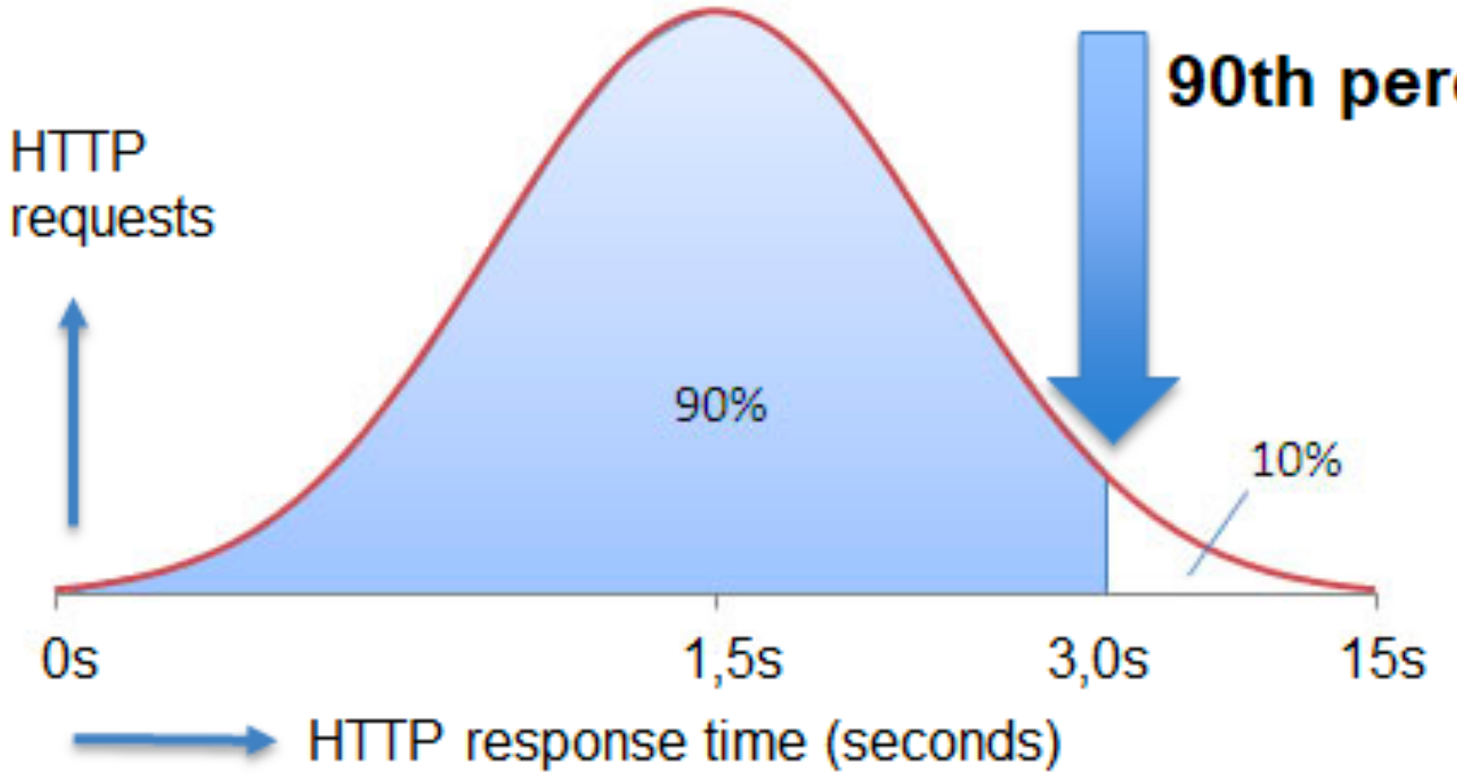
# Standard deviation

Average variance from the calculated mean value



# Percentile

50, 90, 95, 99 percentile ?



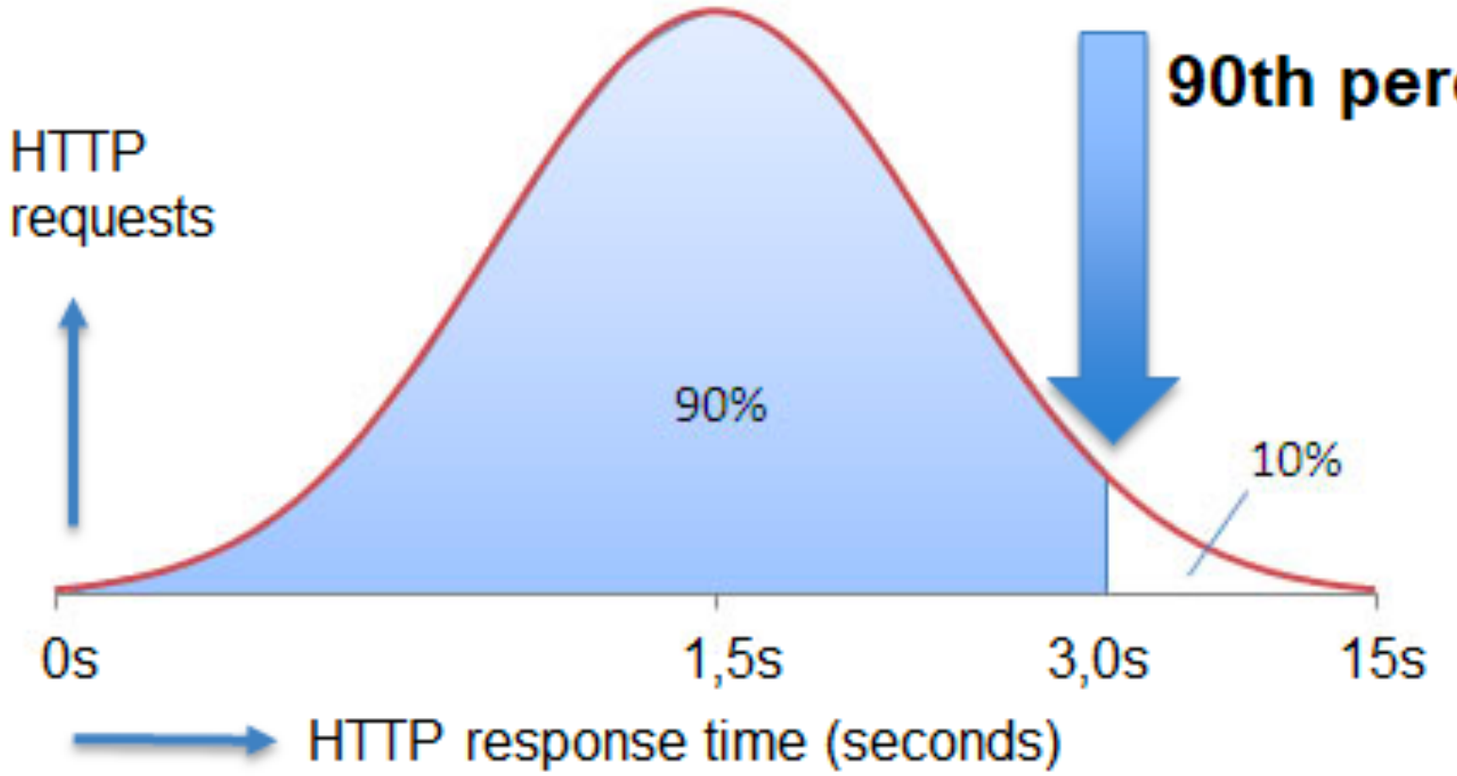
# Percentile as a SLA

The value below which a percentage of data falls


*80% of people are shorter than you*

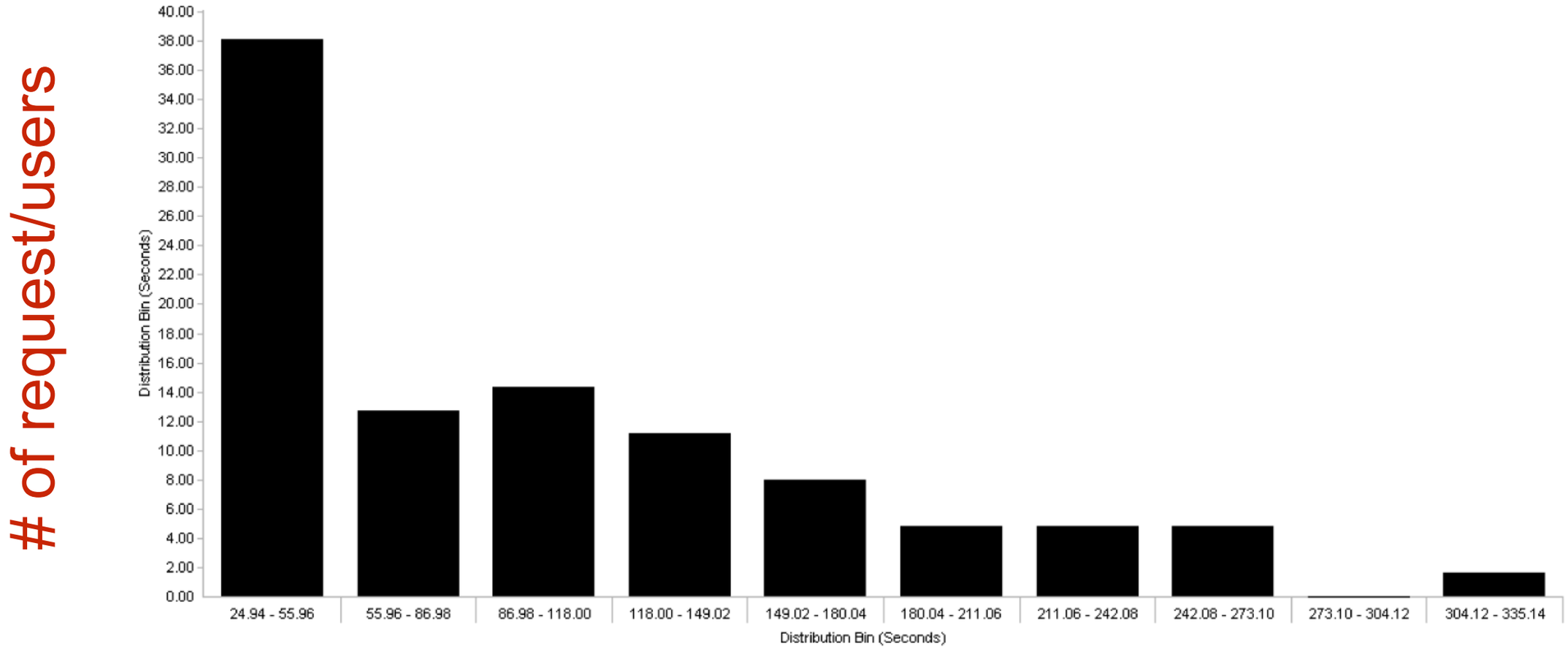
# 90th Percentile

90% of the requests is processed in 3.0 seconds or less



# Response time distribution

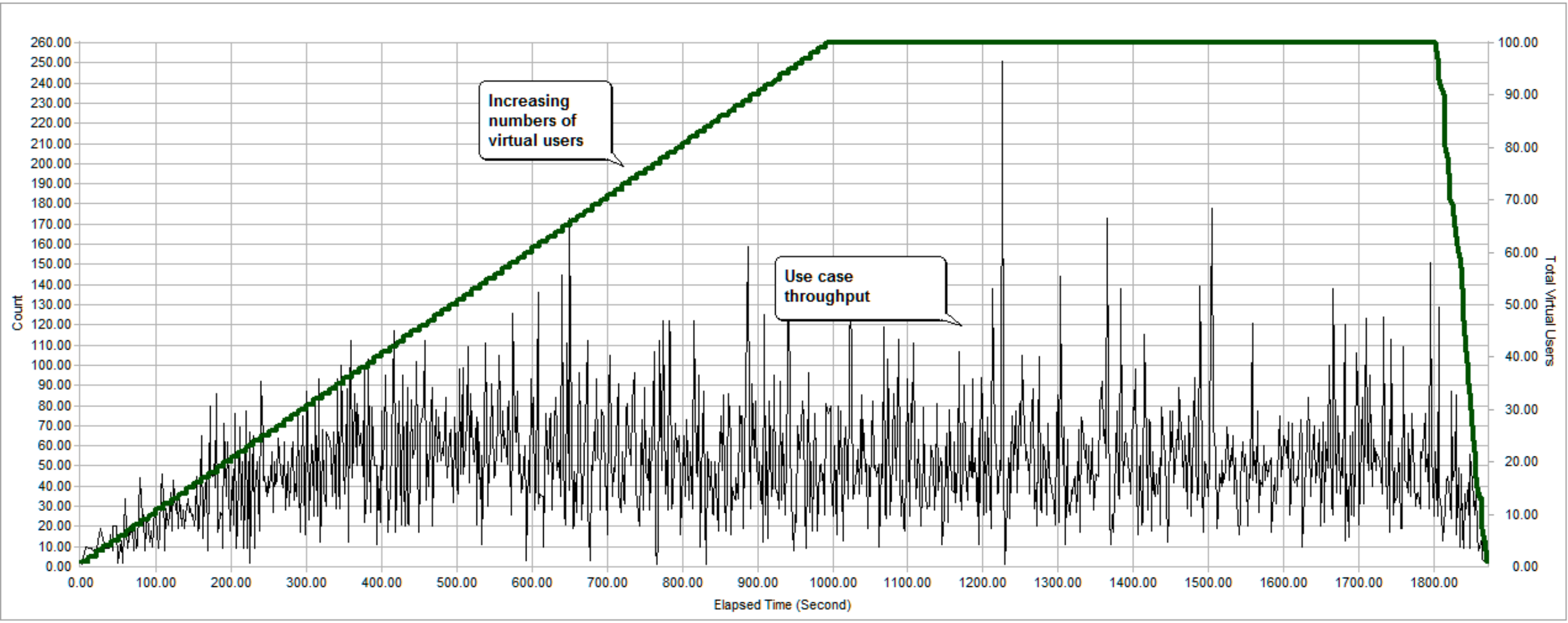
Aggregate all the response times collected during a performance test into a series of groups/buckets



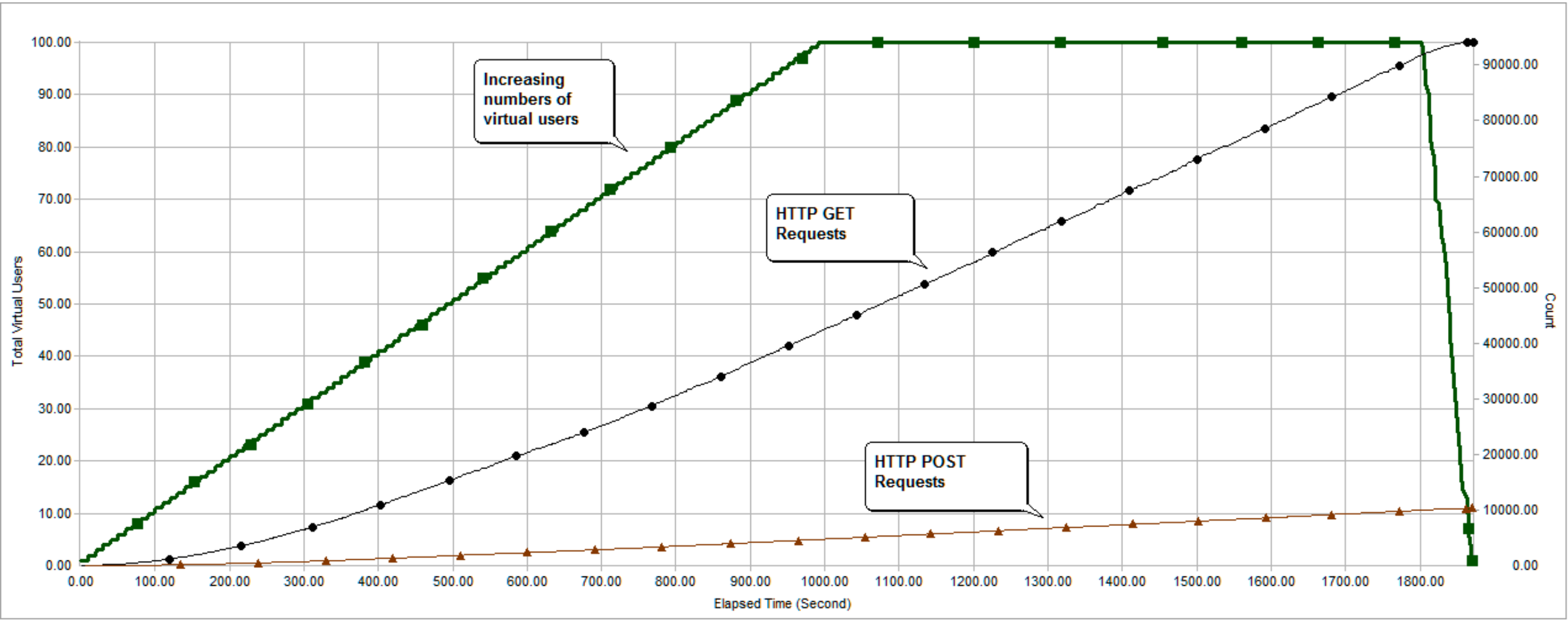

Response time

# Throughput

## How mush data/work/use cases can handled simultaneously ?



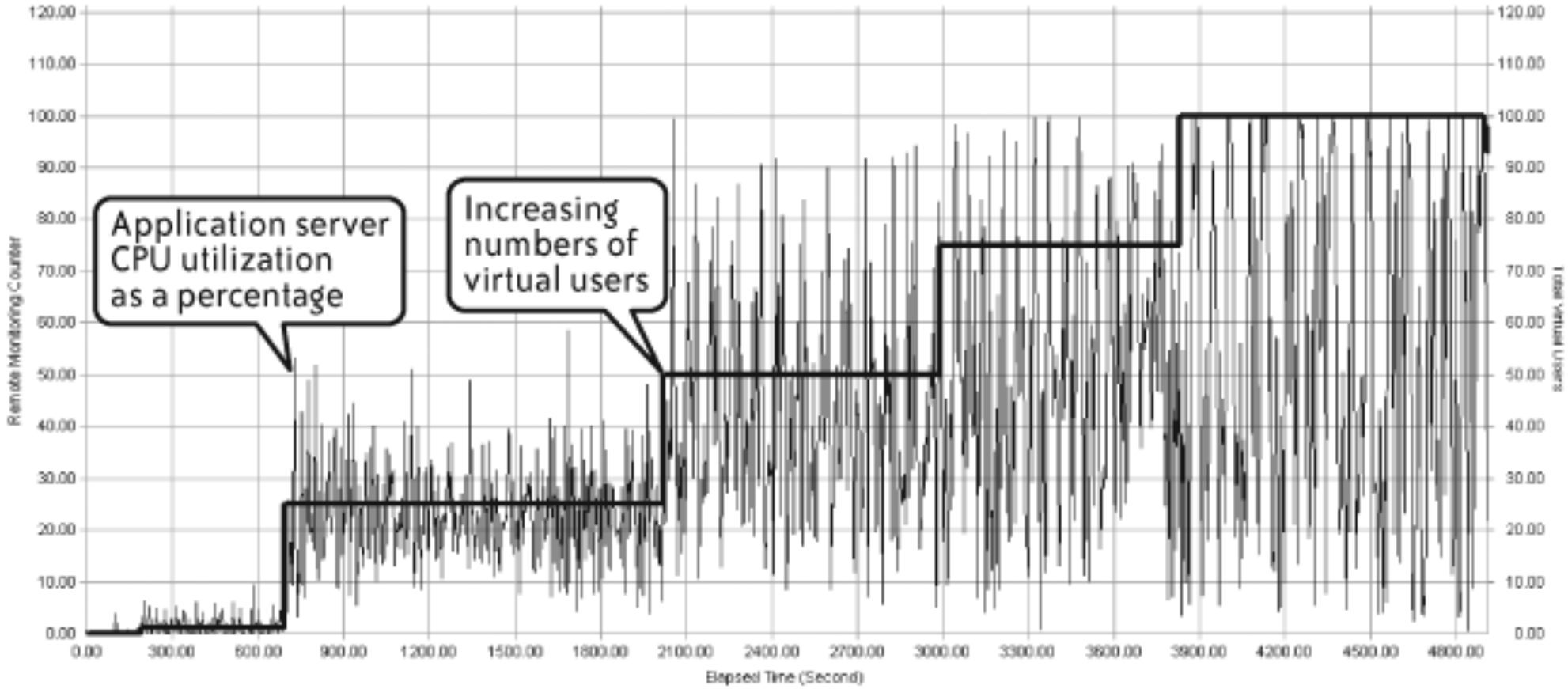
# Working with Web request



# Server KPI performance

CPU usage
Memory usage

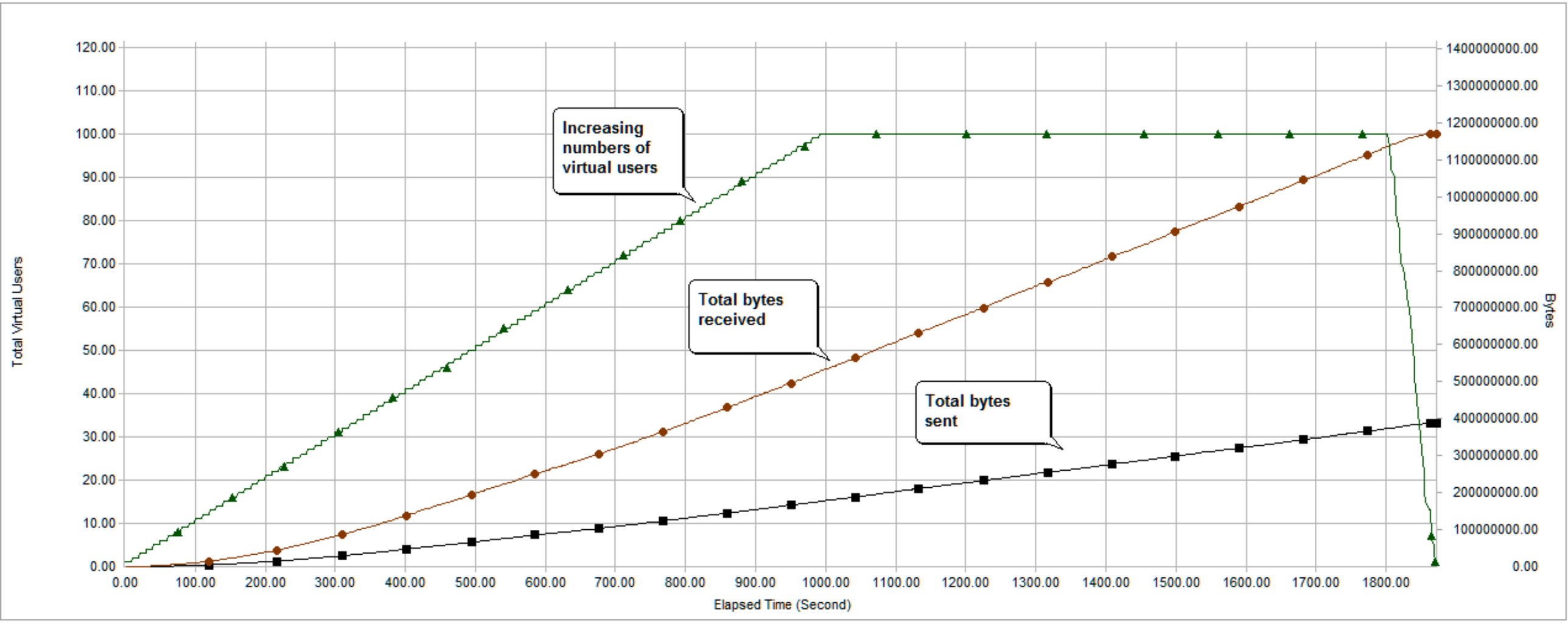
# Concurrent virtual users correlated with database CPU utilization



# Network KPI performance

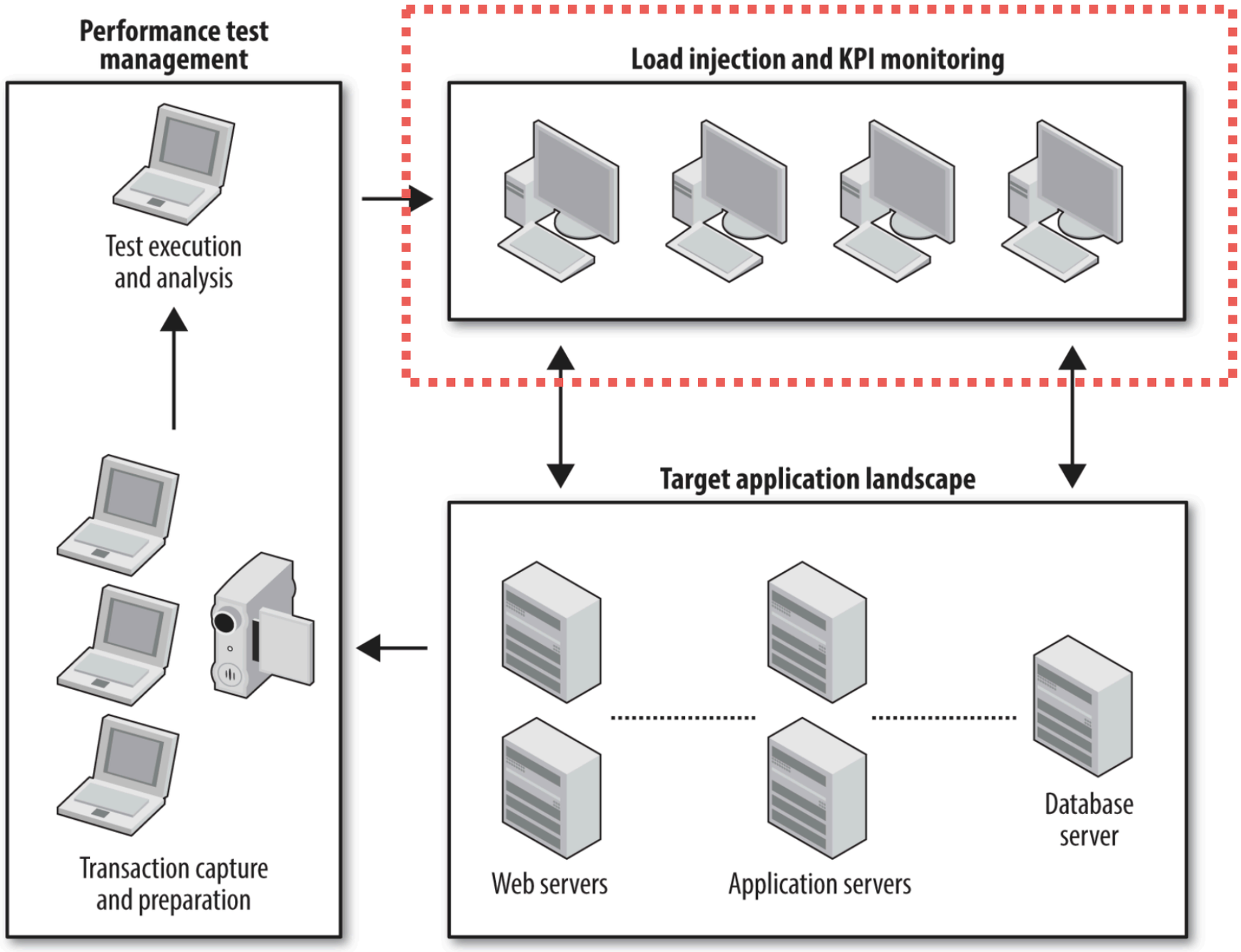
Size of data in request and response
Number of connection

# Network byte transfers correlated with concurrent virtual users



# Server and Network KPI

# Performance testing architecture

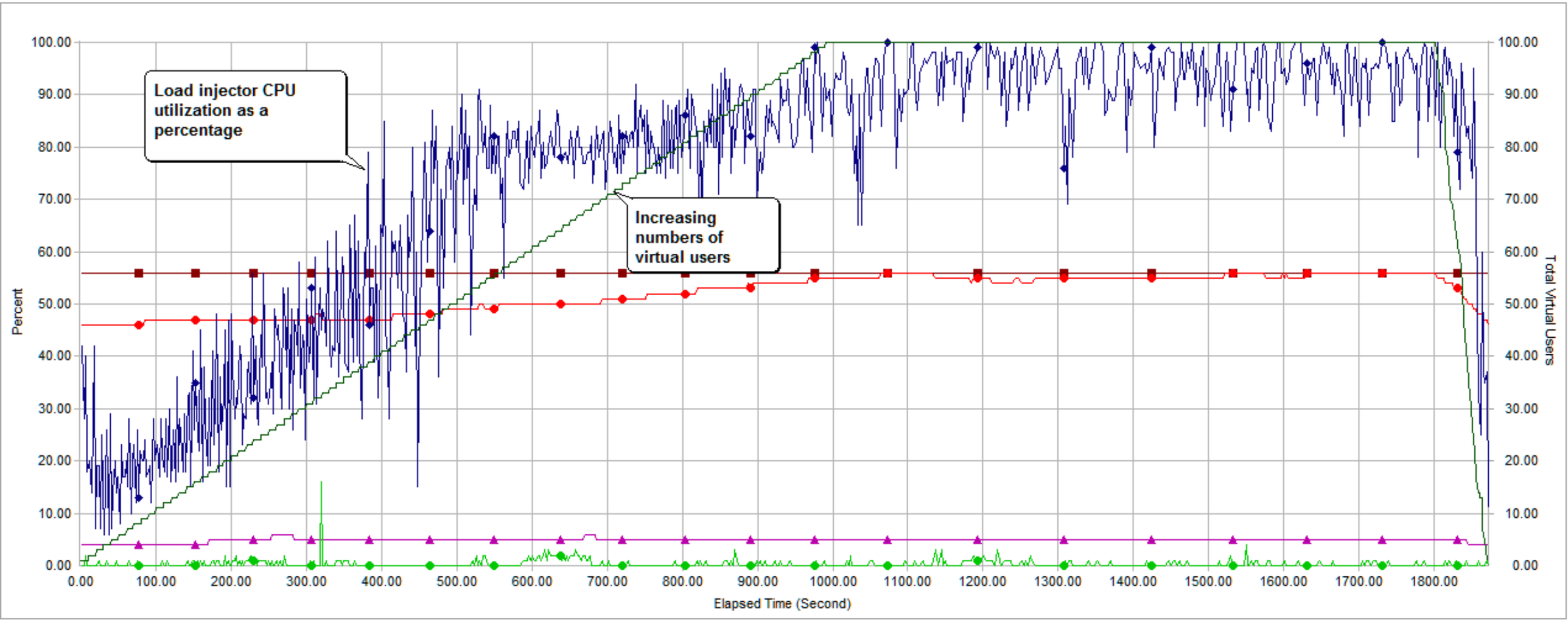


# Load injector performance

CPU usage
Memory usage
Disk usage
File system

*Better load injector make better virtual users*

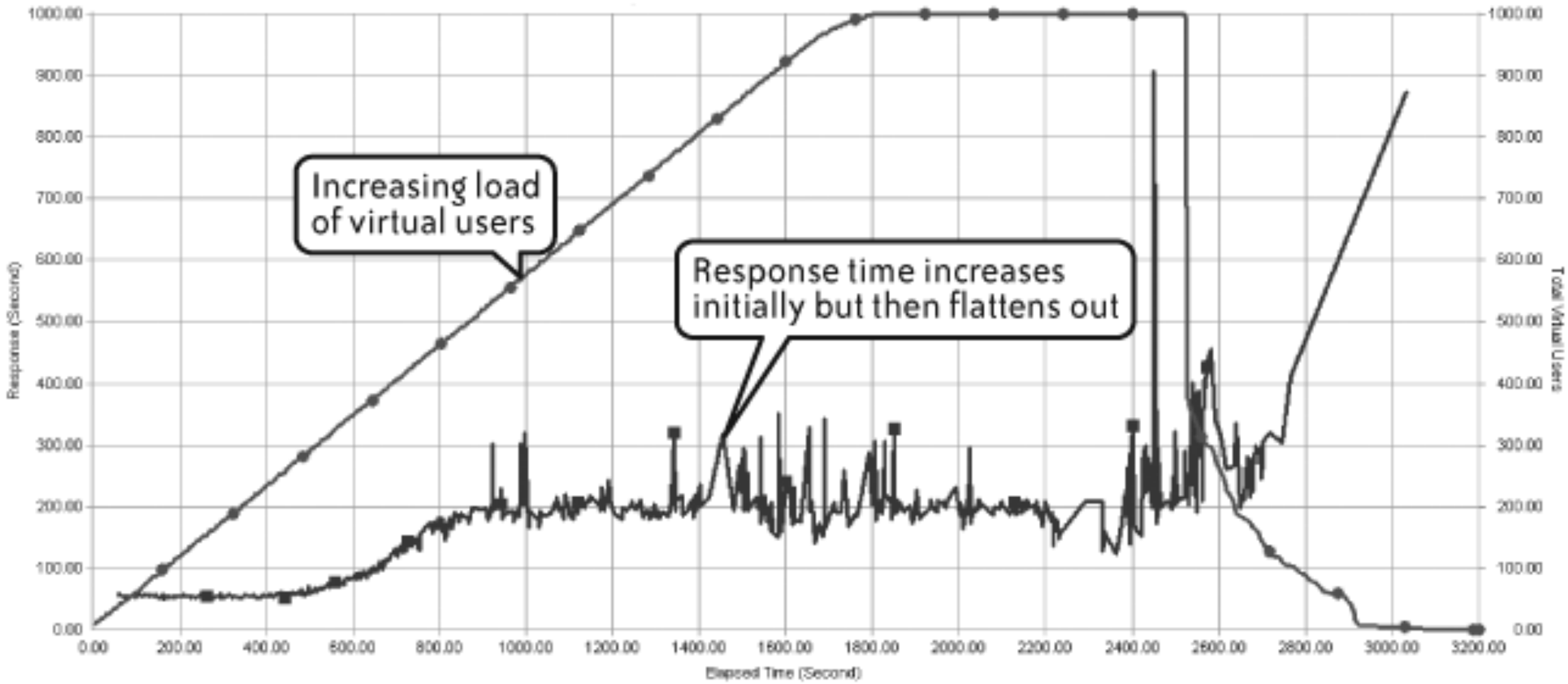
# Load injector performance



# Root causes analysis

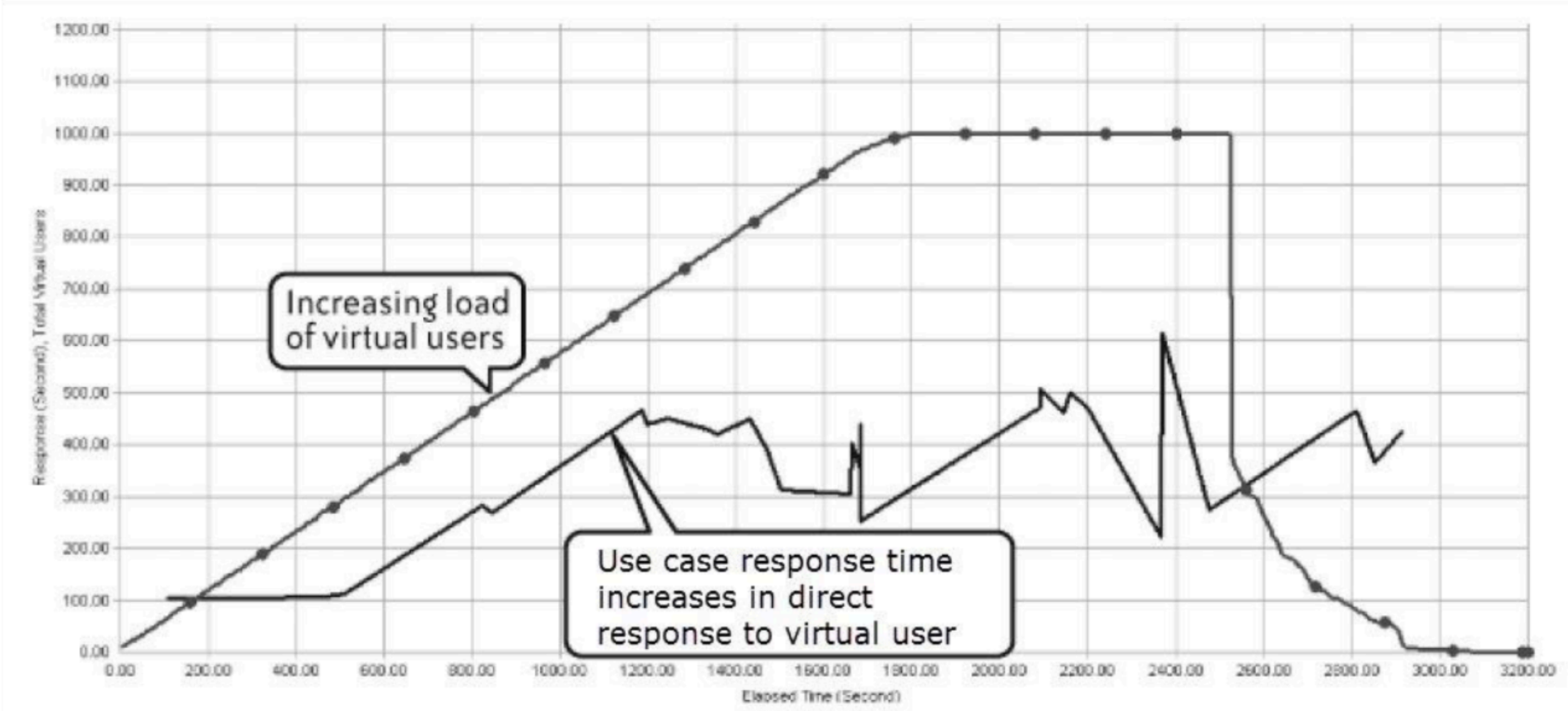
# Scalability and response time

Good or bad ?

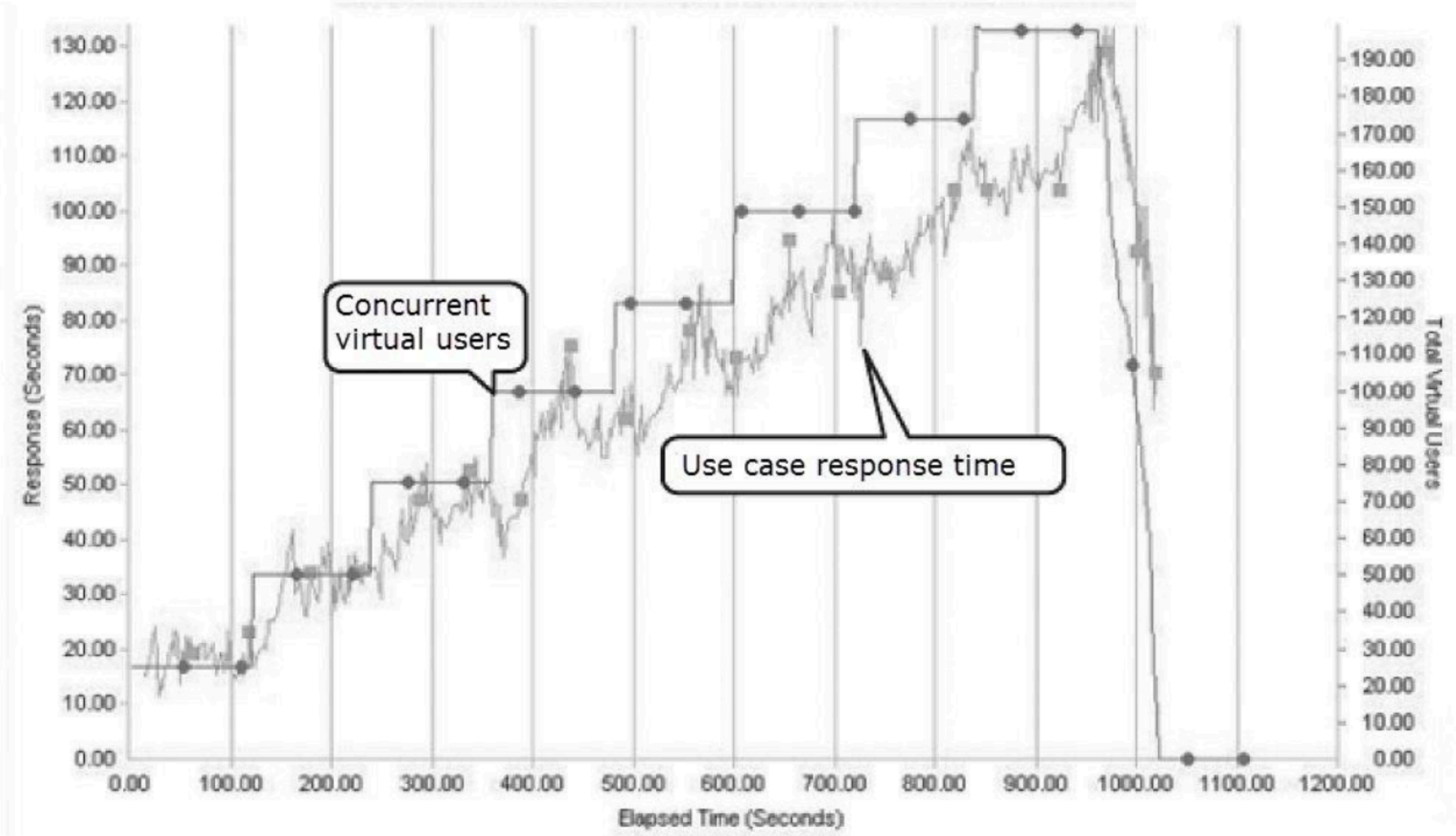


# Scalability and response time

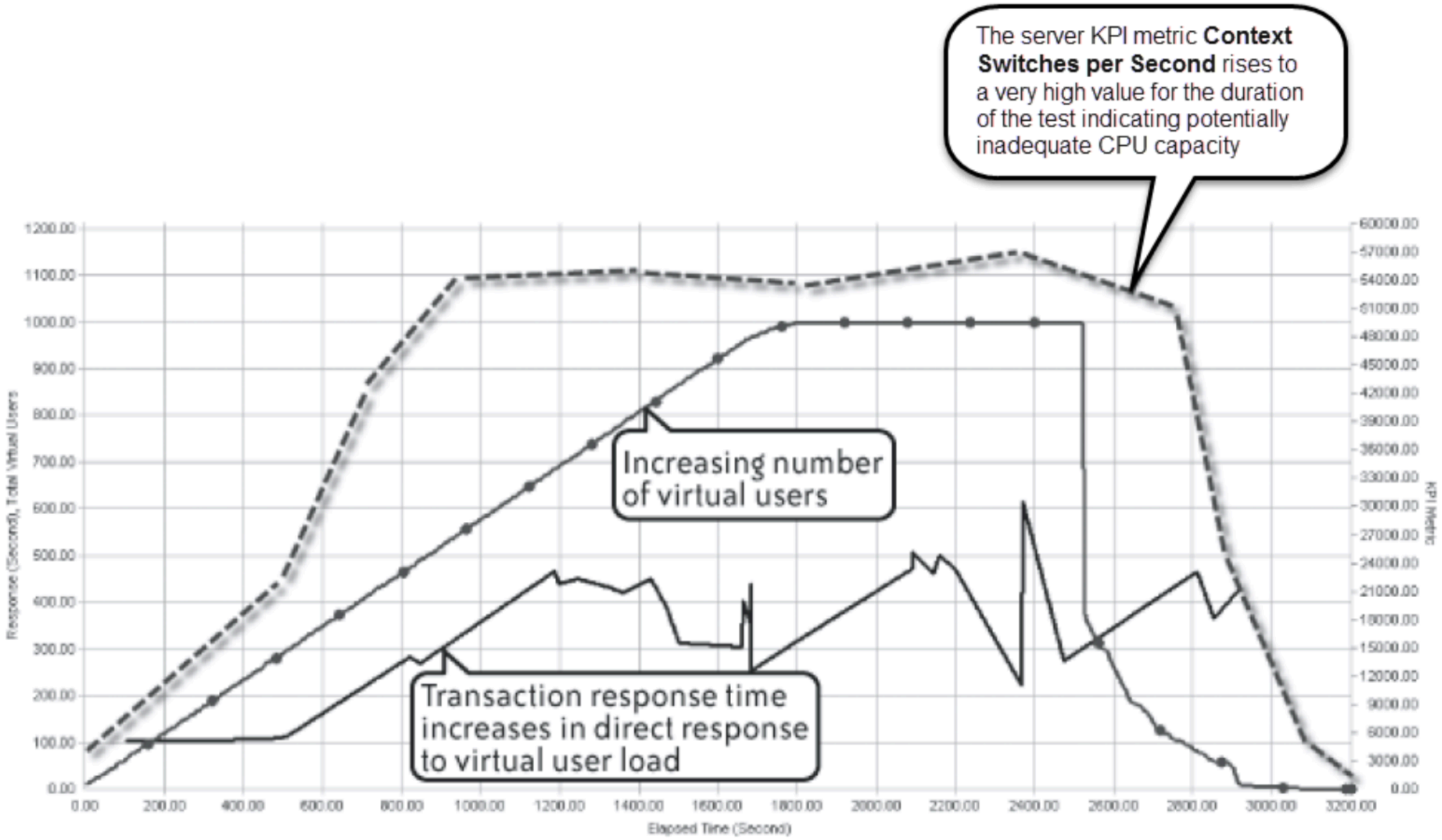
## Good or bad ?



# Good or bad ?

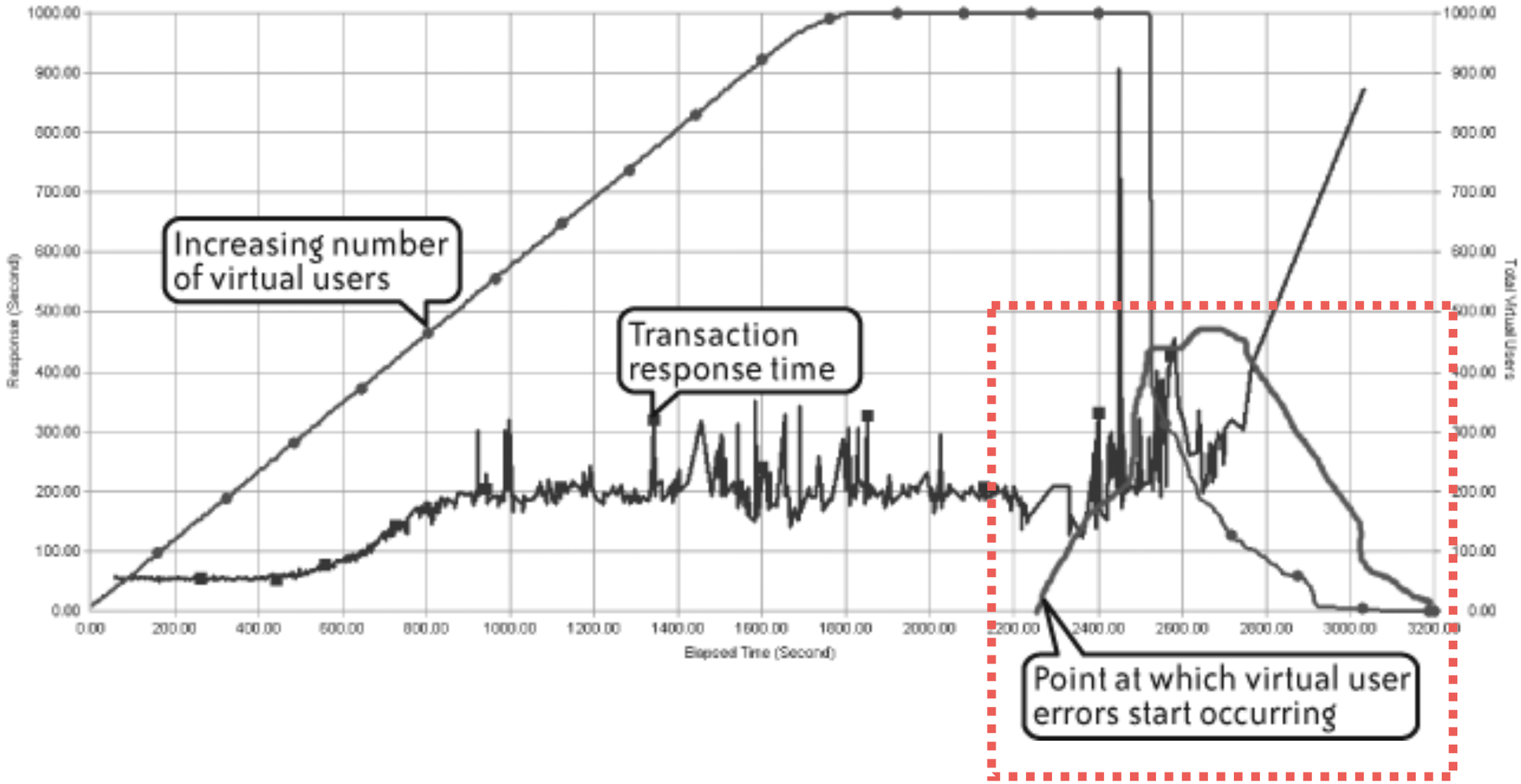


# Good or bad ?



# Error rate ?

Errors that occur during a performance test



# Analysis checklists

Help to adopt a consistent approach to analysing the results

# Analysis checklists

Pre-test tasks
During test execution tasks
Post-test tasks

# Pre-test tasks

Configure the appropriate server/app/network KPI

How to test ?

Make sure that you can access the app from the load injector

Configure of the load injector

Configure of 3-party tools and data

# During test execution tasks

Make sure every **tests** are **executed**
Go or no go when **errors** are occurred
Go or no go when **throughputs** are dropped
CPU, memory, disk, network usage !!

# Post-test tasks

Make sure you collect all relevant data

Backup all testing resources (script, input, result)

When producing report, make sure you map results to the performance targets