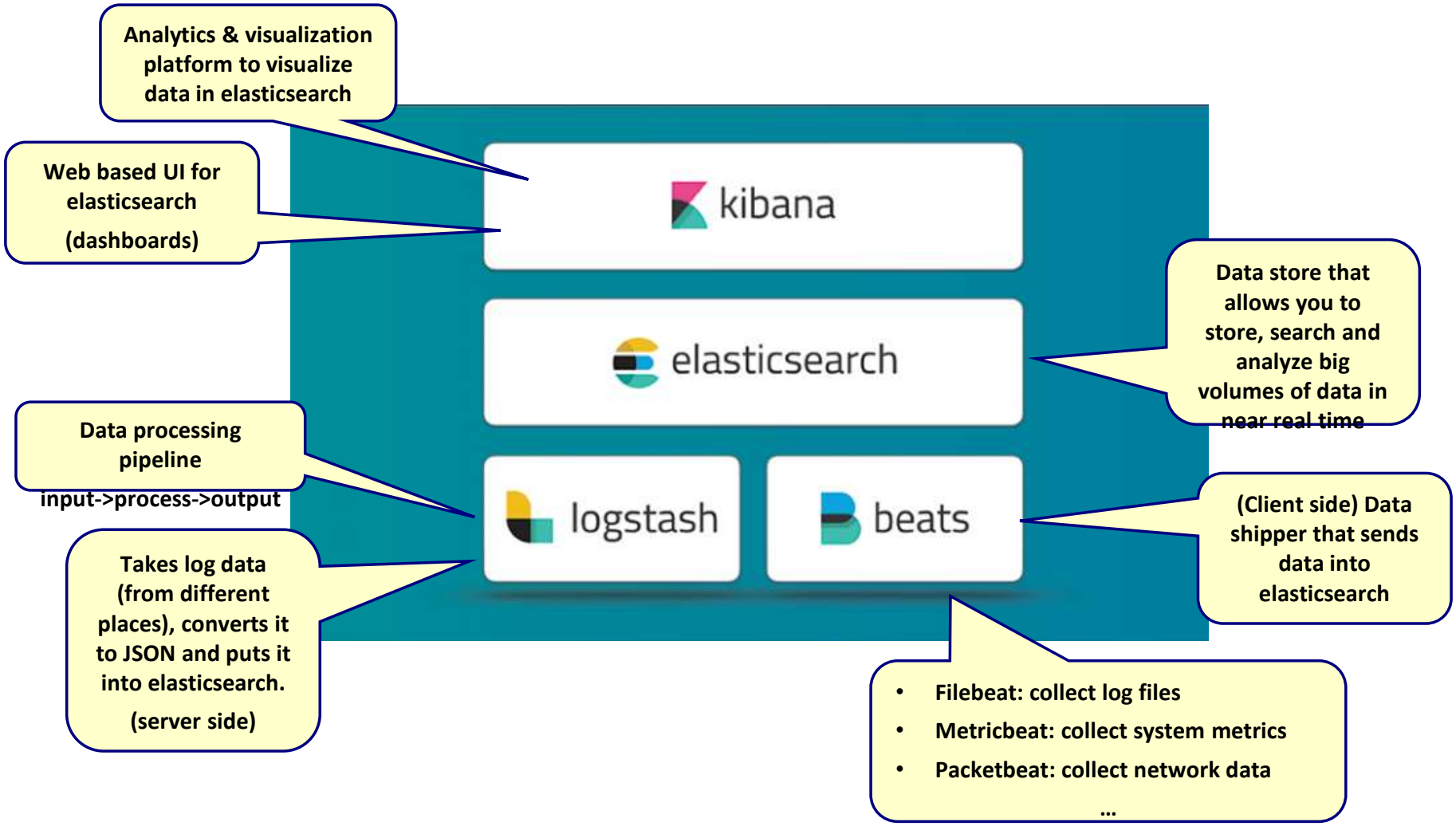
CS544

LESSON 13
MONITORING

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
March 28 **Lesson 1** Enterprise Architecture introduction and Spring Boot	March 29 **Lesson 2** Dependency injection AOP	March 30 **Lesson 3** JDBC JPA	March 31 **Lesson 4** JPA mapping 1	April 1 **Lesson 5** JPA mapping 2	April 2 **Lesson 6** JPA queries	April 3
April 4 **Lesson 7** Transactions	April 5 **Lesson 8** MongoDB	April 6 **Midterm Review**	April 7 **Midterm exam**	April 8 **Lesson 9** REST webservices	April 9 **Lesson 10** SOAP webservices	April 10
April 11 **Lesson 11** Messaging	April 12 **Lesson 12** Scheduling Events Configuration	April 13 **Lesson 13** Monitoring	April 14 **Lesson 14** Testing your application	April 15 **Final review**	April 16 **Final exam**	April 17
April 18 **Project**	April 19 **Project**	April 20 **Project**	April 21 **Presentations**			

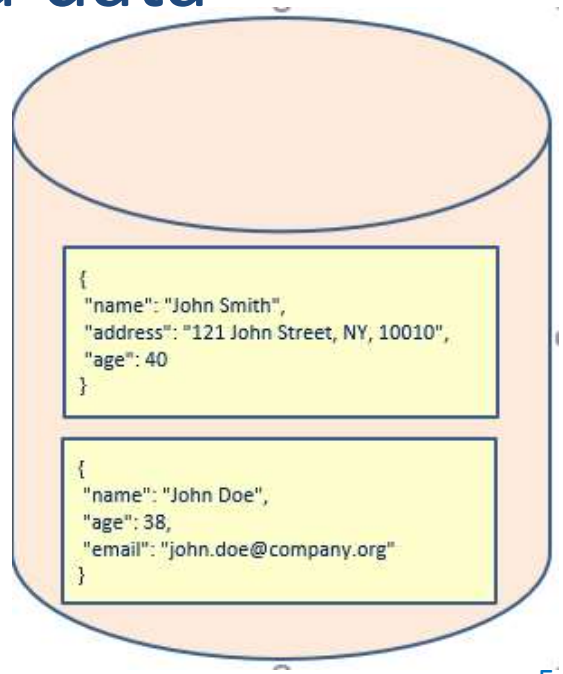
THE ELASTIC STACK

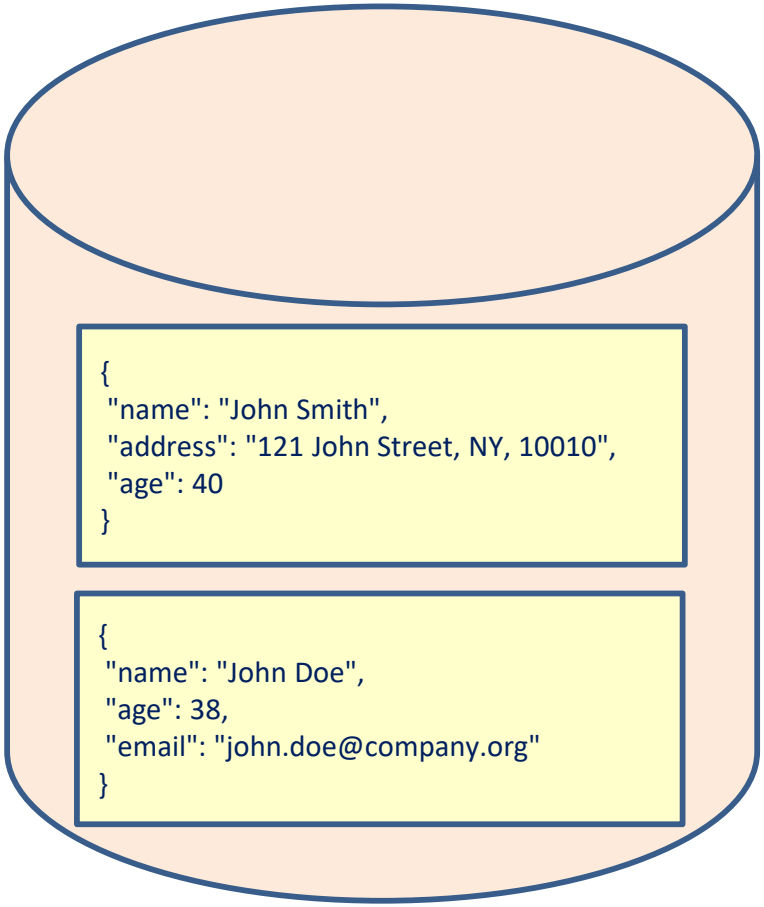
Elastic stack components



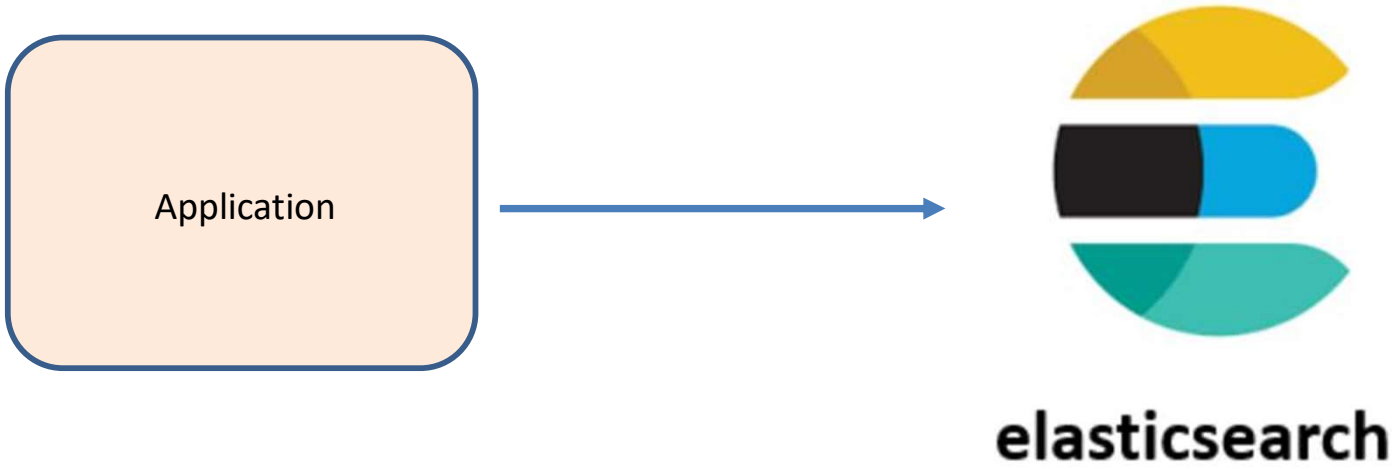
What is Elasicsearch?

- Database
  - Data is stored as documents
  - Data is structured in JSON format
- Full text search engine
- Analytics platform for structured data

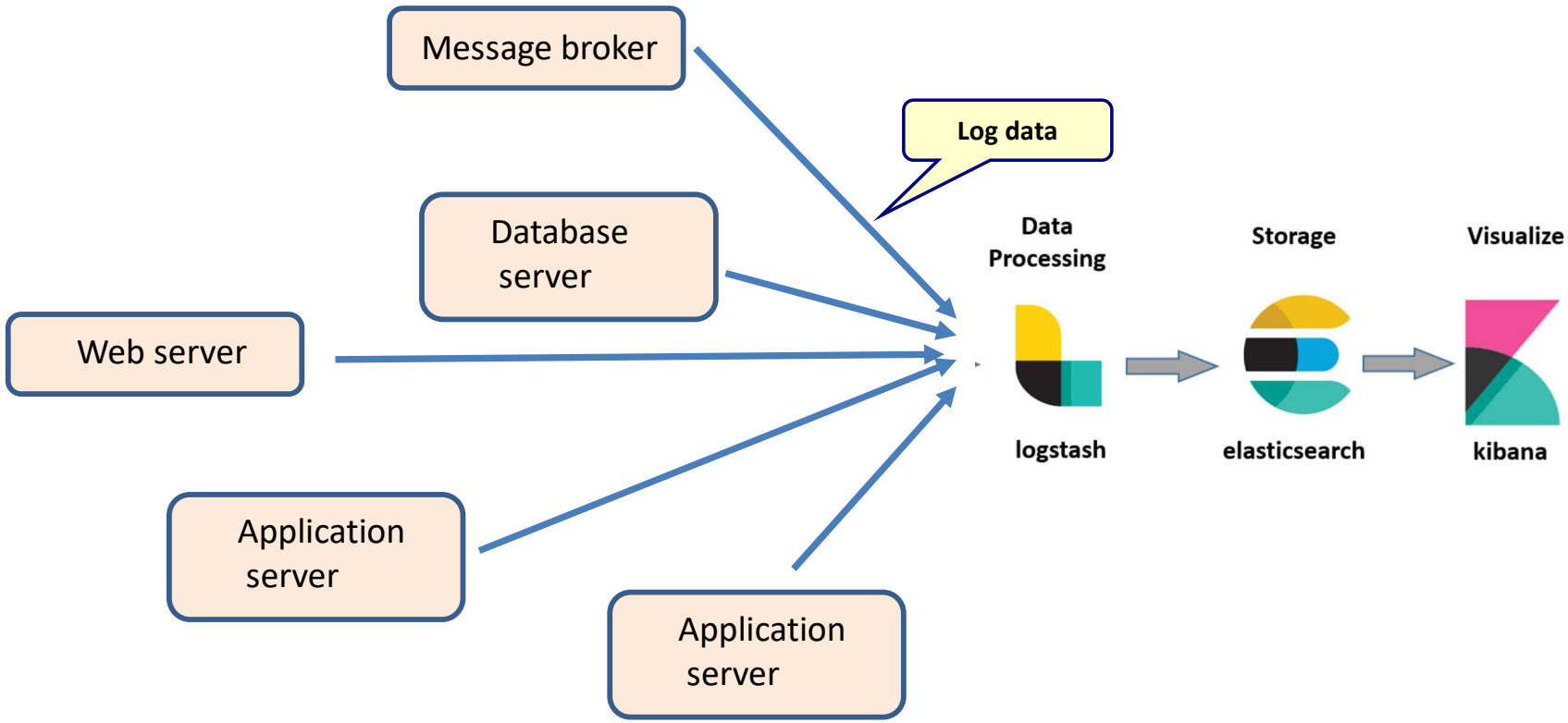



{
"name": "John Smith",
"address": "121 John Street, NY, 10010",
"age": 40
}
{
"name": "John Doe",
"age": 38,
"email": "john.doe@company.org"
}

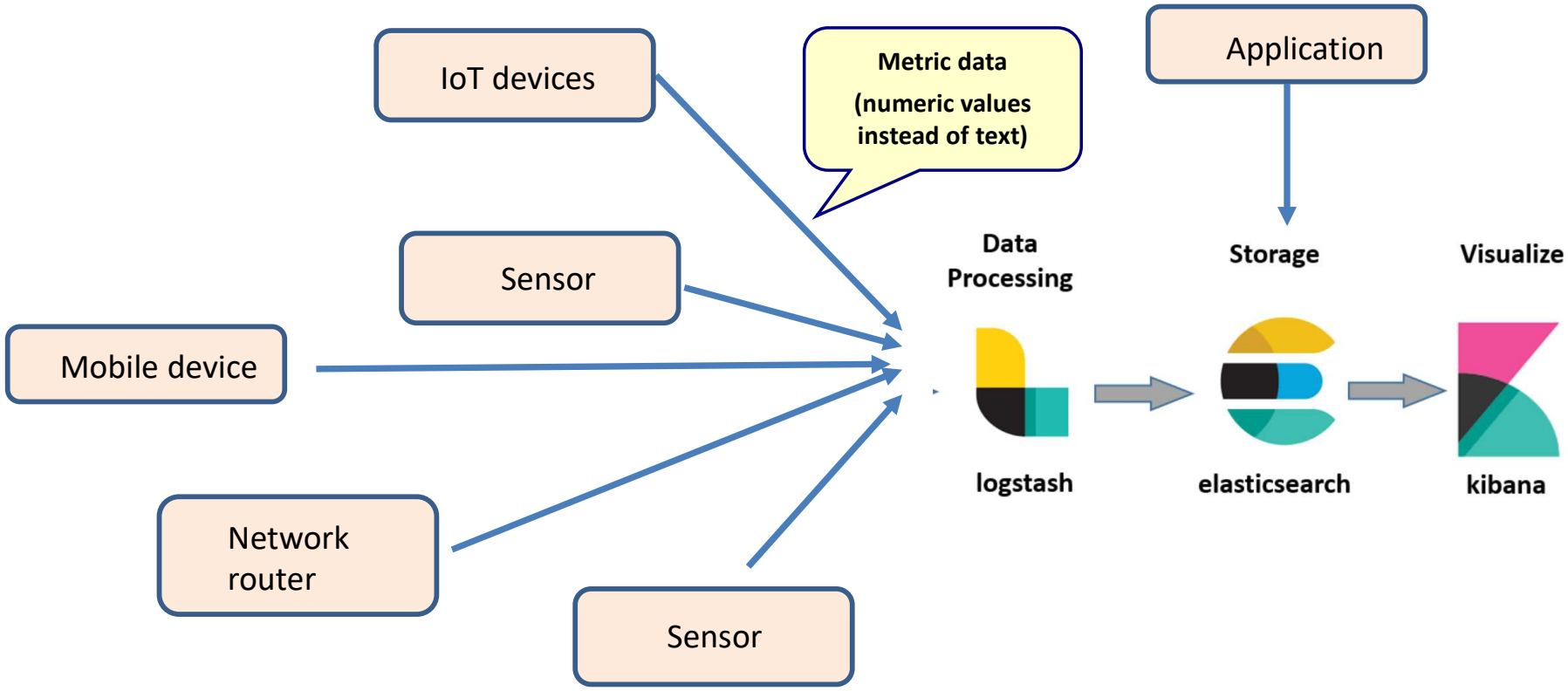
Use case: search in large data sets



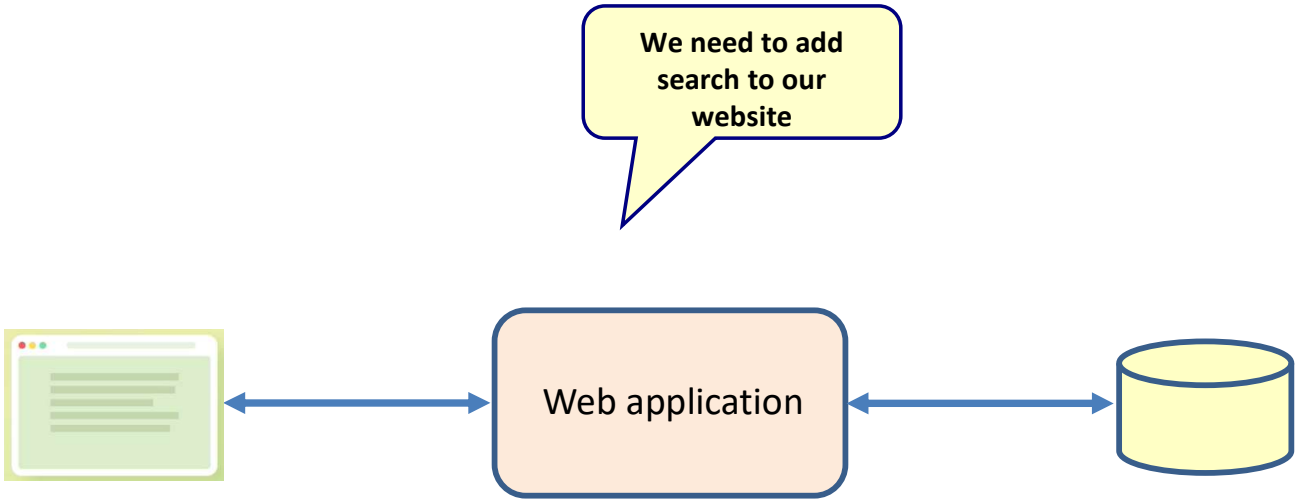
Use case: Log analytics



Use case: Metrics analytics



Use case example: add search to our website



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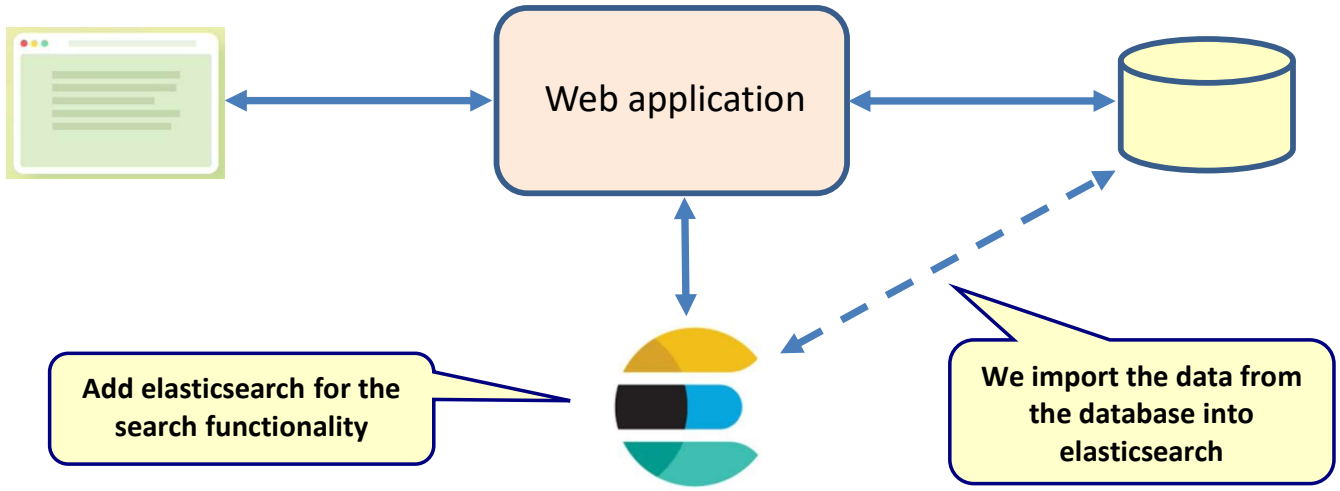
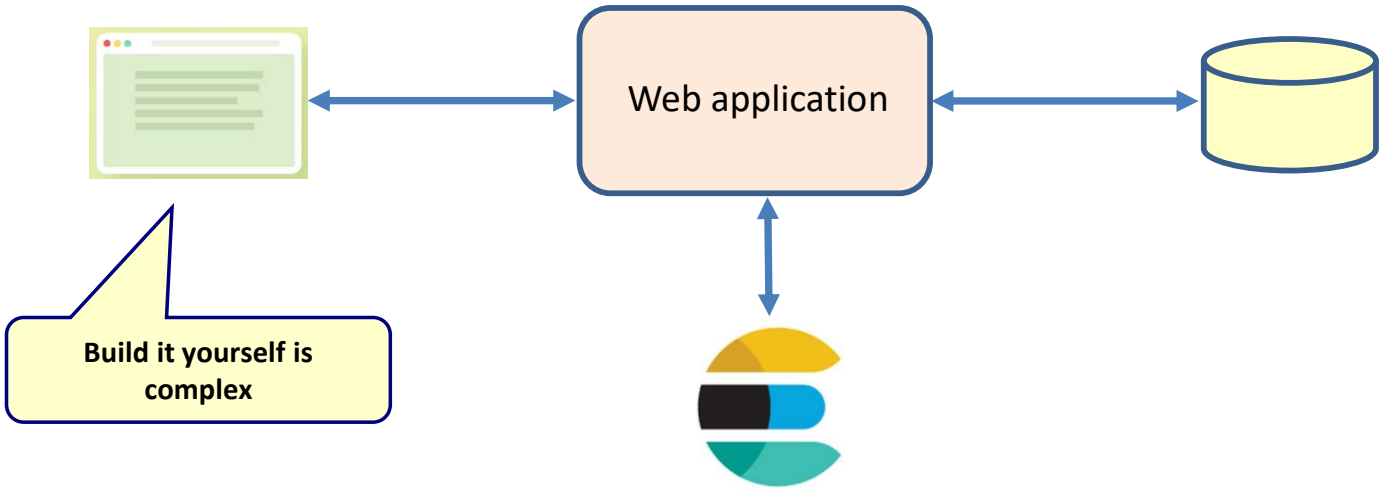
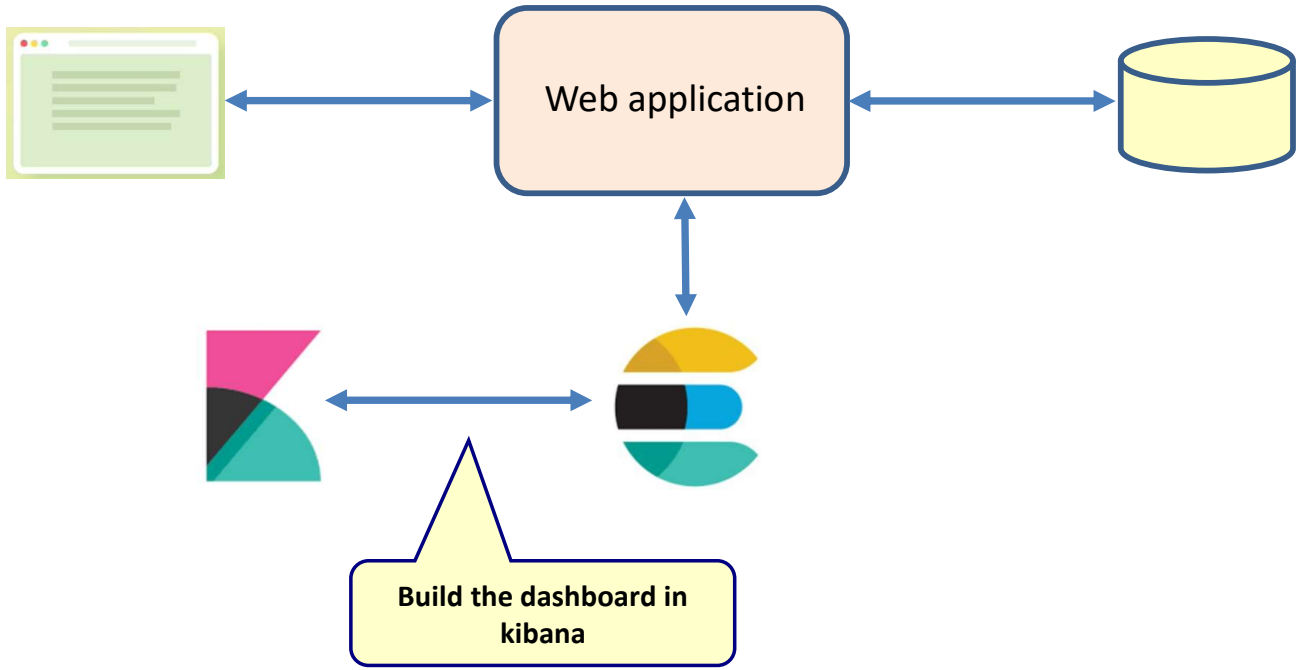


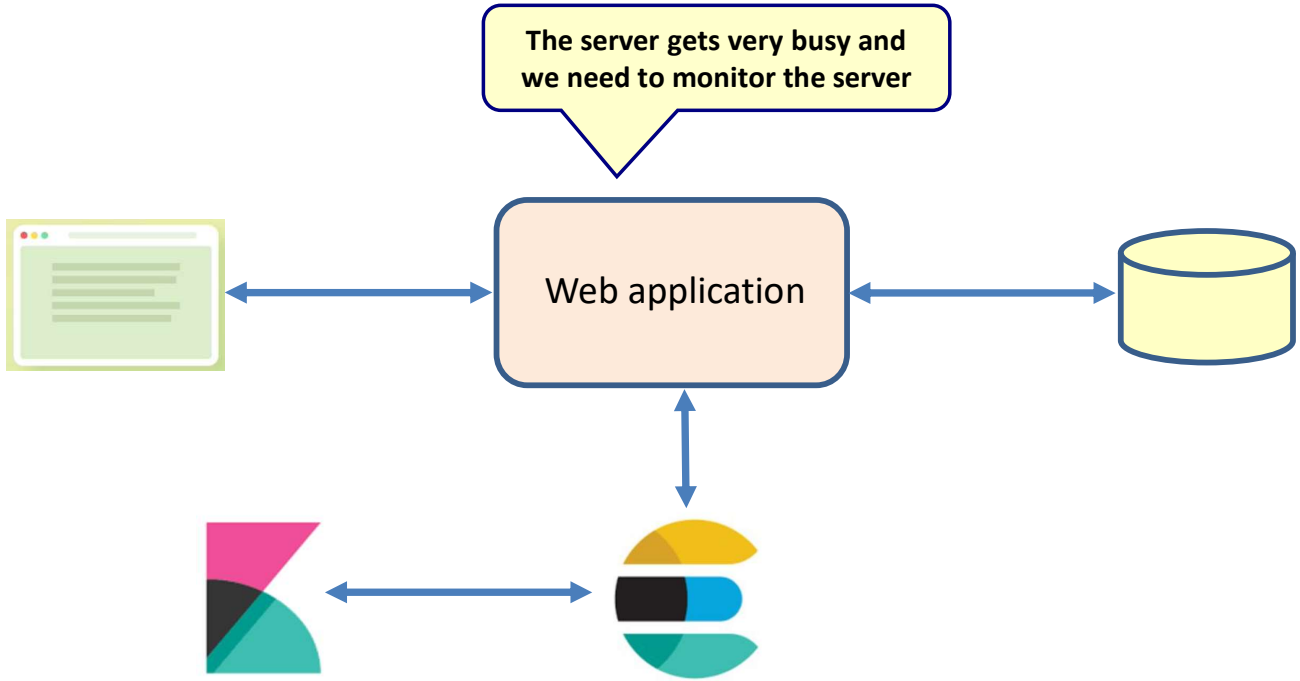
Use case example: implement a dashboard



Use case example: implement a dashboard



Use case example: add server monitoring



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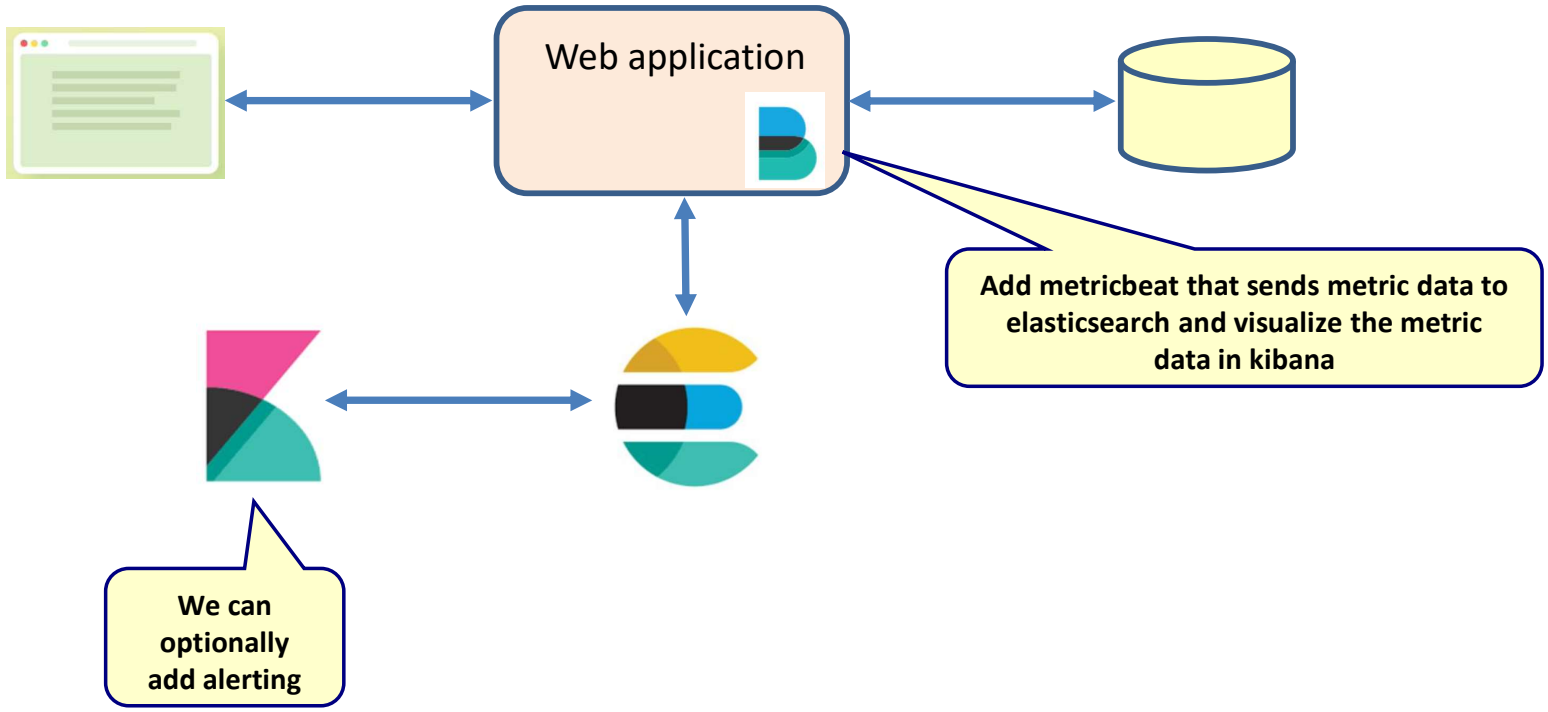
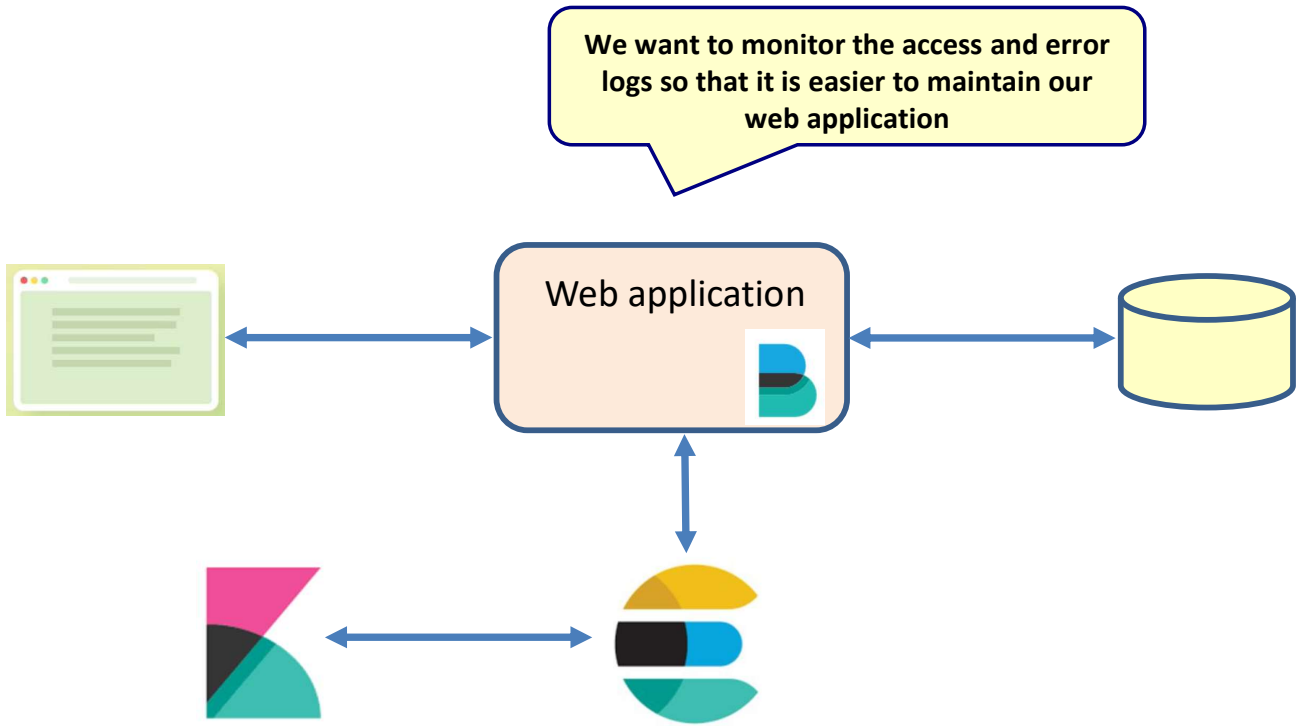
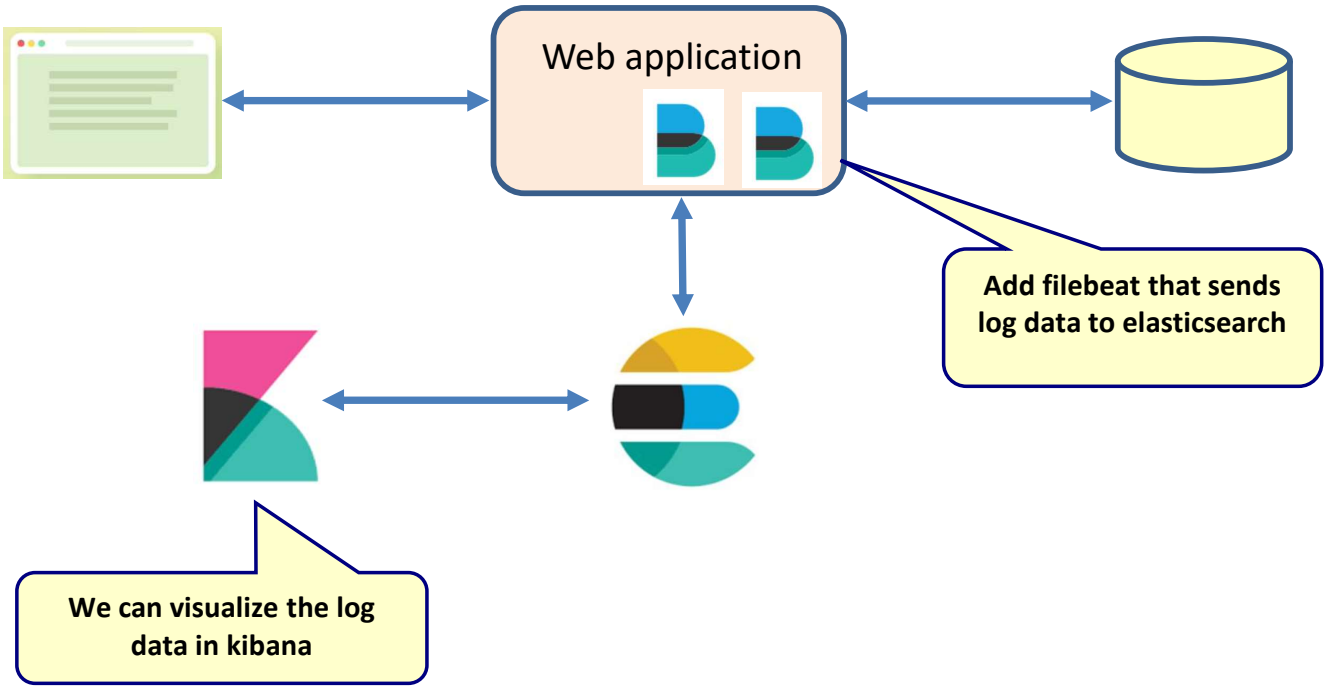


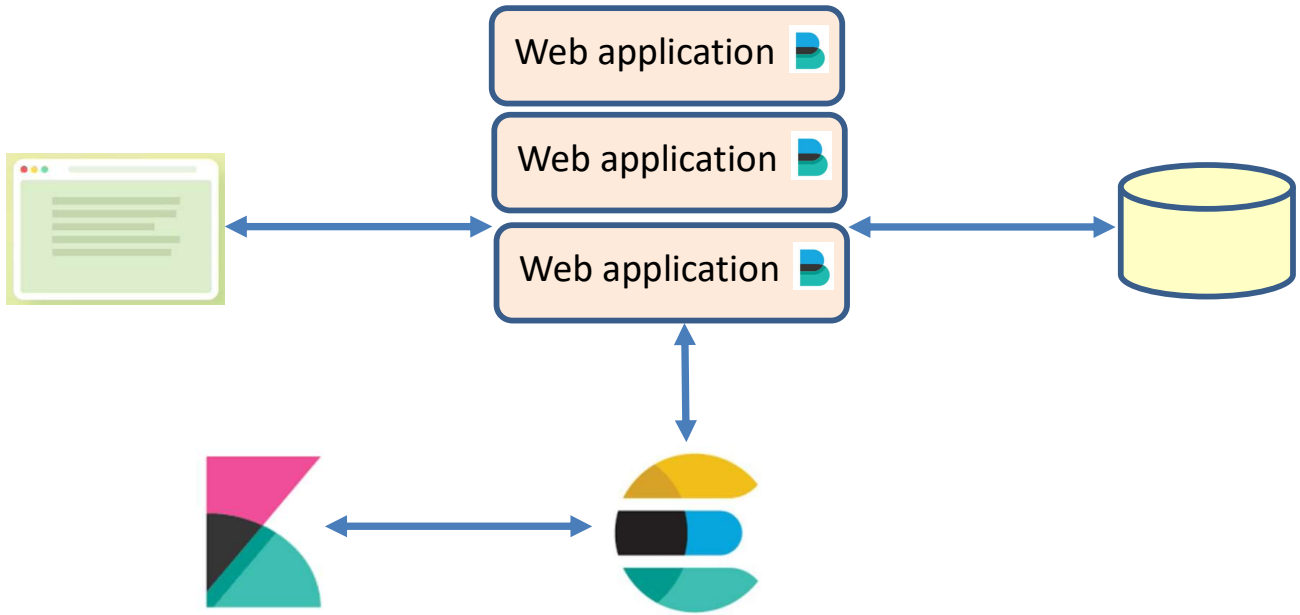
Use case example: add access + error log monitoring



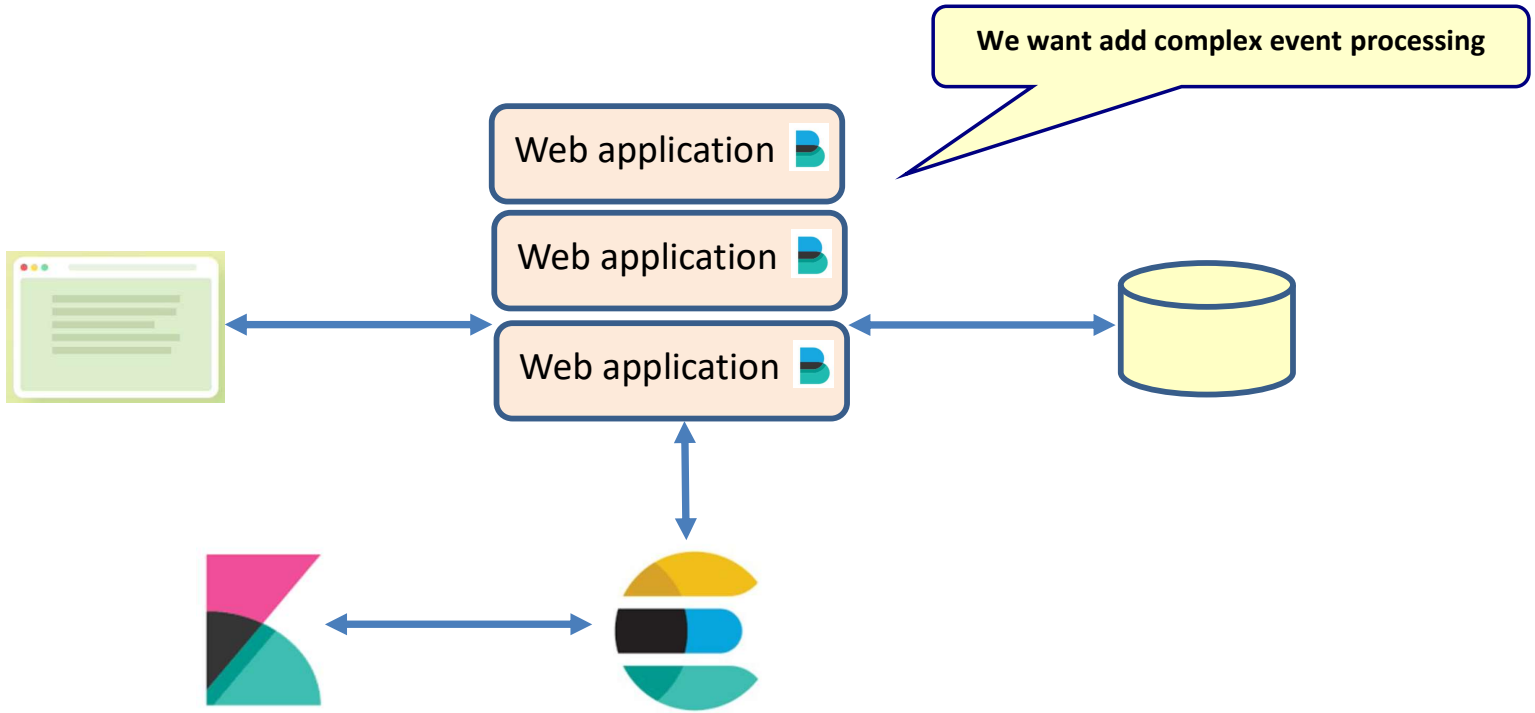
Use case example: add access + error log monitoring



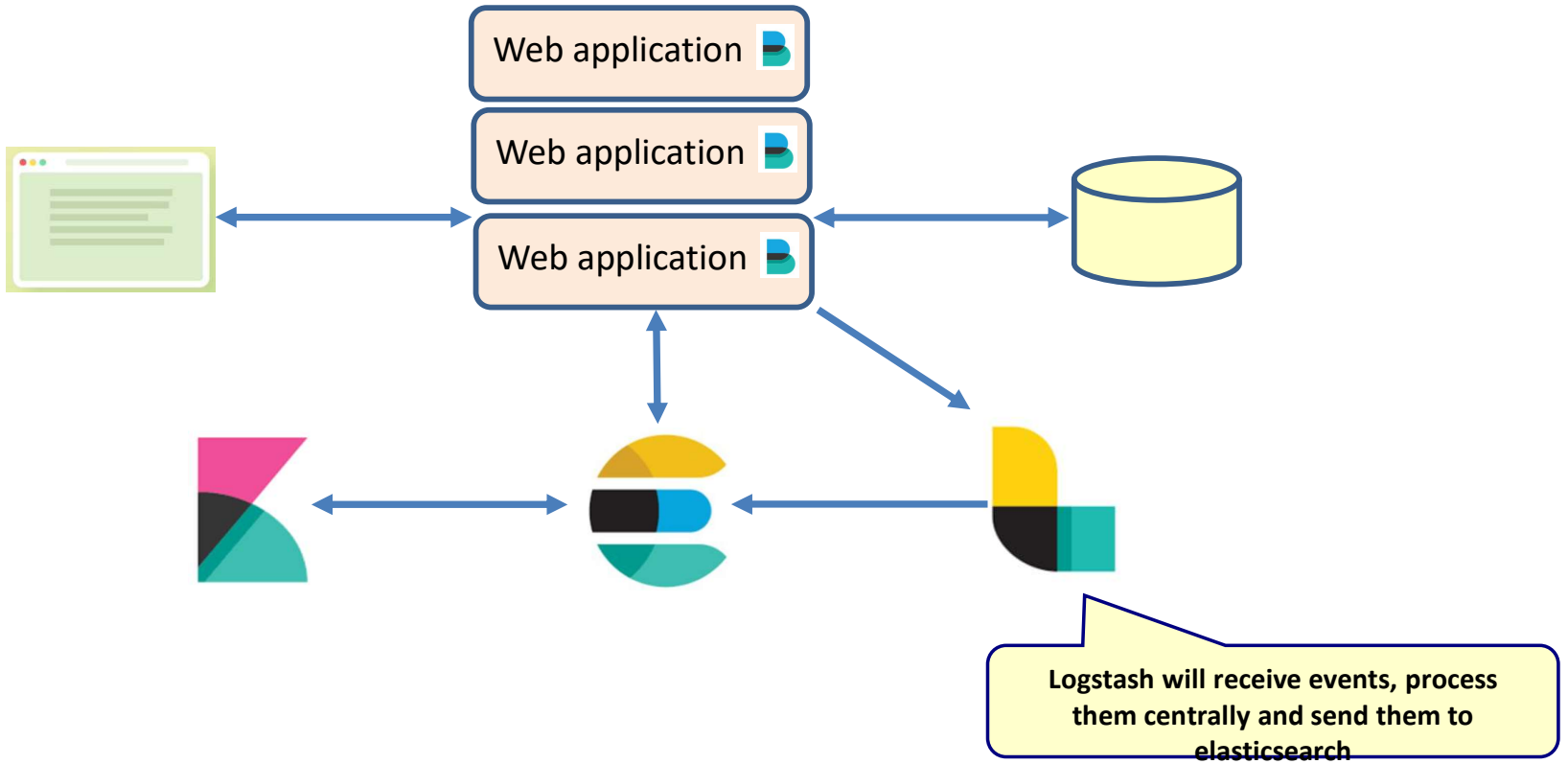
Use case example: multiple servers for load balancing



~~Use case example: add complex event~~ processing



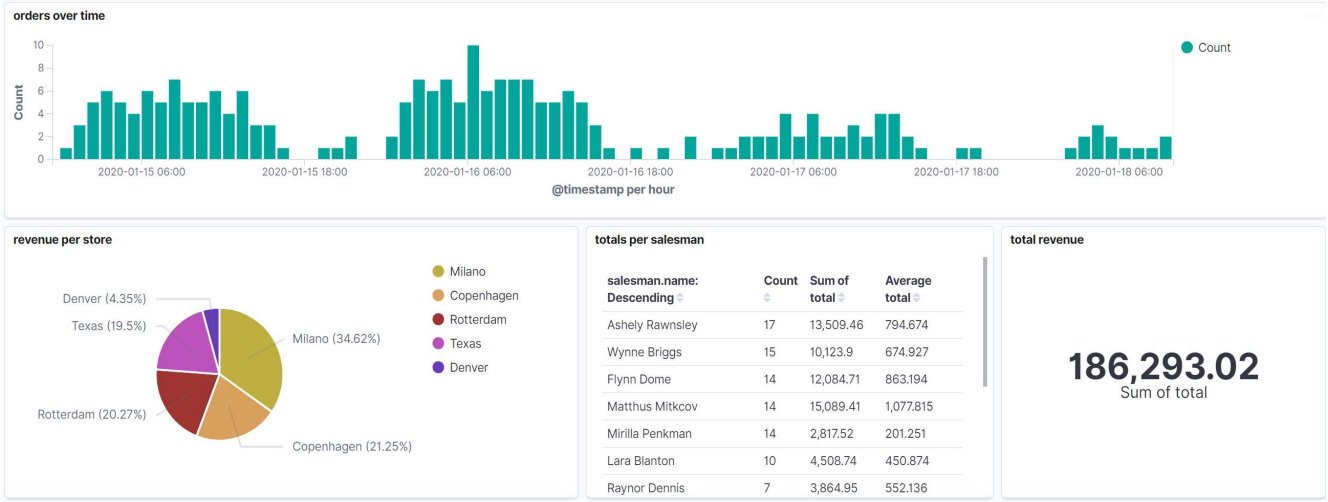
~~Use case example: add complex event~~ processing



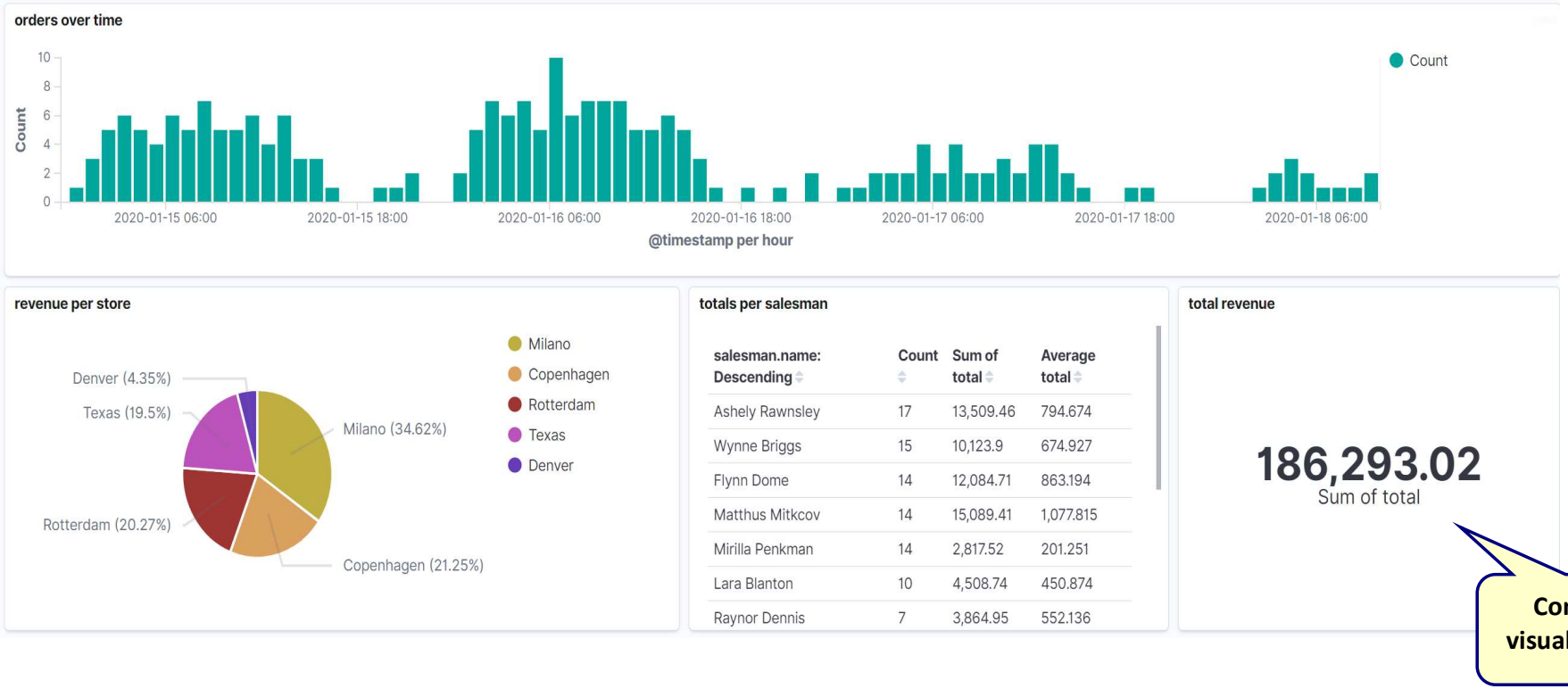
KIBANA

Kibana

- Web UI on top of elasticsearch
- Has its own Kibana query language (KQL)
- Objects (Queries, visualizations, dashboards, etc.) are saved in elasticsearch



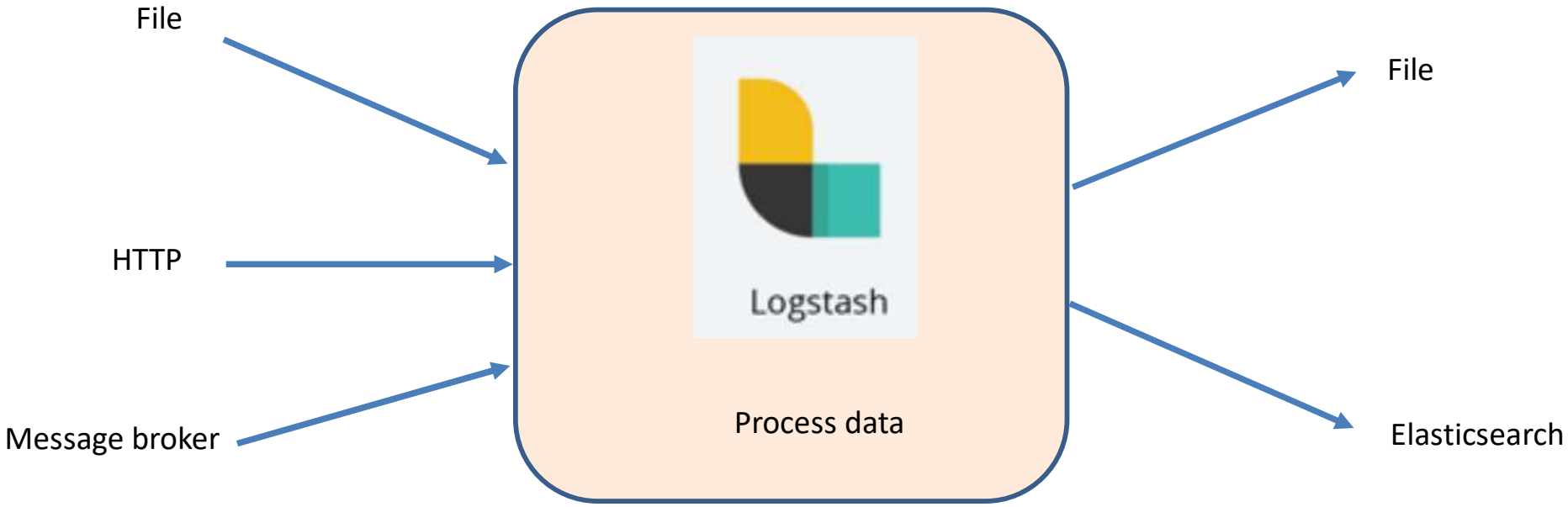
Dashboard



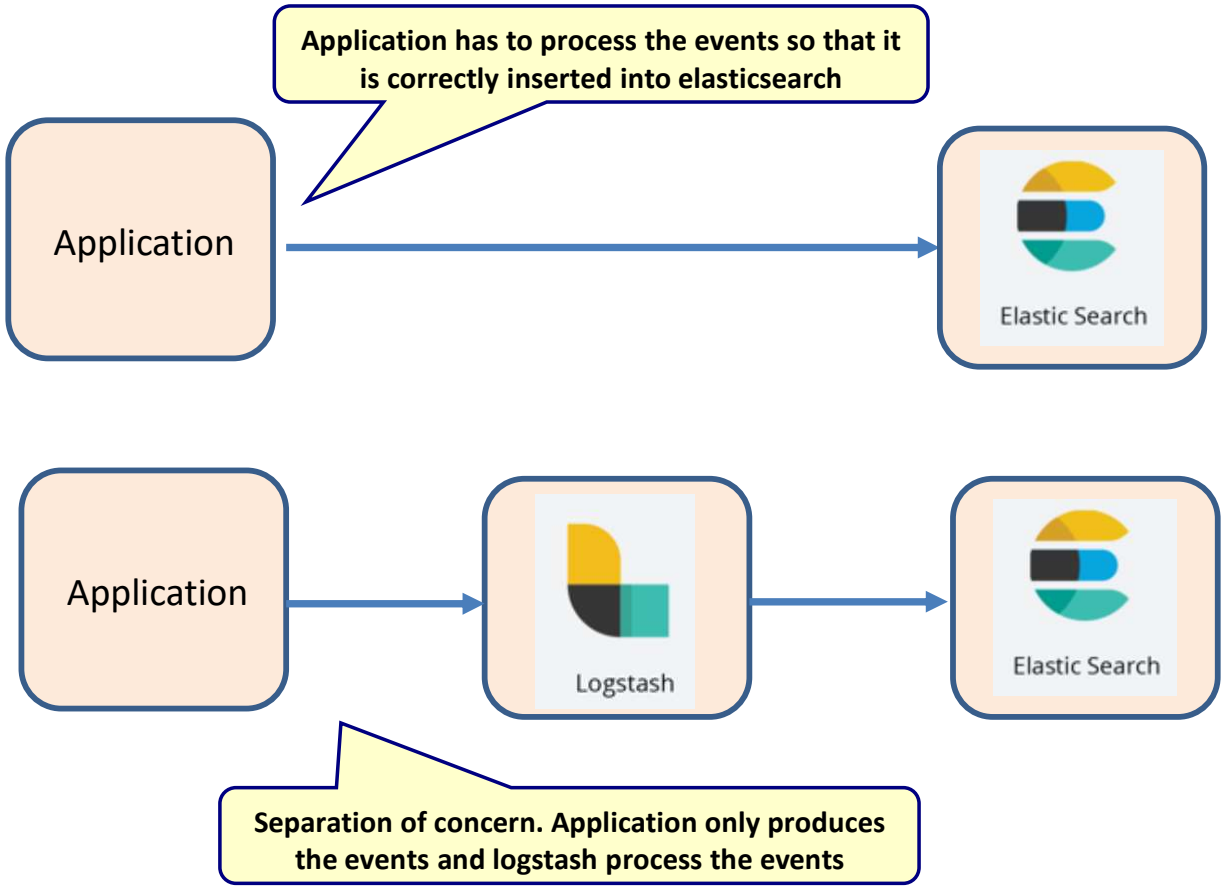
LOGSTASH

Logstash

- Event processing engine



Why logstash in ELK?



Logstash configuration

input.txt

```
Hello world
```

pipeline.conf

```
input {
  file {
    path => "C:/elasticsearchtraining/temp/input.txt"
    start_position => "beginning"
  }
}

output {
  stdout {
    codec => rubydebug
  }
  file {
    path => "C:/elasticsearchtraining/temp/output.txt"
  }
}
```

output.txt

```
{
"host":"DESKTOP-BVHRK6K",
"@version":"1",
"path":"C:/elasticsearchtraining/temp/input.txt",
"message":"Hello world\r",
"@timestamp":"2021-01-16T13:52:32.726Z"
}
```

Anytime this file changes, read from this file

Write the output to the console

Write the output to the specified file

Logstash configuration

input.txt

```
Hi there
```

pipeline.conf

```
input {
 file {
   path => "C:/elasticsearchtraining/temp/input.txt"
          start_position => "beginning"
 }
}

filter {
   mutate {
      uppercase => ["message"]
   }
}

output {
 stdout {
   codec => rubydebug
 }
 file {
   path => "C:/elasticsearchtraining/temp/output.txt"
 }
}
```

output.txt

```
{
"path":"C:/elasticsearchtraining/temp/input.txt",
"message":"HI THERE\r",
"host":"DESKTOP-BVHRK6K",
"@version":"1",
"@timestamp":"2021-01-16T14:17:10.537Z"
}
```

Logstash configuration

input.txt

```
get 2500 300
```

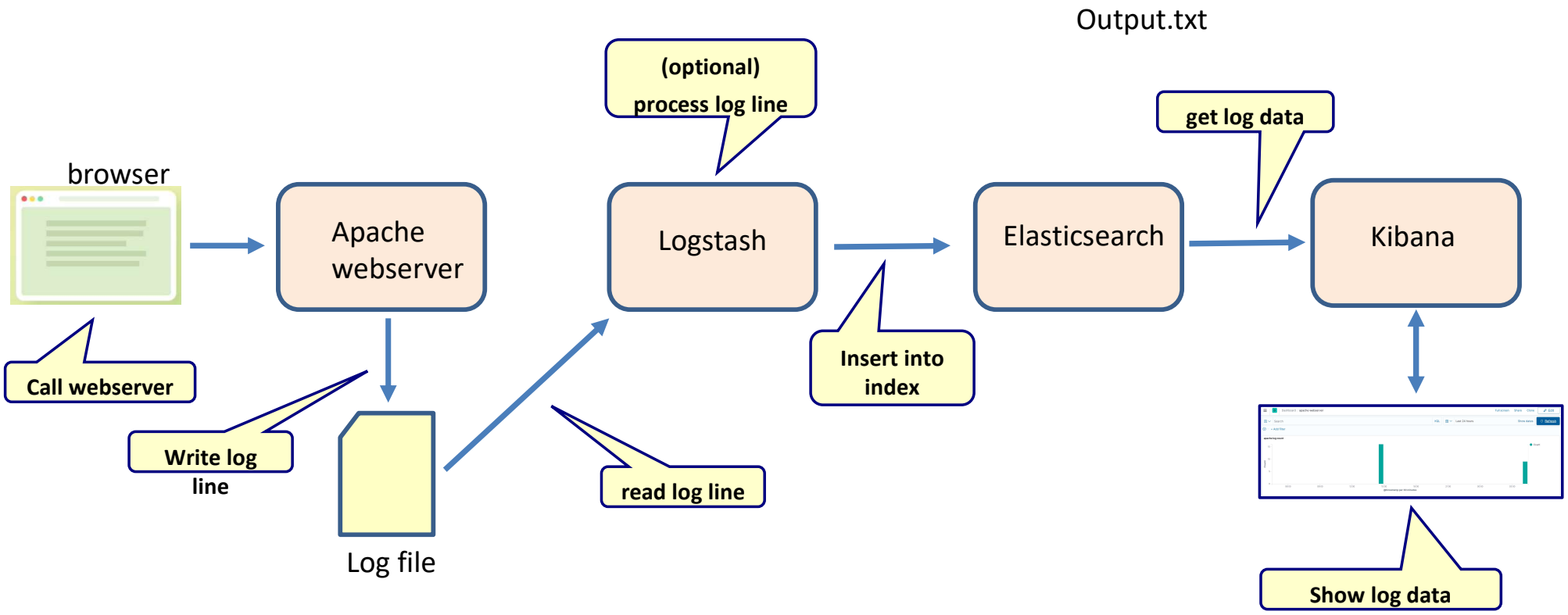
output.txt

```
{
"bytes":"2500",
"@timestamp":"2021-01-16T14:46:40.613Z",
"path":"C:/elasticsearchtraining/temp/input.txt",
"duration":"300",
"method":"GET",
"@version":"1",
"message":"get 2500 300\r",
"host":"DESKTOP-BVHRK6K"
}
```

pipeline.conf

```
input {
  file {
    path => "C:/elasticsearchtraining/temp/input.txt"
    start_position => "beginning"
  }
}

filter {
    grok{
      match => {"message" => "%{WORD:method} %{NUMBER:bytes} %{NUMBER:duration}"}
    }
    mutate {
        uppercase => ["method"]
    }
}

output {
  stdout {
    codec => rubydebug
  }
  file {
    path => "C:/elasticsearchtraining/temp/output.txt"
  }
}
```

logstash example

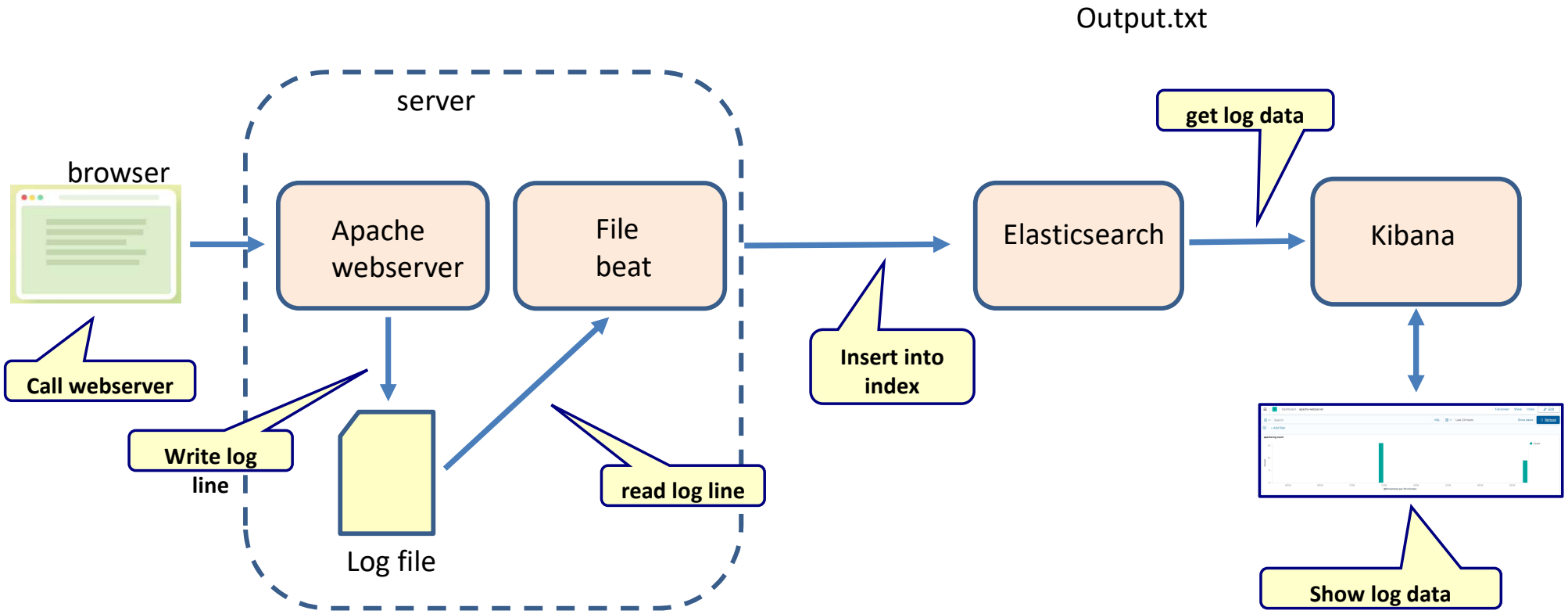


BEATS

Beats

- Data shippers that act as agents installed on the different servers in your infrastructure for collecting logs or metrics
  - log files (Filebeat)
  - network data (Packetbeat)
  - server metrics (Metricbeat)
- Once collected, the data is sent either directly into Elasticsearch or to Logstash for additional processing

filebeat example



Filebeat configuration

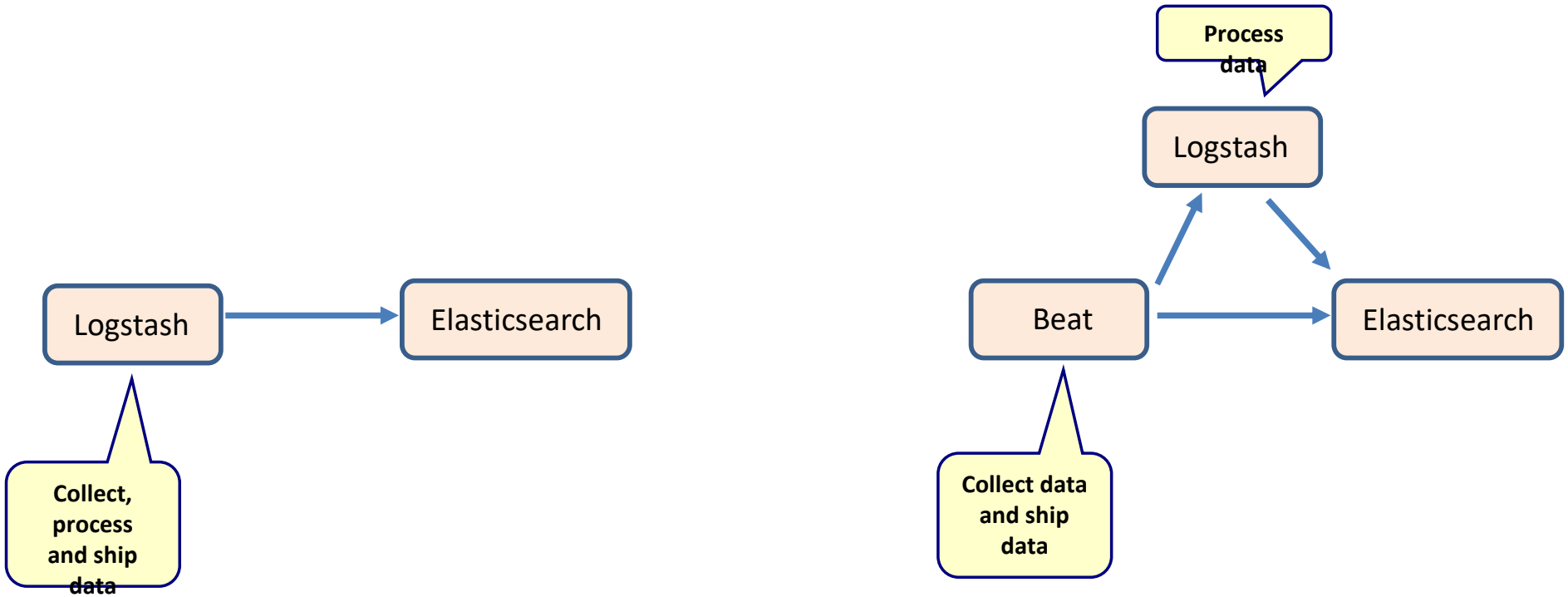
filebeat.yml

```
filebeat.inputs:

# Each - is an input. Most options can be set at the input level, so
# you can use different inputs for various configurations.
# Below are the input specific configurations.

- type: log

  # Change to true to enable this input configuration.
  enabled: true

  # Paths that should be crawled and fetched. Glob based paths.
  paths:
    - C:/elasticsearchtraining/Apache24/logs/access.log


output.elasticsearch:
  # Array of hosts to connect to.
  hosts: ["localhost:9200"]
```

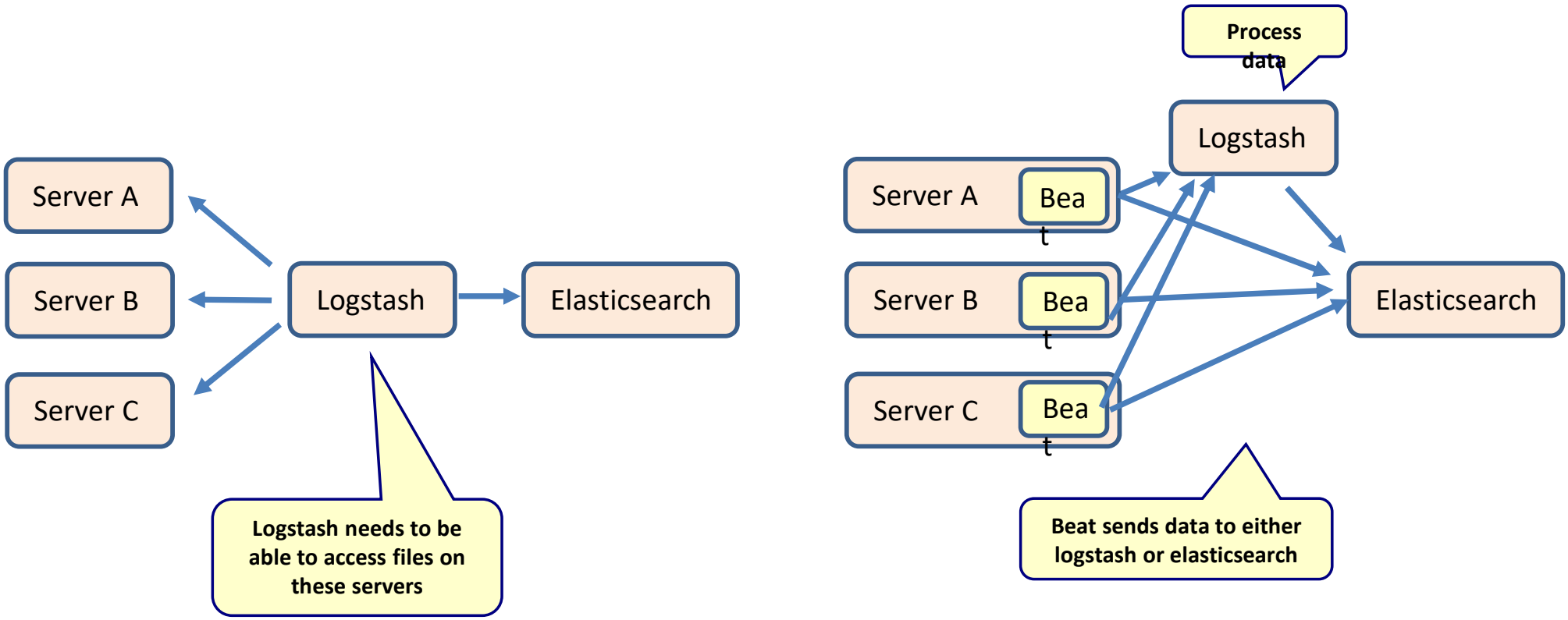
read the access log file

Output to default index 'filebeat' in elasticsearch

Difference between beats and logstash



Difference between beats and logstash



ACTUATORS

/actuator


```
{"_links":{"self":{"href":"http://localhost:8080/actuator","templated":false},"beans":
{"href":"http://localhost:8080/actuator/beans","templated":false},"caches-cache":
{"href":"http://localhost:8080/actuator/caches/{cache}","templated":true},"caches":
{"href":"http://localhost:8080/actuator/caches","templated":false},"health":
{"href":"http://localhost:8080/actuator/health","templated":false},"health-path":
{"href":"http://localhost:8080/actuator/health/{*path}","templated":true},"info":
{"href":"http://localhost:8080/actuator/info","templated":false},"conditions":
{"href":"http://localhost:8080/actuator/conditions","templated":false},"shutdown":
{"href":"http://localhost:8080/actuator/shutdown","templated":false},"configprops":
{"href":"http://localhost:8080/actuator/configprops","templated":false},"configprops-prefix":
{"href":"http://localhost:8080/actuator/configprops/{prefix}","templated":true},"env":
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{"href":"http://localhost:8080/actuator/env/{toMatch}","templated":true},"loggers":
{"href":"http://localhost:8080/actuator/loggers","templated":false},"loggers-name":
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{"href":"http://localhost:8080/actuator/scheduledtasks","templated":false},"mappings":
{"href":"http://localhost:8080/actuator/mappings","templated":false}}}
```

Actuator

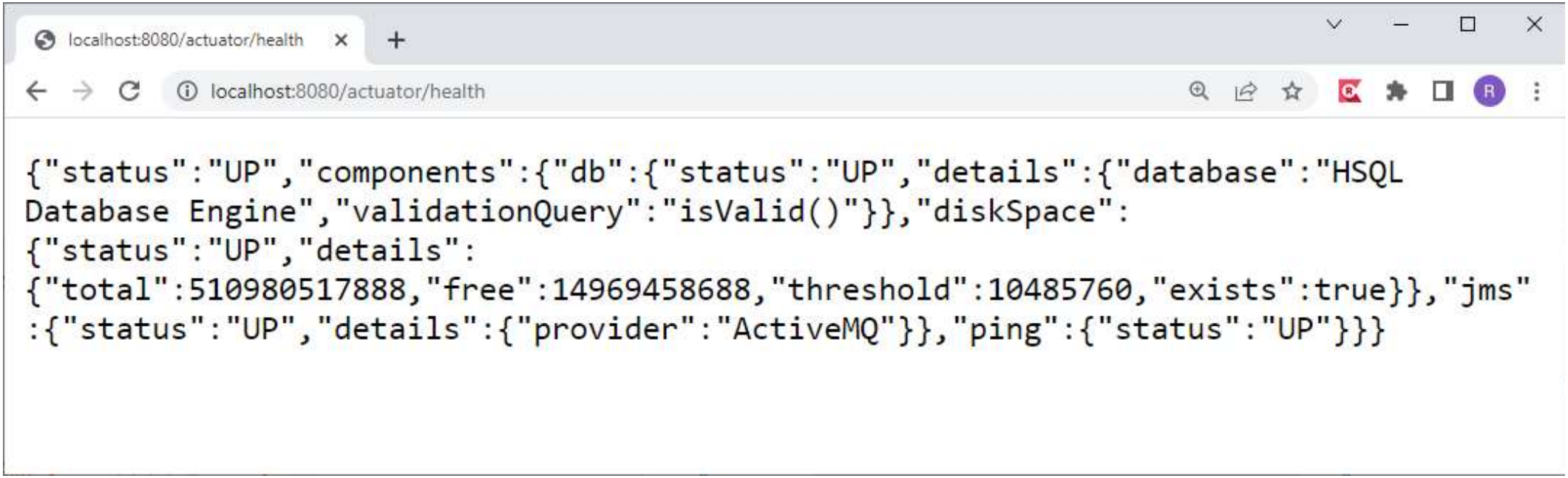
- Actuator brings production-ready features to our application

```
<dependency>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-starter-actuator</artifactId>
</dependency>
```

- Once this dependency is on the classpath several endpoints are available for us out of the box.
- You can modify existing actuators and you can write you own actuators

/actuator/health

This is all that is shown by default




```
management.endpoint.health.show-details=ALWAYS
```

Show all health information

Exposing actuators

- Only the /health actuator is exposed by default

- Exposing particular actuators

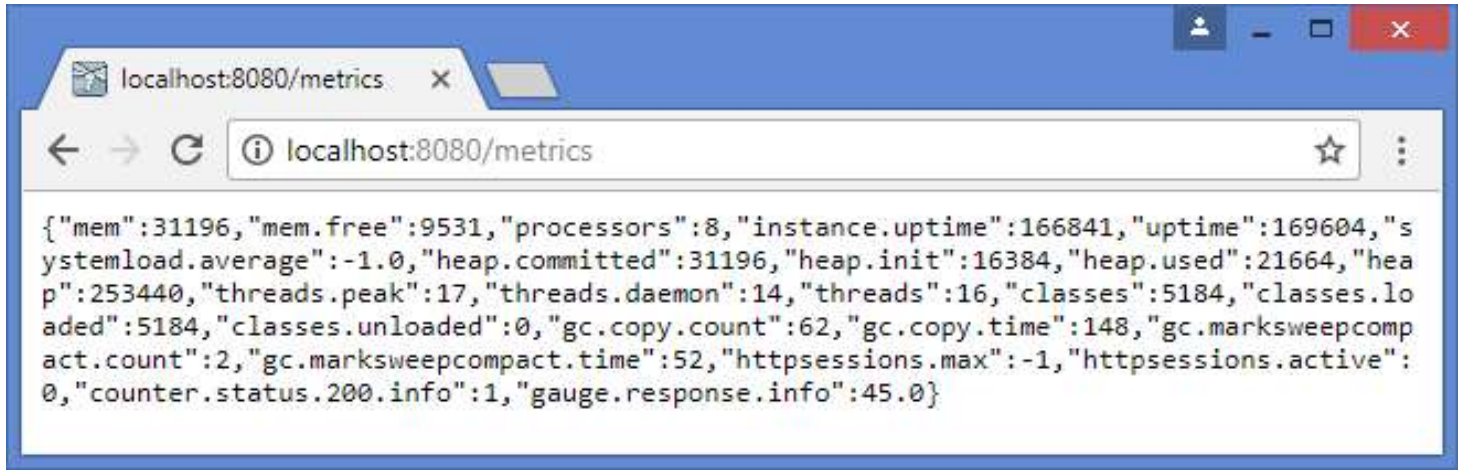
```
management.endpoints.web.exposure.include=beans,mappings
```

- Exposing all actuators

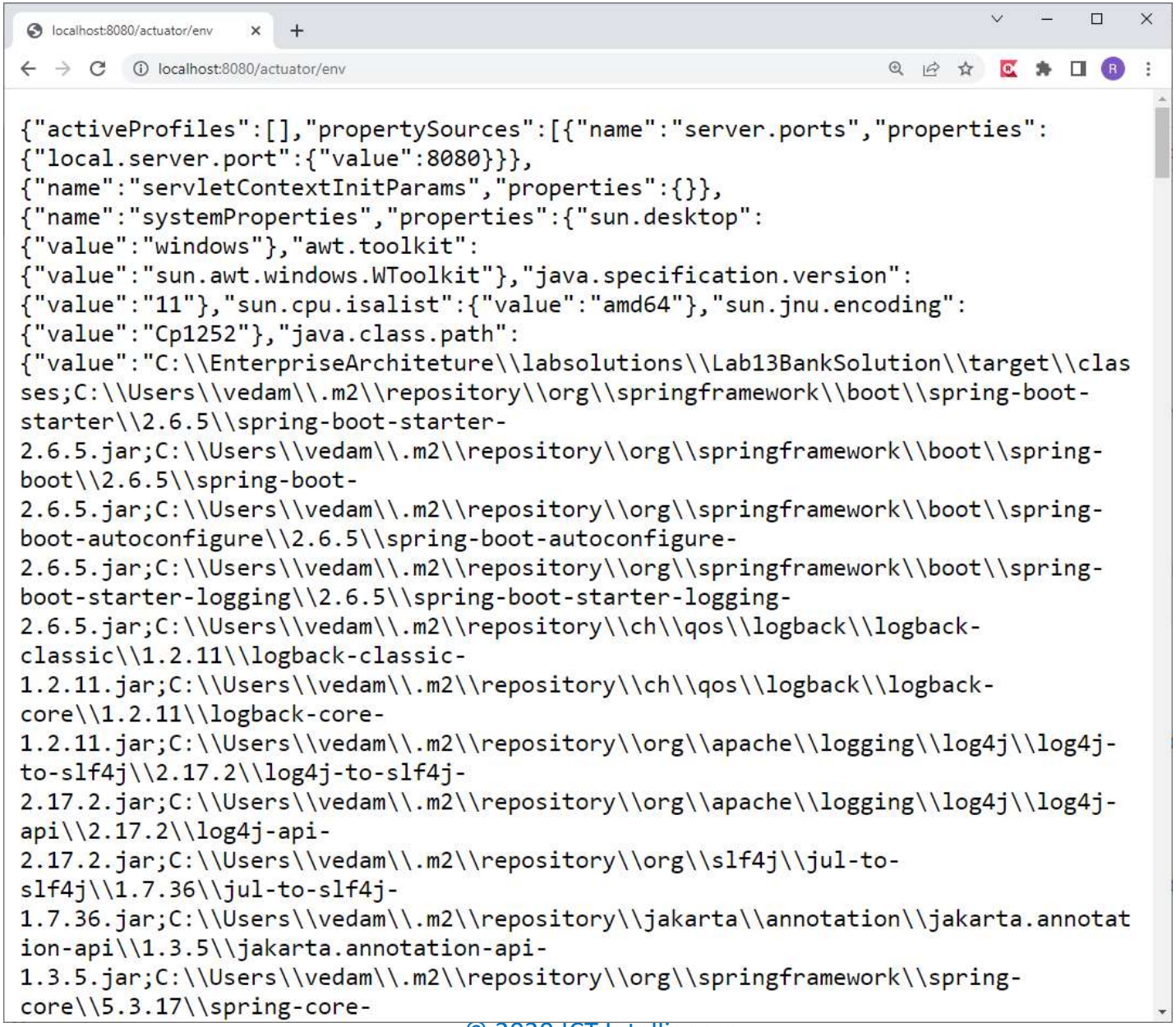
```
management.endpoints.web.exposure.include=*
```

/actuator/metrics

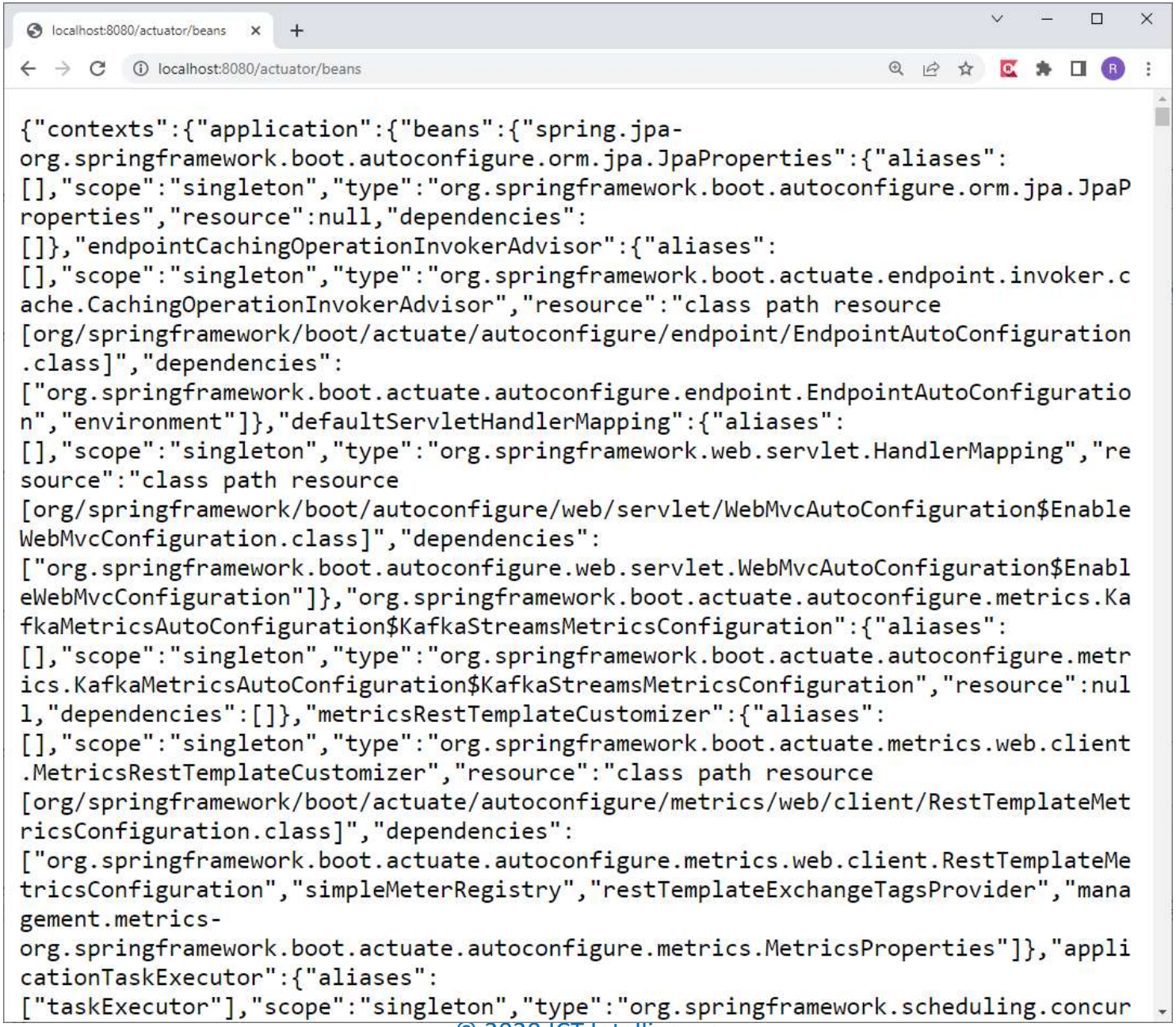
- Gives information such as memory, heap, processors, threads, classes loaded, classes unloaded, thread pools along with some HTTP metrics as well



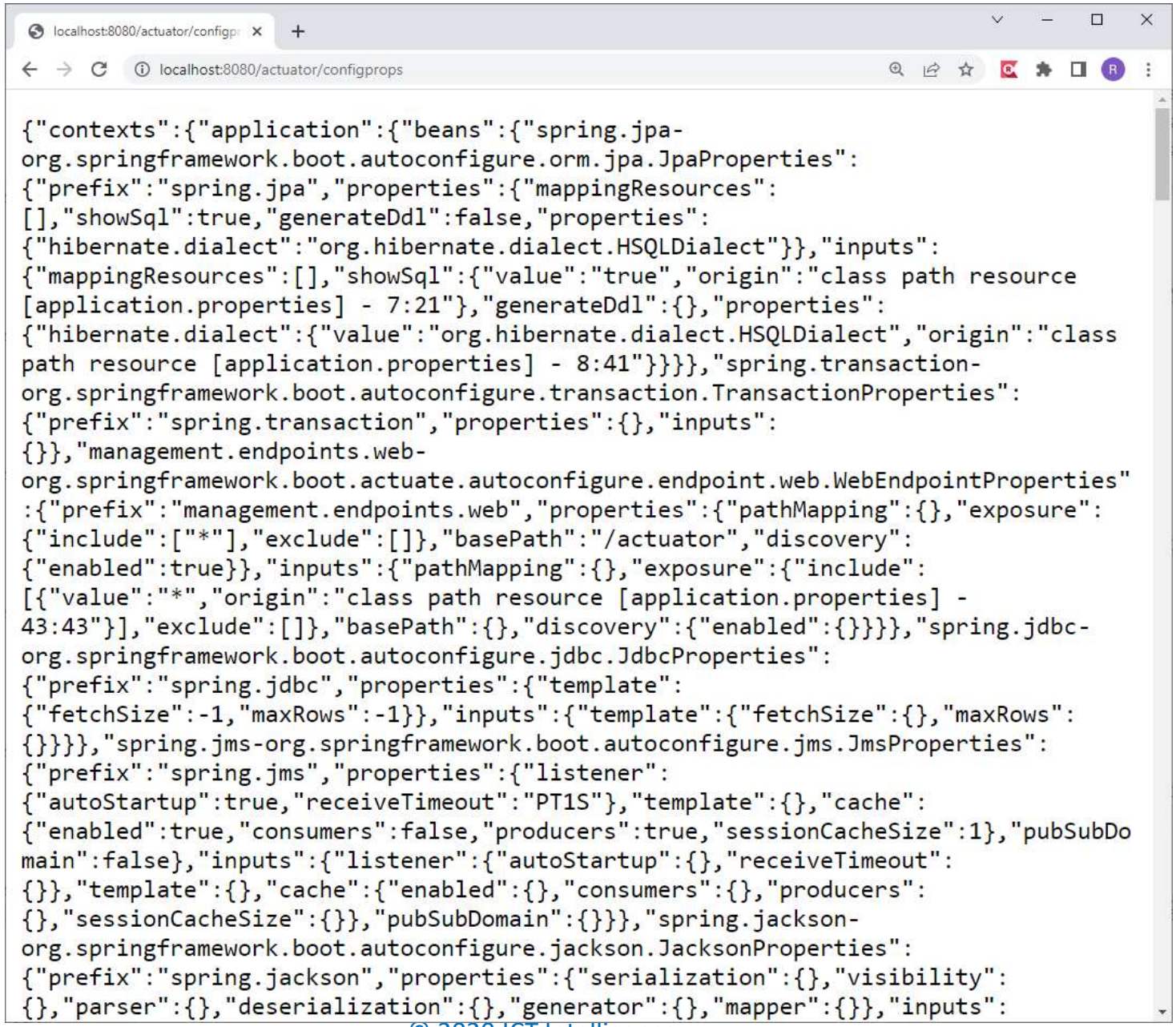
/actuator/env



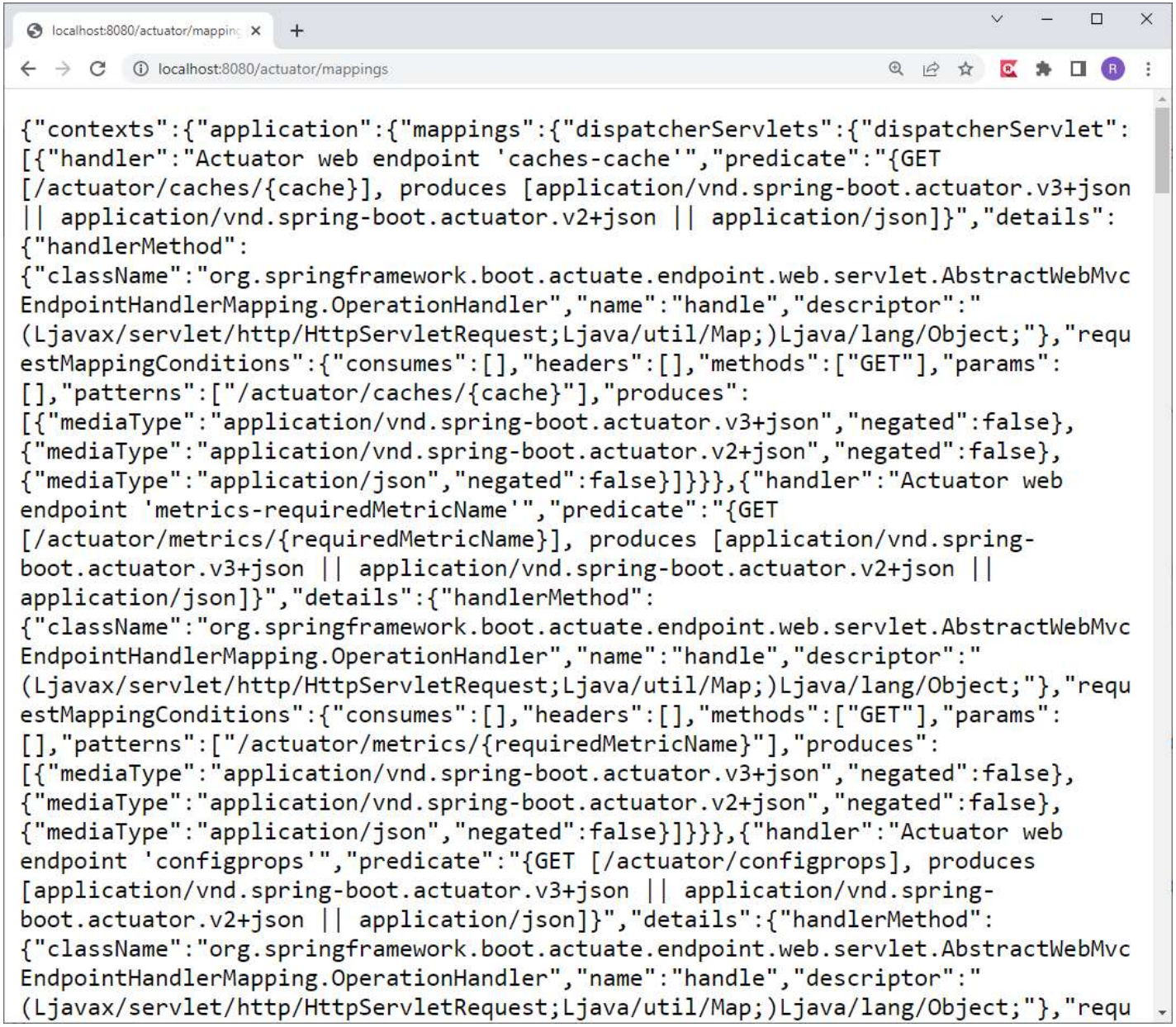
/actuator/beans



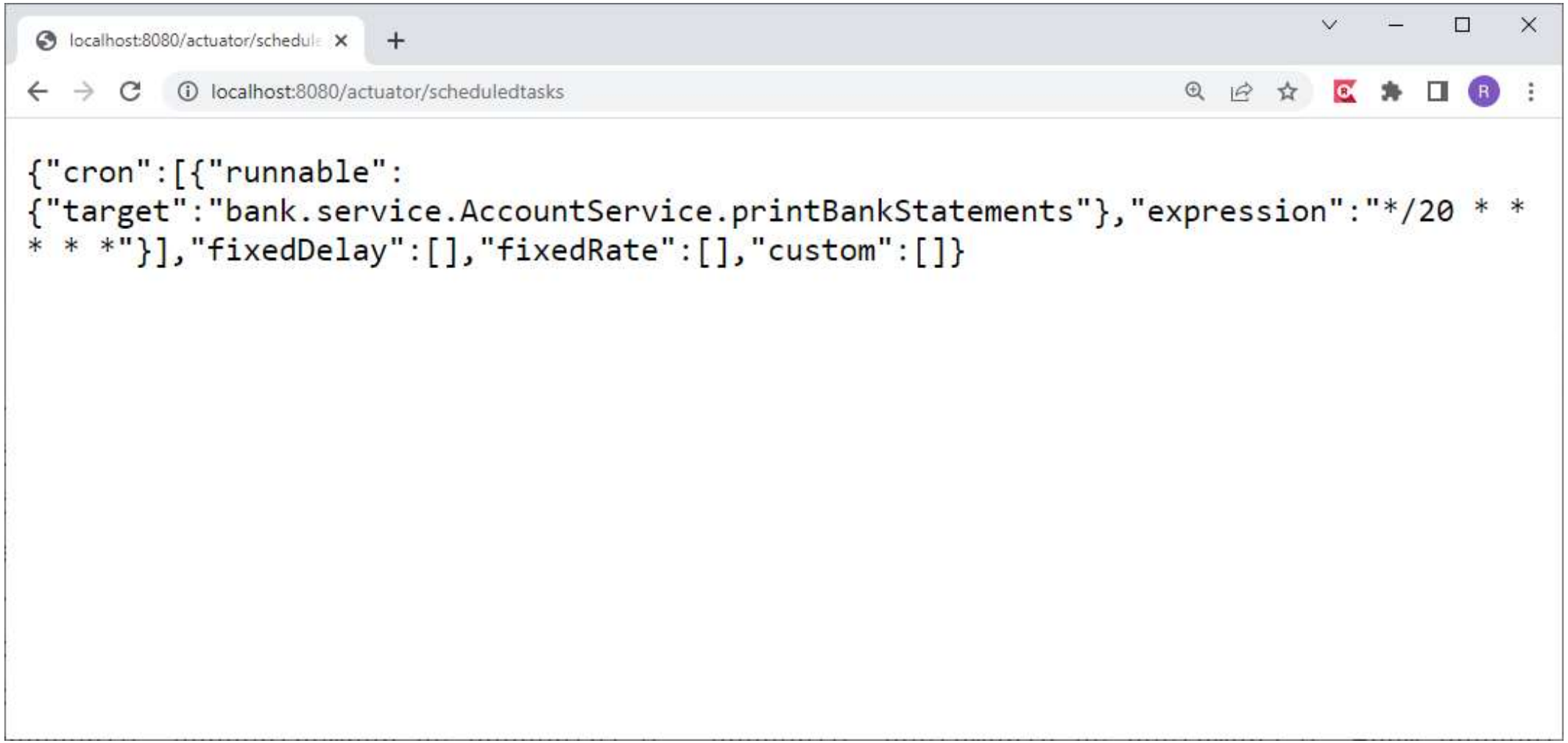
/actuator/configprops



/actuator/mappings



/actuator/scheduledtasks



Available actuators

GET	/autoconfig	Provides an auto-configuration report describing what auto-configuration conditions passed and failed.
GET	/configprops	Describes how beans have been injected with configuration properties (including default values).
GET	/beans	Describes all beans in the application context and their relationship to each other.
GET	/dump	Retrieves a snapshot dump of thread activity.
GET	/env	Retrieves all environment properties.

Available actuators

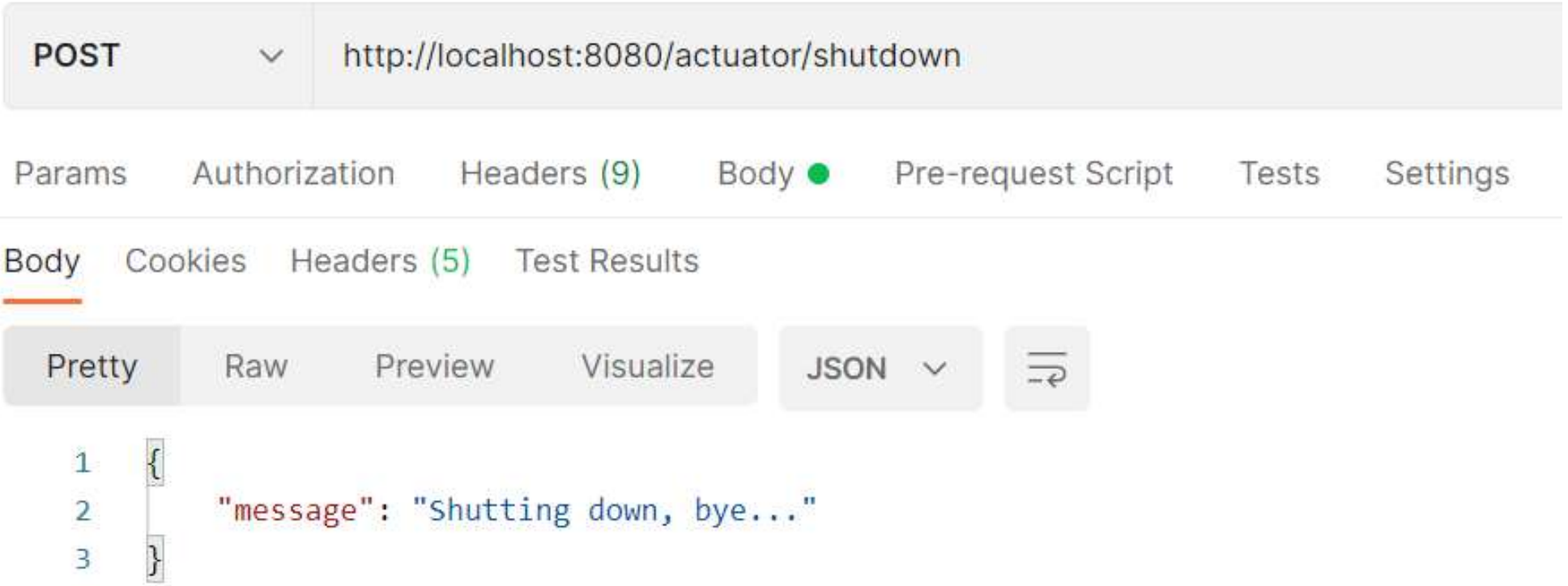
GET	/env/{name}	Retrieves a specific environment value by name.
GET	/health	Reports health metrics for the application, as provided by HealthIndicator implementations.
GET	/info	Retrieves custom information about the application, as provided by any properties prefixed with info.
GET	/mappings	Describes all URI paths and how they're mapped to controllers (including Actuator endpoints).
GET	/metrics	Reports various application metrics such as memory usage and HTTP request counters.

Available actuators

GET	/metrics/{name}	Reports an individual application metric by name.
POST	/shutdown	Shuts down the application; requires that endpoints.shutdown.enabled be set to true.
GET	/trace	Provides basic trace information (timestamp, headers, and so on) for HTTP requests.

shutdown

```
management.endpoint.shutdown.enabled=true
```



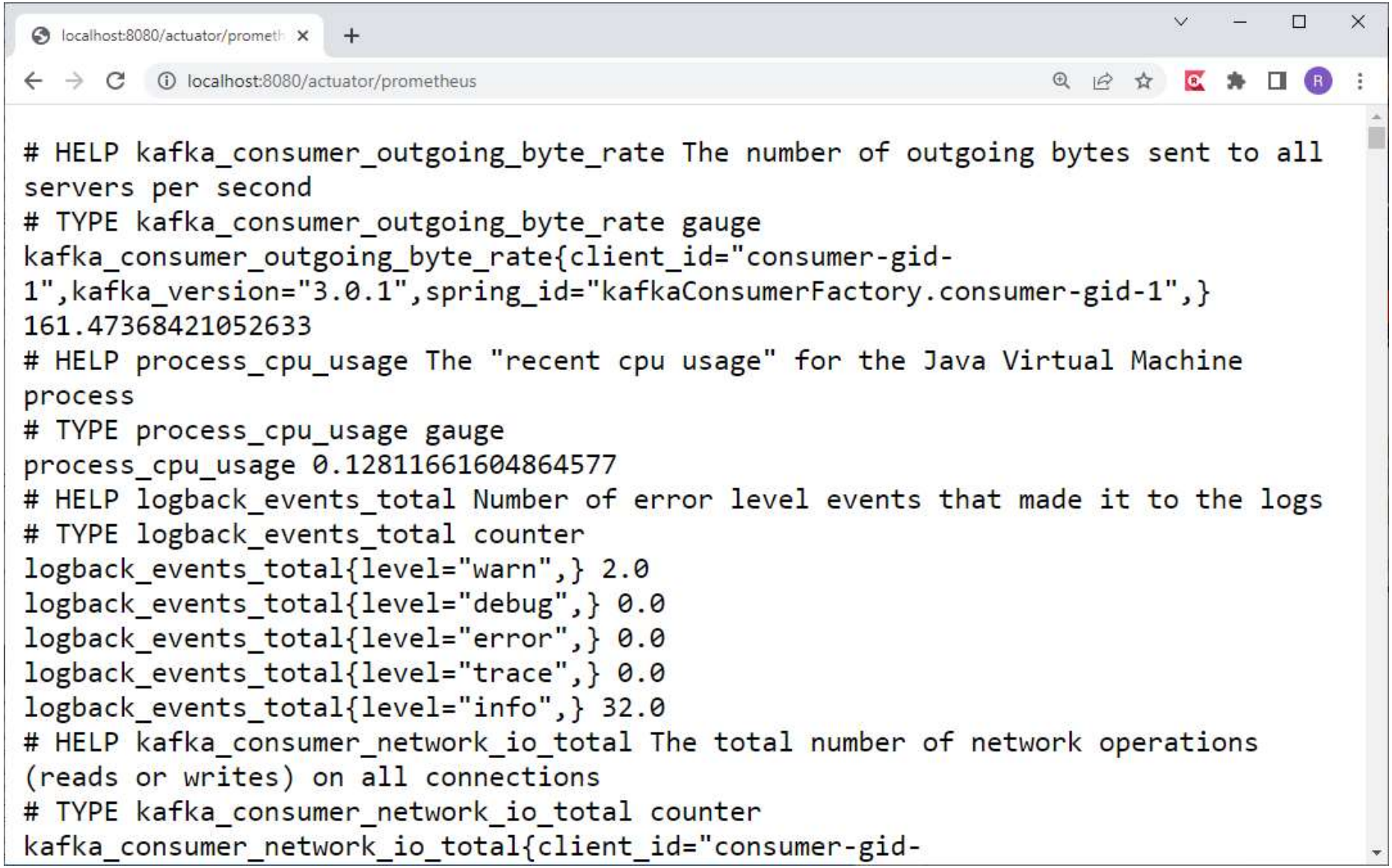
MONITOR ACTUATOR DATA

Micrometer

- Captures metric data and expose this data via an actuator endpoint

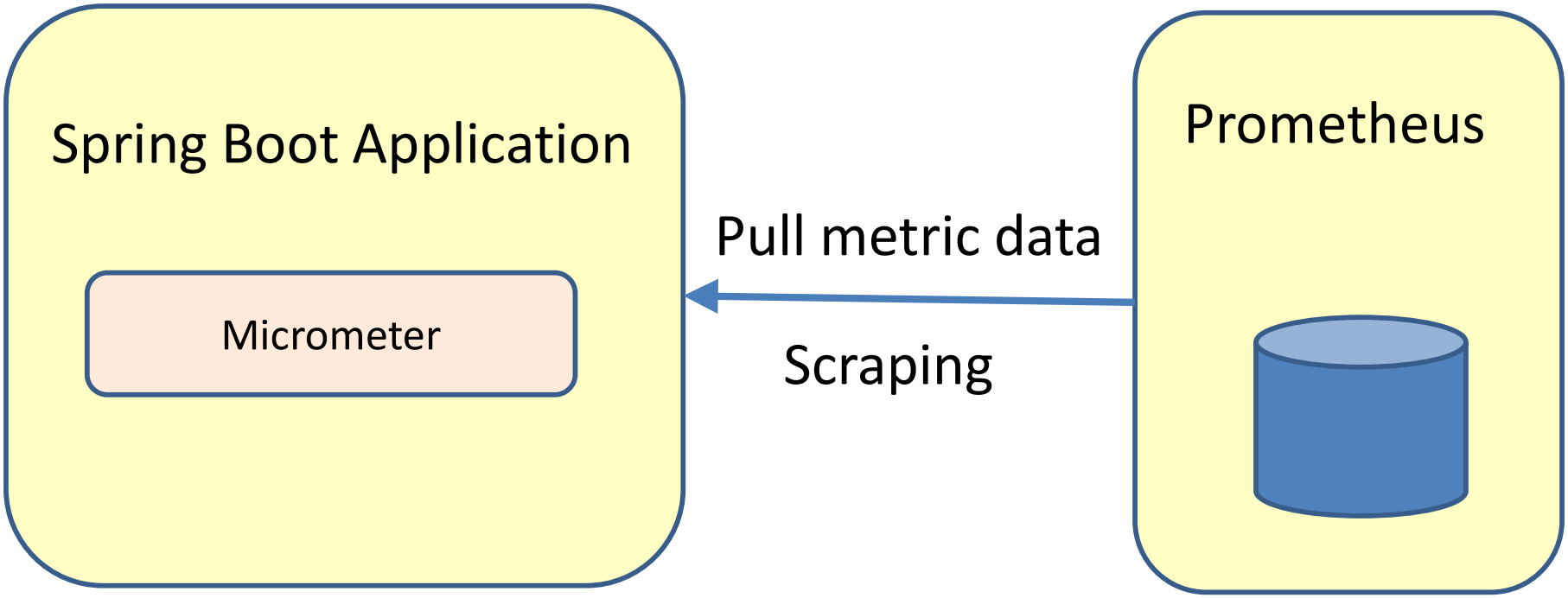
```
<dependency>
  <groupId>io.micrometer</groupId>
  <artifactId>micrometer-registry-prometheus</artifactId>
</dependency>
```

Actuator/prometheus



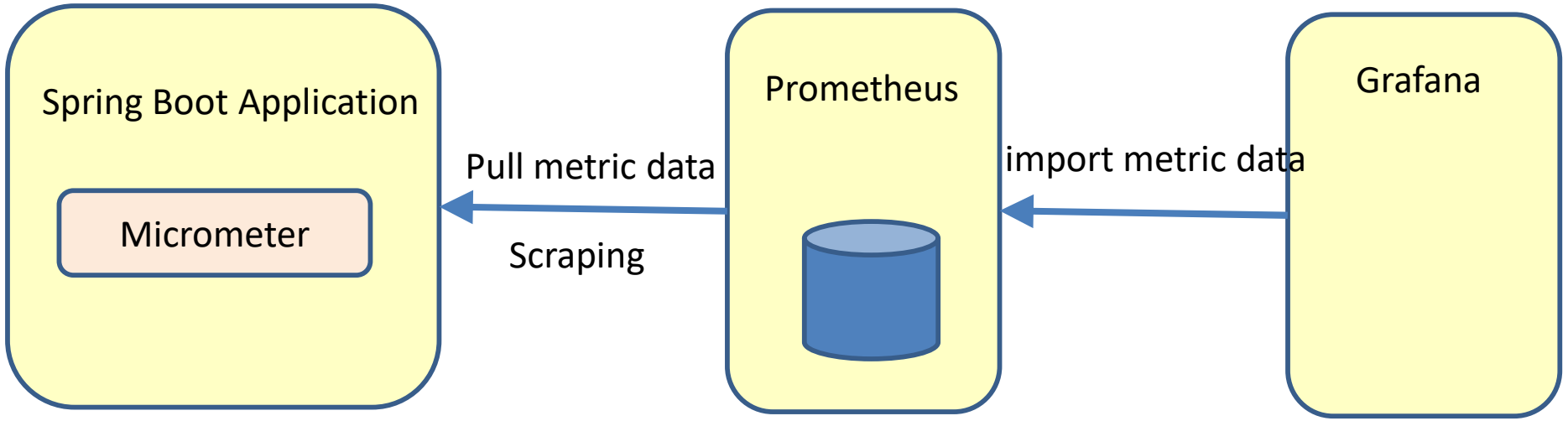
Prometheus

- Time series database
- Stores metric and performance data

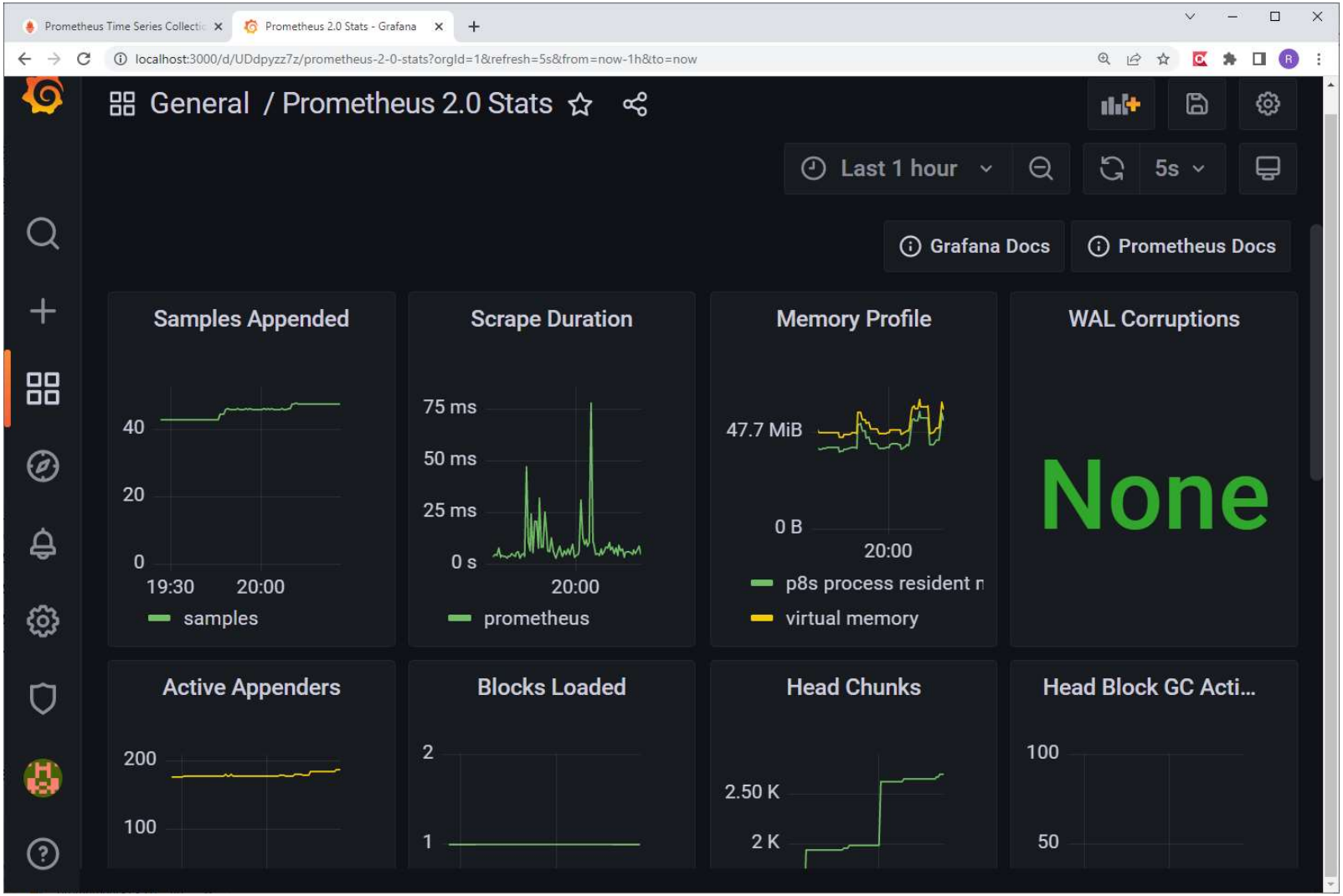


Grafana

- Dashboard to visualize metric data

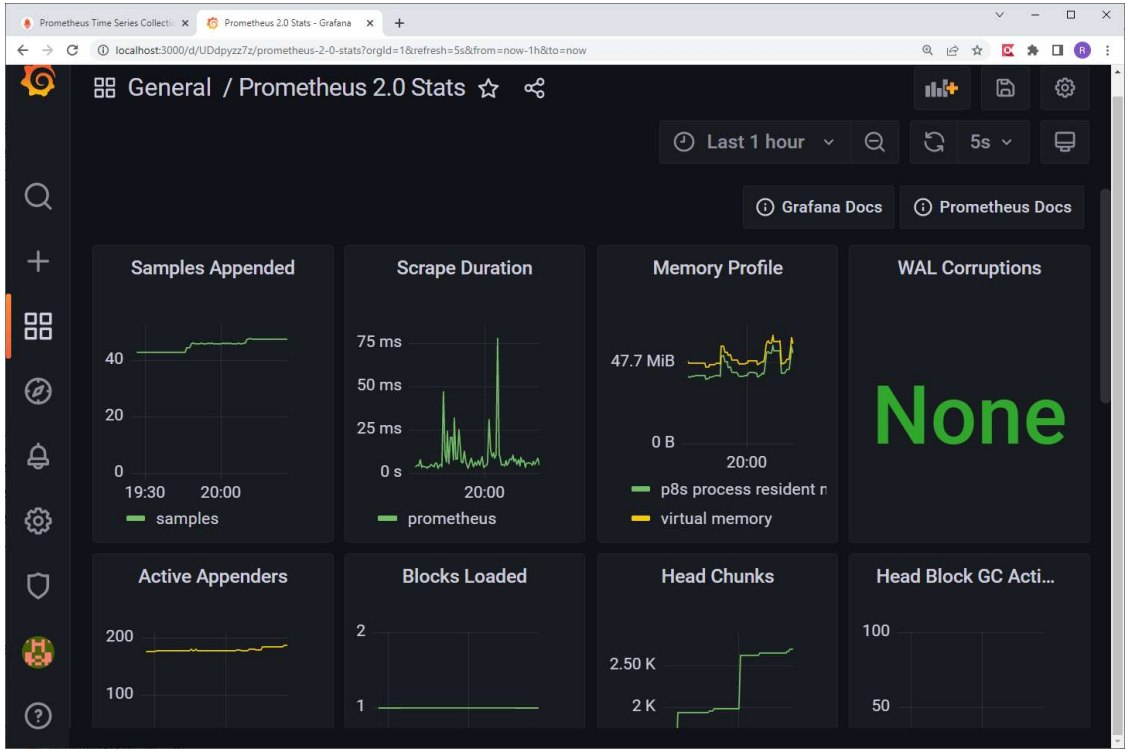


Grafana dashboard



Grafana

- Make your own dashboards
- Alerts
- Refresh interval
- Timespan
- User configuration



UNIT TESTING WITH JUNIT

What is unit testing?

- A unit test is a test that test one single class.
  - A test case test one single method
  - A test class test one single class
  - A test suite is a collection of test classes
- Unit tests make use of a testing framework

- A unit test
  1. Create an object
  2. Call a method
  3. Check if the result is correct

Example of unit testing

```
package count;

public class Counter {
    private int counterValue=0;

    public int increment(){
       return ++counterValue;
    }
    public int decrement(){
       return --counterValue;
    }
    public int getCounterValue() {
       return counterValue;
    }
 }
```

Example of unit testing

```
public class Counter {
    private int counterValue=0;

    public int increment(){
       return ++counterValue;
    }
    public int decrement(){
       return --counterValue;
    }
    public int getCounterValue() {
       return counterValue;
    }
}
```

```
import static org.junit.Assert.*;
import org.junit.*

public class CounterTest {
    private Counter counter;

     @Before
     public void setUp() throws Exception {
       counter = new Counter();
     }
     @Test
     public void testIncrement(){
        assertEquals("Counter.increment does not work correctly",1,counter.increment());
        assertEquals("Counter.increment does not work correctly",2,counter.increment());
     }
     @Test
     public void testDecrement(){
        assertEquals("Counter.decrement does not work correctly",-1,counter.decrement());
        assertEquals("Counter.decrement does not work correctly",-2,counter.decrement());
     }
}
```

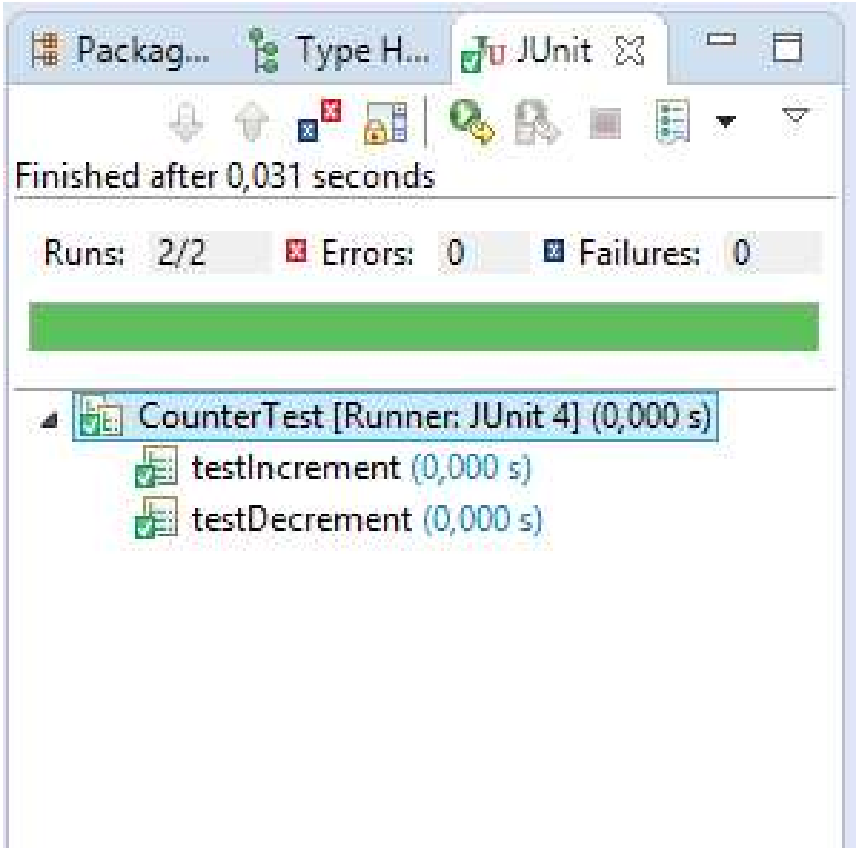
Initialization

Test method

Test method

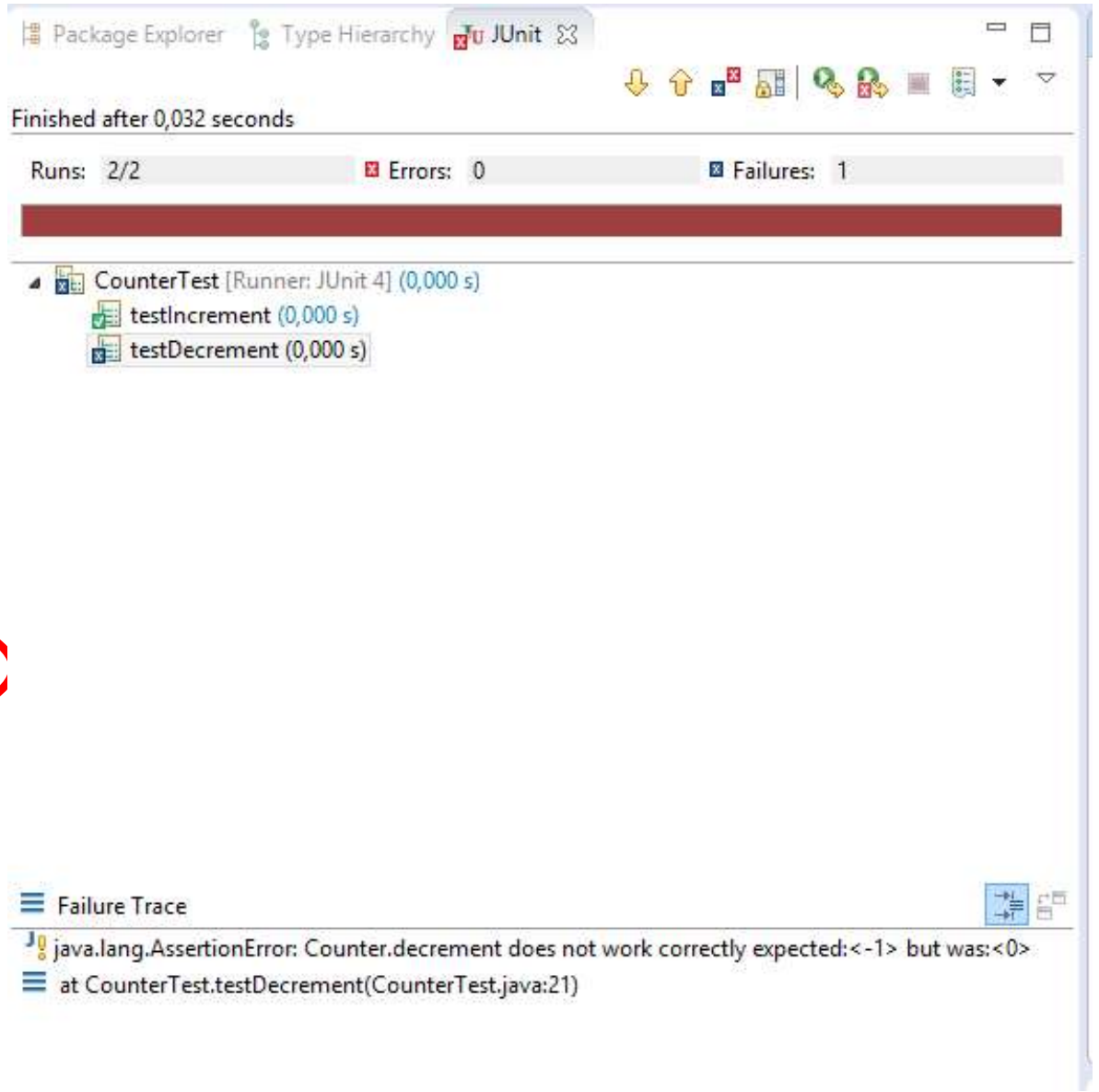
Running the test

```
package count;

public class Counter {
    private int counterValue=0;

    public int increment(){
        return ++counterValue;
    }
    public int decrement(){
        return --counterValue;
    }
    public int getCounterValue() {
        return counterValue;
    }
 }
```



Running the test

```
package count;

public class Counter {
    private int counterValue=0;

    public int increment(){
        return ++counterValue;
    }
    public int decrement(){
        return counterValue;
    }
    public int getCounterValue() {
        return counterValue;
    }
 }
```



JUnit test case

```
public class Calculator
{
    public double add( double number1, double number2 )
    {
        return number1 + number2;
    }
}
```

```
import static org.junit.Assert.*;
import org.junit.Test;

public class CalculatorTest
{
    @Test
    public void add()
    {
        Calculator calculator = new Calculator();
        double result = calculator.add( 10, 50 );
        assertEquals( 60, result, 0 );
    }
}
```

expected

Value to assert

delta

Junit assert methods

- static void assertTrue(boolean ***test***)
- static void assertTrue(String **message**, boolean ***test***)

- static void assertFalse(boolean ***test***)
- static void assertFalse(String **message**, boolean ***test***)

- assertEquals(Object ***expected***, Object ***actual***)
- assertEquals(String **message**, ***expected***, ***actual***)

- assertSame (Object ***expected***, Object ***actual***)
- assertSame(String **message**, Object ***expected***, Object ***actual***)

- assertNotSame(Object ***expected***, Object ***actual***)
- assertNotSame(String **message**, Object ***expected***, Object ***actual***)

- assertNull(Object ***object***)
- assertNull(String **message**, Object ***object***)

- assertNotNull(Object ***object***)
- assertNotNull(String **message**, Object ***object***)

- fail()
- fail(String **message**)

http://junit.org/apidocs/org/junit/Assert.html

@Before and @After

```
public class CounterTest {
    private Counter counter;

    @Before
    public void setUp() throws Exception {
       counter = new Counter();
    }

    @After
    public void tearDown() throws Exception {
       counter=null;
    }
    @Test
    public void testConstructor(){
        assertEquals("Counter constructor does not set counter to
                     0",0,counter.getCounterValue());
     }
}
```

This method is called before every testmethod

This method is called after every testmethod

@BeforeClass and @AfterClass

```
public class CounterTest {
    private static Counter counter;

    @BeforeClass
    public static void setUpOnce() throws Exception {
        counter = new Counter();
    }

    @AfterClass
    public static void tearDownOnce() throws Exception {
        counter=null;
    }
    @Test
    public void testConstructor(){
         assertEquals("Counter constructor does not set counter to
                       0",0,counter.getCounterValue());
     }
}
```

This method is called once, before the testmethods are called

This method is called once, after the testmethods are called

Timeout tests

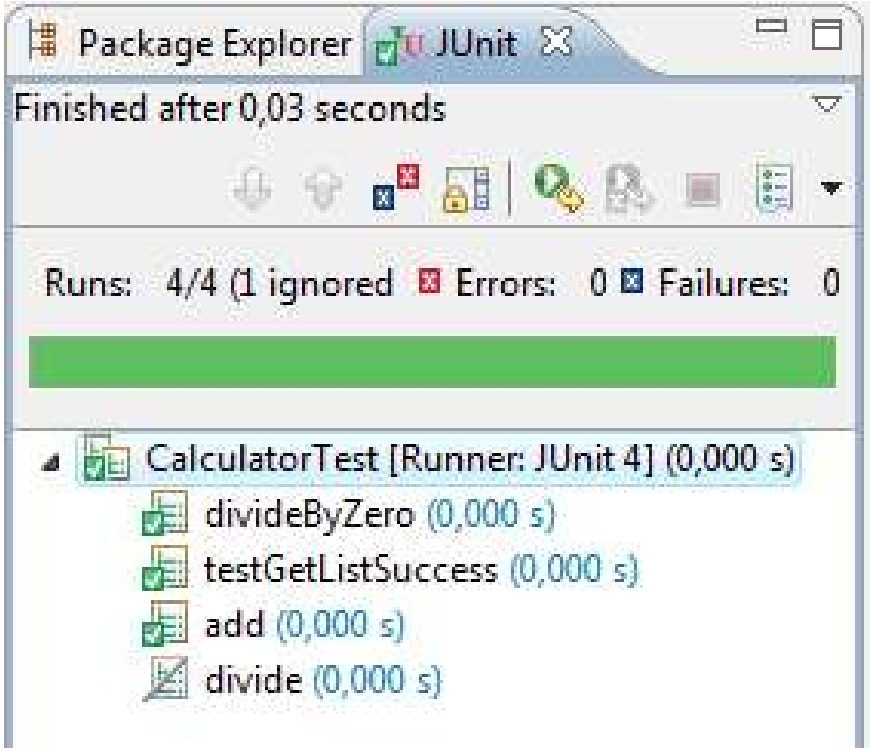
```
@Test(timeout=2000)
public void longOperation() {

}
```

Fail if the test method takes longer than 2000 milliseconds

Skip a test

```
@Test
@Ignore
public void divide(){
    assertEquals( 5, calculator.divide( 10, 2 ), 0 );
}
```

Skip this test



Test suite

```
import org.junit.runner.RunWith;
import org.junit.runners.Suite;
import org.junit.runners.Suite.SuiteClasses;

@RunWith(value=Suite.class)
@SuiteClasses(value={CalculatorTest.class, ParameterizedTest.class})
public class CalculatorTestSuite {

}
```

Suite of 2 test classes

- You can also have a suite of suites
- Organize your tests

JUnit example: Calculator

```
public class Calculator {
    private double value;

    public Calculator() {
      value =0.0;
    }
    public void add(double number) {
      value = value + number;
    }
    public void subtract (double number) {
      value = value - number;
    }
    public void multiply(double number) {
      value = value * number;
    }
    public void divide (double number) throws DivideByZeroException{
      if (number == 0){
        throw new DivideByZeroException();
      }
      value = value / number;
    }
    public double getValue() {
      return value;
    }
}
```

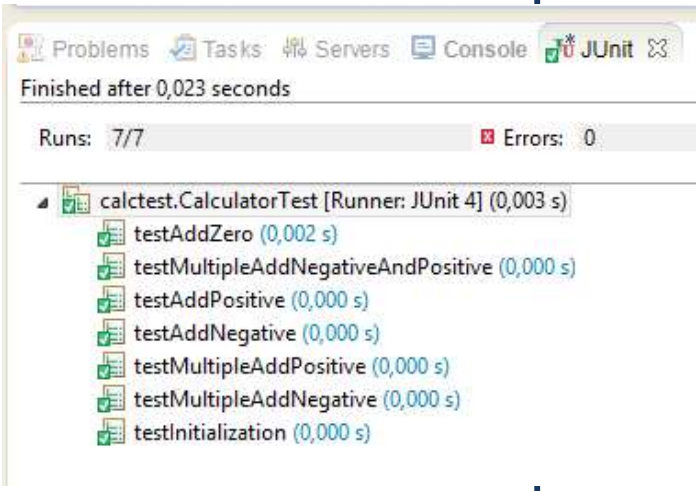
JUnit example: CalculatorTest

```
import static org.junit.Assert.*;
import org.junit.Before;
import org.junit.Test;

import calculation.Calculator;

public class CalculatorTest {

  private Calculator calculator;

  @Before
  public void setup(){
    calculator = new Calculator();
  }

  @Test
  public void testInitialization() {
    assertEquals(0.0, calculator.getValue(),0.0000001);
  }

  @Test
  public void testAddZero() {
    calculator.add(0.0);
    assertEquals(0.0, calculator.getValue(),0.0000001);
  }
```

JUnit example: CalculatorTest

```
@Test
public void testAddPositive() {
  calculator.add(23.255);
  assertEquals(23.255, calculator.getValue(),0.0000001);
}
@Test
public void testAddNegative() {
  calculator.add(-23.255);
  assertEquals(-23.255, calculator.getValue(),0.0000001);
}
@Test
public void testMultipleAddPositive() {
  calculator.add(23.255);
  calculator.add(10.255);
  assertEquals(33.510, calculator.getValue(),0.0000001);
}
@Test
public void testMultipleAddNegative() {
  calculator.add(-23.255);
  calculator.add(-10.255);
  assertEquals(-33.510, calculator.getValue(),0.0000001);
}
@Test
public void testMultipleAddNegativeAndPositive() {
  calculator.add(-23.255);
  calculator.add(10.250);
  assertEquals(-13.005, calculator.getValue(),0.0000001);
}
```

Only test methods for add()



HAMCREST MATCHERS

Traditional asserts

- Parameter order is counter-intuitive
- Assert statements don't read well

assertEquals(***expected***, ***actual***)

```
import static org.junit.Assert.*;

@Test
public void AssertEqualToRed(){
    String color = "red";
    assertEquals("red", color);
}
```

assertThat with hamcrest matchers

```
import static org.junit.Assert.*;
import static org.hamcrest.CoreMatchers.*;
import org.junit.Before;
import org.junit.Test;

public class CalculatorHamcrestTest{
Calculator calculator=null;

    @Before
    public void createAcalculator(){
      calculator = new Calculator();
    }

    @Test
    public void add(){
        assertThat( calculator.add( 10, 50), equalTo (60.0));
    }

    @Test
    public void divide(){
        assertThat(calculator.divide( 10, 2 ), equalTo (5.0));
    }
}
```

Static import of matchers

matcher

assertThat

actual

expected

assert vs assertThat

```
import static org.junit.Assert.*;

@Test
public void AssertEqualToRed(){
    String color = "red";
    assertEquals("red", color);
}
```

assert

```
import static org.junit.Assert.*;
import static org.hamcrest.Matchers.*;

@Test
public void hamcrestAssertEqualToRed(){
    String color = "red";
    assertThat(color, equalTo("red"));
}
```

assertThat

assertThat equality tests

```
String color = "red";
assertThat(color, is("red"));
```

assertThat … is

```
String color = "red";
assertThat(color, equalTo("red"));
```

assertThat … equalTo

```
String color = "red";
assertThat(color, not("blue"));
```

assertThat … not

```
String color = "red";
assertThat(color, isOneOf("blue","red"));
```

assertThat … isOneOf

```
List myList = new ArrayList();
assertThat(myList, is(Collection.class));
```

assertThat … is a class

assertThat testing for null values

```
String color = "red";
assertThat(color, is(notNullValue()));
assertNotNull(color);
```

notNullValue

```
String color = null;
assertThat(color, is(nullValue()));
assertNull(color);
```

nullValue

assertThat testing with collections

```
List<String> colors = new ArrayList<String>();
colors.add("red");
colors.add("green");
colors.add("blue");
assertThat(colors, hasItem("blue"));
```

hasItem

```
assertThat(colors, hasItems("red","blue"));
```

hasItems

```
String[] colors = new String[] {"red","green","blue"};
assertThat(colors, hasItemInArray("blue"));
```

hasItemInArray

```
assertThat("red", isIn(colors));
```

isIn

```
List<Integer> ages = new ArrayList<Integer>();
ages.add(20);
ages.add(30);
ages.add(40);
assertThat(ages, not(hasItem(lessThan(18))));
```

Combined matchers

Hamcrest matchers

- Core
  - anything - always matches, useful if you don't care what the object under test is
  - describedAs - decorator to adding custom failure description
  - is - decorator to improve readability
- Logical
  - allOf - matches if all matchers match, short circuits (like Java &&)
  - anyOf - matches if any matchers match, short circuits (like Java ||)
  - not - matches if the wrapped matcher doesn't match and vice versa
- Object
  - equalTo - test object equality using Object.equals
  - hasToString - test Object.toString
  - instanceOf, isCompatibleType - test type
  - notNullValue, nullValue - test for null
  - sameInstance - test object identity
- Beans
  - hasProperty - test JavaBeans properties
- Collections
  - array - test an array's elements against an array of matchers
  - hasEntry, hasKey, hasValue - test a map contains an entry, key or value
  - hasItem, hasItems - test a collection contains elements
  - hasItemInArray - test an array contains an element
- Number
  - closeTo - test floating point values are close to a given value
  - greaterThan, greaterThanOrEqualTo, lessThan, lessThanOrEqualTo - test ordering
- Text
  - equalToIgnoringCase - test string equality ignoring case
  - equalToIgnoringWhiteSpace - test string equality ignoring differences in runs of whitespace
  - containsString, endsWith, startsWith - test string matching

Hamcrest packages

Matcher Library	
org.hamcrest.beans	Matchers of Java Bean properties and their values.
org.hamcrest.collection	Matchers of arrays and collections.
org.hamcrest.core	Fundamental matchers of objects and values, and composite matchers.
org.hamcrest.internal	
org.hamcrest.number	Matchers that perform numeric comparisons.
org.hamcrest.object	Matchers that inspect objects and classes.
org.hamcrest.text	Matchers that perform text comparisons.
org.hamcrest.xml	Matchers of XML documents.

http://hamcrest.org/JavaHamcrest/javadoc/1.3/