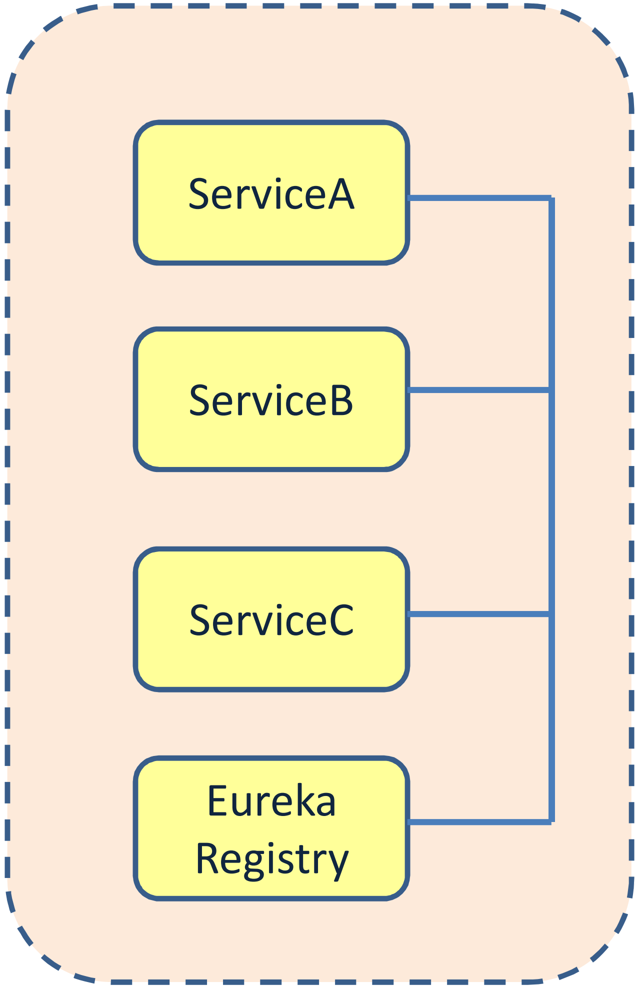
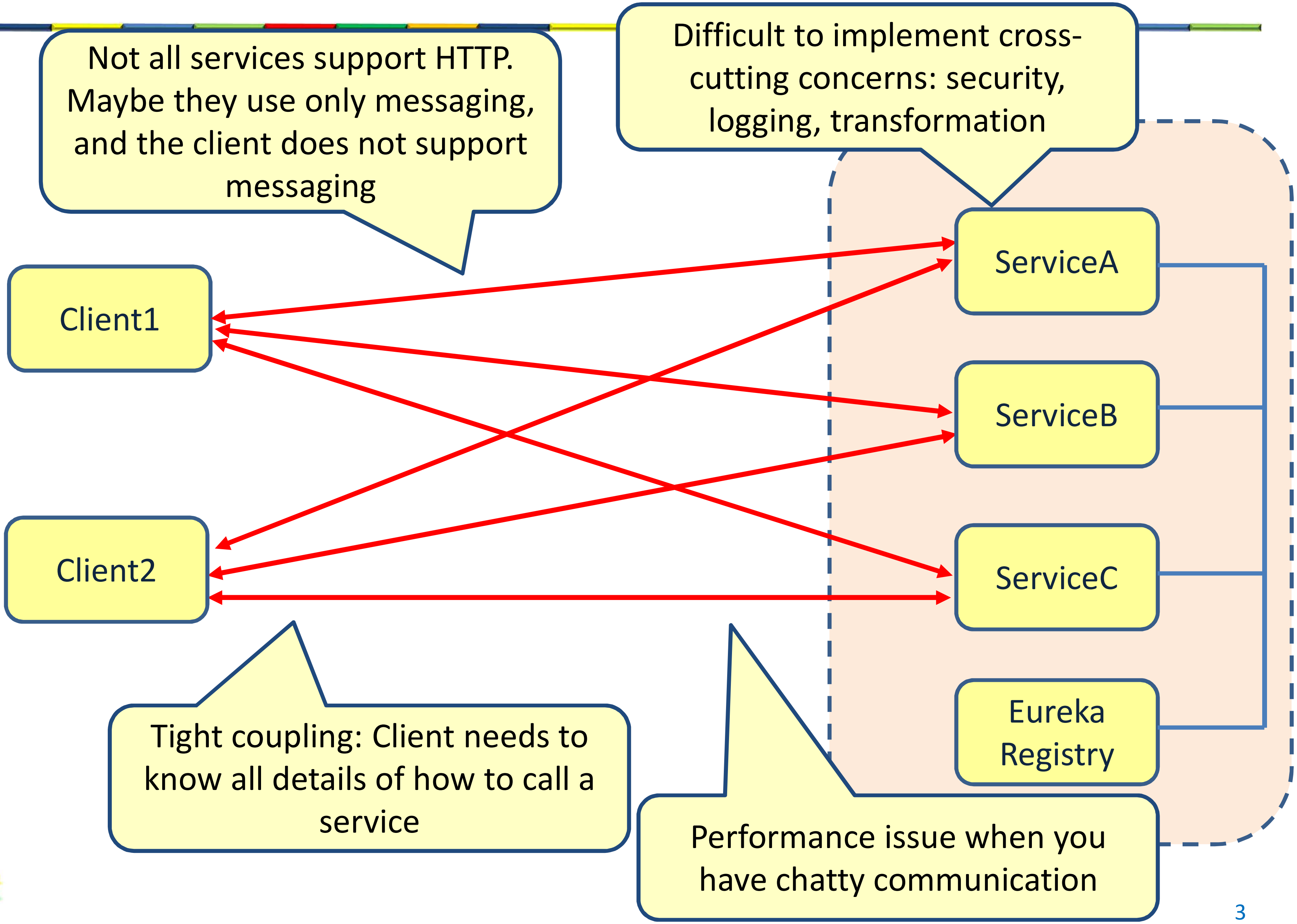
API GATEWAY: ZUUL

Microservice architecture



Services talk to each other using the registry

Adding clients



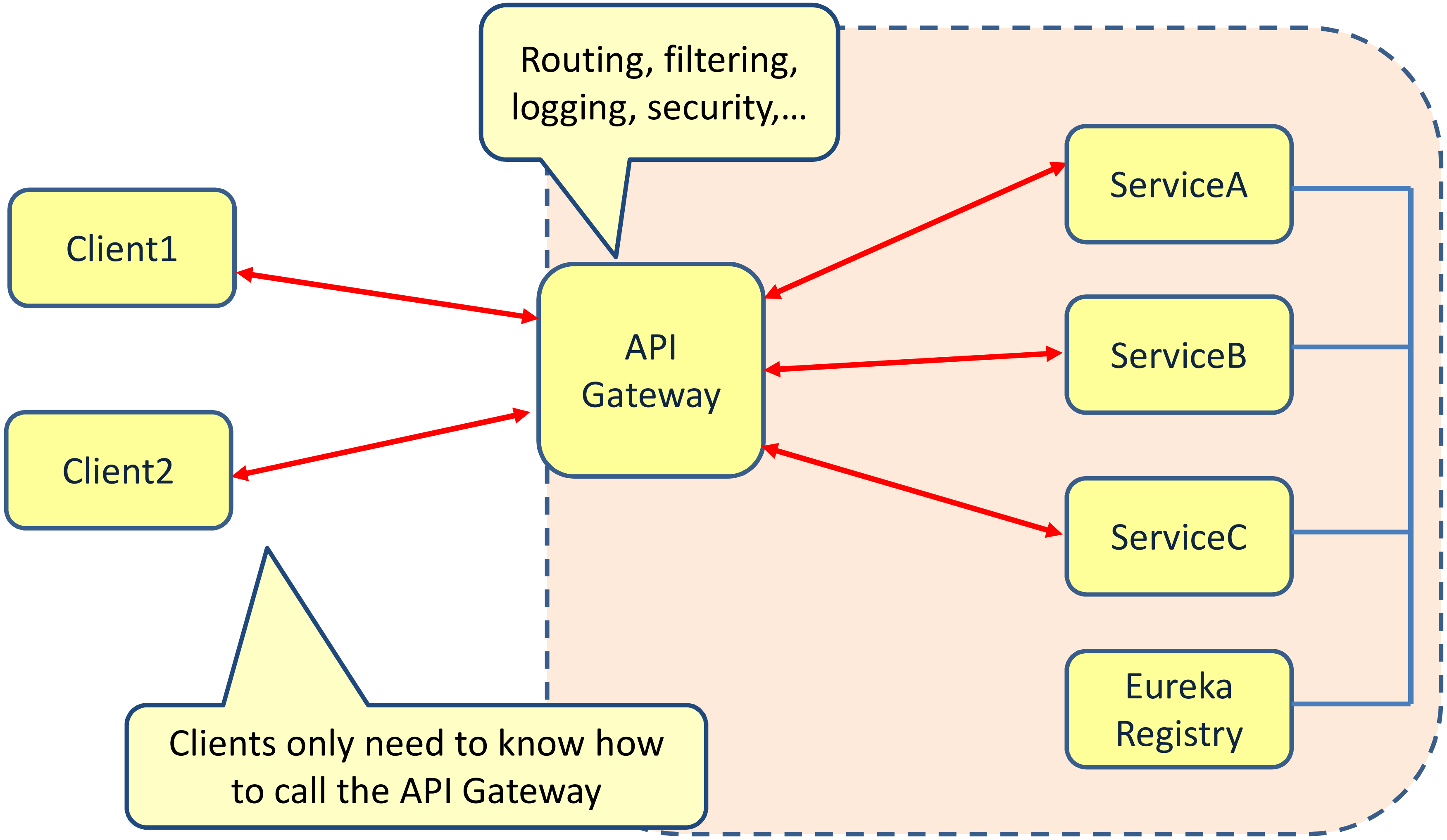
Not all services support HTTP. Maybe they use only messaging, and the client does not support messaging

Difficult to implement cross-cutting concerns: security, logging, transformation

Tight coupling: Client needs to know all details of how to call a service

Performance issue when you have chatty communication

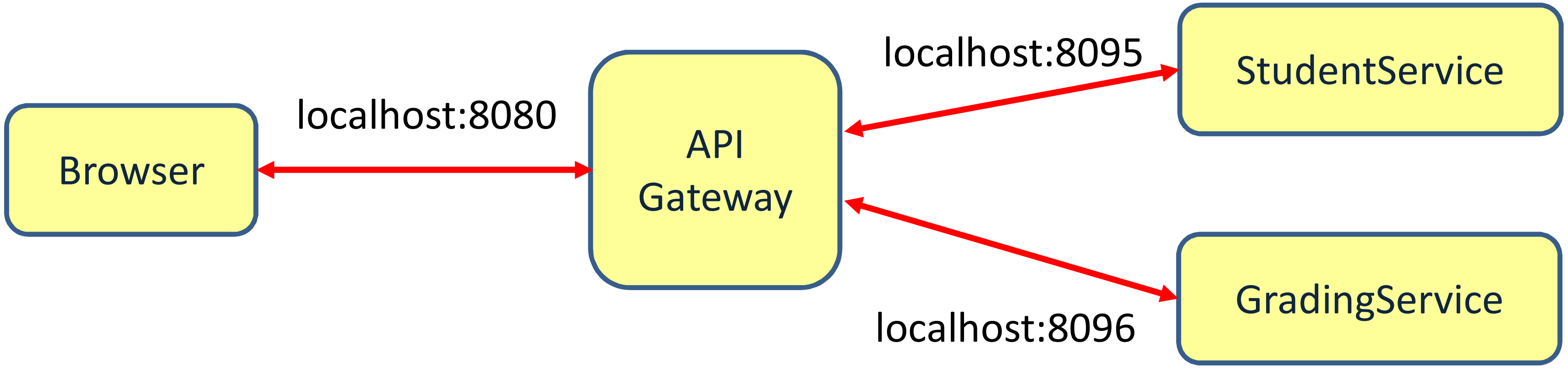
Api Gateway



Routing, filtering, logging, security,…

Clients only need to know how to call the API Gateway

Api Gateway example



Zuul dependency

pom.xml

```
<dependency>
  <groupId>org.springframework.cloud</groupId>
  <artifactId>spring-cloud-starter-netflix-zuul</artifactId>
</dependency>
```

StudentService

```java
@SpringBootApplication
@EnableDiscoveryClient
public class StudentServiceApplication {

  public static void main(String[] args) {
    SpringApplication.run(StudentServiceApplication.class, args);
  }
}
```

application.yml

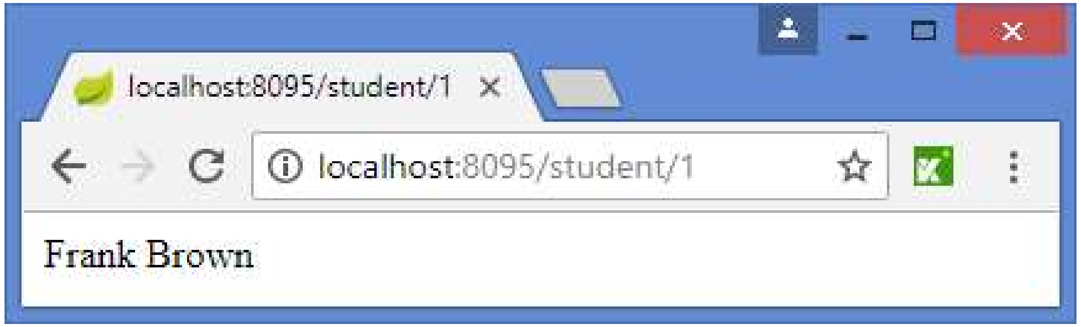
```yaml
server:
  port: 8095

eureka:
  client:
    serviceUrl:
      defaultZone: http://localhost:8761/eureka/
```

bootstrap.yml

```yaml
spring:
  application:
    name: StudentService
```

StudentService: the controller

```
@RestController
public class StudentController {
  @RequestMapping("/student/{studentid}")
  public String getName(@PathVariable("studentid") String studentid) {
    return "Frank Brown";
  }
}
```



Frank Brown

GradingService

```java
@SpringBootApplication
@EnableDiscoveryClient
public class GradingServiceApplication {

  public static void main(String[] args) {
    SpringApplication.run(StudentServiceApplication.class, args);
  }
}
```

application.yml

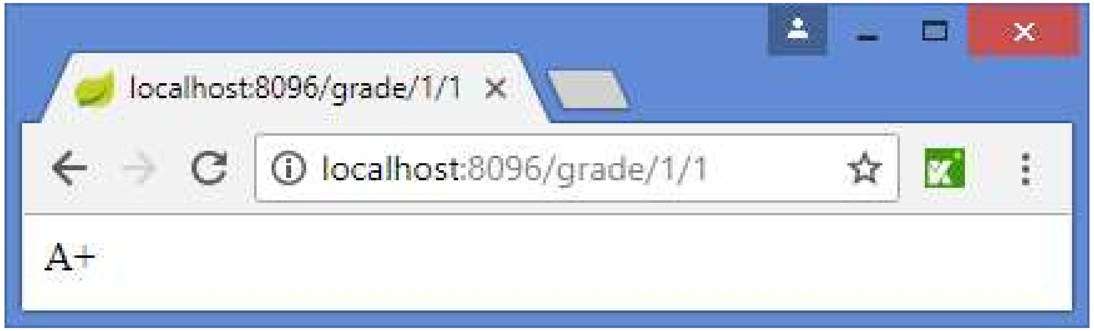
```yaml
server:
  port: 8096

eureka:
  client:
    serviceUrl:
      defaultZone: http://localhost:8761/eureka/
```

bootstrap.yml

```yaml
spring:
  application:
    name: GradingService
```

GradingService: the controller

```
@RestController
public class GradingController {
  @RequestMapping("/grade/{studentid}/{courseid}")
  public String getGrade(@PathVariable("studentid") String studentid,
                         @PathVariable("courseid") String courseid) {
    return "A+";
  }
}
```



A+

API Gateway: Zuul

```java
@SpringBootApplication
@EnableZuulProxy
public class ApiGatewayApplication {

  public static void main(String[] args) {
    SpringApplication.run(ApiGatewayApplication.class, args);
  }
}
```

bootstrap.yml

```yaml
spring:
  application:
    name: ZuulService
```

API Gateway: Zuul

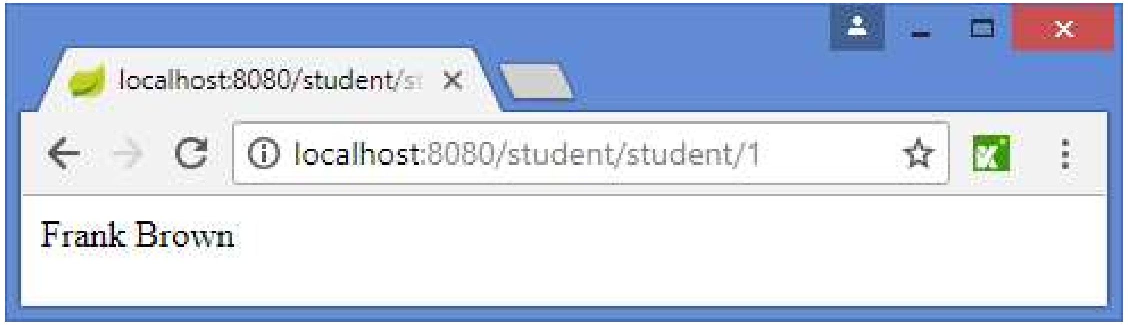
application.yml

```
server:
  port: 8080

zuul:
  routes:
    student:
      url: http://localhost:8095
    grades:
      url: http://localhost:8096
```

Route localhost:8080/student to localhost:8095

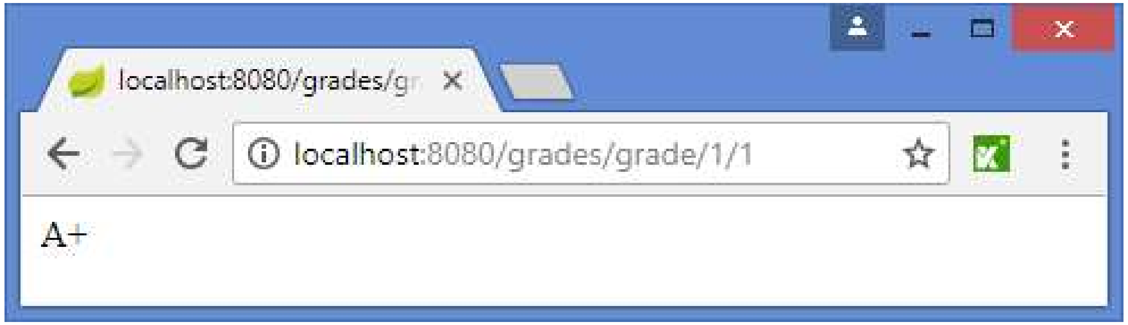
Route localhost:8080/grades to localhost:8096

Using the API Gateway



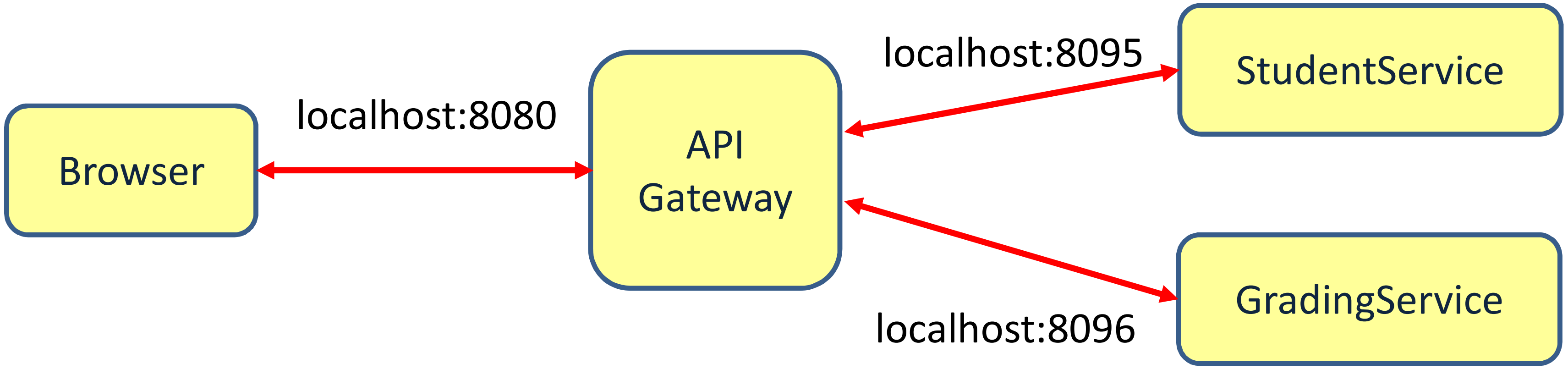
localhost:8080/student/student/1

Frank Brown

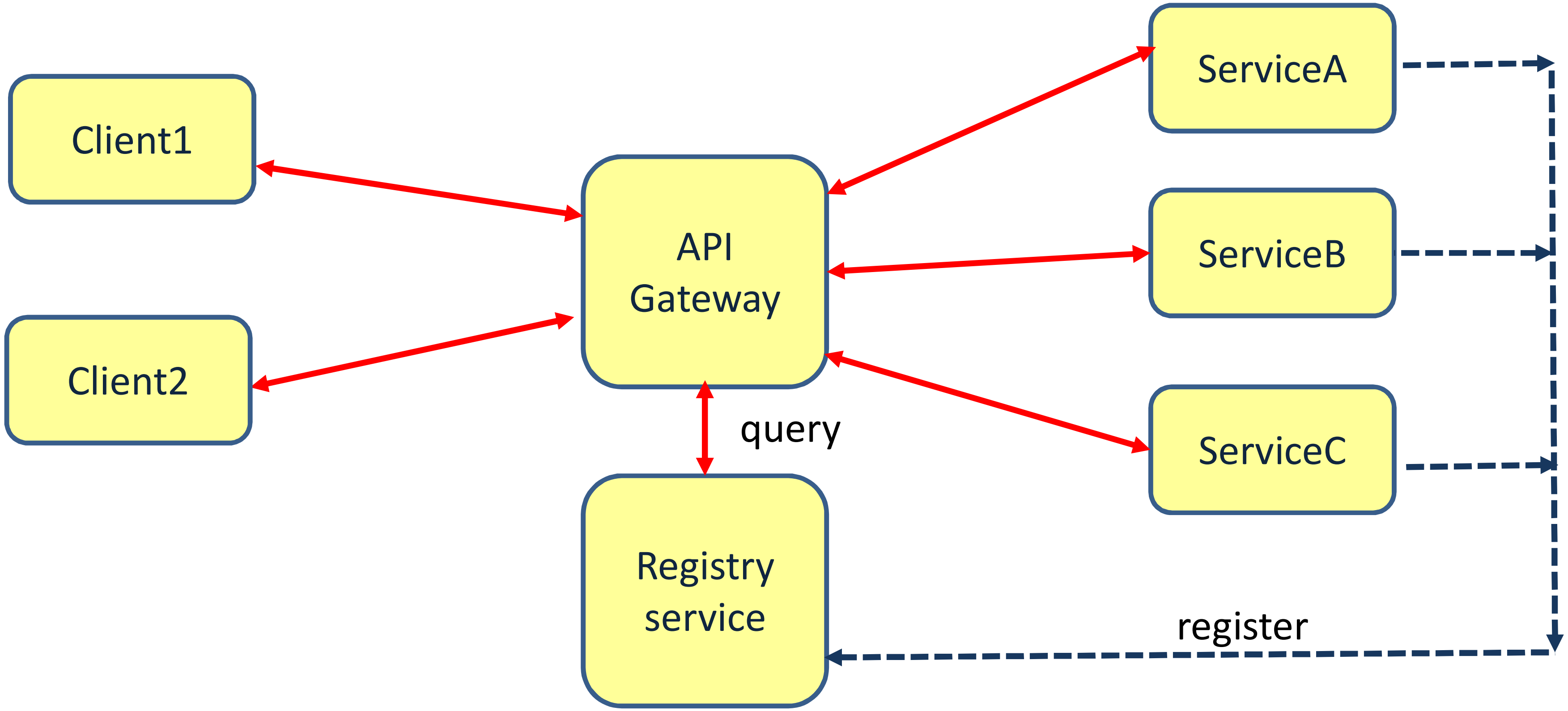


localhost:8080/grades/grade/1/1

A+



Api Gateway and registry service



query

API Gateway: Zuul

```
@SpringBootApplication
@EnableZuulProxy
@EnableDiscoveryClient
public class ApiGatewayApplication {

  public static void main(String[] args) {
    SpringApplication.run(ApiGatewayApplication.class, args);
  }
}
```

Give The API server access to Eureka

bootstrap.yml

```
spring:
  application:
    name: ZuulService
```

API Gateway: Zuul

application.yml

```
server:
  port: 8080

eureka:
  client:
    serviceUrl:
      defaultZone: http://localhost:8761/eureka/
    registerWithEureka: true
    fetchRegistry: true

zuul:
  routes:
    student:
      serviceId: StudentService
    grades:
      serviceId: GradingService
```

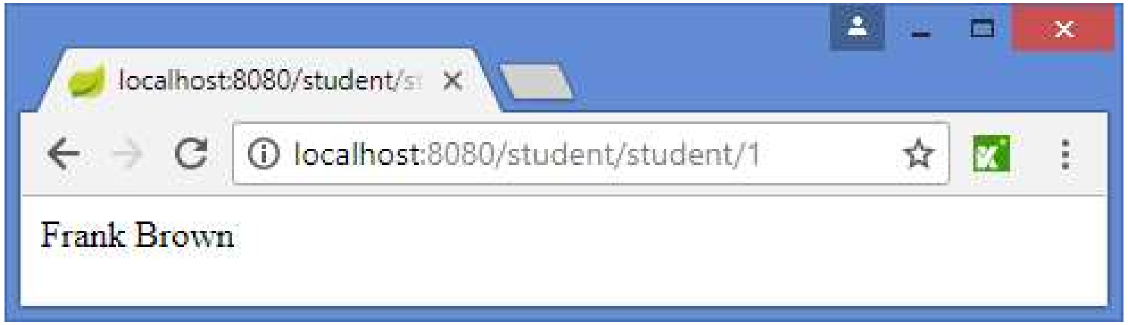
Register with Eureka

Fetch from Eureka

Route localhost:8080/student to the service that is registered in Eureka with the name StudentService

Route localhost:8080/grades to the service that is registered in Eureka with the name GradingService

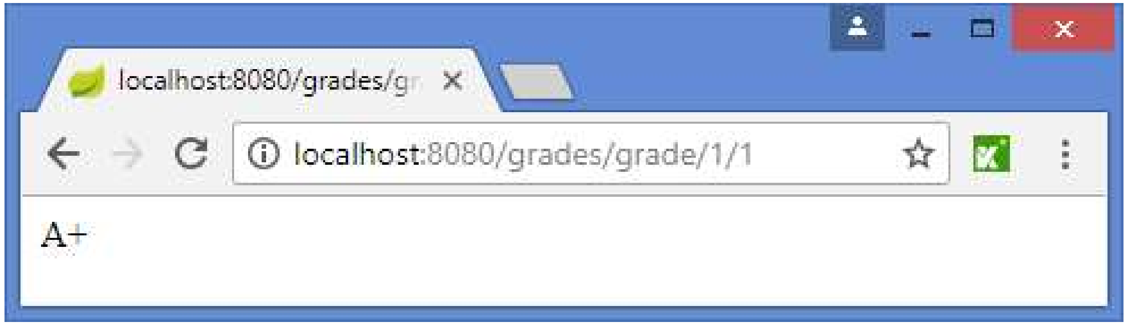
Using the API Gateway



localhost:8080/student/st

localhost:8080/student/student/1

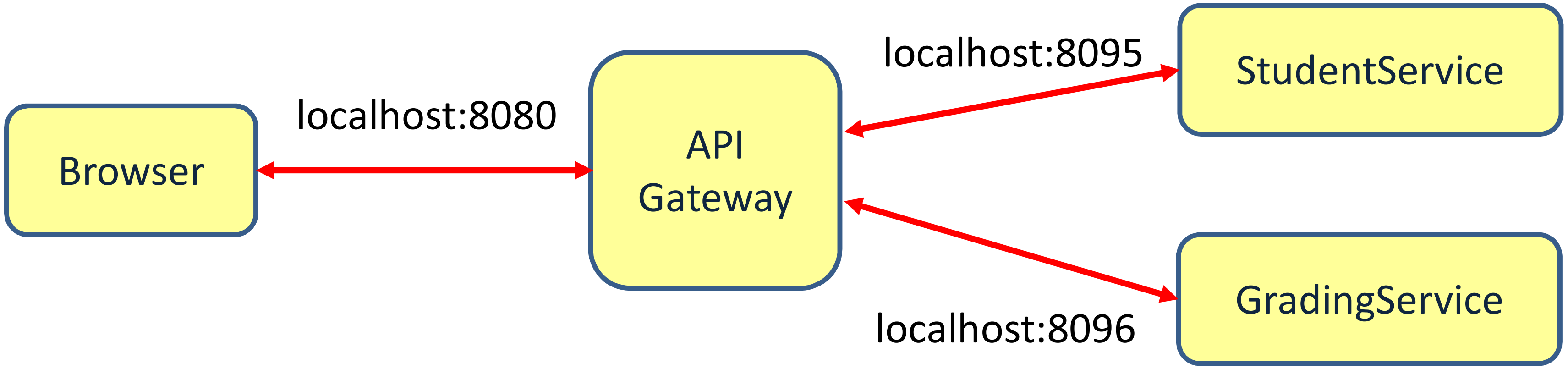
Frank Brown



localhost:8080/grades/gr

localhost:8080/grades/grade/1/1

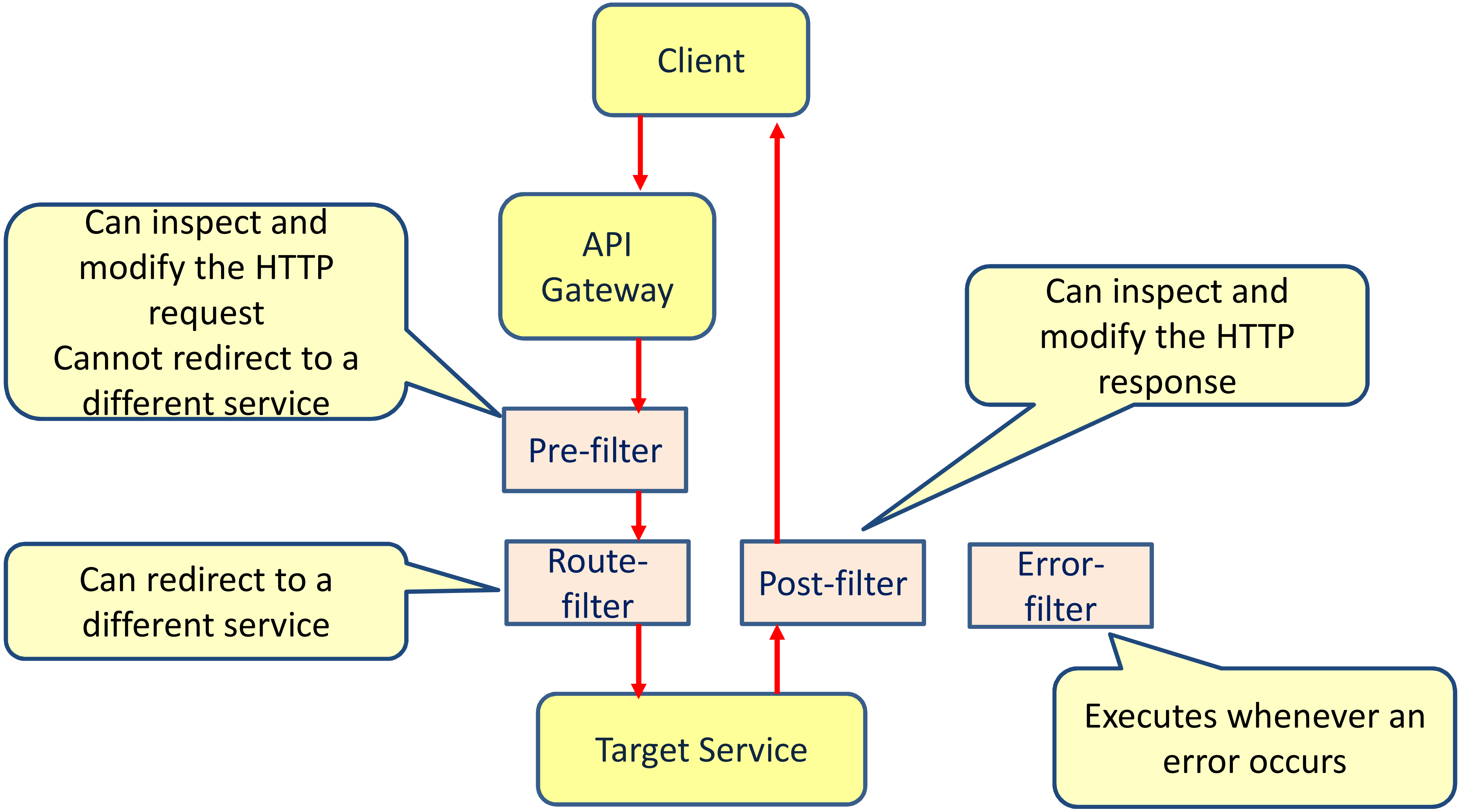
A+



Cross cutting concerns

- Security, logging, tracking, transformations
- Implemented with filters
  - Pre-filters
  - Post-filters
  - Route-filters

API Gateway Filters



Client
API Gateway
Can inspect and modify the HTTP request
Cannot redirect to a different service
Pre-filter
Can inspect and modify the HTTP response
Can redirect to a different service
Route-filter
Post-filter
Error-filter
Target Service
Executes whenever an error occurs

Pre-filter

```java
@Component
public class SimpleFilter extends ZuulFilter {
  @Override
  public String filterType() {
    return "pre";
  }
  @Override
  public int filterOrder() {
    return 1;
  }
  @Override
  public boolean shouldFilter() {
    return true;
  }
  @Override
  public Object run() {
    RequestContext ctx = RequestContext.getCurrentContext();
    HttpServletRequest request = ctx.getRequest();

    System.out.println(request.getMethod() + " request to " +
                       request.getRequestURL().toString());
    return null;
  }
}
```

Type of filter

Order of nested filters

Should the filter be active?

Functionality of the filter

Main point

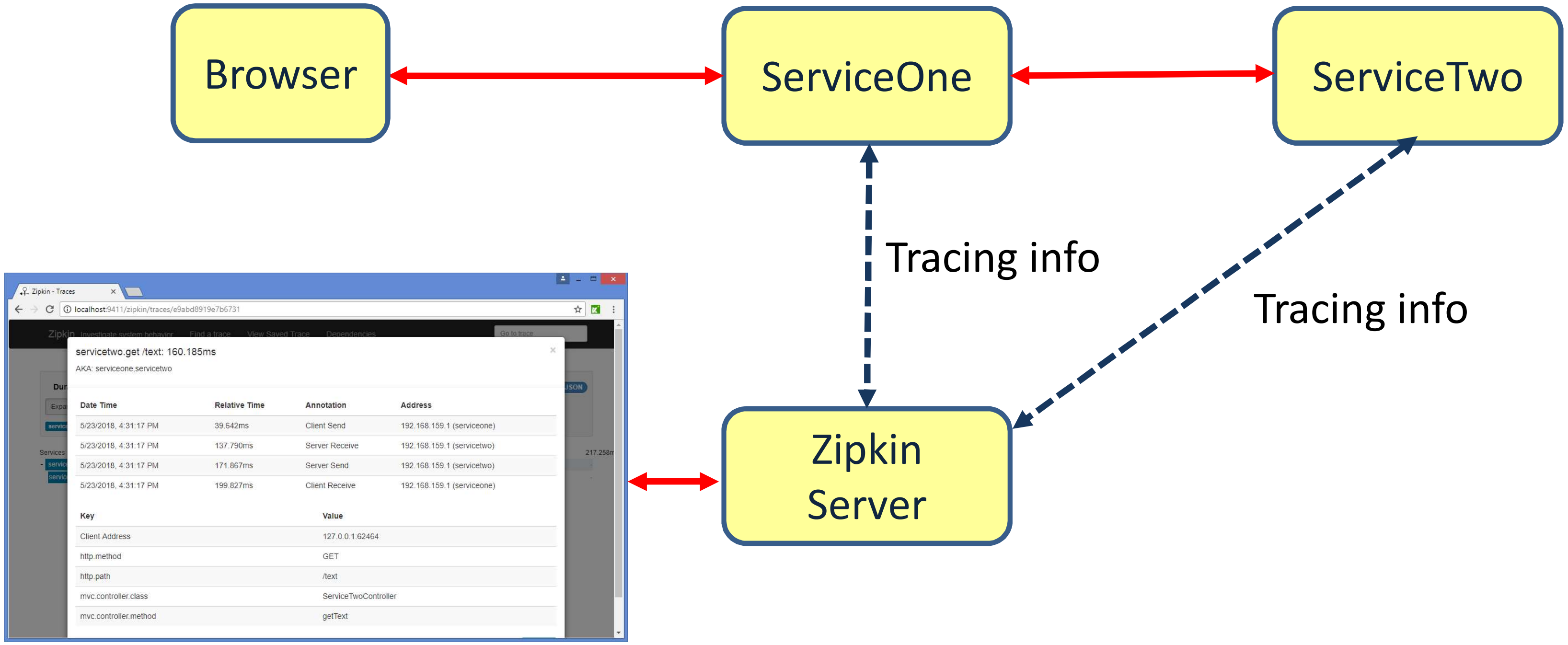
- The API gateway sits between the client applications and the microservices so that we get loose coupling between them.

- Pure Consciousness provides a unified interface to all aspects of creation, and the daily experience of Pure Consciousness makes life much more enjoyable.

DISTRIBUTED TRACING: ZIPKIN

Distributed Tracing

- One central place where one can see the end-to-end tracing of all communication between services



servicetwo.get /text: 160.185ms

AKA: serviceone,servicetwo

Date Time	Relative Time	Annotation	Address
5/23/2018, 4:31:17 PM	39.642ms	Client Send	192.168.159.1 (serviceone)
5/23/2018, 4:31:17 PM	137.790ms	Server Receive	192.168.159.1 (servicetwo)
5/23/2018, 4:31:17 PM	171.867ms	Server Send	192.168.159.1 (servicetwo)
5/23/2018, 4:31:17 PM	199.827ms	Client Receive	192.168.159.1 (serviceone)

Key	Value
Client Address	127.0.0.1:62464
http.method	GET
http.path	/text
mvc.controller.class	ServiceTwoController
mvc.controller.method	getText

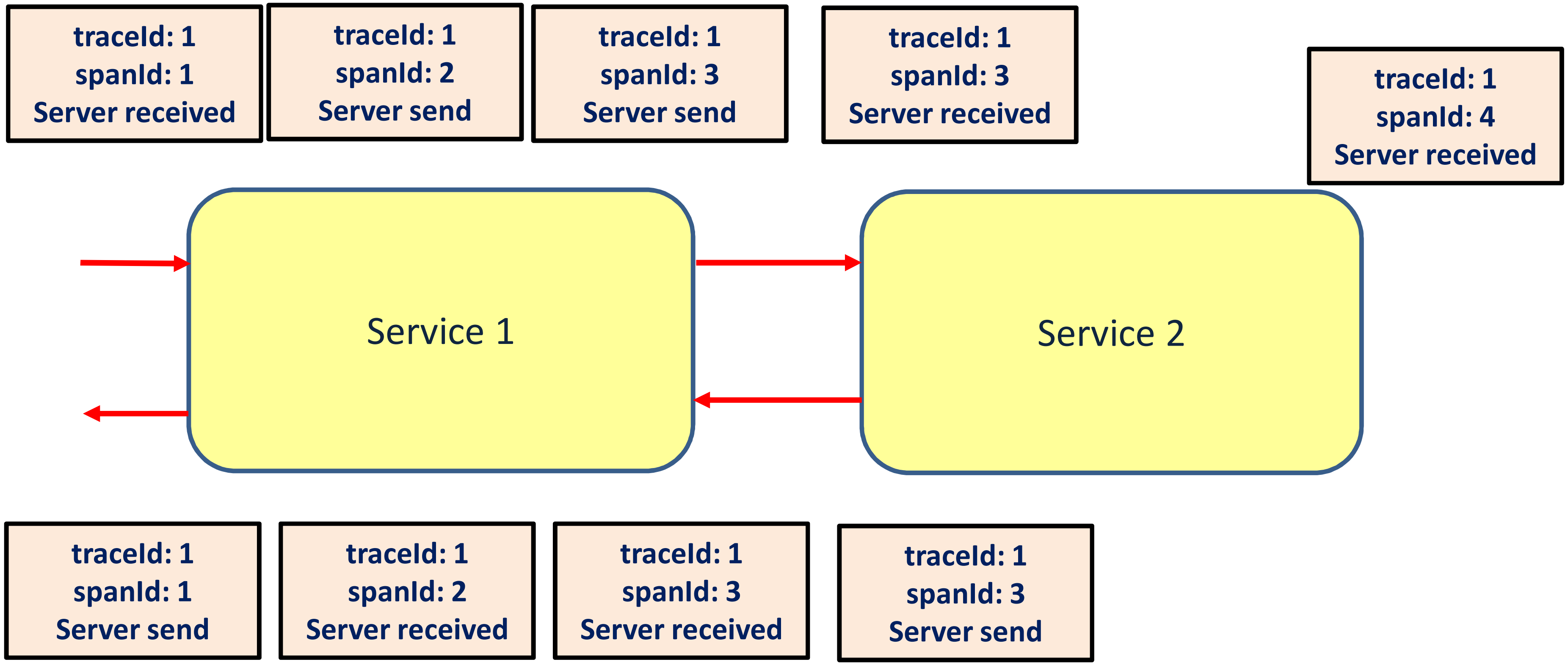
Spring cloud Sleuth

- Adds unique id’s to a request so we can trace the request
  - Span id: id for an individual operation
  - Trace id: id for a set of spans

- Also embeds these unique id’s to log messages

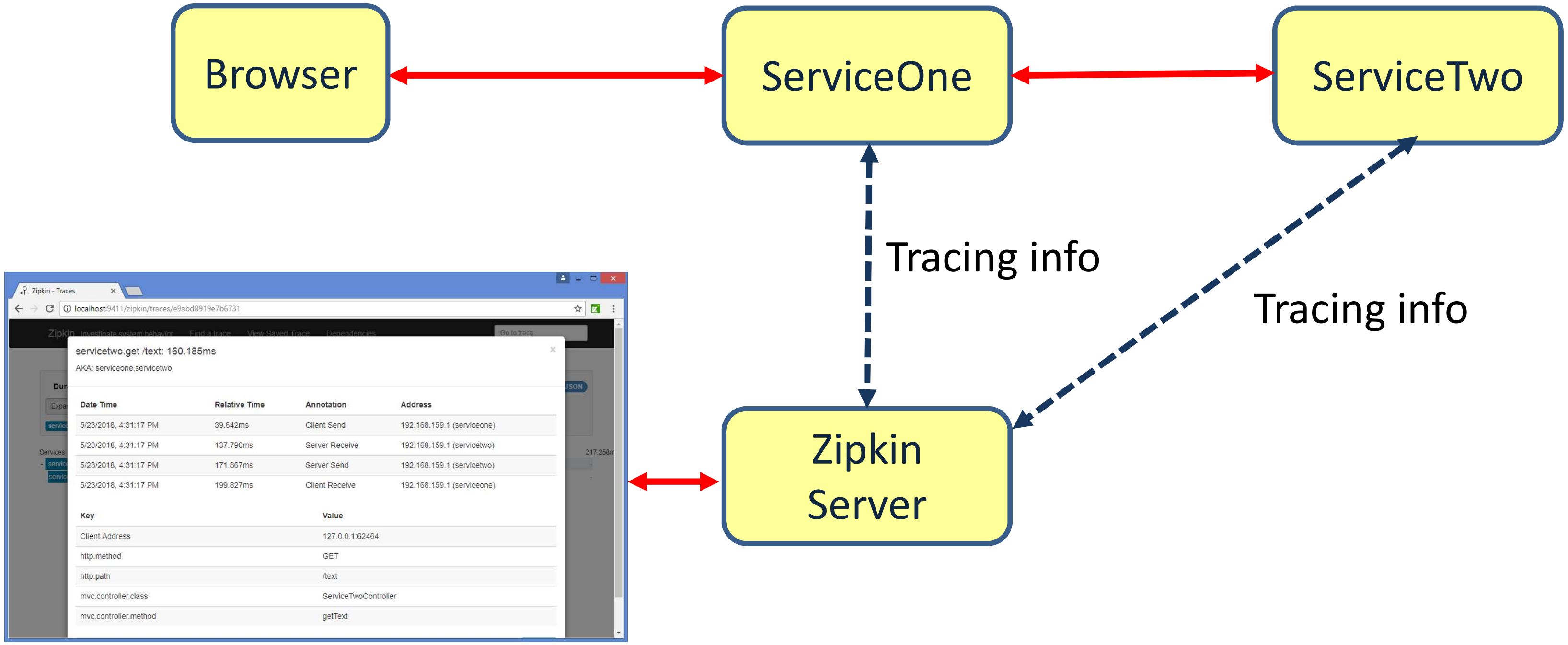
Spring cloud Sleuth

- Span: an individual operation
- Trace: a set of spans



Zipkin

- Centralized tracing server
  - Collects tracing information
- Zipkin console shows the data


Browser
ServiceOne
ServiceTwo
Tracing info
Tracing info
Zipkin Server
Zipkin - Traces
localhost:9411/zipkin/traces/e9abd8919e7b6731
Zipkin Investigate system behavior Find a trace View Saved Trace Dependencies
Go to trace
JSON

servicetwo.get /text: 160.185ms

AKA: serviceone,servicetwo

Date Time	Relative Time	Annotation	Address
5/23/2018, 4:31:17 PM	39.642ms	Client Send	192.168.159.1 (serviceone)
5/23/2018, 4:31:17 PM	137.790ms	Server Receive	192.168.159.1 (servicetwo)
5/23/2018, 4:31:17 PM	171.867ms	Server Send	192.168.159.1 (servicetwo)
5/23/2018, 4:31:17 PM	199.827ms	Client Receive	192.168.159.1 (serviceone)

Key	Value
Client Address	127.0.0.1:62464
http.method	GET
http.path	/text
mvc.controller.class	ServiceTwoController
mvc.controller.method	getText

Zipkin and Sleuth dependency

pom.xml

```
<dependency>
  <groupId>org.springframework.cloud</groupId>
  <artifactId>spring-cloud-starter-sleuth</artifactId>
</dependency>
<dependency>
  <groupId>org.springframework.cloud</groupId>
  <artifactId>spring-cloud-starter-zipkin</artifactId>
</dependency>
```

Service1

```
@SpringBootApplication
public class Service1Application {
  public static void main(String[] args) {
    SpringApplication.run(Service1Application.class, args);
  }
}
```

```
@RestController
public class ServiceOneController {

  @Autowired
  RestTemplate restTemplate;

  @RequestMapping("/text")
  public String getText() {
    String service2Text = restTemplate.getForObject("http://localhost:9091/text",
                                                     String.class);
    return "Hello "+ service2Text;
  }

  @Bean
  RestTemplate getRestTemplate() {
    return new RestTemplate();
  }
}
```

Service1

application.yml

```yaml
server:
  port: 9090

spring:
  zipkin:
    base-url: http://localhost:9411/

sleuth:
    sampler:
      probability: 1 #100% (default = 10%)
```

bootstrap.yml

```yaml
spring:
  application:
    name: ServiceOne
```

Service1

pom.xml

```xml
<dependency>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-starter-web</artifactId>
</dependency>
<dependency>
  <groupId>org.springframework.cloud</groupId>
  <artifactId>spring-cloud-starter-sleuth</artifactId>
</dependency>
<dependency>
  <groupId>org.springframework.cloud</groupId>
  <artifactId>spring-cloud-starter-zipkin</artifactId>
</dependency>
```

Service2

```
@SpringBootApplication
public class Service2Application {
  public static void main(String[] args) {
    SpringApplication.run(Service2Application.class, args);
  }
}
```

```
@RestController
public class ServiceTwoController {

  @RequestMapping("/text")
  public String getText() {
    return "World";
  }
}
```

Service1

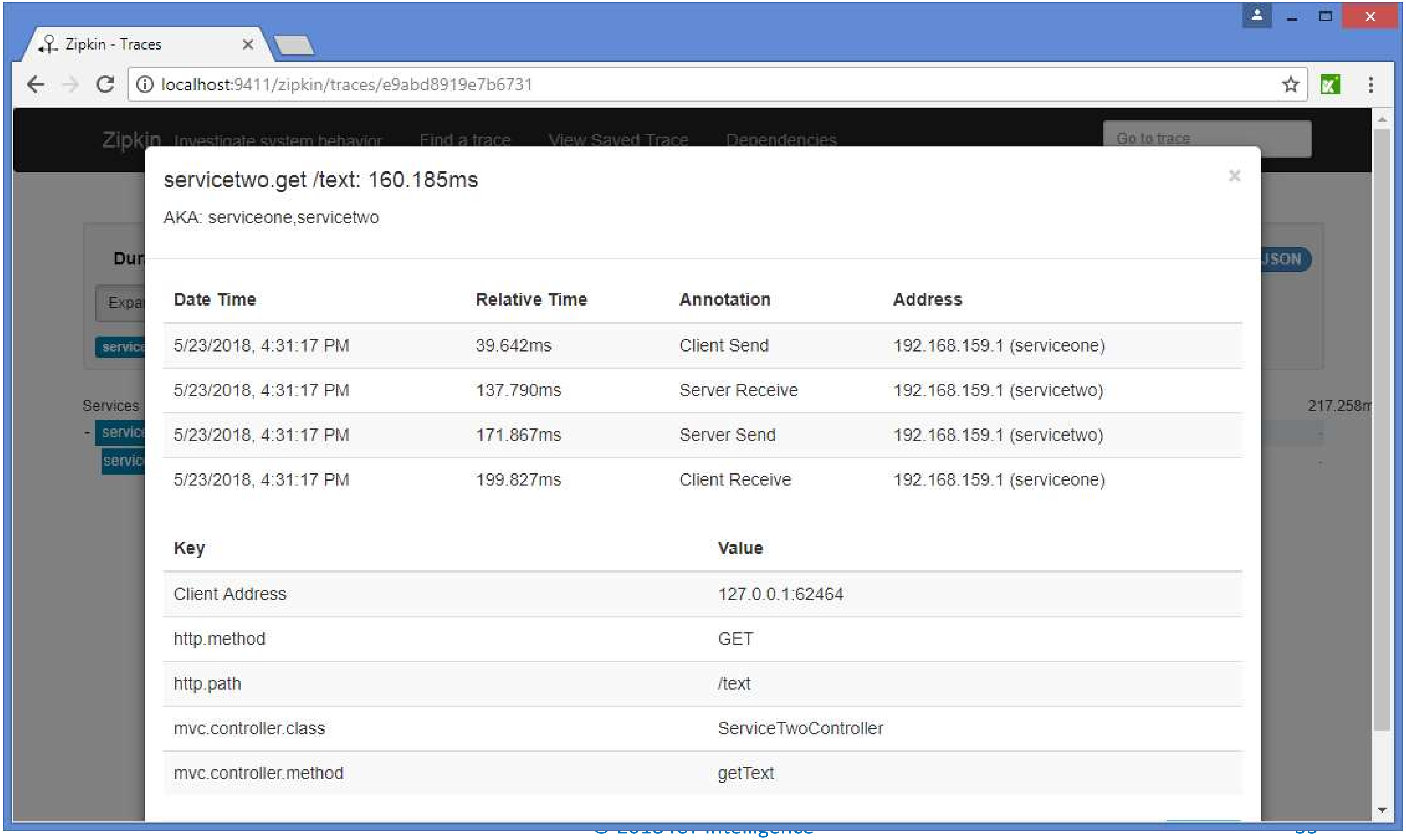
application.yml

```
server:
  port: 9091

spring:
  zipkin:
    base-url: http://localhost:9411/

  sleuth:
    sampler:
      probability: 1 #100% (default = 10%)
```

bootstrap.yml

```
spring:
  application:
    name: ServiceTwo
```

Zipkin console



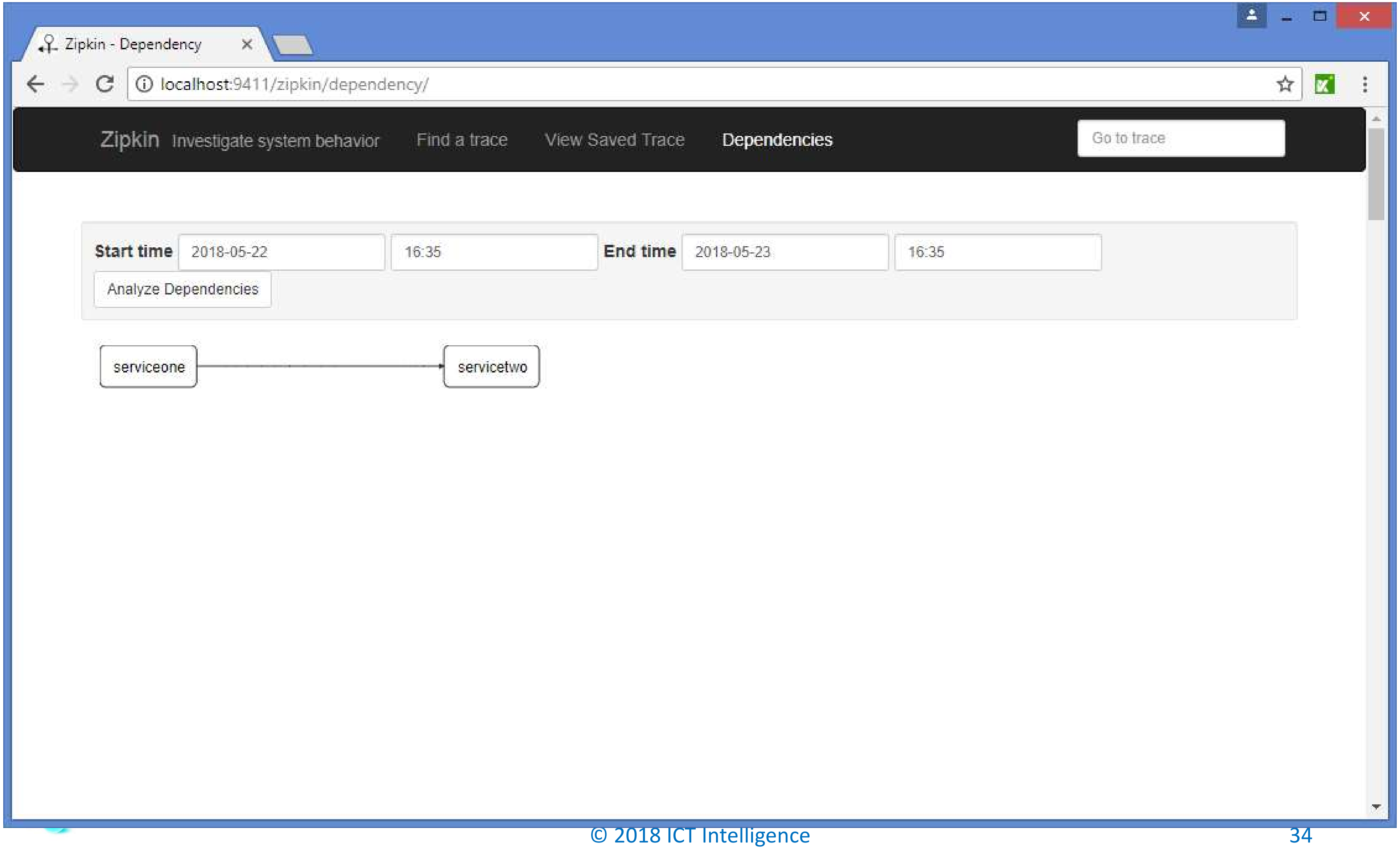
servicetwo.get /text: 160.185ms

AKA: serviceone,servicetwo

Date Time	Relative Time	Annotation	Address
5/23/2018, 4:31:17 PM	39.642ms	Client Send	192.168.159.1 (serviceone)
5/23/2018, 4:31:17 PM	137.790ms	Server Receive	192.168.159.1 (servicetwo)
5/23/2018, 4:31:17 PM	171.867ms	Server Send	192.168.159.1 (servicetwo)
5/23/2018, 4:31:17 PM	199.827ms	Client Receive	192.168.159.1 (serviceone)

Key	Value
Client Address	127.0.0.1:62464
http.method	GET
http.path	/text
mvc.controller.class	ServiceTwoController
mvc.controller.method	getText

Zipkin console



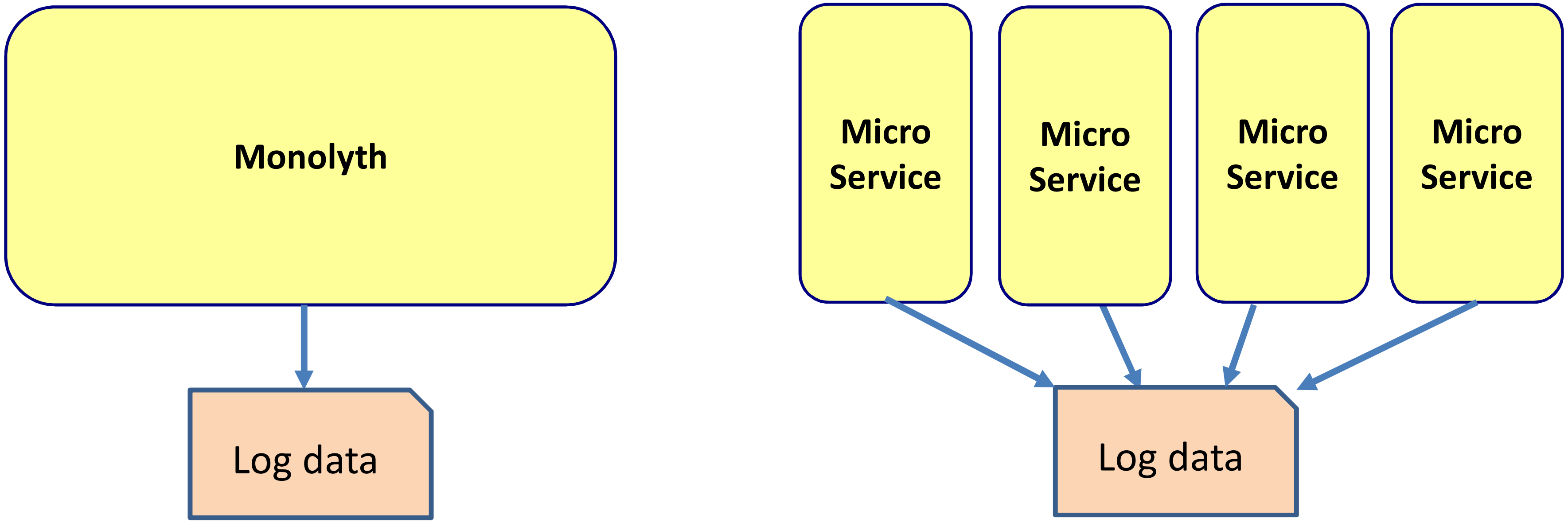
Zipkin - Dependency

localhost:9411/zipkin/dependency/

Start time 2018-05-22 16:35 End time 2018-05-23 16:35

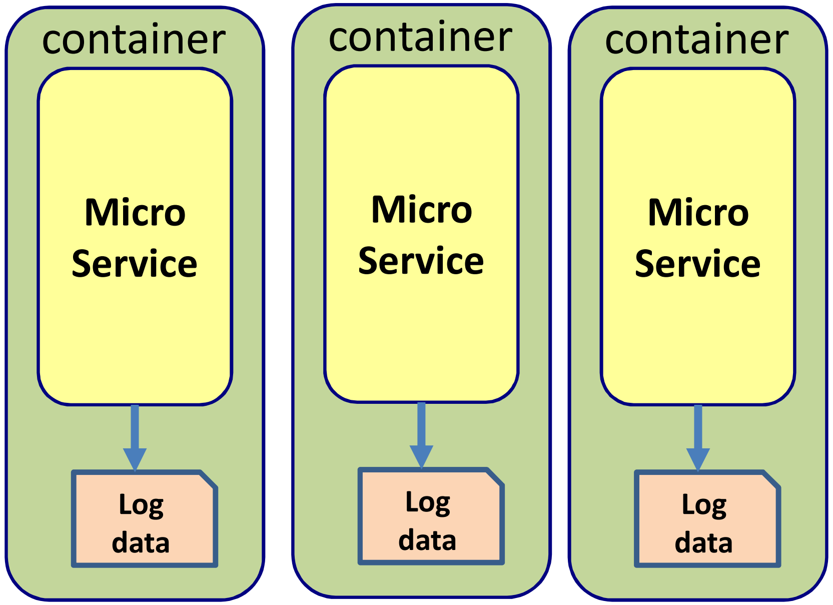
DISTRIBUTED LOGGING: ELK

Logging



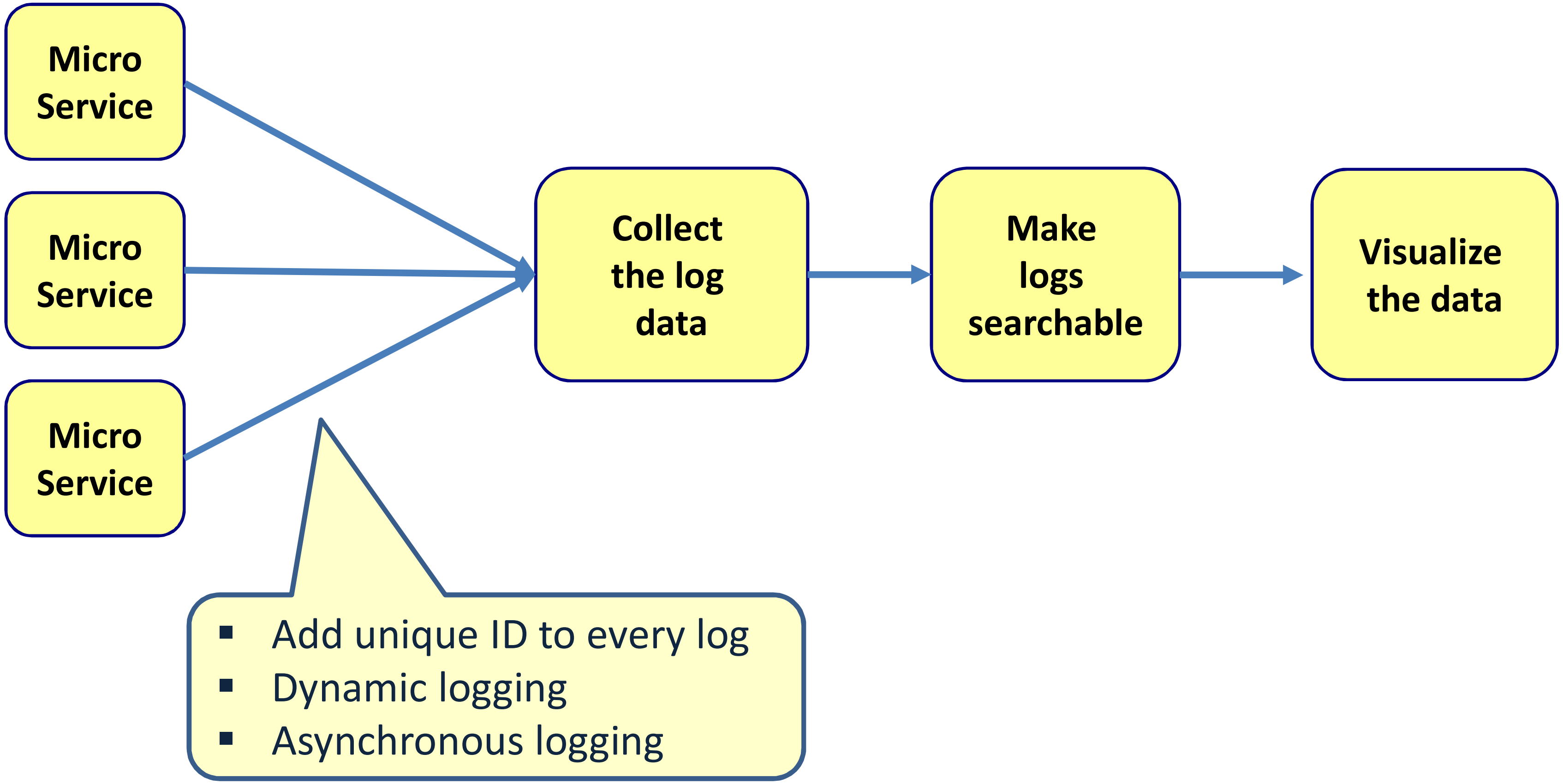
- We need to collect all log data from all services to know what has happened

The need for centralized logging



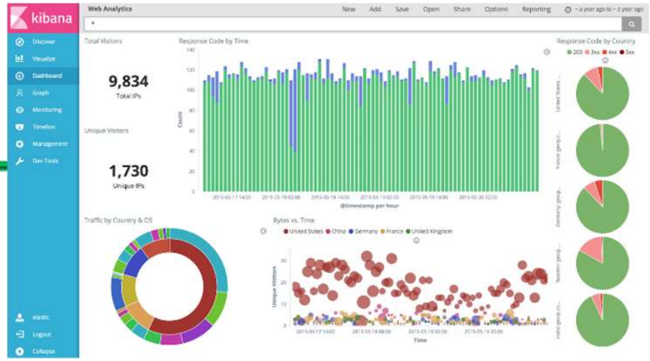
- Local logging does not work
  - Containers come and go
  - Containers have no fixed address

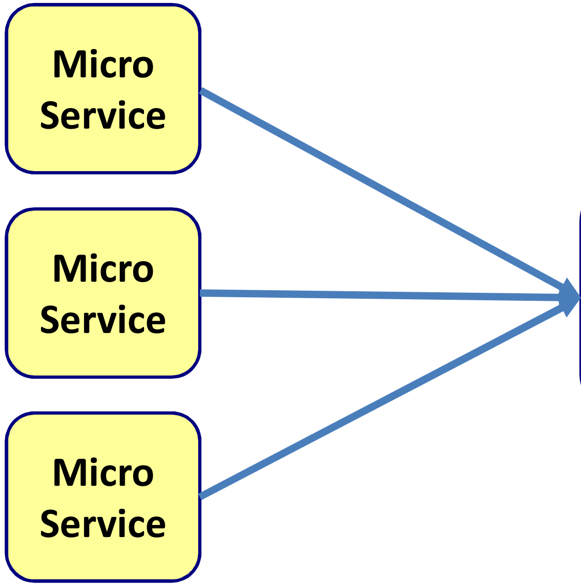
Microservice logging architecture

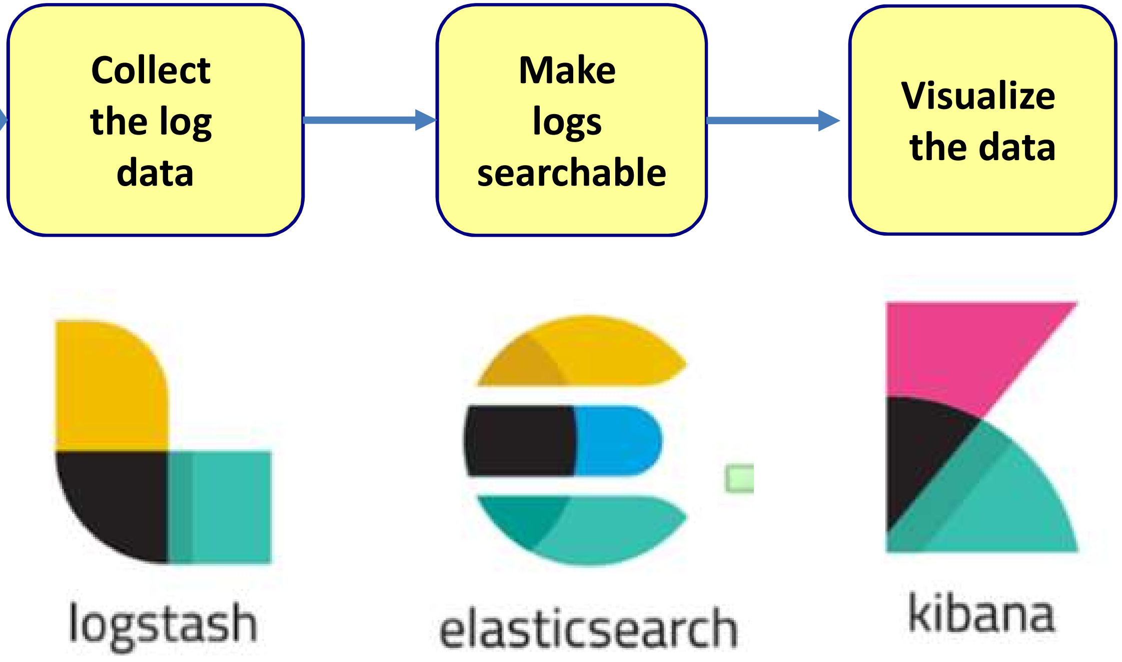


- Add unique ID to every log
- Dynamic logging
- Asynchronous logging

ELK stack







Collect logs
Transform
Time normalization

Schema less search DB
Highly scalable
Fast searching

Main point

- In a microservice architecture, we need centralized tracing and logging to monitor our systems

- The Unified Field is the abstract field that unites all diversity in creation.

RESILIENCE

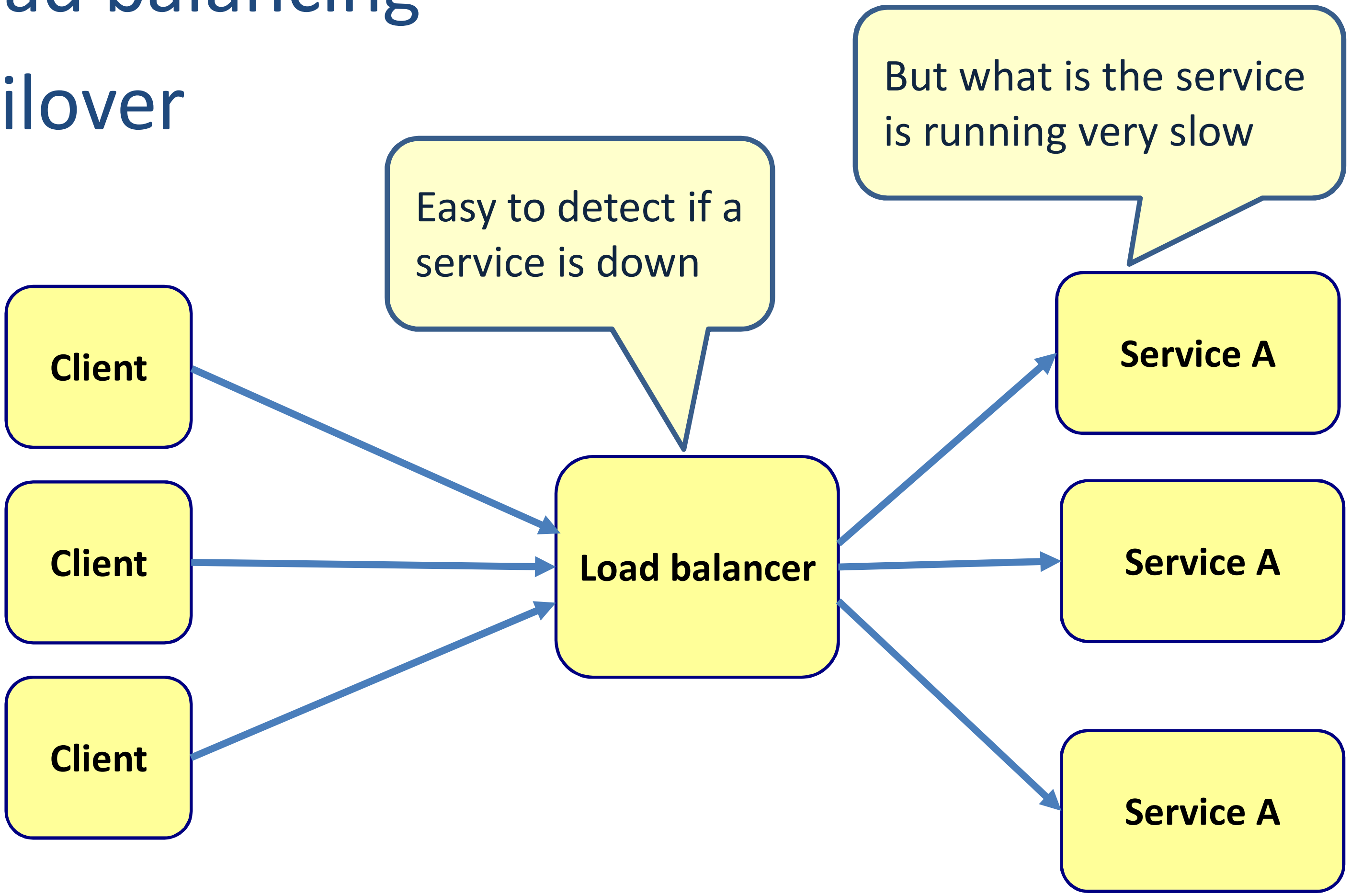
The ability to recover from failures

Fallacies of distributed computing

- The network is reliable
- Latency is zero
- Bandwidth is infinite
- The network is secure
- Topology doesn’t change
- There is one administrator
- Transport cost is zero
- The network is homogeneous

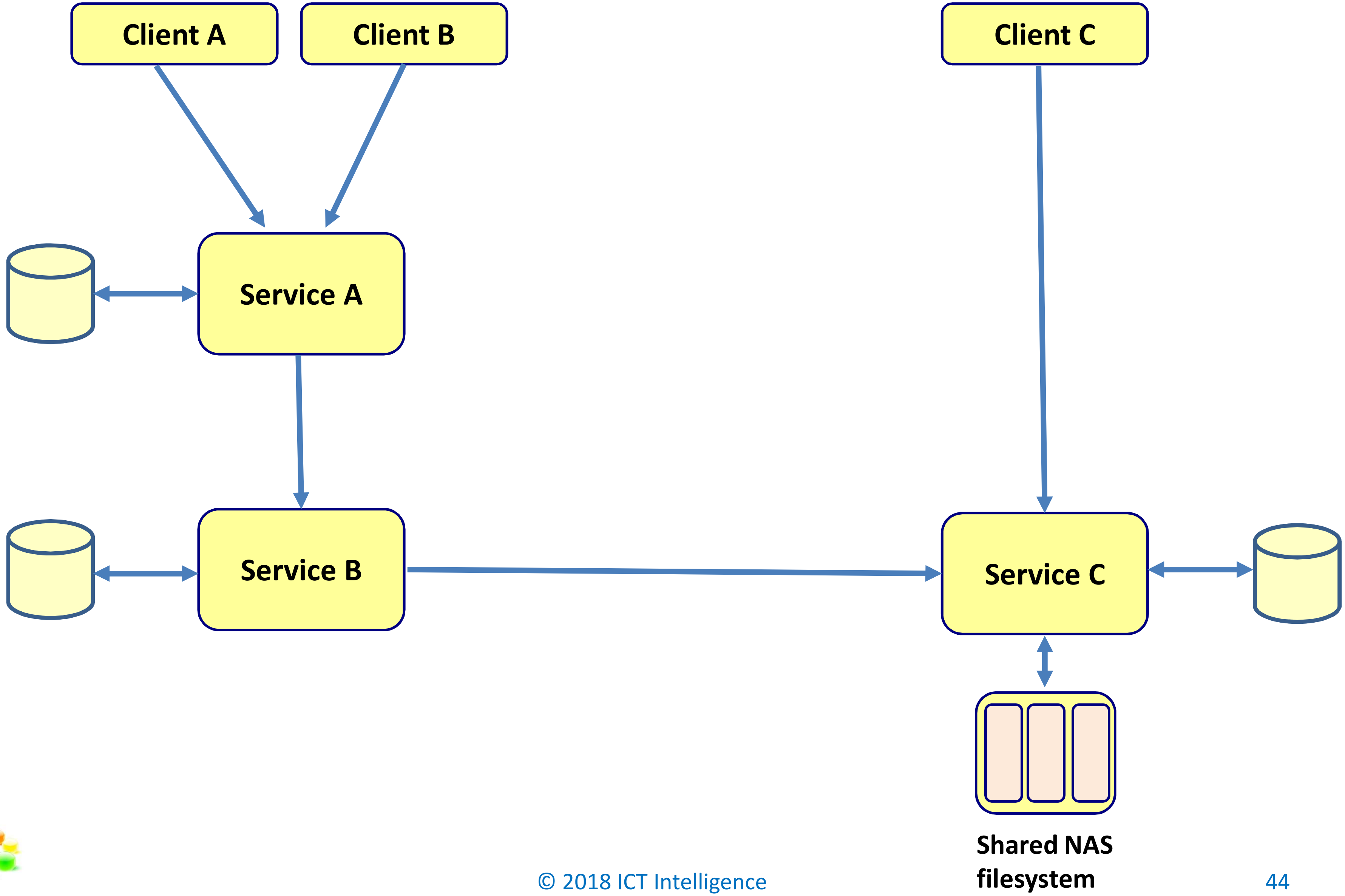
Clustering

- Load balancing
- Failover

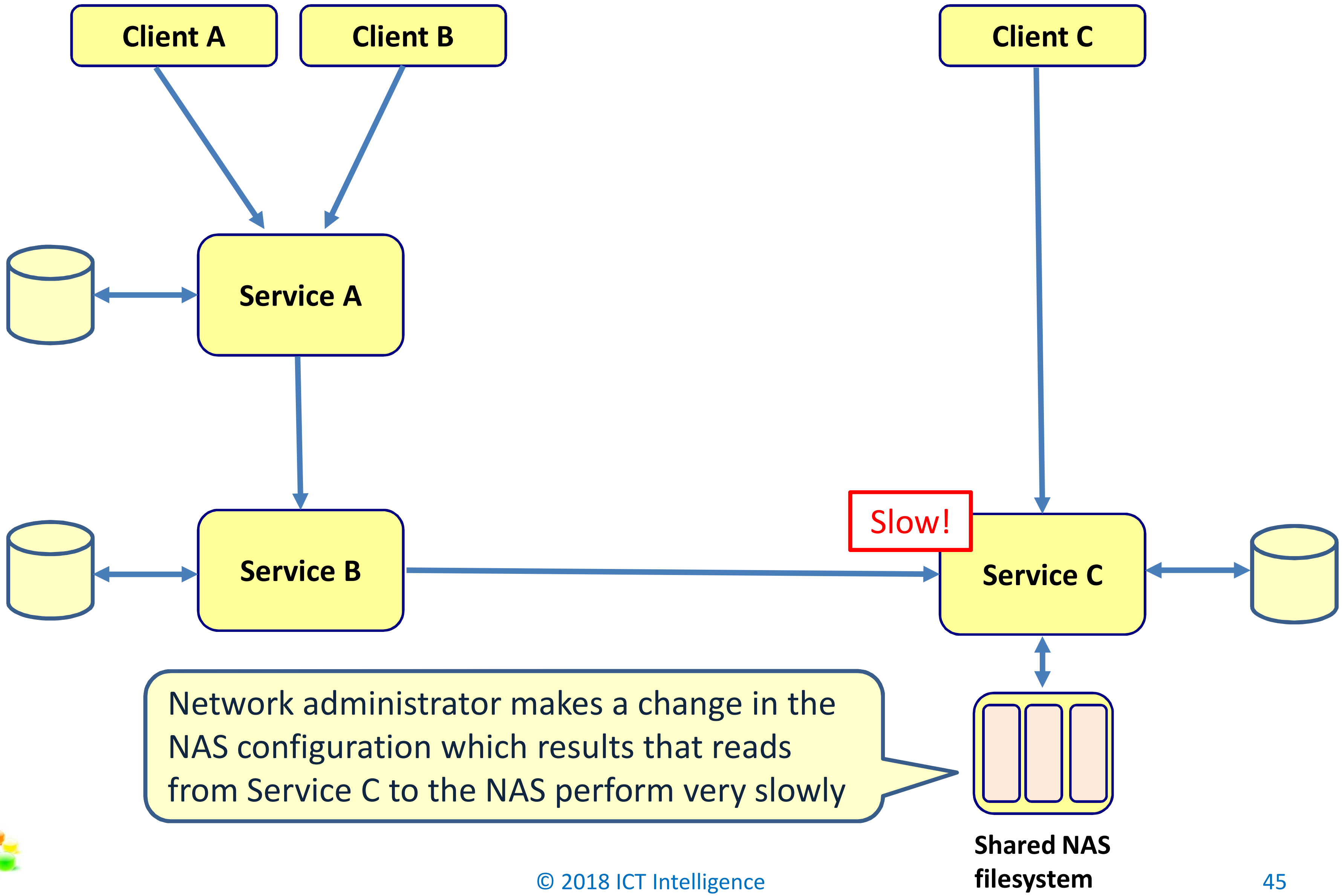


But what is the service is running very slow
Easy to detect if a service is down
Client
Client
Client
Load balancer
Service A
Service A
Service A

Example

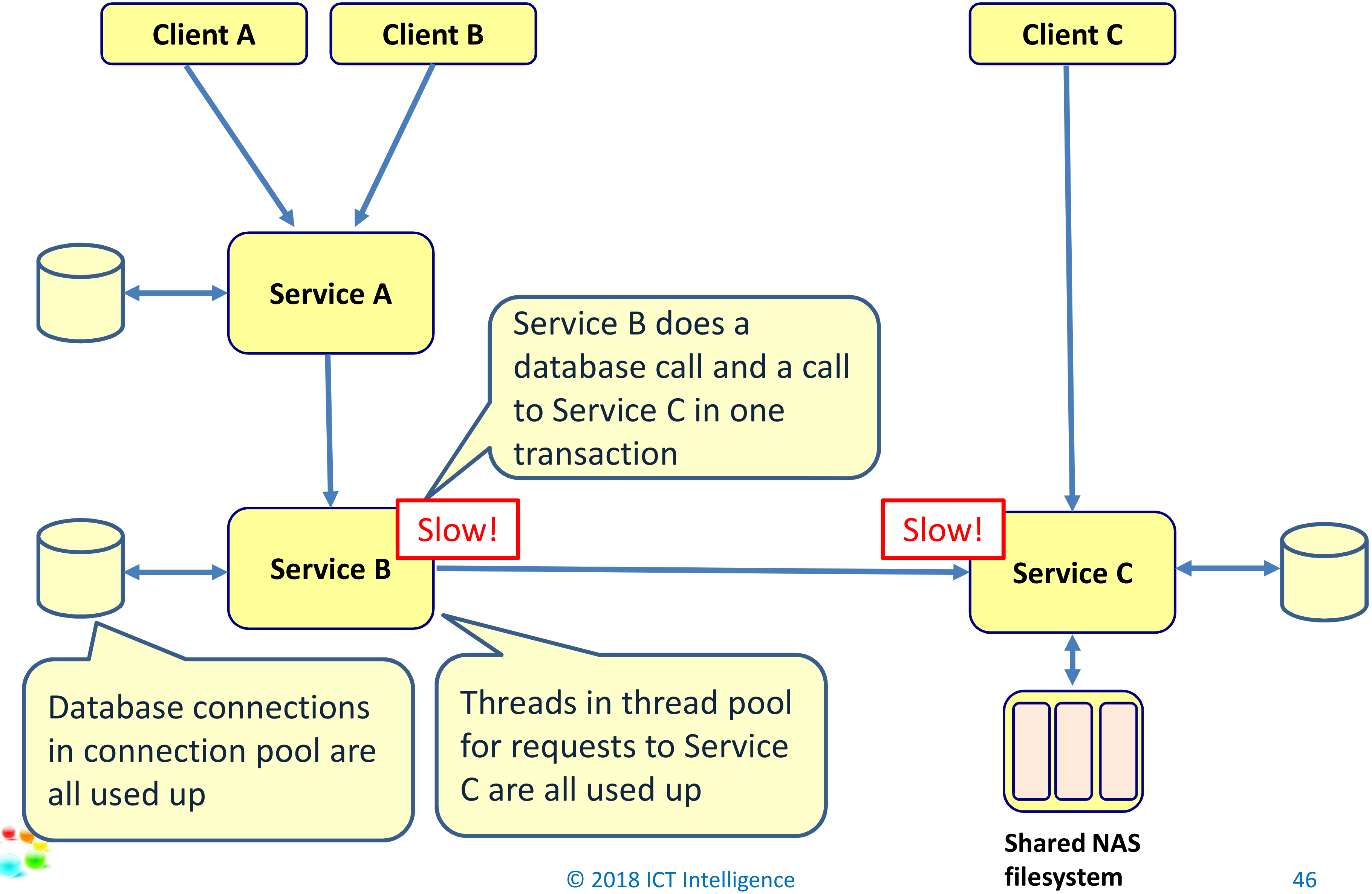

Client A
Client B
Client C
Service A
Service B
Service C
Shared NAS filesystem

Example



Network administrator makes a change in the NAS configuration which results that reads from Service C to the NAS perform very slowly

Example

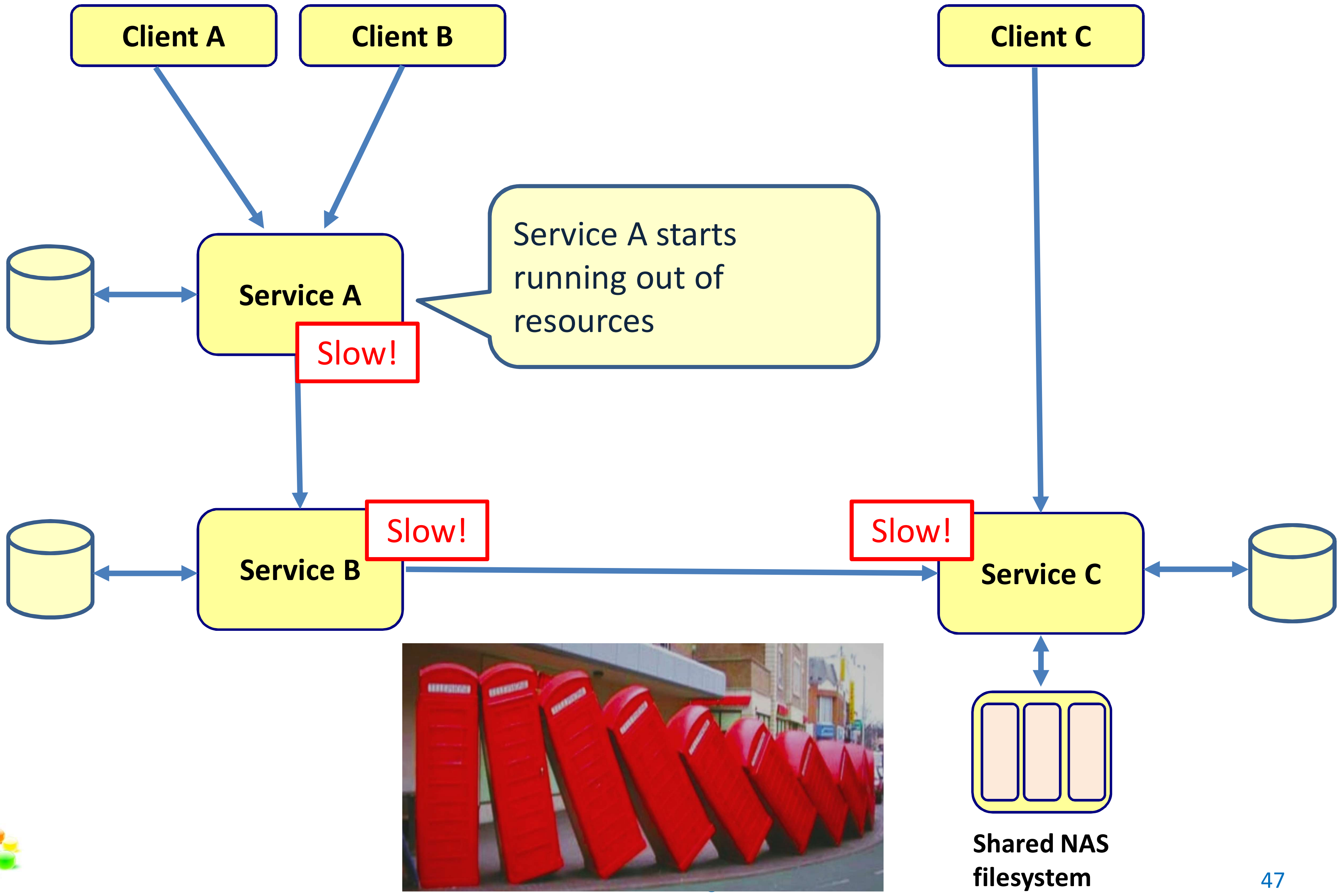


Service B does a database call and a call to Service C in one transaction

Database connections in connection pool are all used up

Threads in thread pool for requests to Service C are all used up

Example



Service A starts running out of resources

RESILLIENCE: HYSTRIX

Hystrix dependency

pom.xml

```
<dependency>
  <groupId>org.springframework.cloud</groupId>
  <artifactId>spring-cloud-starter-netflix-hystrix</artifactId>
</dependency>
```

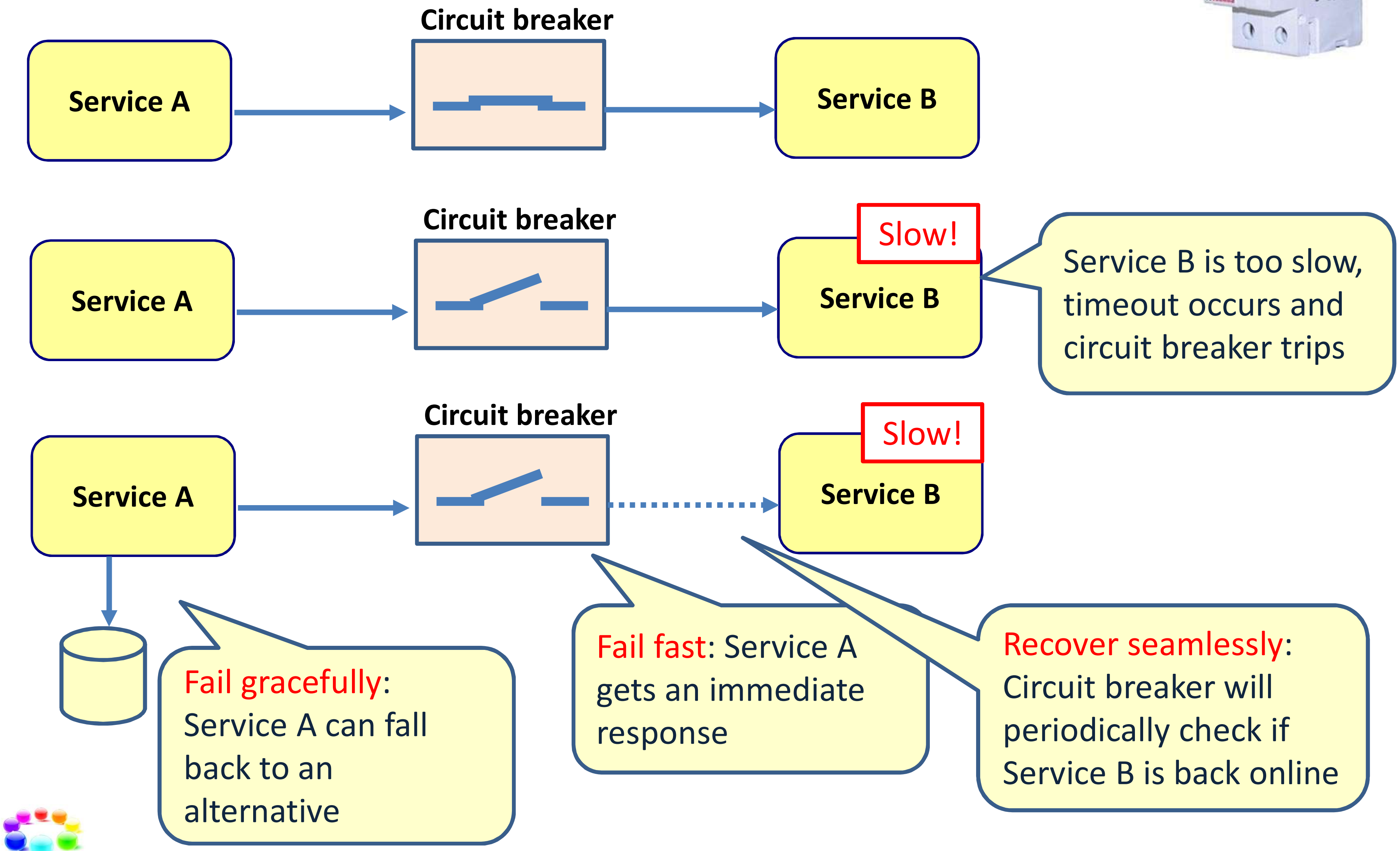
Resilience patterns

- Timeouts
- Circuit breaker
- Bulkheads

Timeouts

- Put timeouts on all out-of-process calls.
  - Other services
  - Database
  - File system
- Log when timeouts occur
  1. Pick a default timeout
  2. Monitor
  3. Adjust

Circuit breaker



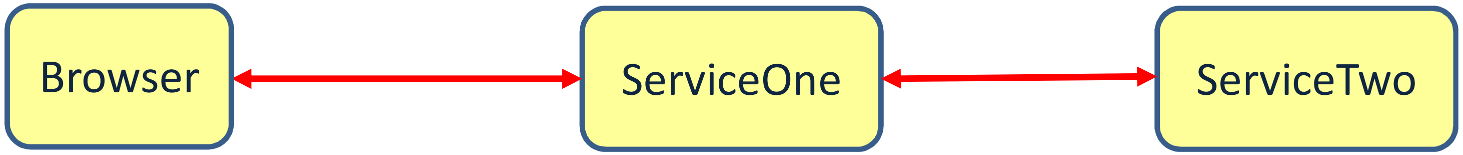
Service B is too slow, timeout occurs and circuit breaker trips

Fail gracefully: Service A can fall back to an alternative

Fail fast: Service A gets an immediate response

Recover seamlessly: Circuit breaker will periodically check if Service B is back online

Enable Hystrix



```
@SpringBootApplication
@EnableCircuitBreaker
public class ServiceOneApplication {

  public static void main(String[] args) {
    SpringApplication.run(Service2Application.class, args);
  }
}
```

Enable Histrix

```
@SpringBootApplication
@EnableCircuitBreaker
public class ServiceTwoApplication {

  public static void main(String[] args) {
    SpringApplication.run(Service2Application.class, args);
  }
}
```

Enable Histrix

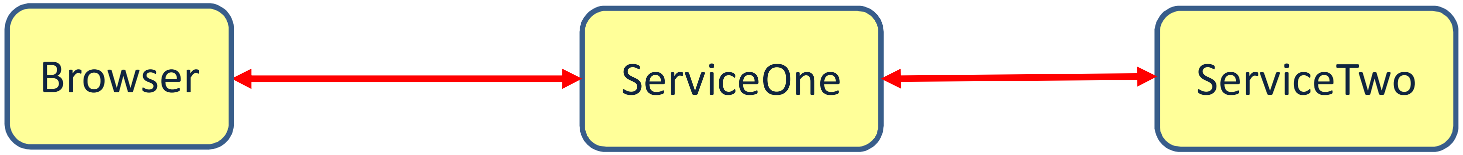
Using the circuit breaker

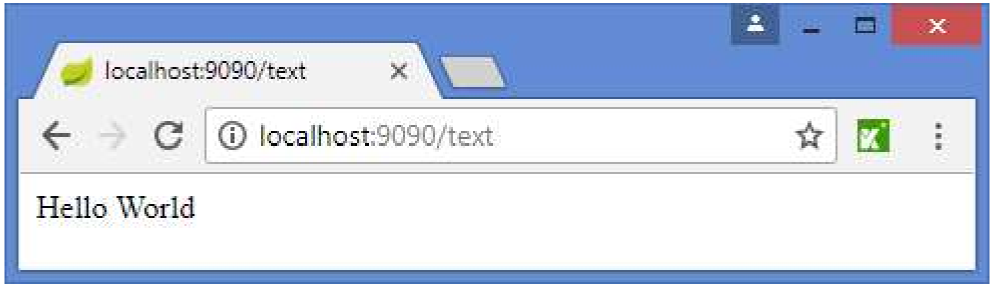
```
public class ServiceOneController {

  @Autowired
  RestTemplate restTemplate;

  @RequestMapping("/text")
  @HystrixCommand(fallbackMethod = "getTextFallback")
  public String getText() {
    String service2Text = restTemplate.getForObject("http://localhost:9091/text",
                                                     String.class);
    return "Hello "+ service2Text;
  }

  public String getTextFallback() {
   return "Hello Histrix";
  }

  @Bean
  RestTemplate getRestTemplate() {
    return new RestTemplate();
  }
}
```

If this method throws an exception or takes longer than 2 seconds, call the fallback method

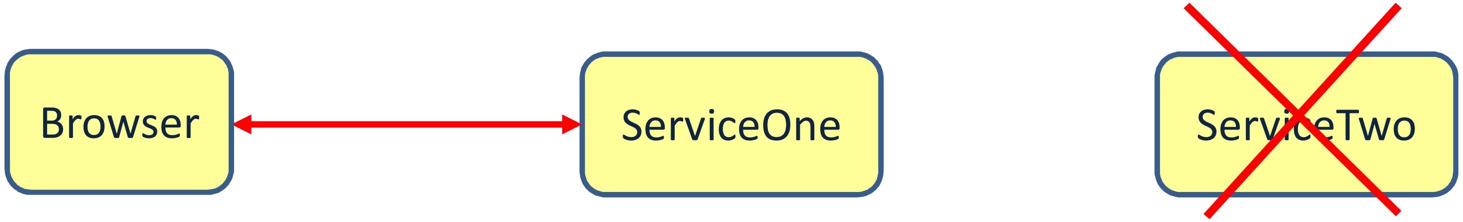
Fallback method

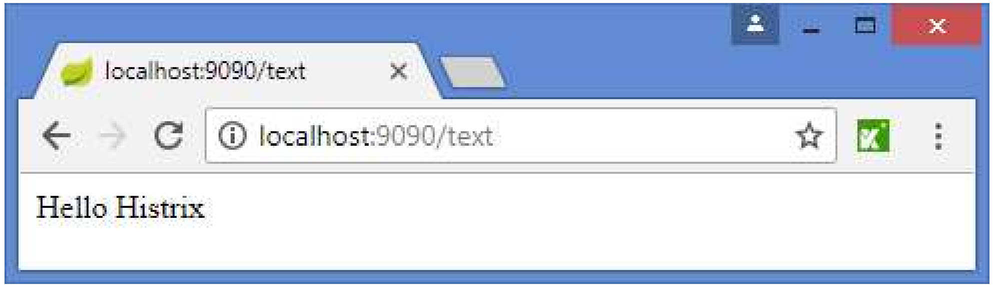
Using Histrix





Hello World





Hello Histrix

Setting the timeout

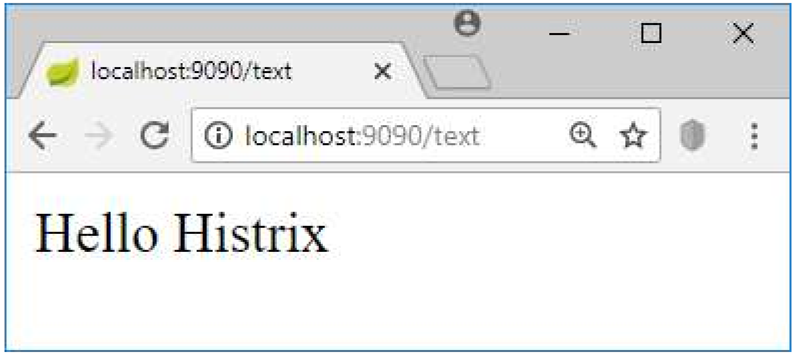
Set timeout to 4 seconds

```
public class ServiceOneController {

  @Autowired
  RestTemplate restTemplate;

  @RequestMapping("/text")
  @HystrixCommand(fallbackMethod = "getTextFallback", commandProperties=
  {@HystrixProperty(name="execution.isolation.thread.timeoutInMilliseconds",
                    value="4000")})
  public String getText() {
    String service2Text = restTemplate.getForObject("http://localhost:9091/text",
                                                     String.class);
    return "Hello "+ service2Text;
  }

  public String getTextFallback() {
   return "Hello Histrix";
  }

  @Bean
  RestTemplate getRestTemplate() {
    return new RestTemplate();
  }
}
```

Setting the timeout

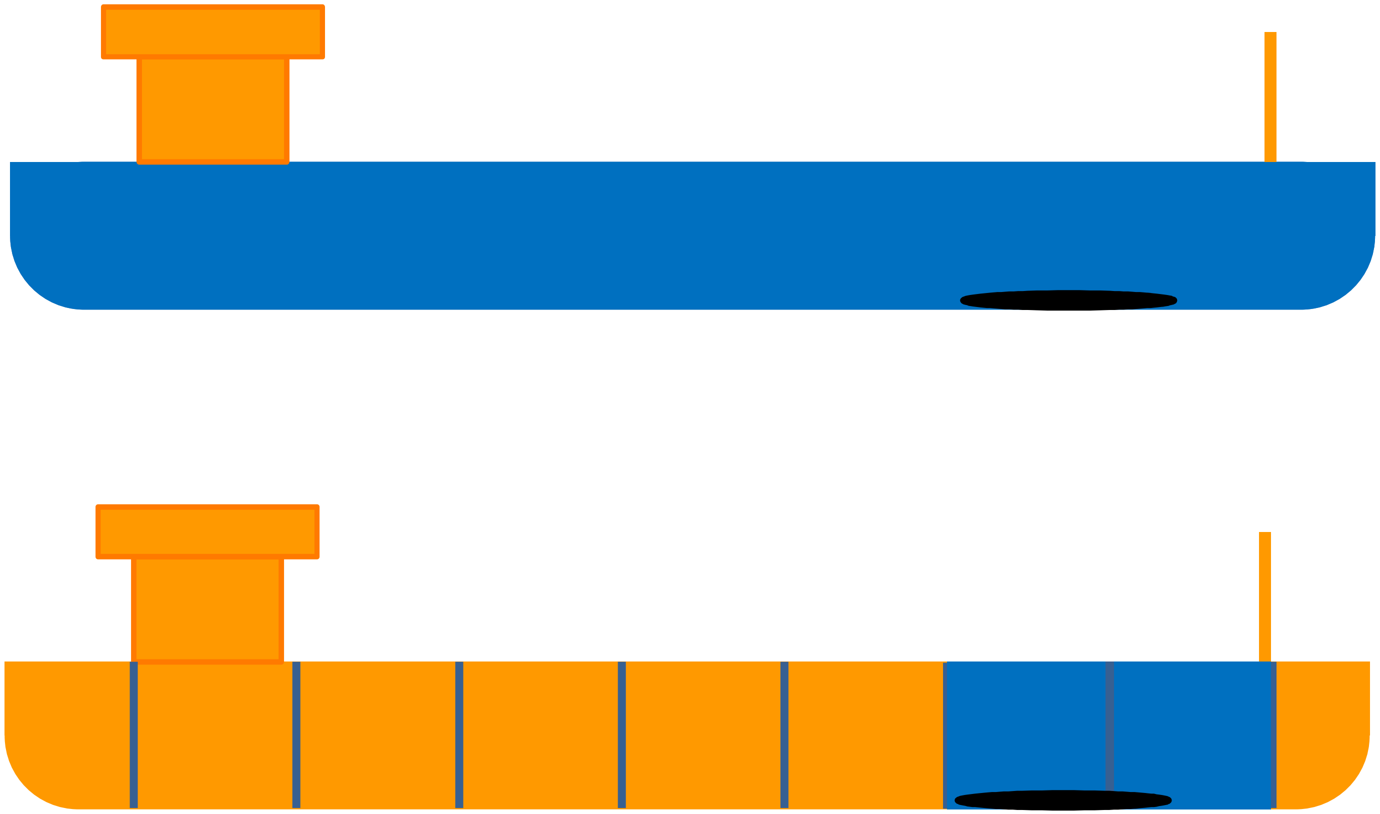
```
@RestController
public class ServiceTwoController {

  @RequestMapping("/text")
  public String getText() throws InterruptedException {
    Thread.sleep(5000);
    return "World";
  }
}
```

Sleep of 5 seconds



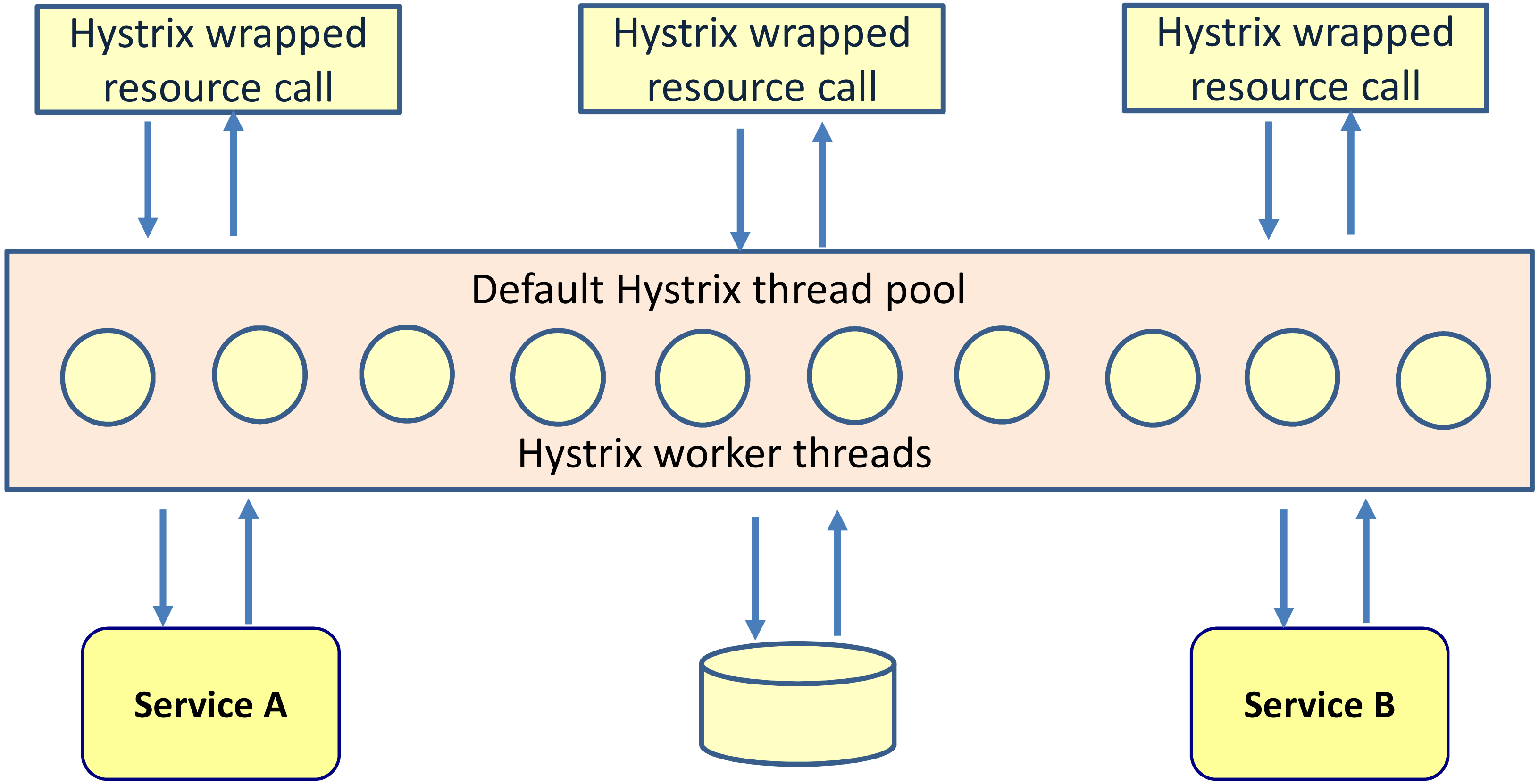
Hello Histrix

Bulkhead



Hystrix thread pool

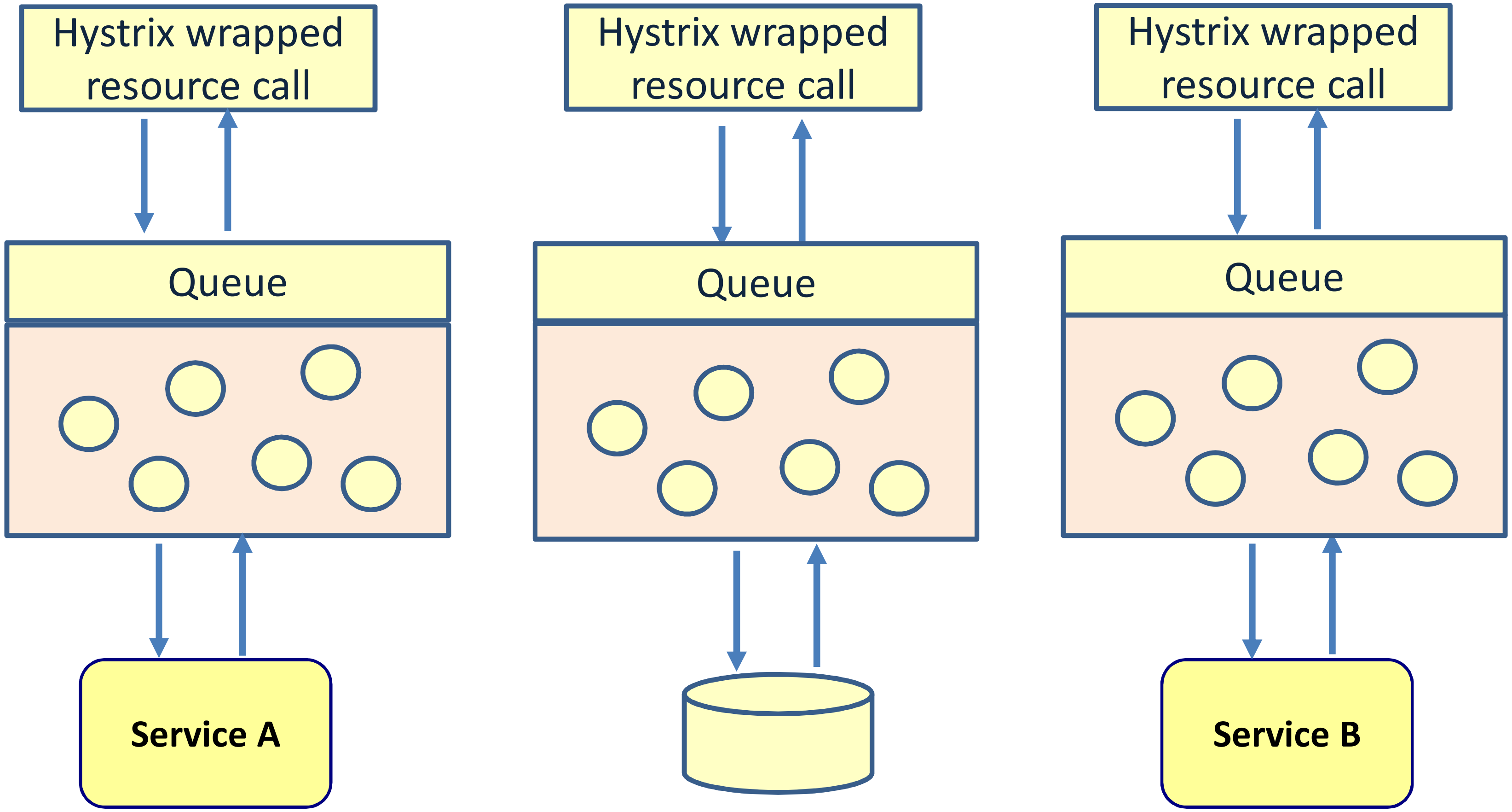
- Hystrix uses a common thread pool for all remote calls


Hystrix wrapped resource call
Hystrix wrapped resource call
Hystrix wrapped resource call
Default Hystrix thread pool
Hystrix worker threads
Service A
Service B

© 2018 ICT Intelligence

Hystrix bulkheads

- Hystrix uses a common thread pool for all remote calls


Hystrix wrapped resource call
Hystrix wrapped resource call
Hystrix wrapped resource call
Queue
Queue
Queue
Service A
Service B

Hystrix bulhead

```
@RequestMapping("/text")
@HystrixCommand(fallbackMethod = "getTextFallback",
  threadPoolKey = "Service2ThreadPool",
  threadPoolProperties = {
    @HystrixProperty(name = "coreSize", value = "30"),
    @HystrixProperty(name = "maxQueueSize", value = "10")
  })
public String getText() {
  String service2Text = restTemplate.getForObject("http://localhost:9091/text",
                                    String.class);
  return "Hello "+ service2Text;
}

public String getTextFallback() {
  return "Hello Histrix";
}
```

Name of the thread pool

Maximum number of threads

Maximum queue size

Main point

- To make a microservice architecture resilient, we need to think of fallback scenarios for distributed calls

- Daily contact with Pure Consciousness is the fallback scenario for many challenges in life. Bring light into the darkness.

Connecting the parts of knowledge with the wholeness of knowledge

1. The API gateway is “a layer of indirection” between clients and microservices.
2. In a distributed microservice architecture you need to program defensively, because things will go wrong.

---

3. **Transcendental consciousness** is the source of all activity.
4. **Wholeness moving within itself:** In Unity Consciousness, one experiences that one self (rishi), and all other objects (chhandas) and the operations between oneself and all other objects (devata) are expressions of one’s own Self.