

University of Stuttgart

Institute of Software Engineering

Software Quality and Architecture Group



Universität Hamburg

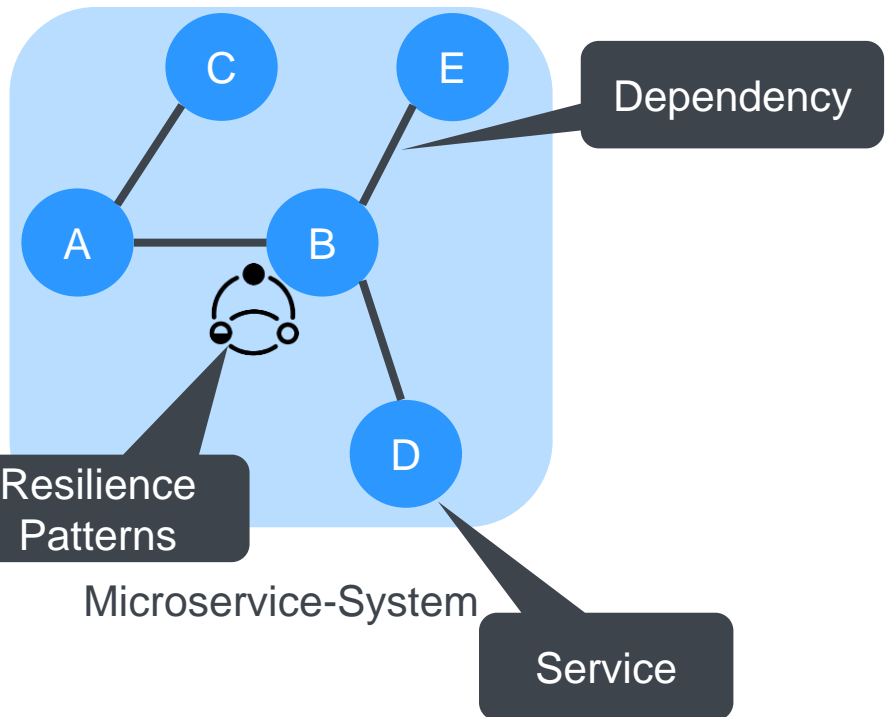
DER FORSCHUNG | DER LEHRE | DER BILDUNG

Extracting Software Architecture from Traces for the Simulation of Microservice Architectures

SSP 22 – Extended Abstract

Tim Thüring, Gabriel Glaser, Abel Gitzing, Marcel Hafner, Sebastian Frank, Alireza Hakamian and André van Hoorn

Extracting Software Architecture from Microservices for Simulation



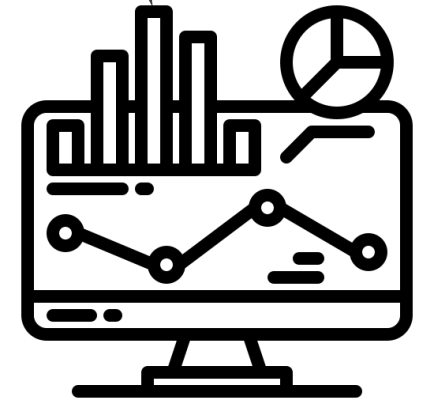
MiSim:
Simulates Microservice architectures with focus on resilience

[Sebastian Frank, Lion Wagner, Alireza Hakamian, Martin Straesser, André van Hoon: MiSim: A Simulator for Resilience Assessment of Microservice-based Architectures. QRS 2022. Accepted]

RESIRIO:
Supports engineers during the requirements specification

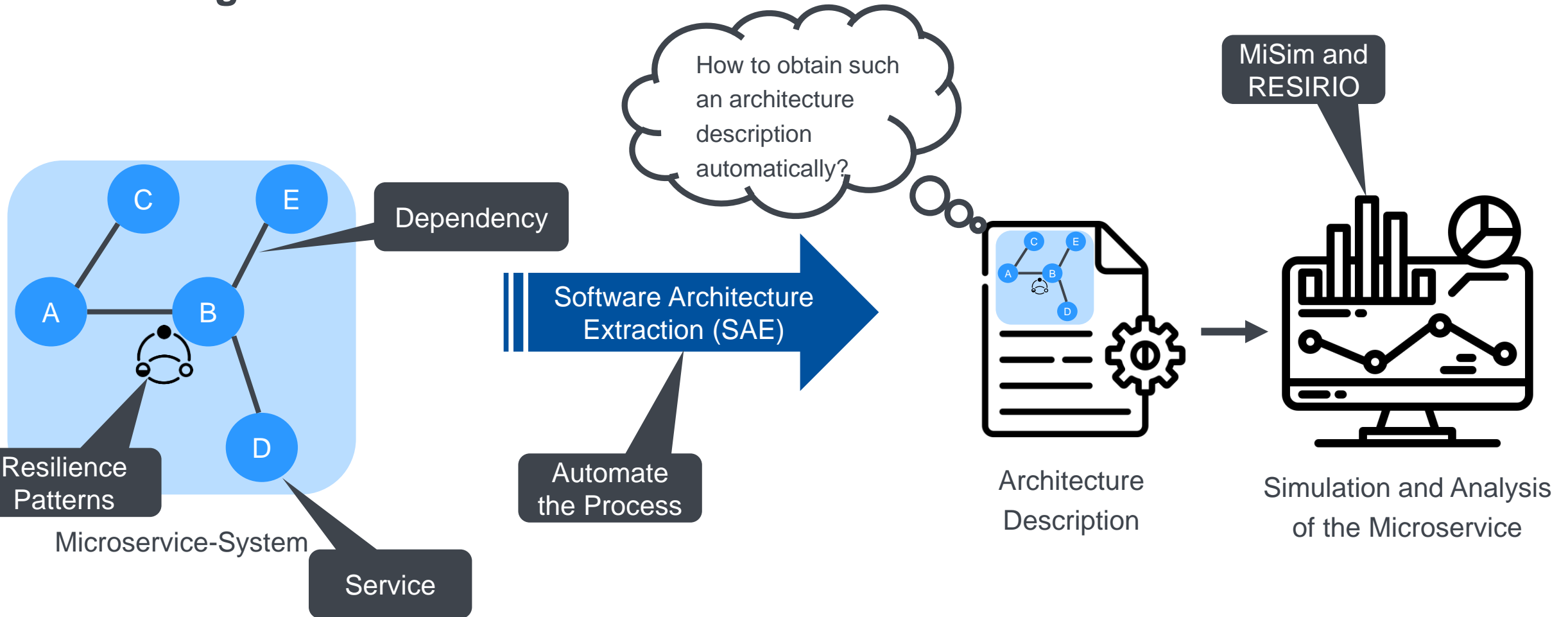
[Sebastian Frank, Alireza Hakamian, Lion Wagner, Dominik Kesim, Christoph Zorn, Jóakim von Kistowski, and André van Hoon. "Interactive Elicitation of Resilience Scenarios Based on Hazard Analysis Techniques." In European Conference on Software Architecture, pp. 229-253. Springer, Cham, 2022.]

MiSim and RESIRIO

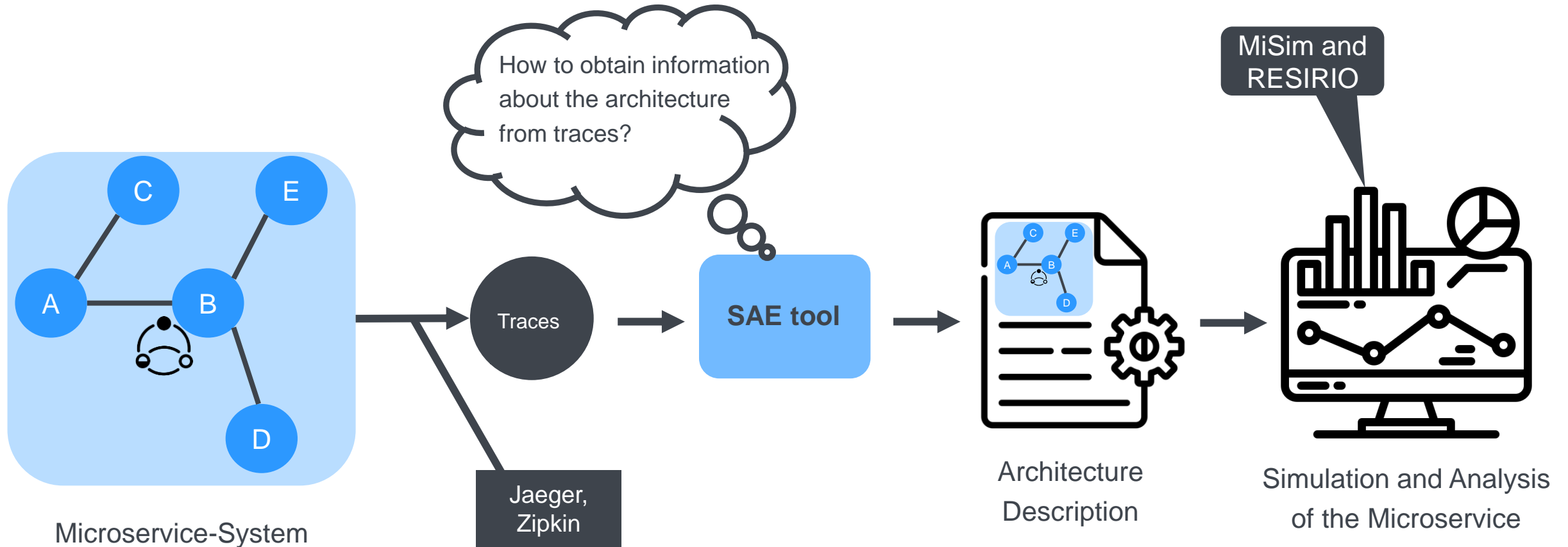


Simulation and Analysis of the Microservice

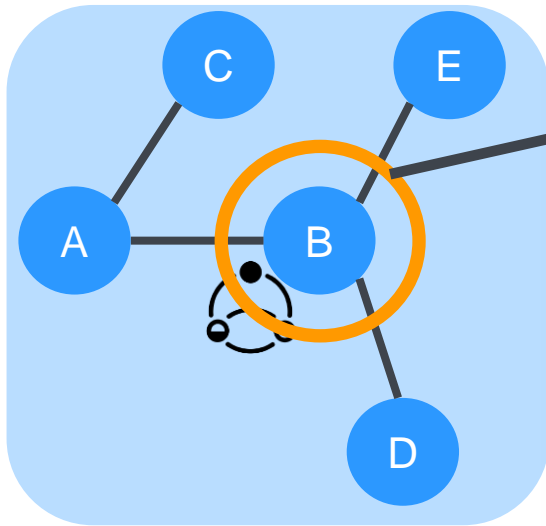
Extracting Software Architecture from Microservices for Simulation



Extracting Software Architecture from Microservices for Simulation



Extracting Software Architecture from Microservices for Simulation



Microservice-System

Zipkin trace

```
{
  "traceId": "6cb77352e359d33b",
  "parentId": "6cb77352e359d33b",
  "id": "71067bc1e862ddae",
  "name": "get /b1", [...]
  "localEndpoint": {
    "serviceName": "b",
    "ipv4": "172.20.0.5"
  },
  "remoteEndpoint": {"ipv4": "172.20.0.6"...}
},
{
  "traceId": "6cb77352e359d33b",
  "parentId": "71067bc1e862ddae",
  "id": "803b25848e301dee",
  "name": "get /d1", [...]
  "localEndpoint": {
    "serviceName": "d",
    "ipv4": "172.20.0.2"
  },
  "remoteEndpoint": {"ipv4": "172.20.0.5"...}
},
}
```

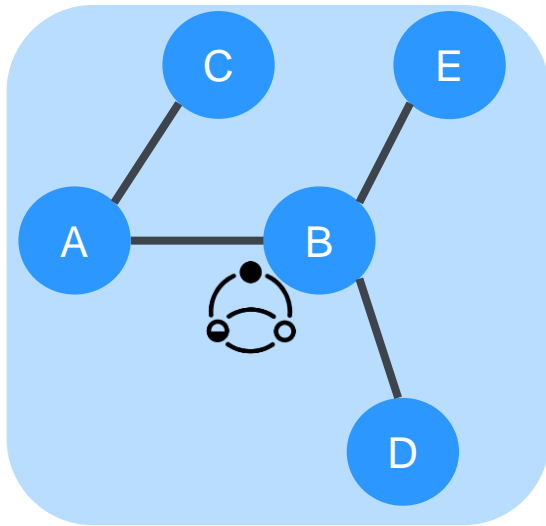
MiSim architecture description

```
{
  "microservices": [
    {
      "name": "b",
      "instances": 1, [...]
      "patterns": [
        {
          "type": "retry",
          "strategy": {
            "type": "exponential",
            "config": {
              "baseBackoff": 0.05051483089426919,
              "base": 2.4928600434324384}}
        }
      ],
      "operations": [
        {
          "name": "get /b1",
          "demand": 100,
          "dependencies": [
            {
              "service": "d",
              "operation": "get /d1" [...]
            }
          ]
        }
      ]
    }
  ]
}
```

Extracting Software Architecture from Microservices for Simulation



Extracting Software Architecture from Microservices for Simulation



Microservice-System

Zipkin trace

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},
{
  "traceId": "6cb77352e359d33b",
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  "id": "803b25848e301dee",
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  },
  "remoteEndpoint": {"ipv4": "172.20.0.5"}
},
}
```

Estimation and Heuristics

MiSim architecture description

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{
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              "operation": "get /d1" [...]
            }
          ]
        }
      ]
    }
  ],
}
```

Goal

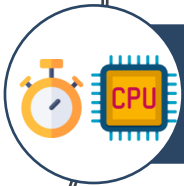
Development of an SAE tool that automates the SAE process and...



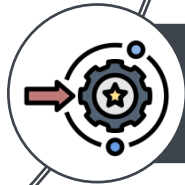
...is compatible with MiSim and RESIRIO



...offers additional features: round-robin load balancer detection, retry detection

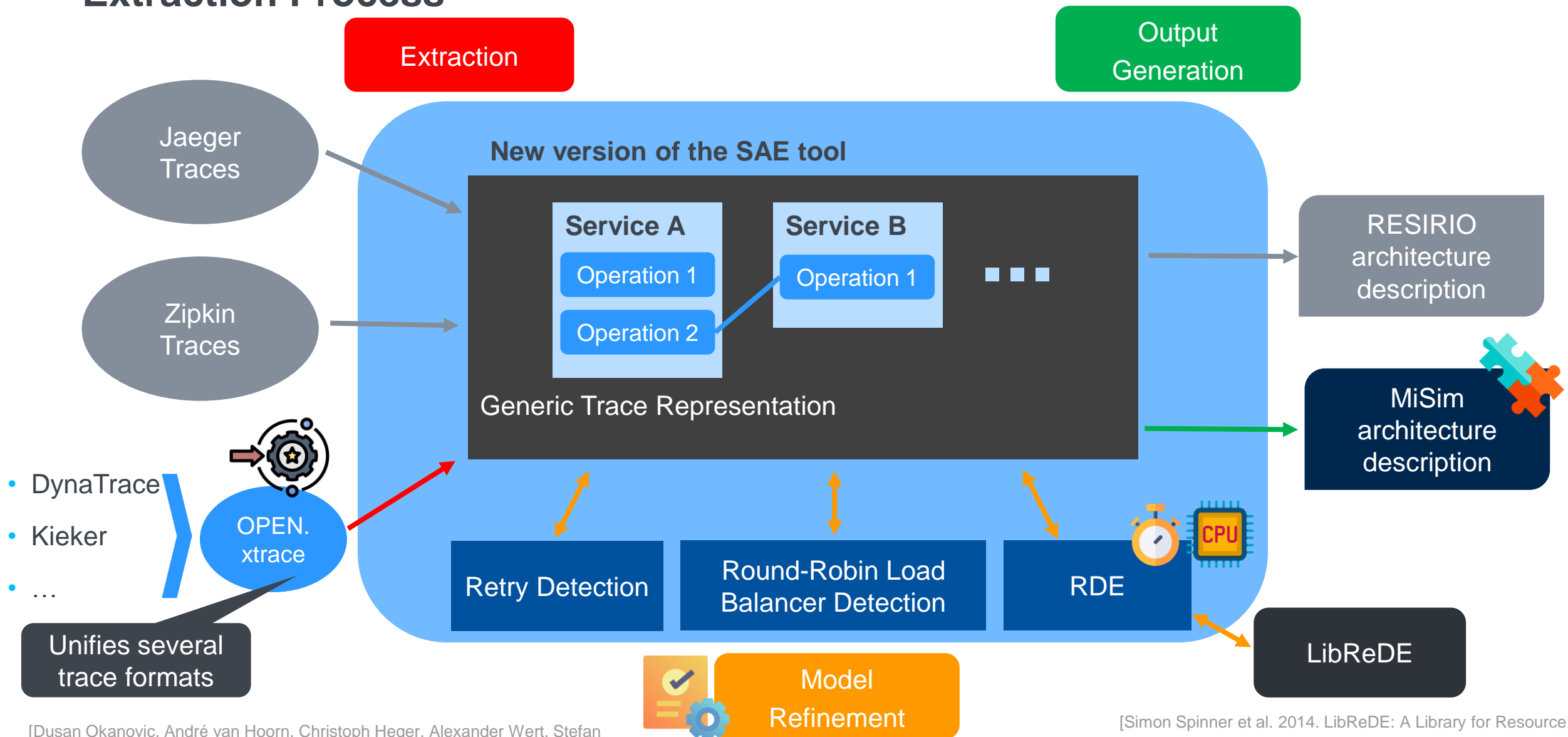


... provides Resource-Demand-Estimation (RDE)



...is compatible with more input formats like DynaTrace or Kieker

Extraction Process

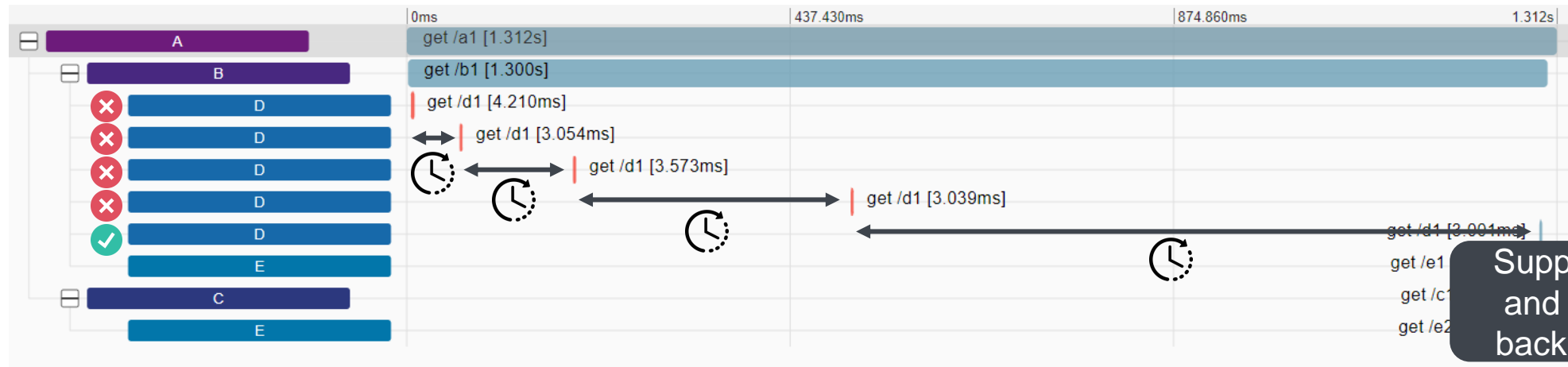


[Dusan Okanovic, André van Hoorn, Christoph Heger, Alexander Wert, Stefan Siegl: Towards Performance Tooling Interoperability: An Open Format for Representing Execution Traces. EPEW 2016: 94-108.]

[Simon Spinner et al. 2014. LibReDE: A Library for Resource Demand Estimation. In Proceedings of the 5th ACM/SPEC International Conference on Performance Engineering (ICPE 2014). ACM Press, New York, NY, USA, 227–228.]



Overview of the SAE Tool – Retry Detection



Detect a Retry – Situation in Trace data



Analyze wait-times

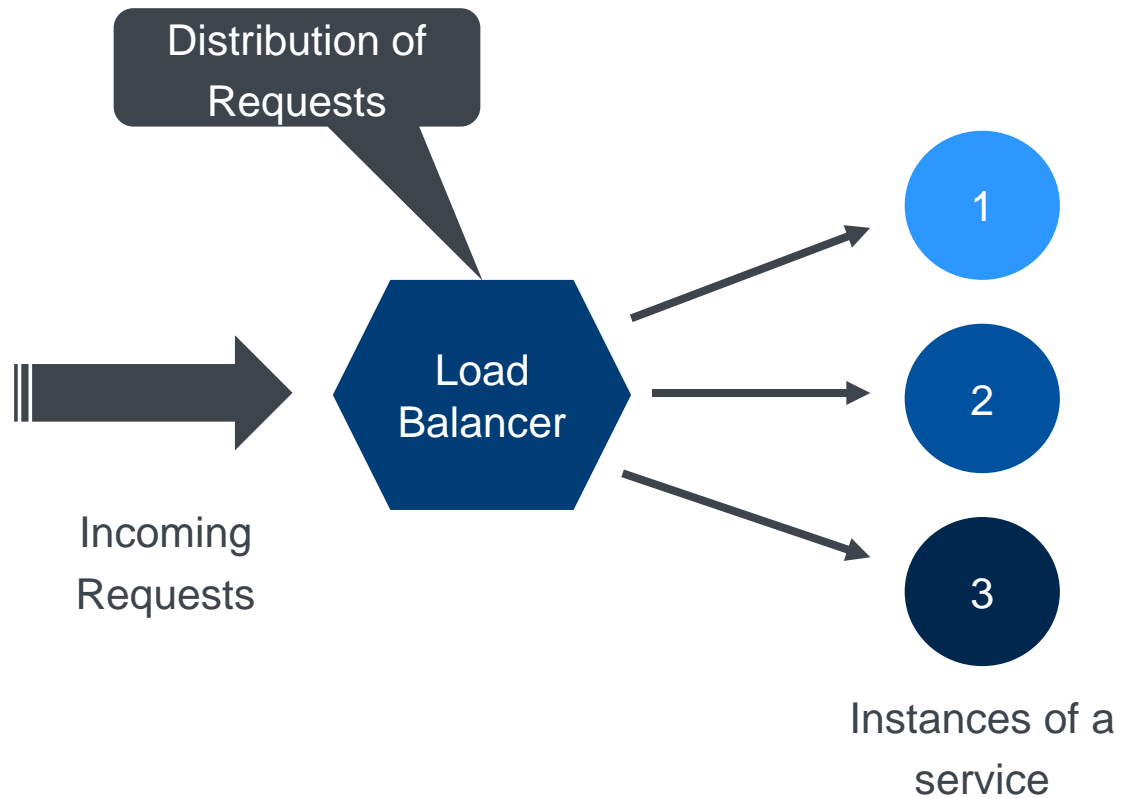


Estimate backoff-function parameters

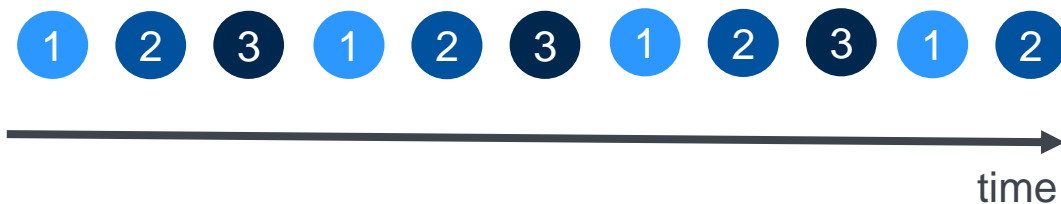
Estimated Retry Configuration



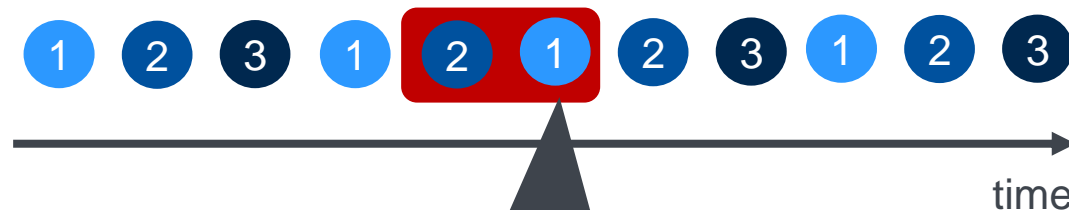
Overview of the SAE Tool – Round-Robin Load Balancer Strategy Detection



Round-Robin Load Balancer Strategy



Round-Robin Load Balancer Strategy Real World



Implementation of a Heuristic to Detect a Round-Robin Strategy



Count the number of errors in the pattern



Round-Robin Strategy if error-rate < 10%



Overview of Evaluation

Retry detection

- Can the SAE tool estimate configuration parameters?

Round-robin load balancer detection

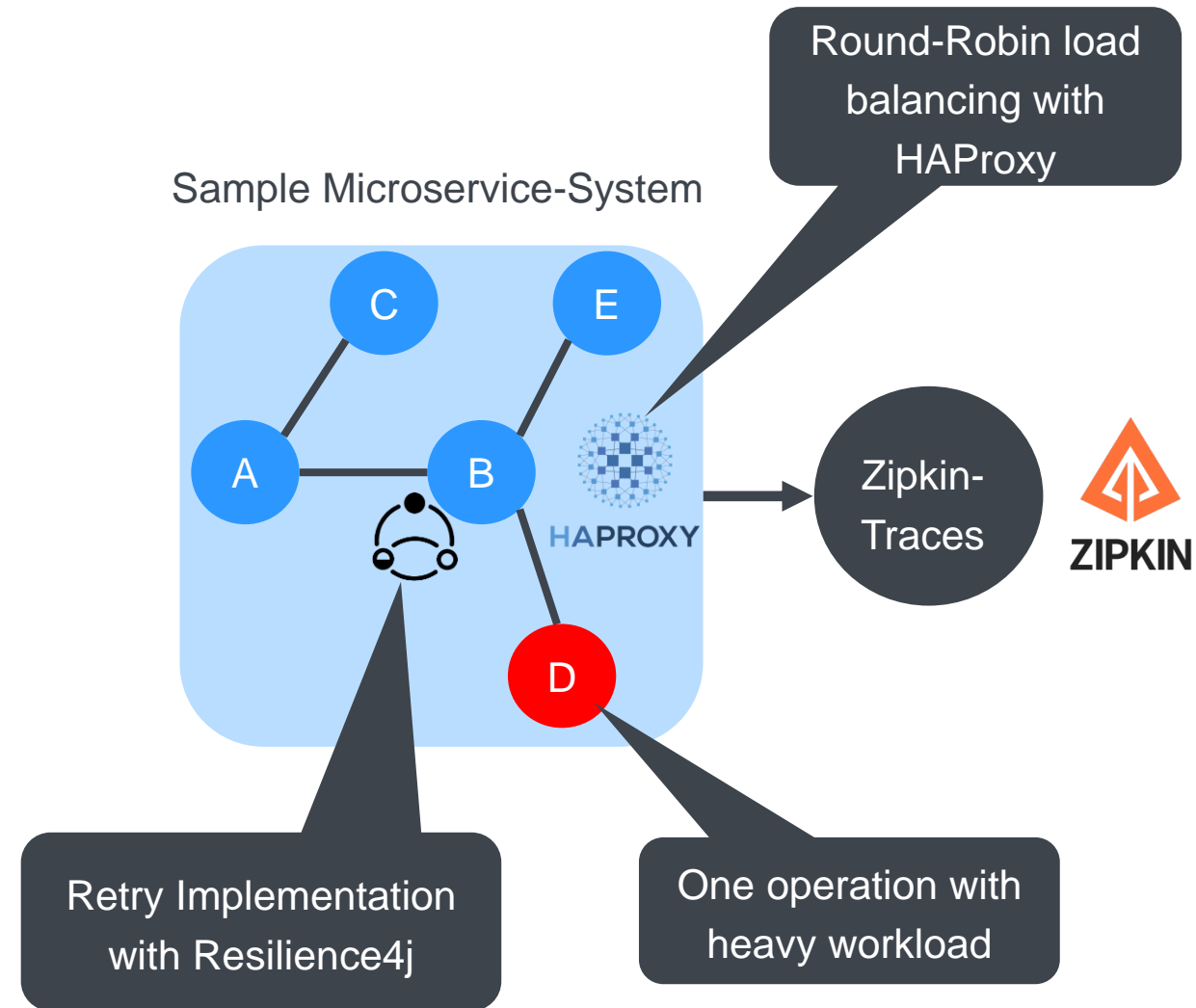
- Can the SAE tool detect a round-robin load balancing strategy?

Resource demand estimation

- Are the calculated resource demands representing the actual situation in a system correctly?

Real-World Traces

- Can the SAE tool handle traces from a real-world system?





Results – Retry Detection

Backoff function: Wait time for x-th retry

Resilience4j Configuration

$$t(x) = 0.05 \cdot 2.5^x$$

Estimation of
configuration parameters



Extracted Configuration

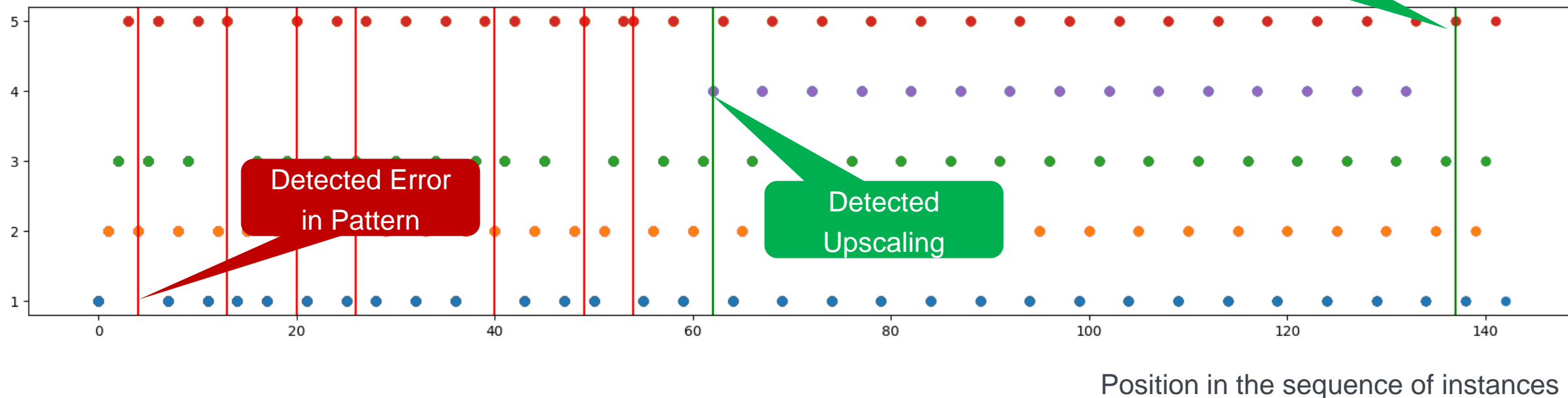
$$t(x) \approx 0.05 \cdot 2.49^x$$



Results – Round-Robin Load Balancer Strategy Detection

5 Instances of one Service:

Instances 1 to 5 of the service



7 Errors, 143 Entries



$$\frac{7}{143} \approx 0.05 < 0.1$$

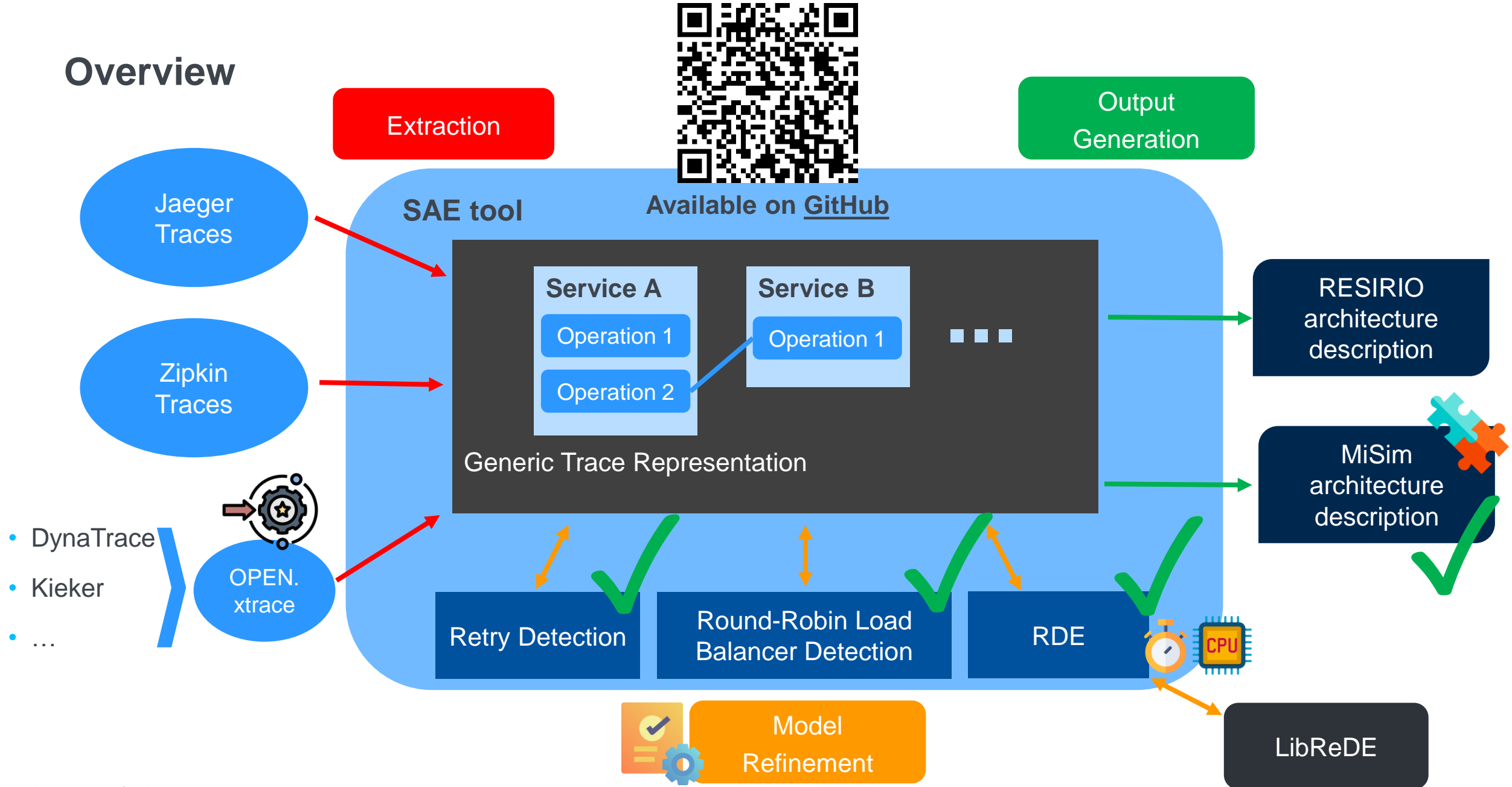
Threshold



Round-Robin Strategy



Overview



All Icons by [flaticon.com](https://www.flaticon.com/)

Sources of Pictures and Icons

- Resilience4j Logo (Slides 2,7): <https://github.com/resilience4j>
- HAproxy Logo (Slide 7): <https://en.wikipedia.org/wiki/HAProxy#/media/File:Haproxy-logo.png>
- Zipkin Logo (Slide 7): <https://github.com/openzipkin>

- All Icons by **Flaticon.com**. Individual authors:
 - Simulation (Slide 2): **xnimrodx**
 - Architecture File (Slide 2, modified): **Freepik**
 - Goal 1 (Slides 3,4,10): **Freepik**
 - Goal 2 (Slides 3,4,5,6,8,9,10): **fjstudio**
 - Goal 3 (Slides 3,4,10): **Freepik** (Stopwatch) and **Flat Icons** (CPU)
 - Goal 4 (Slides 3,4,10): **noomtah**
 - Checkmark (Slides 5,6,9,10): **Alfredo Hernandez**
 - Cross (Slide 5): **Alfredo Hernandez**
 - Wait Symbol (Slide 5): **Freepik**