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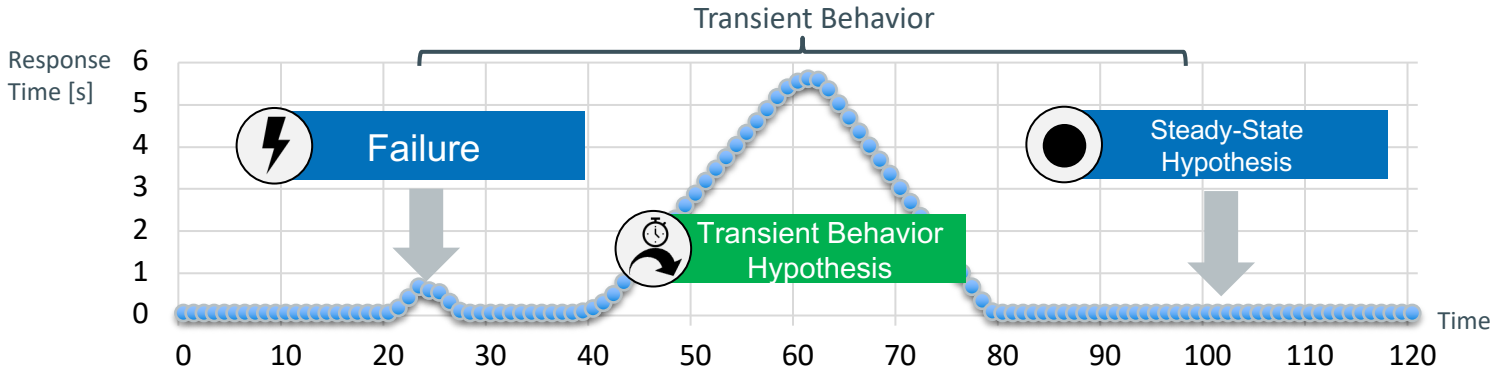
software campus
Bundesministerium für Bildung und Forschung



D. Zahariev, S. Frank, A. Hakamian, A. van Hoorn

Supporting and Verifying Transient Behavior Specifications in Chaos Engineering

[1] Frank, S., Hakamian, A., Wagner, L., Kesim, D., Zorn, C., von Kistowski, J., & van Hoorn, A. (2022). Interactive Elicitation of Resilience Scenarios Based on Hazard Analysis Techniques. In *European Conference on Software Architecture* (pp. 229-253). Springer, Cham.

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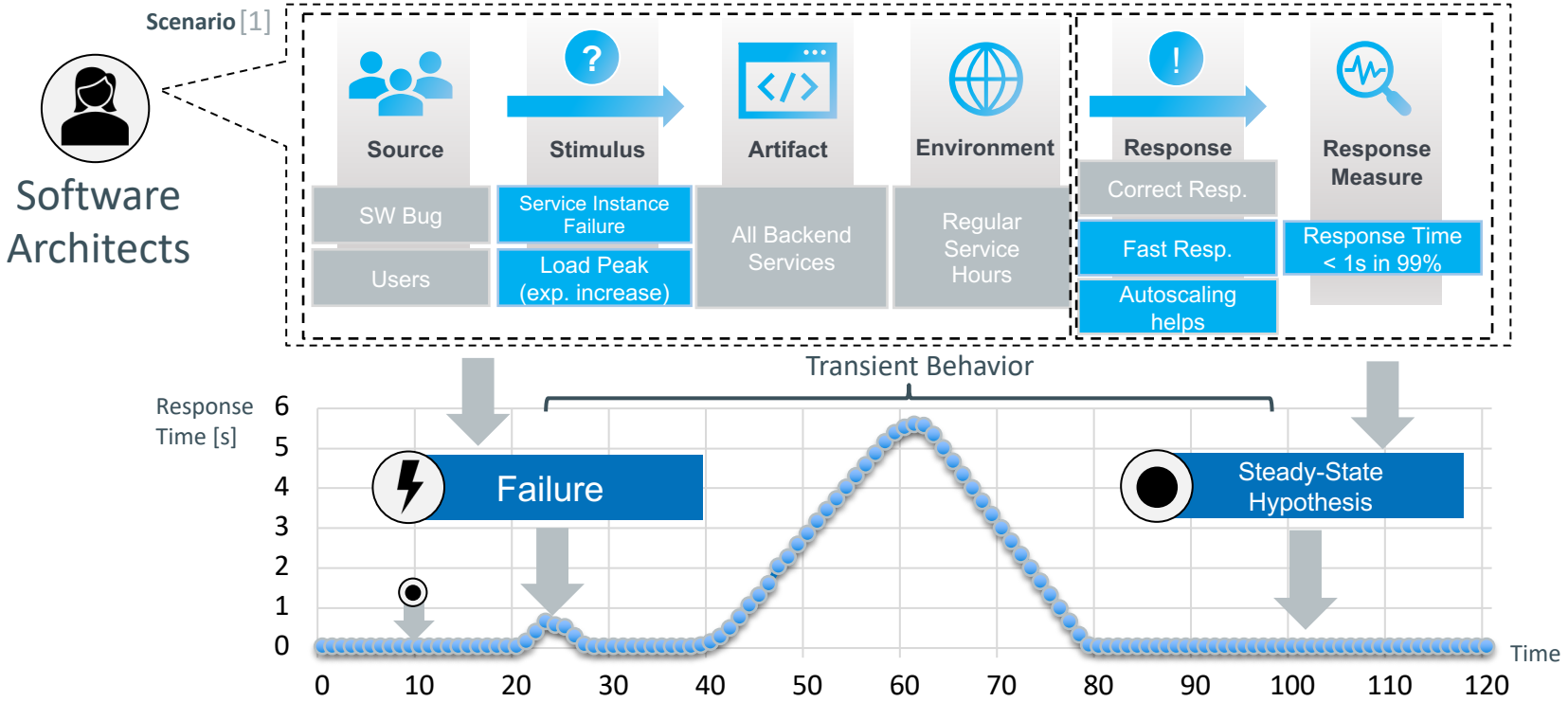
Transient Behavior in Chaos Engineering?



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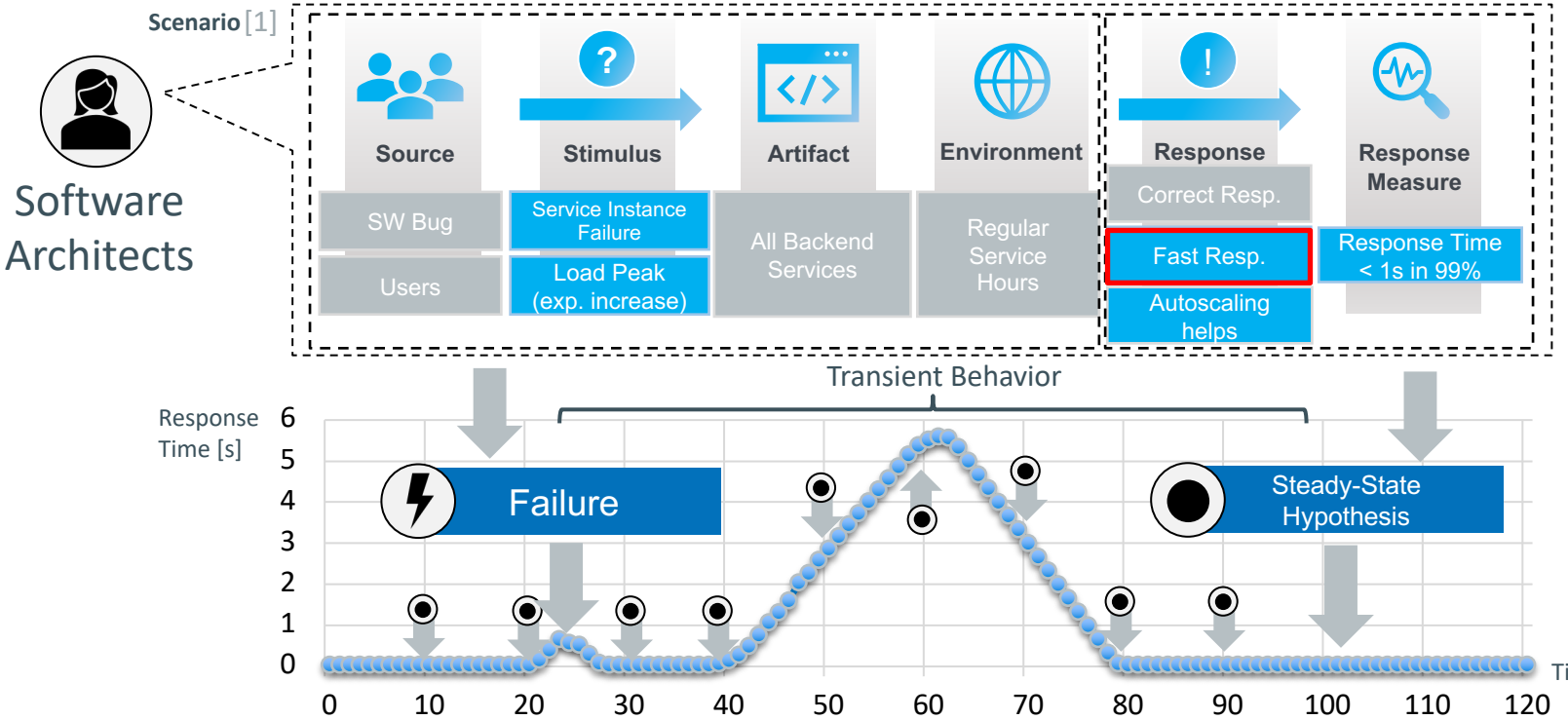

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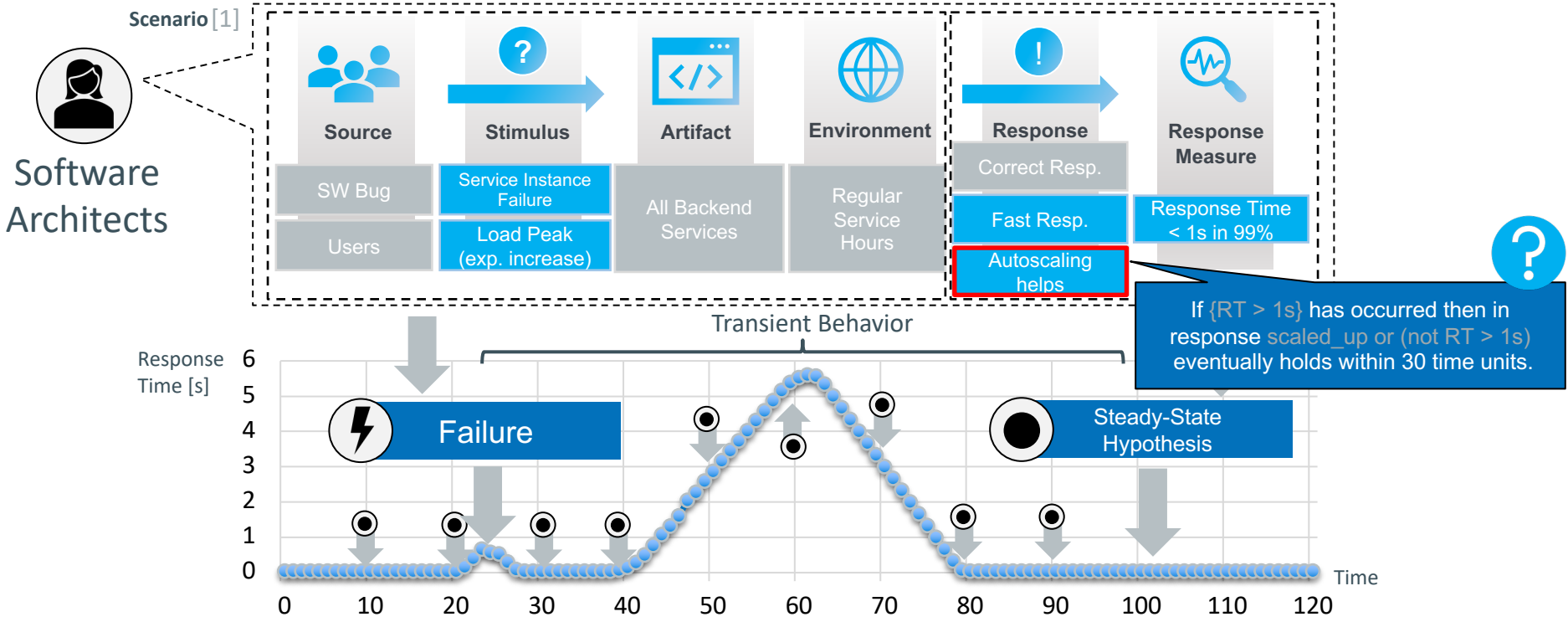
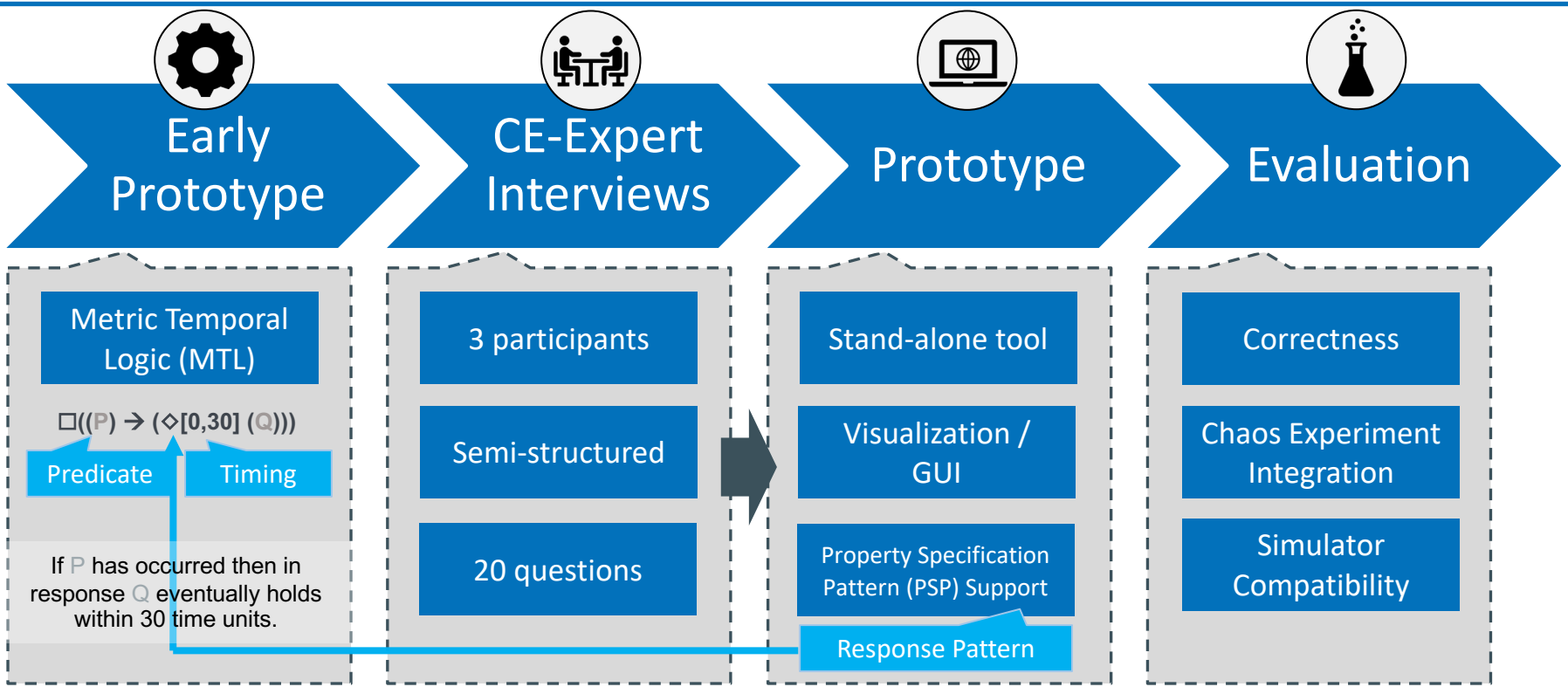
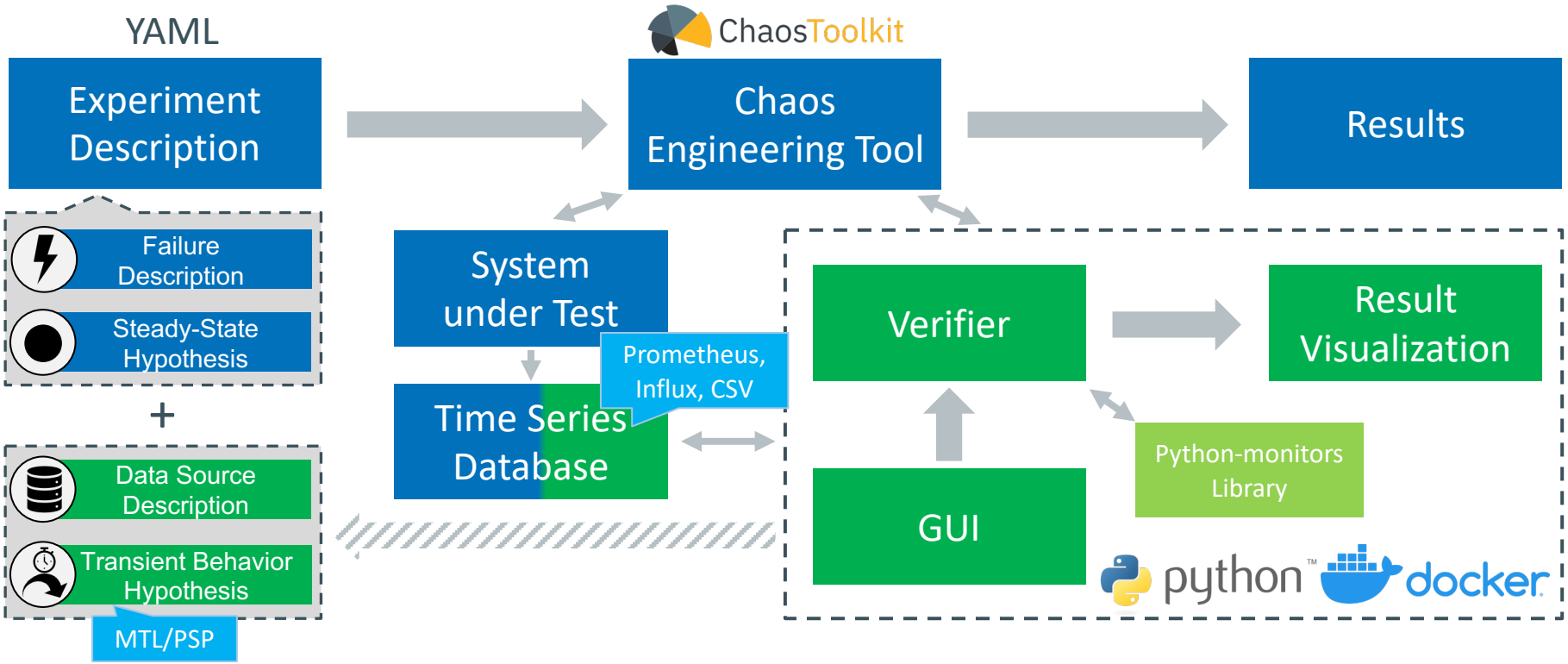
Transient Behavior in Chaos Engineering?



Method


Early Prototype
CE-Expert Interviews
Prototype
Evaluation
Metric Temporal Logic (MTL)
□((P) → (◇[0,30] (Q)))
Predicate
Timing
If P has occurred then in response Q eventually holds within 30 time units.
3 participants
Semi-structured
20 questions
Stand-alone tool
Visualization / GUI
Property Specification Pattern (PSP) Support
Response Pattern
Correctness
Chaos Experiment Integration
Simulator Compatibility

Transient Behavior Verifier (Tool)



Using the Transient Behavior Verifier

```
"specification": "always((response_time_medium(rt))
 -> (once[0,30] (scaled_up(scaling1) or scaled_up(scaling2)
  or (not response_time_medium(rt))))",
"specification_type": "mtl",
"future-mtl": "true",
```

If {RT > 1s} has occurred then in response scaled_up or (not RT > 1s) eventually holds within 30 time units.

Transient Behavior Hypothesis

Metrics

Verifier

Result Visualization

Using the Transient Behavior Verifier

```
"specification": "always((response_time_medium(rt))
 -> (once[0,30] (scaled_up(scaling1) or scaled_up(scaling2)
  or (not response_time_medium(rt))))",
"specification_type": "mtl",
"future-mtl": "true",
"predicates_info": [
    {
      "predicate_name": "scaled_up",
      "predicate_logic": "equal",
      "predicate_comparison_value": "1"
    }    {
      "predicate_name": "response_time_medium",
      "predicate_logic": "bigger",
      "predicate_comparison_value": "1.0"
    }
 ],
```

If {RT > 1s} has occurred then in response scaled_up or (not RT > 1s) eventually holds within 30 time units.

Transient Behavior Hypothesis

Metrics

Verifier

Result Visualization

Using the Transient Behavior Verifier

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"predicates_info": [
    {
      "predicate_name": "scaled_up",
      "predicate_logic": "equal",
      "predicate_comparison_value": "1"
    }    {
      "predicate_name": "response_time_medium",
      "predicate_logic": "bigger"
      "predicate_comparison_value": "1.0"
    }
  ],
"measurement_source": "influx"
  "measurement_points": [
    {
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      "measurement_column": "SELECT \"AvgResponseTime\"
FROM \"TimeBatchRuns\".\"autogen\".\"Batch_Time\""
    },
    [same for 'scaling_ex1' and 'scaling_ex2']
```

If {RT > 1s} has occurred then in response scaled_up or (not RT > 1s) eventually holds within 30 time units.

Transient Behavior Hypothesis

Data Source Description

Metrics

Verifier

Result Visualization

Using the Transient Behavior Verifier

```
"specification": "always((response_time_medium(rt))
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    {
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      "predicate_comparison_value": "1"
    }    {
      "predicate_name": "response_time_medium",
      "predicate_logic": "bigger",
      "predicate_comparison_value": "1.0"
    }
  ],
"measurement_source": "csv",
  "measurement_points": [
    {
      "measurement_name": "rt",
      "measurement_column": "response_time"
    },
    [same for 'scaling_ex1' and 'scaling_ex2']
  ]
```

If {RT > 1s} has occurred then in response scaled_up or (not RT > 1s) eventually holds within 30 time units.

time	scaling_ex1	scaling_ex2	response_time
1	0	0	0.04
…	…	…	…

Transient Behavior Hypothesis

Data Source Description

Verifier

Result Visualization

Using the Transient Behavior Verifier


```
"specification": "always((response_time_medium(rt))
 -> (once[0,30] (scaled_up(scaling1) or scaled_up(scaling2)
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      "predicate_comparison_value": "1"
    }    {
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"measurement_source": "csv",
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    },
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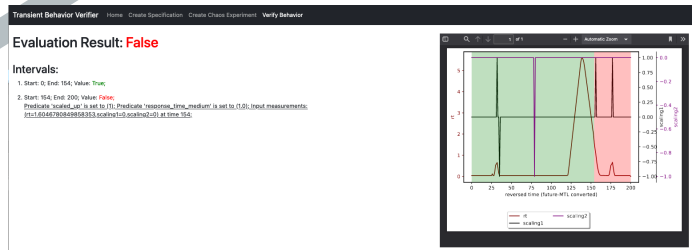
time	scaling_ex1	scaling_ex2	response_time
1	0	0	0.04
...	...	...	...

Transient Behavior Hypothesis

Data Source Description

Verifier

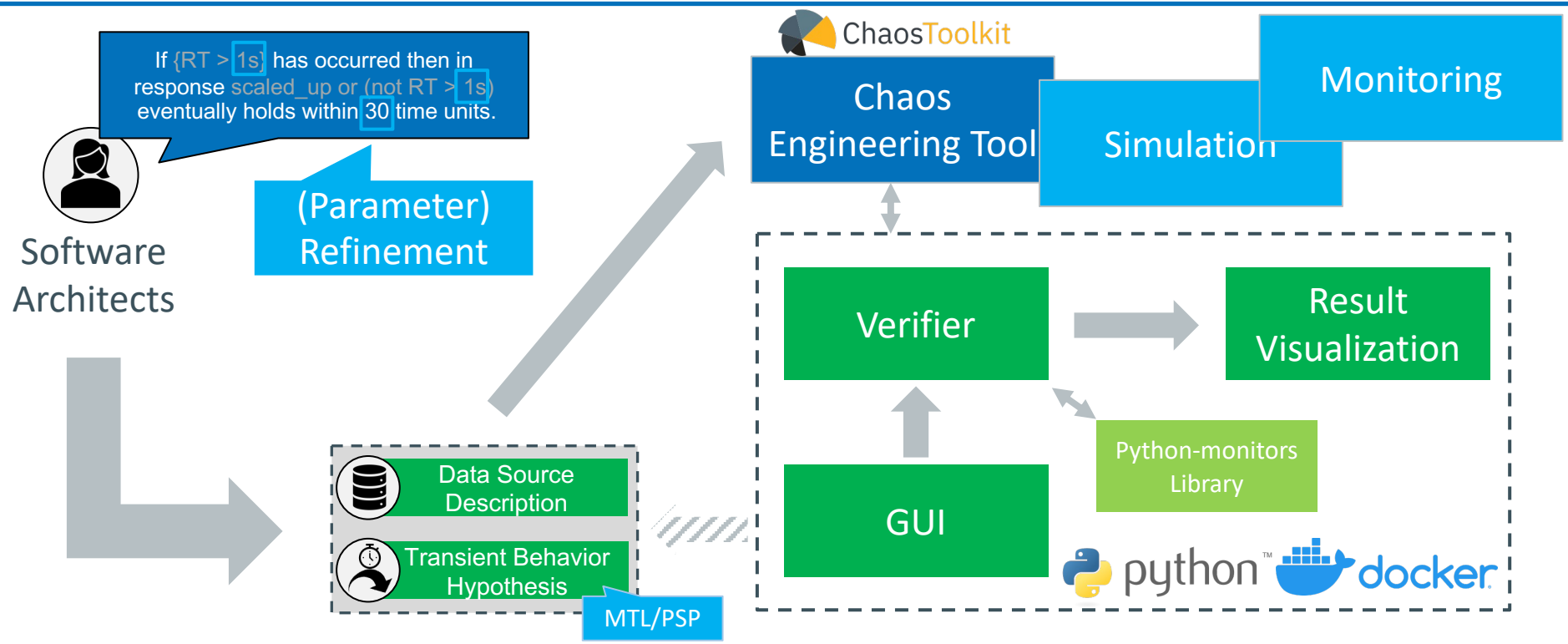


Evaluation

[1] Ulus, D. (2019, October). Timescales: A benchmark generator for MTL monitoring tools. In *International Conference on Runtime Verification* (pp. 402-412). Springer, Cham.

[2] Frank, S., Hakamian, A., Wagner, L., Kesim, D., Zorn, C., von Kistowski, J., & van Hoorn, A. (2022). Interactive Elicitation of Resilience Scenarios Based on Hazard Analysis Techniques. In *European Conference on Software Architecture* (pp. 229-253). Springer, Cham.

[3] Frank, S., Wagner L., Hakamian, A., Straesser, M., van Hoorn, A.: MiSim: A Simulator for Resilience Assessment of Microservice-based Architectures. QRS 2022. Accepted.

Correctness	Timescales Benchmark [1]	10x MTL Specifications (Only 4 PSP types)	160 Tests: Size x Satisfaction x past/future-MTL	✓
CE Integration	Industry System Mock [2] (3 Services, Microk8s)	3 Experiments (2x MTL, 1x PSP)	2x InfluxDB, 1x Prometheus	✓
Simulator [3] Compatibility	Industry System Mock [2] (3 Services)	1x MTL, 1x PSP Specifications		✓

Summary & Future Work