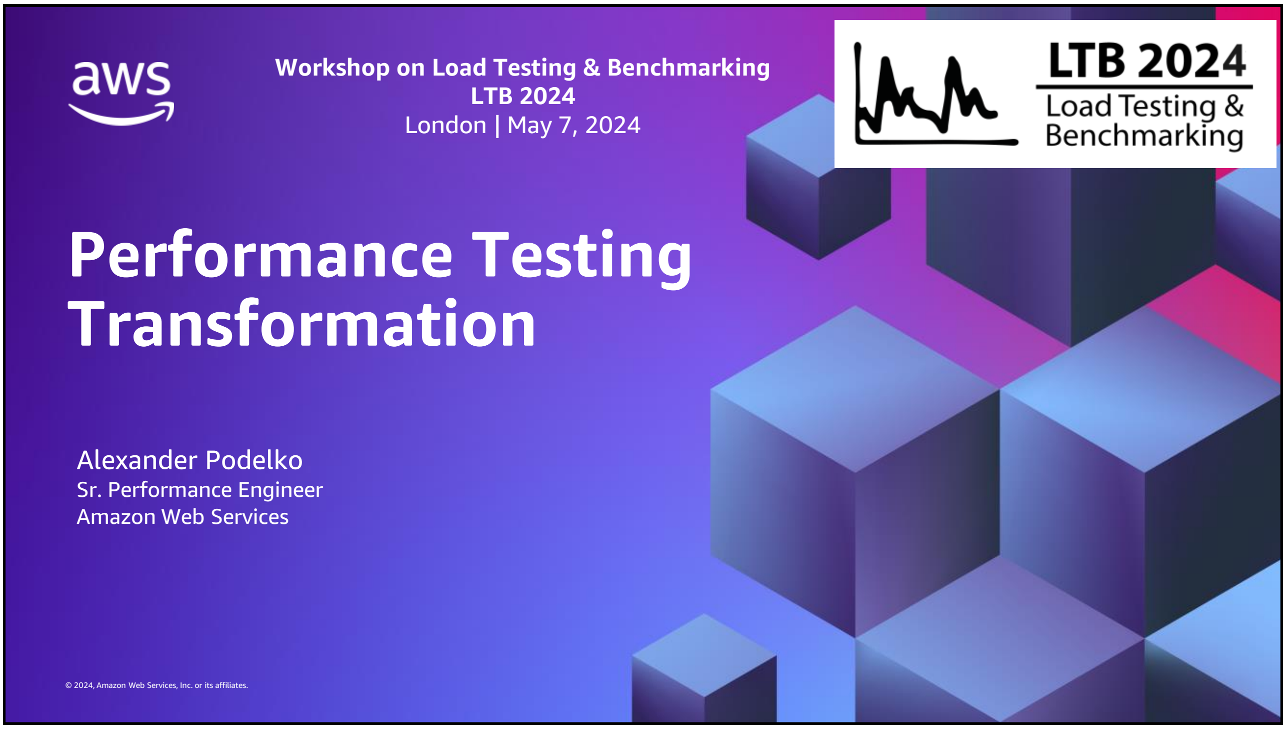

Workshop on Load Testing & Benchmarking
LTB 2024
London | May 7, 2024

LTB 2024
Load Testing & Benchmarking

Performance Testing Transformation

Alexander Podelko
Sr. Performance Engineer
Amazon Web Services

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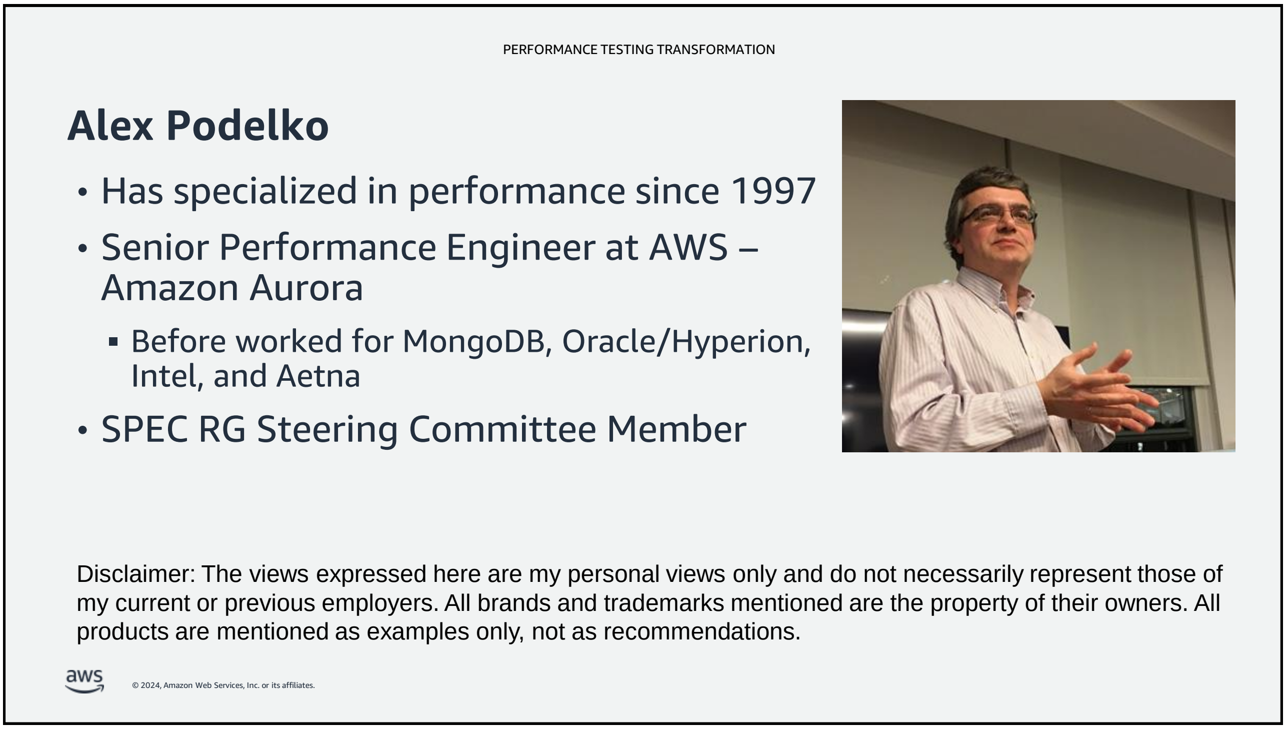

PERFORMANCE TESTING TRANSFORMATION

Alex Podelko

- Has specialized in performance since 1997
- Senior Performance Engineer at AWS – Amazon Aurora
  - Before worked for MongoDB, Oracle/Hyperion, Intel, and Aetna
- SPEC RG Steering Committee Member

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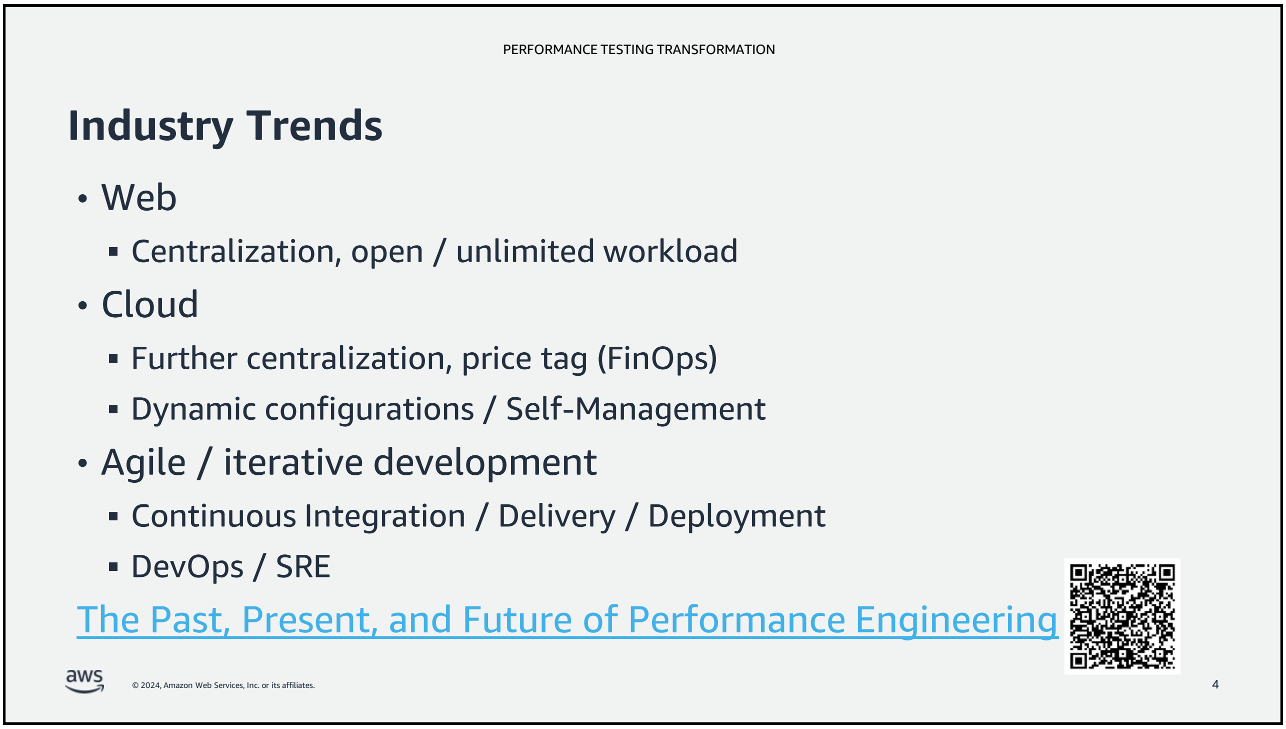
Adjusting Performance Testing to Industry Trends:

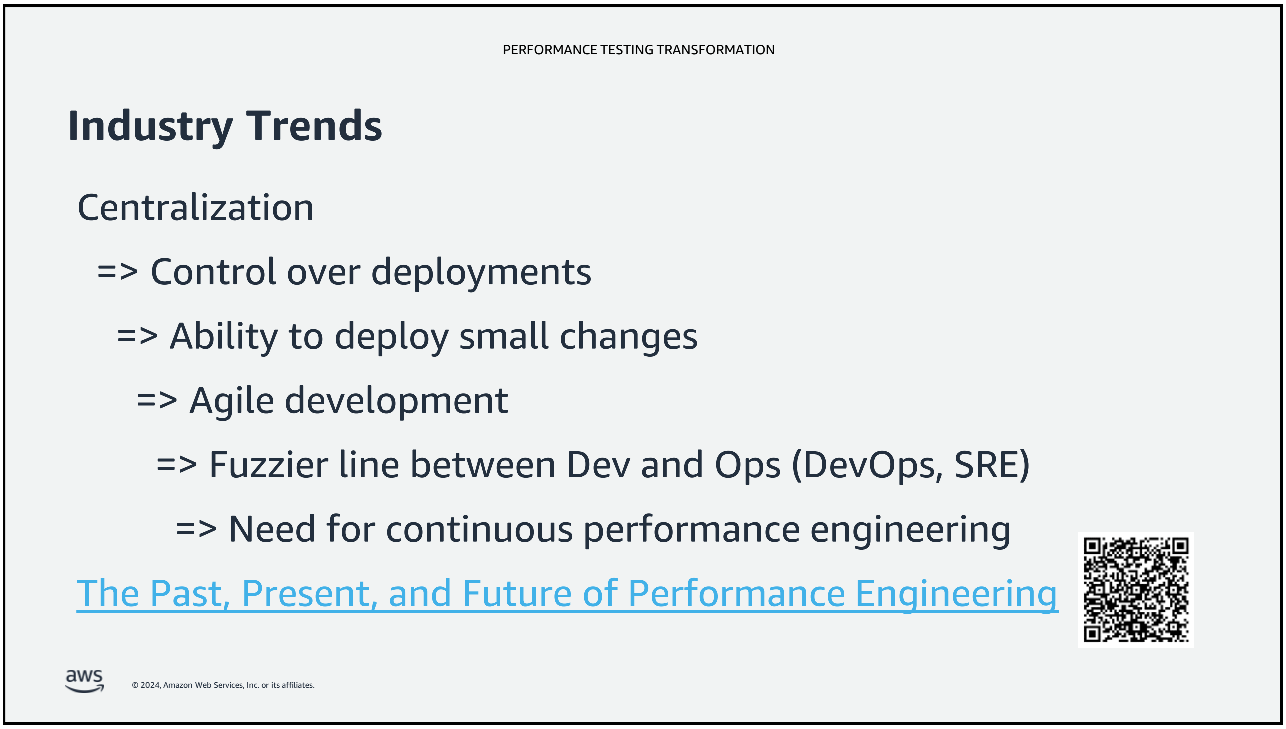
<u>Adding</u> early and continuous performance testing



Industry Trends

- Web
  - Centralization, open / unlimited workload
- Cloud
  - Further centralization, price tag (FinOps)
  - Dynamic configurations / Self-Management
- Agile / iterative development
  - Continuous Integration / Delivery / Deployment
  - DevOps / SRE

[The Past, Present, and Future of Performance Engineering]



Industry Trends

Centralization

=> Control over deployments

=> Ability to deploy small changes

=> Agile development

=> Fuzzier line between Dev and Ops (DevOps, SRE)

=> Need for continuous performance engineering

The Past, Present, and Future of Performance Engineering

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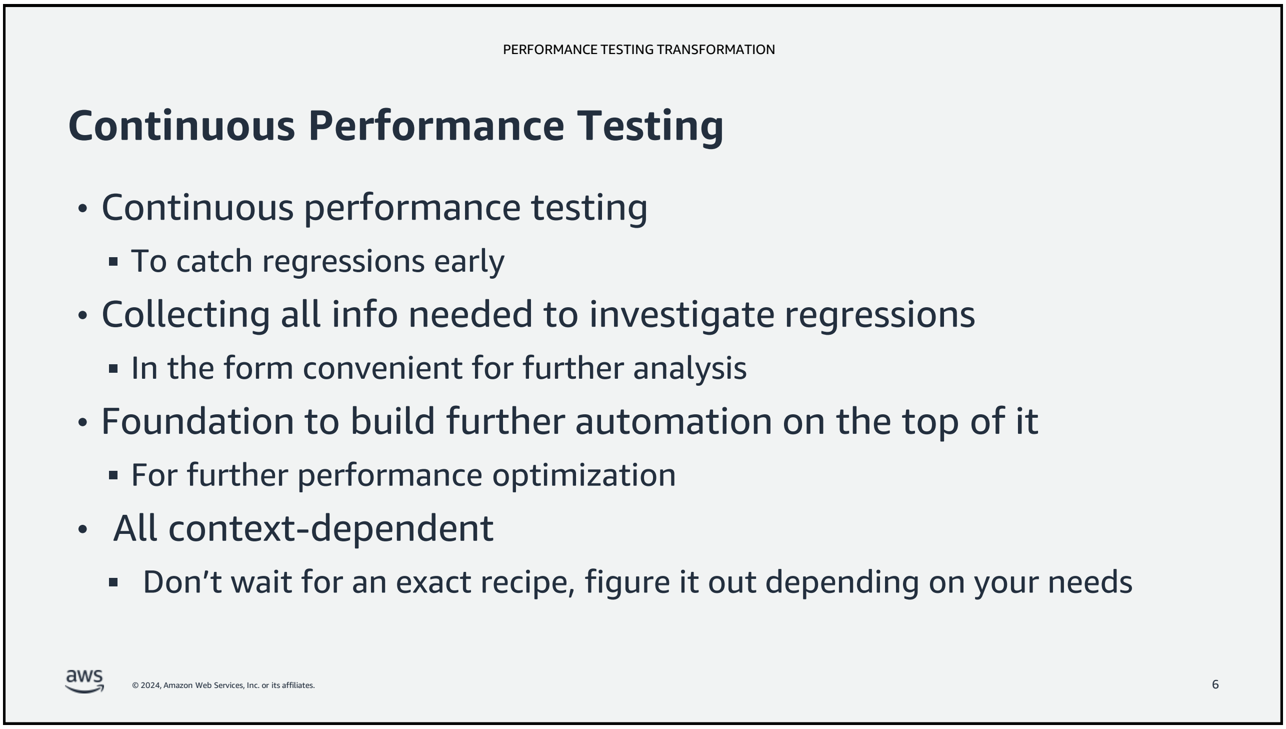

Continuous Performance Testing

- Continuous performance testing
  - To catch regressions early
- Collecting all info needed to investigate regressions
  - In the form convenient for further analysis
- Foundation to build further automation on the top of it
  - For further performance optimization
- All context-dependent
  - Don’t wait for an exact recipe, figure it out depending on your needs

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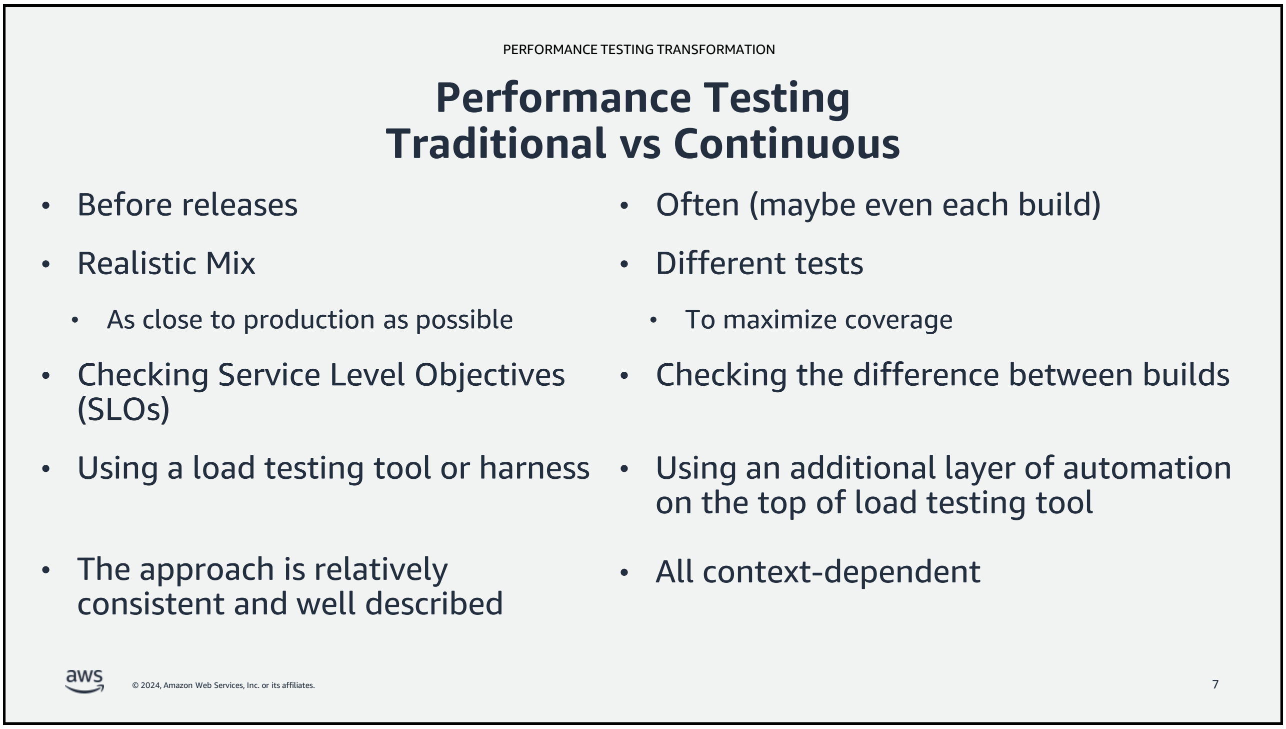

PERFORMANCE TESTING TRANSFORMATION

Performance Testing Traditional vs Continuous

- Before releases
- Realistic Mix
  - As close to production as possible
- Checking Service Level Objectives (SLOs)
- Using a load testing tool or harness
- The approach is relatively consistent and well described

- Often (maybe even each build)
- Different tests
  - To maximize coverage
- Checking the difference between builds
- Using an additional layer of automation on the top of load testing tool
- All context-dependent

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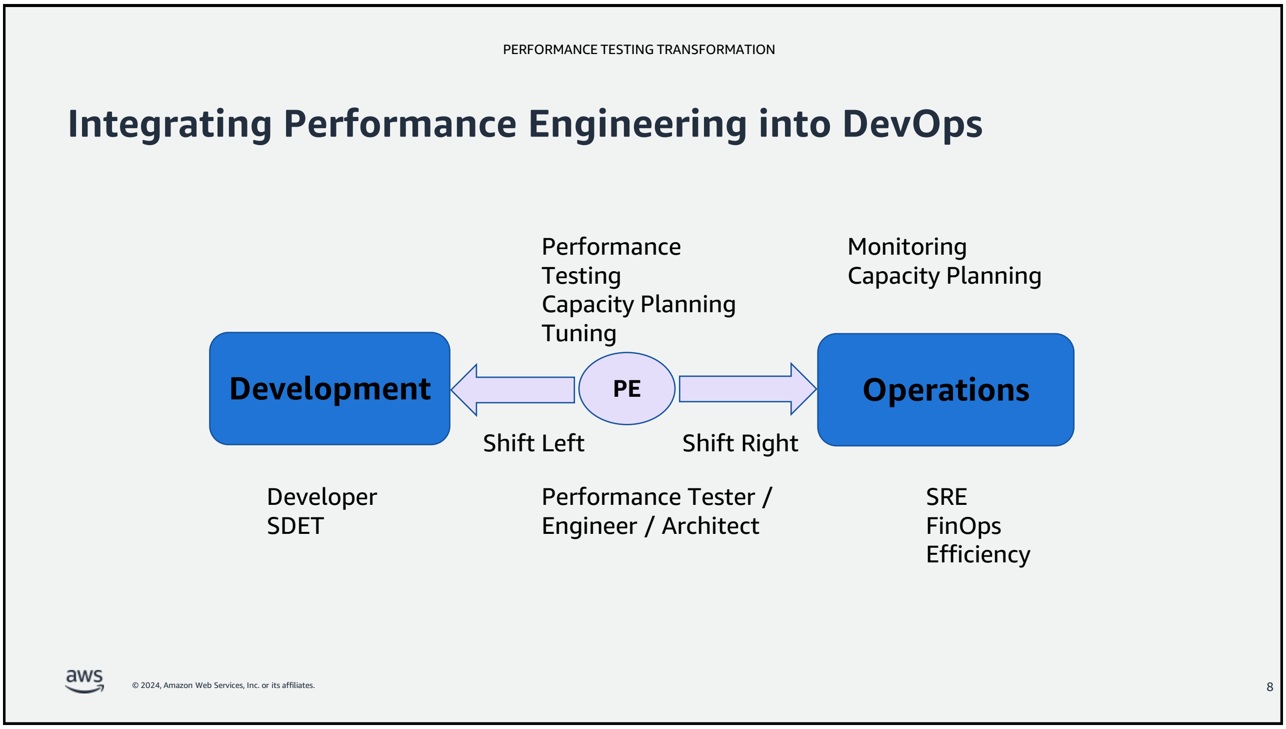

PERFORMANCE TESTING TRANSFORMATION

Integrating Performance Engineering into DevOps

Performance Testing
Capacity Planning
Tuning

Monitoring
Capacity Planning

Development

PE

Operations

Shift Left

Shift Right

Developer
SDET

Performance Tester / Engineer / Architect

SRE
FinOps
Efficiency

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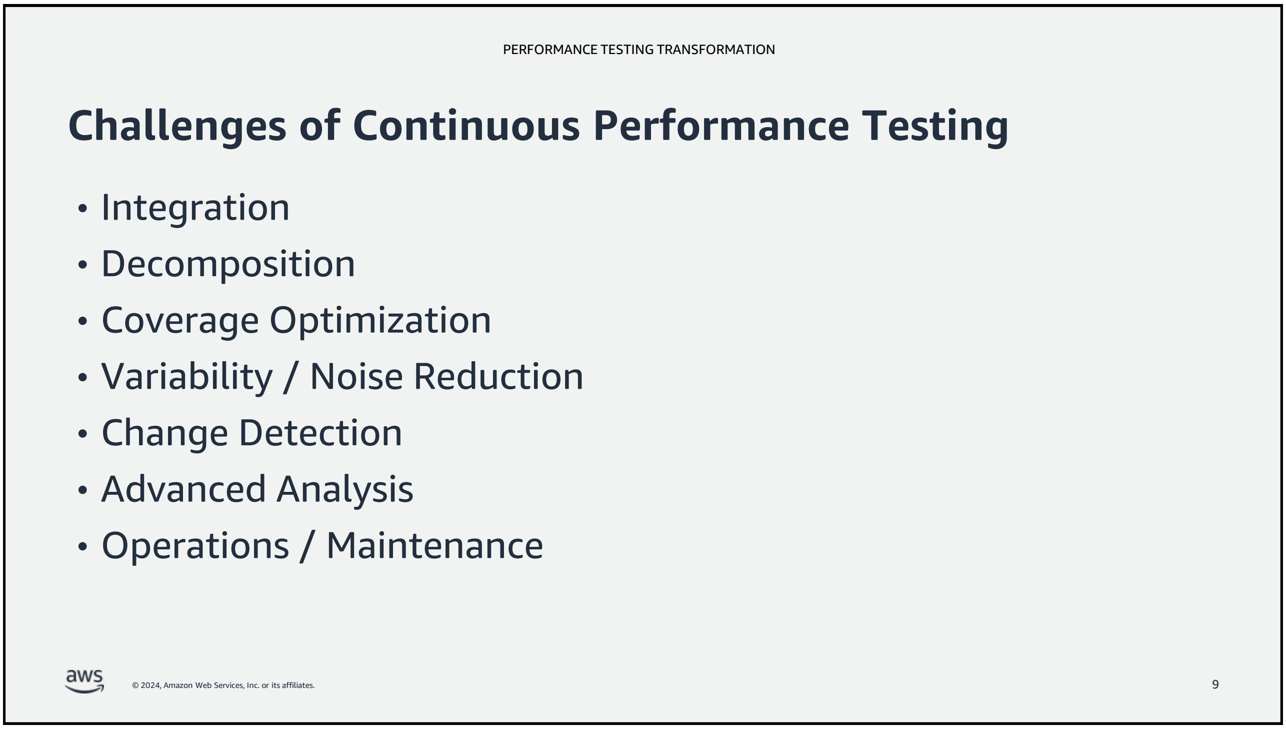

PERFORMANCE TESTING TRANSFORMATION

Challenges of Continuous Performance Testing

- Integration
- Decomposition
- Coverage Optimization
- Variability / Noise Reduction
- Change Detection
- Advanced Analysis
- Operations / Maintenance

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The Challenge of Integration

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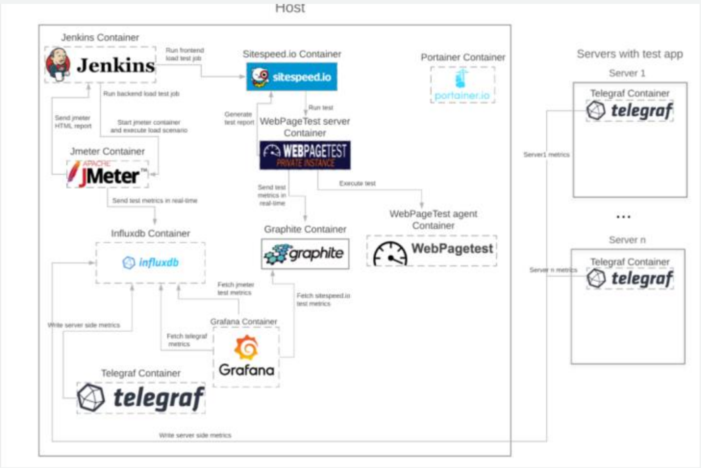
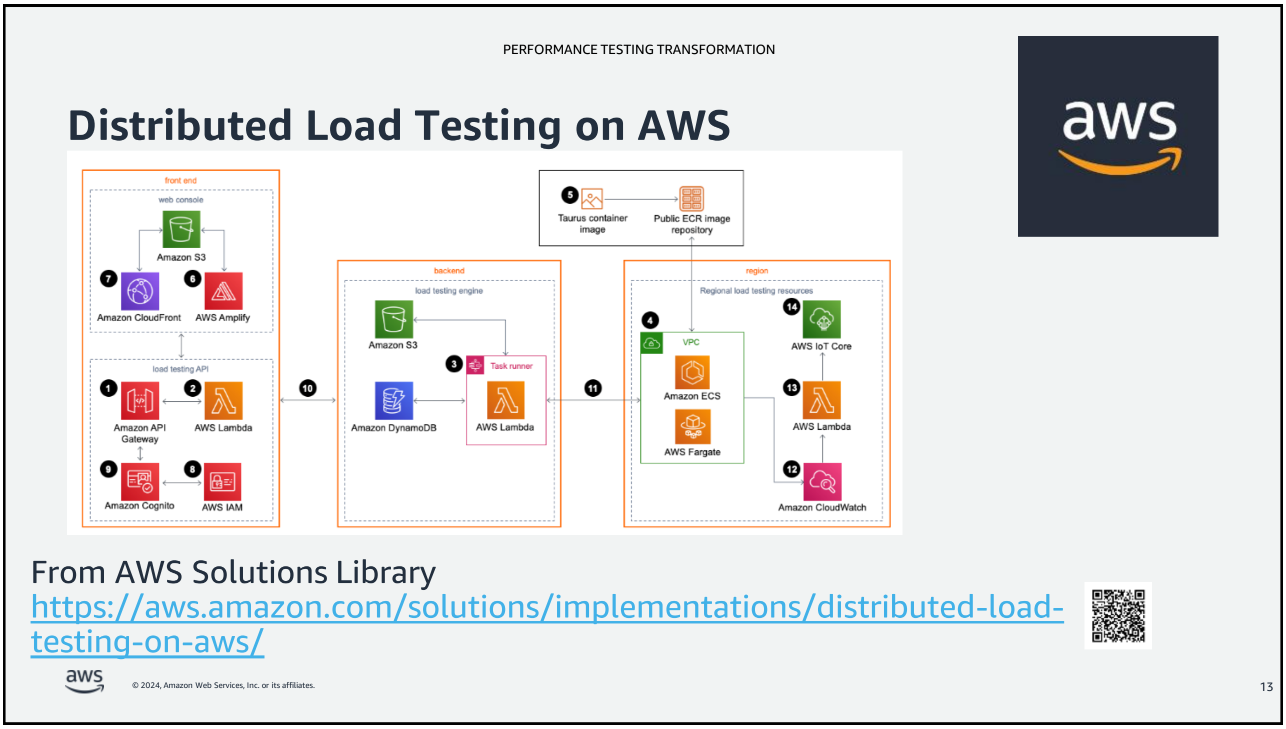
Continuous Integration: Load Testing Tools

- CI support in load testing tools
  - Integration with CI Servers (Jenkins, Hudson, etc.)
  - Automation support
- CI tools support for performance testing
  - Jenkins Performance Plugin
- Performance Testing Frameworks
  - Combining multiple tools

A Performance Testing Framework

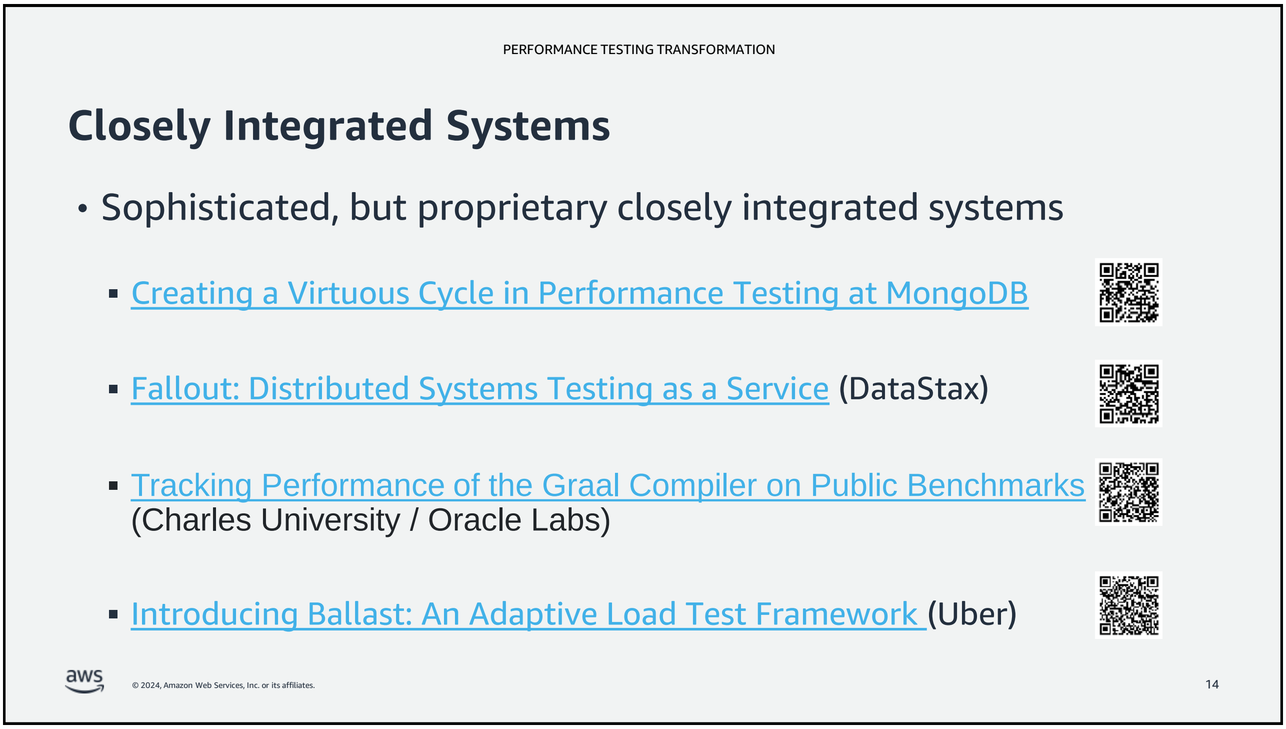


An example: https://github.com/serputko/performance-testing-framework



Distributed Load Testing on AWS

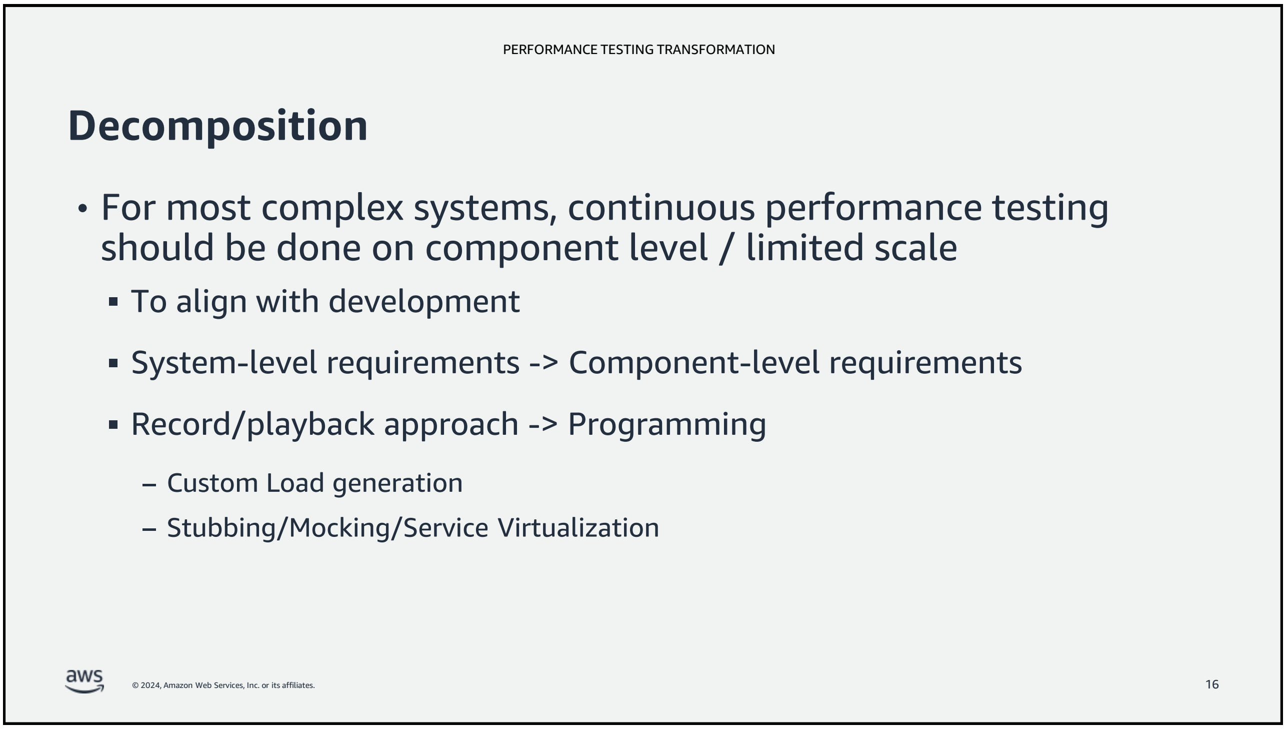
From AWS Solutions Library
https://aws.amazon.com/solutions/implementations/distributed-load-testing-on-aws/



Closely Integrated Systems

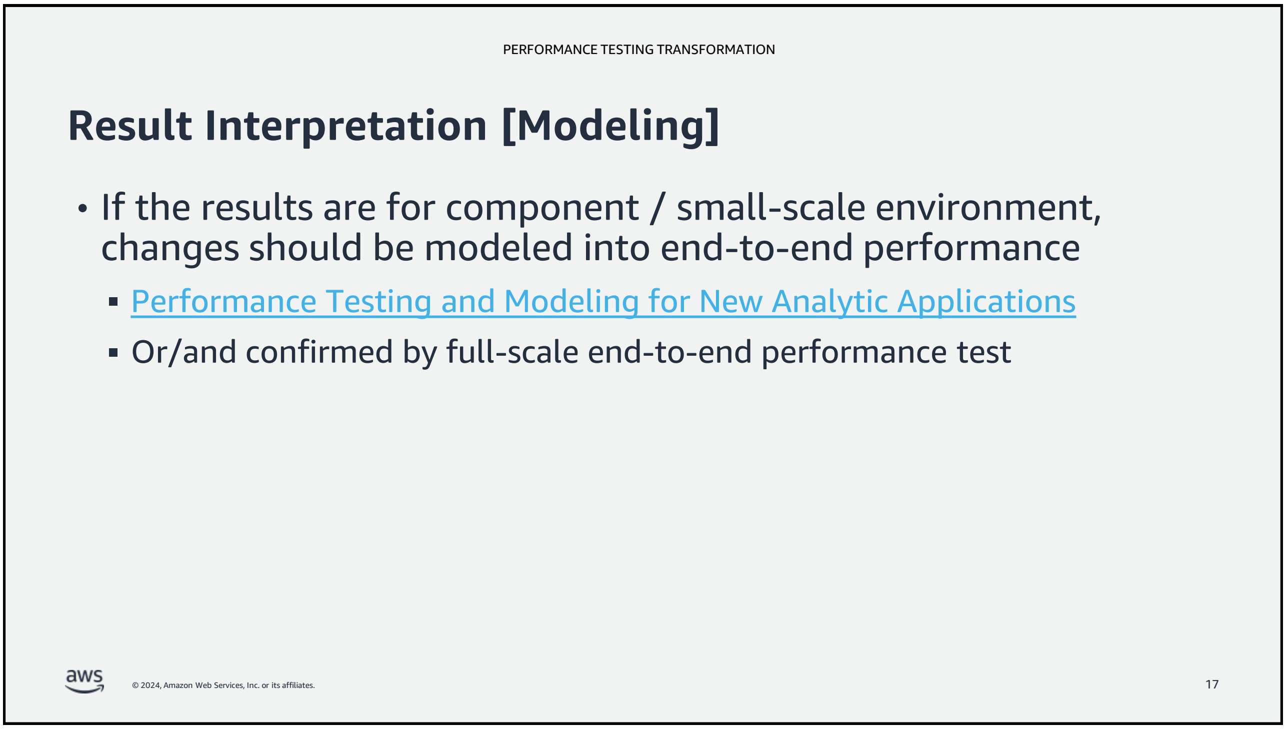
- Sophisticated, but proprietary closely integrated systems
  - Creating a Virtuous Cycle in Performance Testing at MongoDB
  - Fallout: Distributed Systems Testing as a Service (DataStax)
  - Tracking Performance of the Graal Compiler on Public Benchmarks (Charles University / Oracle Labs)
  - Introducing Ballast: An Adaptive Load Test Framework (Uber)

The Challenge of Decomposition



Decomposition

- For most complex systems, continuous performance testing should be done on component level / limited scale
  - To align with development
  - System-level requirements -> Component-level requirements
  - Record/playback approach -> Programming
    - Custom Load generation
    - Stubbing/Mocking/Service Virtualization

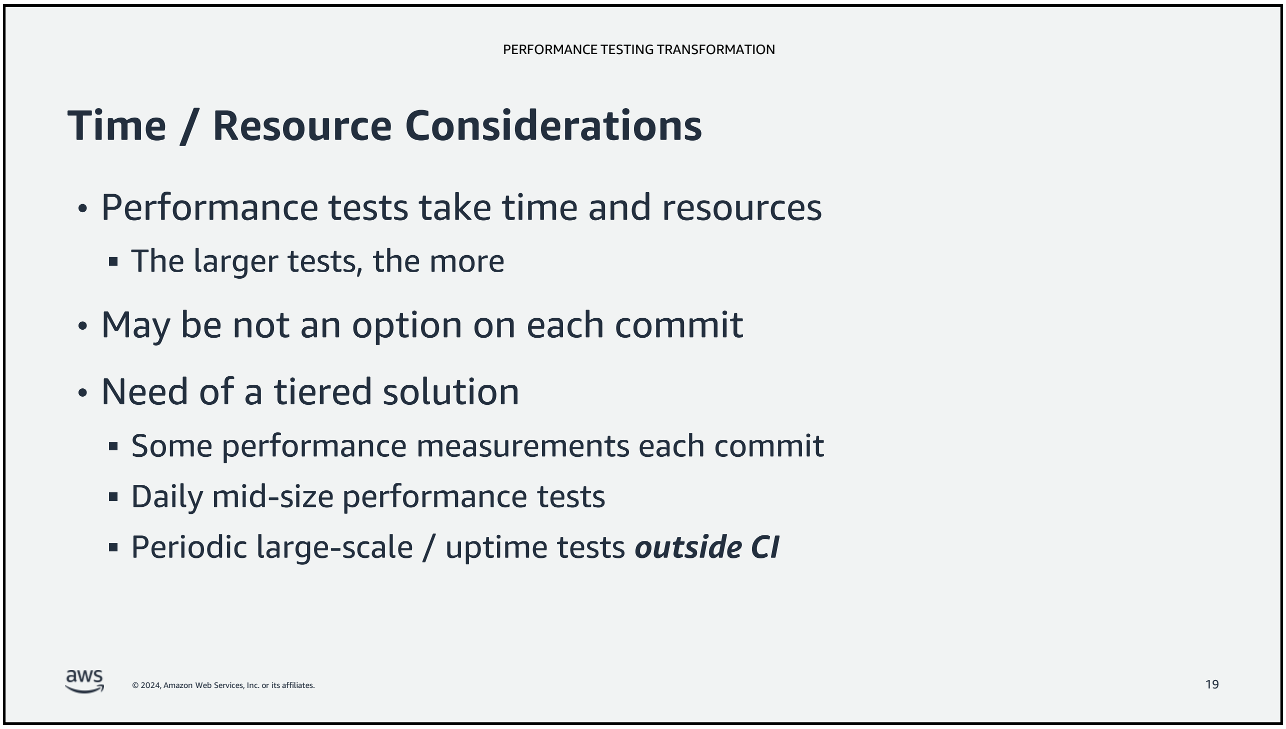


PERFORMANCE TESTING TRANSFORMATION

Result Interpretation [Modeling]

- If the results are for component / small-scale environment, changes should be modeled into end-to-end performance
  - Performance Testing and Modeling for New Analytic Applications
  - Or/and confirmed by full-scale end-to-end performance test

The Challenge of Coverage Optimization



Time / Resource Considerations

- Performance tests take time and resources
  - The larger tests, the more
- May be not an option on each commit
- Need of a tiered solution
  - Some performance measurements each commit
  - Daily mid-size performance tests
  - Periodic large-scale / uptime tests ***outside CI***

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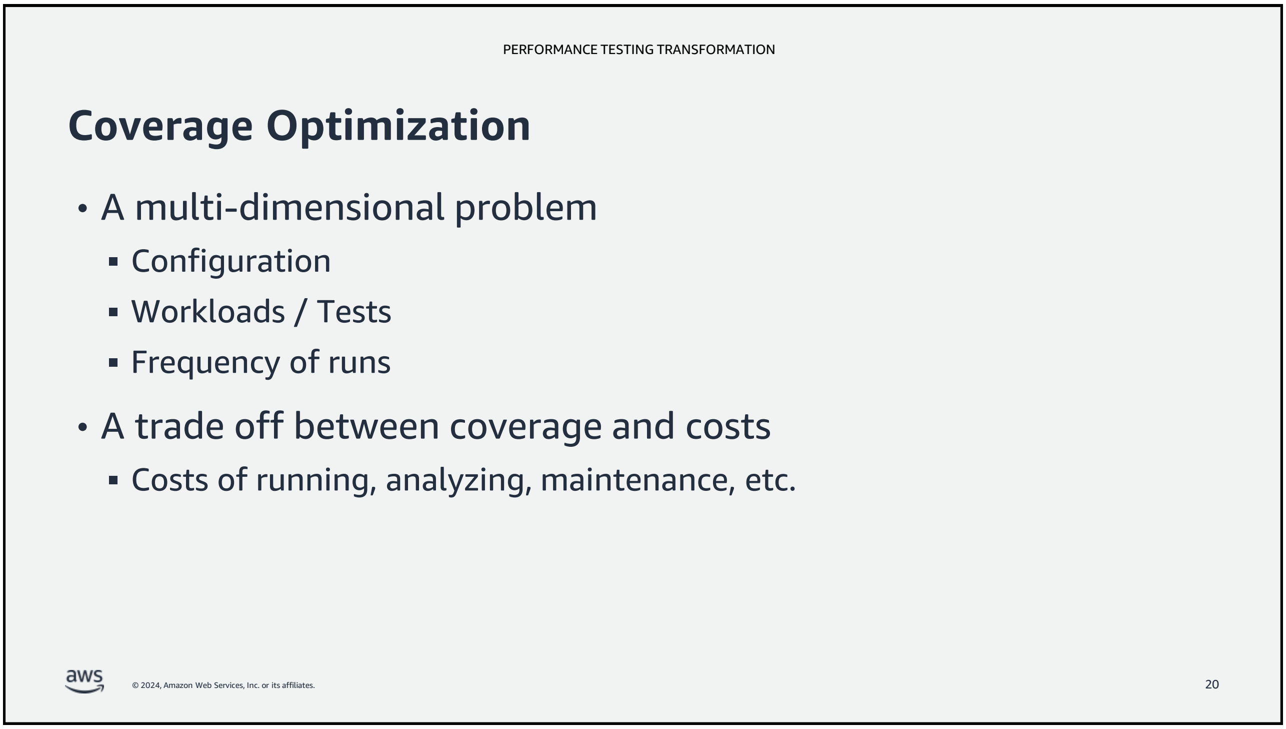

Coverage Optimization

- A multi-dimensional problem
  - Configuration
  - Workloads / Tests
  - Frequency of runs
- A trade off between coverage and costs
  - Costs of running, analyzing, maintenance, etc.

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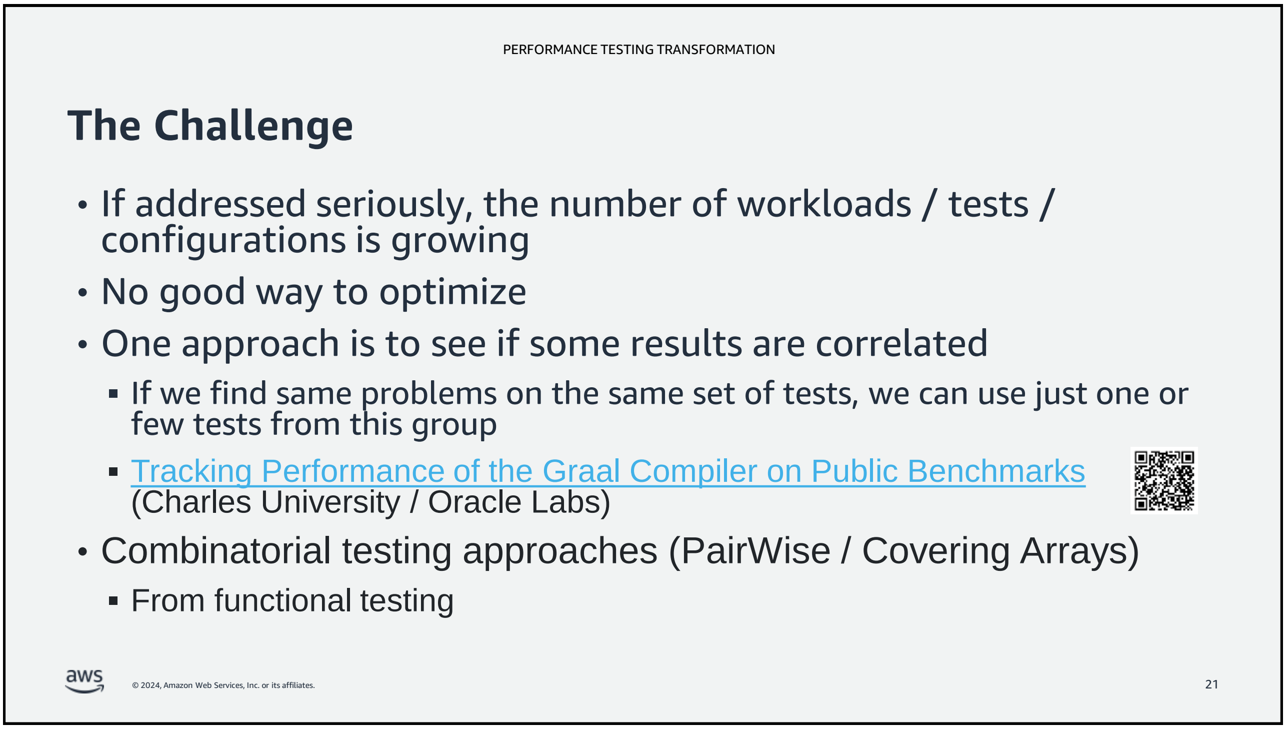
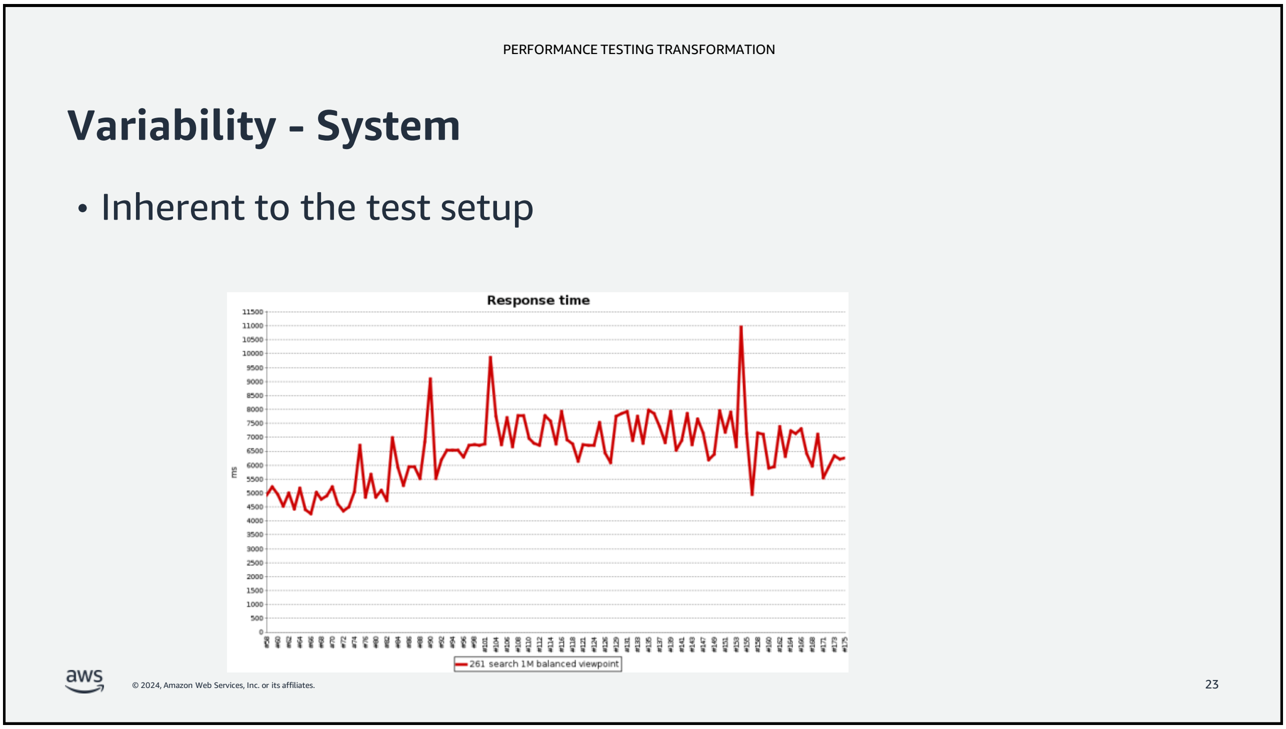


The Challenge

- If addressed seriously, the number of workloads / tests / configurations is growing
- No good way to optimize
- One approach is to see if some results are correlated
  - If we find same problems on the same set of tests, we can use just one or few tests from this group
  - Tracking Performance of the Graal Compiler on Public Benchmarks (Charles University / Oracle Labs)
- Combinatorial testing approaches (PairWise / Covering Arrays)
  - From functional testing

The Challenge of Variability



PERFORMANCE TESTING TRANSFORMATION

Variability - System

- Inherent to the test setup

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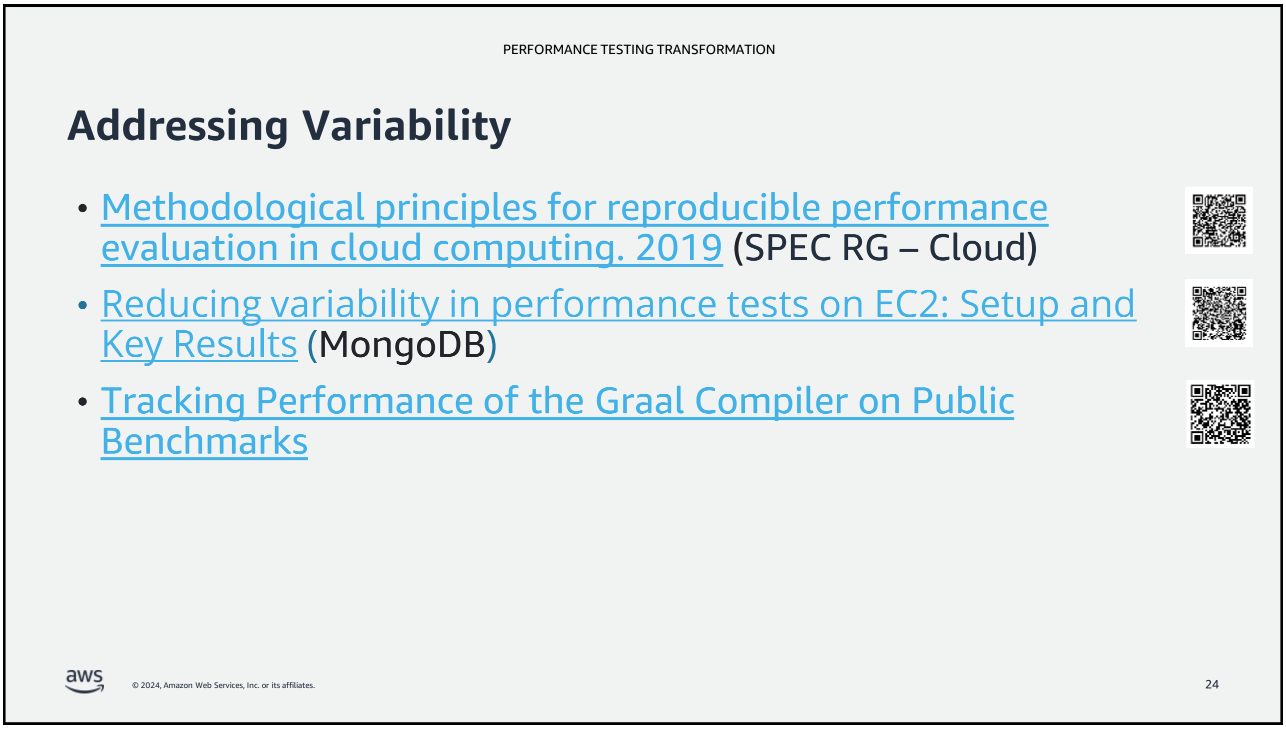

PERFORMANCE TESTING TRANSFORMATION

Addressing Variability

- Methodological principles for reproducible performance evaluation in cloud computing. 2019 (SPEC RG – Cloud)
- Reducing variability in performance tests on EC2: Setup and Key Results (MongoDB)
- Tracking Performance of the Graal Compiler on Public Benchmarks

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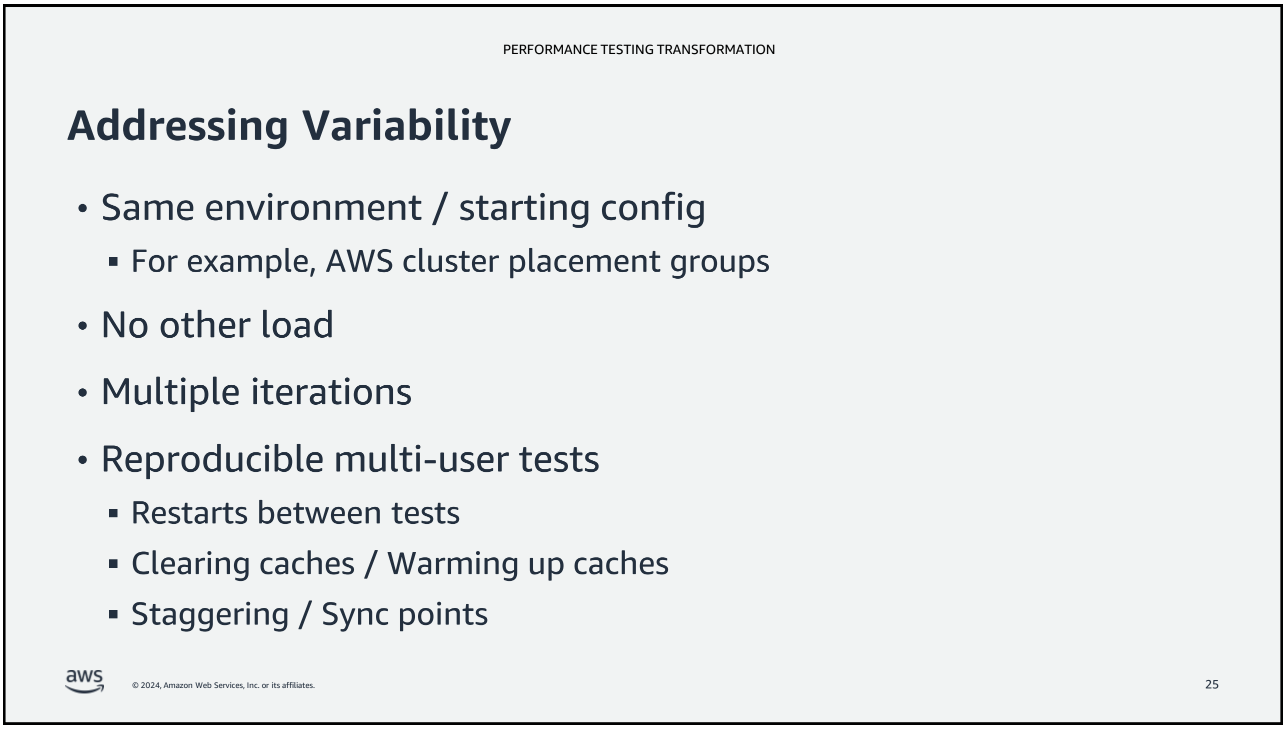

PERFORMANCE TESTING TRANSFORMATION

Addressing Variability

- Same environment / starting config
  - For example, AWS cluster placement groups
- No other load
- Multiple iterations
- Reproducible multi-user tests
  - Restarts between tests
  - Clearing caches / Warming up caches
  - Staggering / Sync points

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The Challenge of Change Detection

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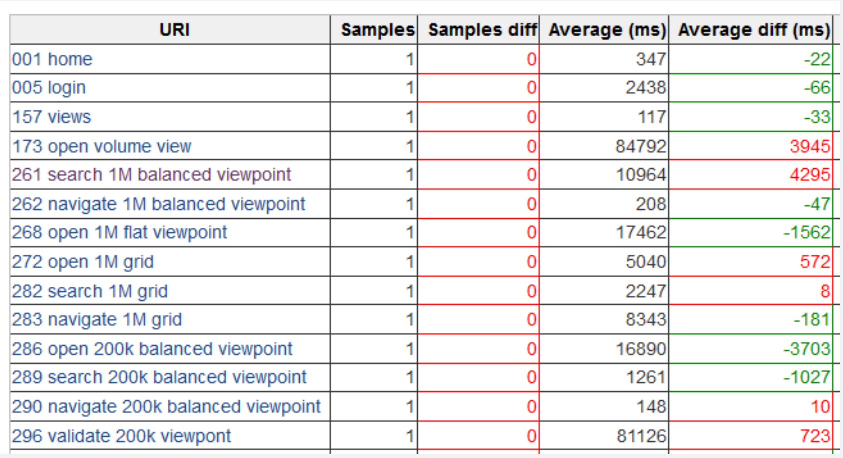
Complex Results

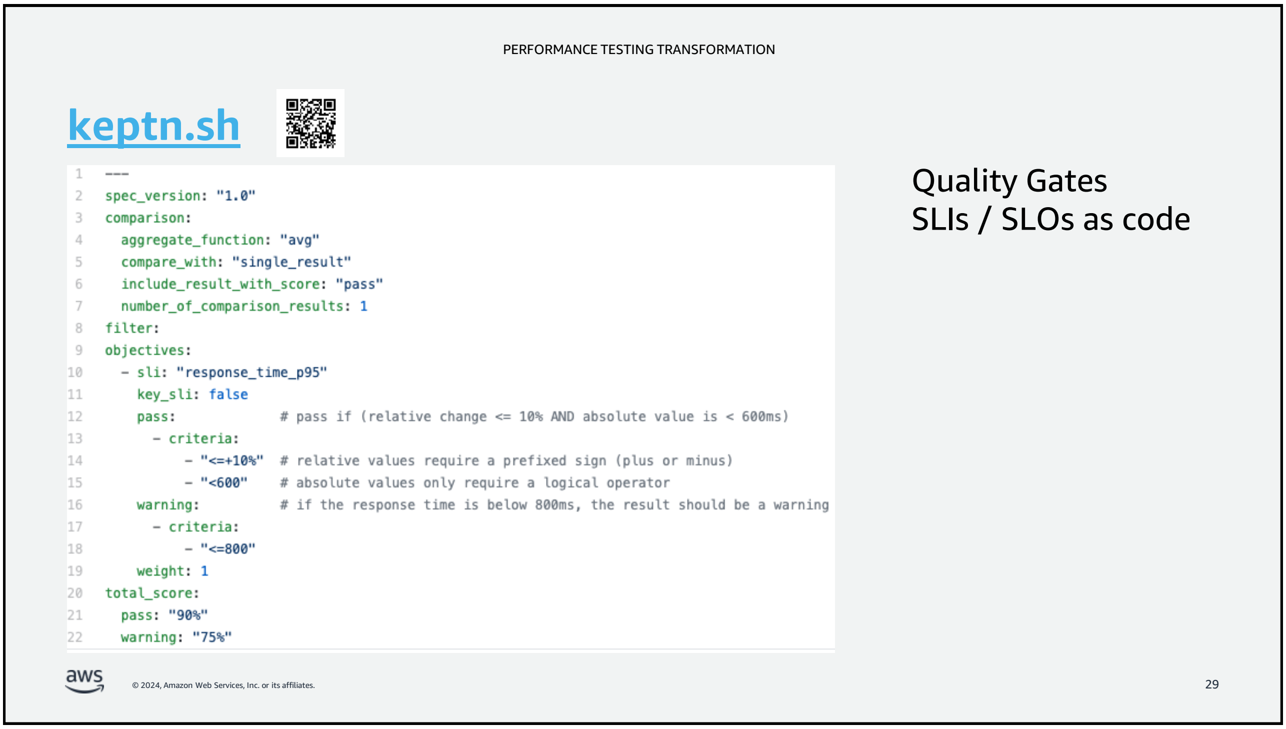
- No easy pass/fail
  - Individual responses, monitoring results, errors, etc.
- No easy comparison
  - Against SLA
  - Between builds
- Variability

Simple Comparison

Jenkins Performance Plugin



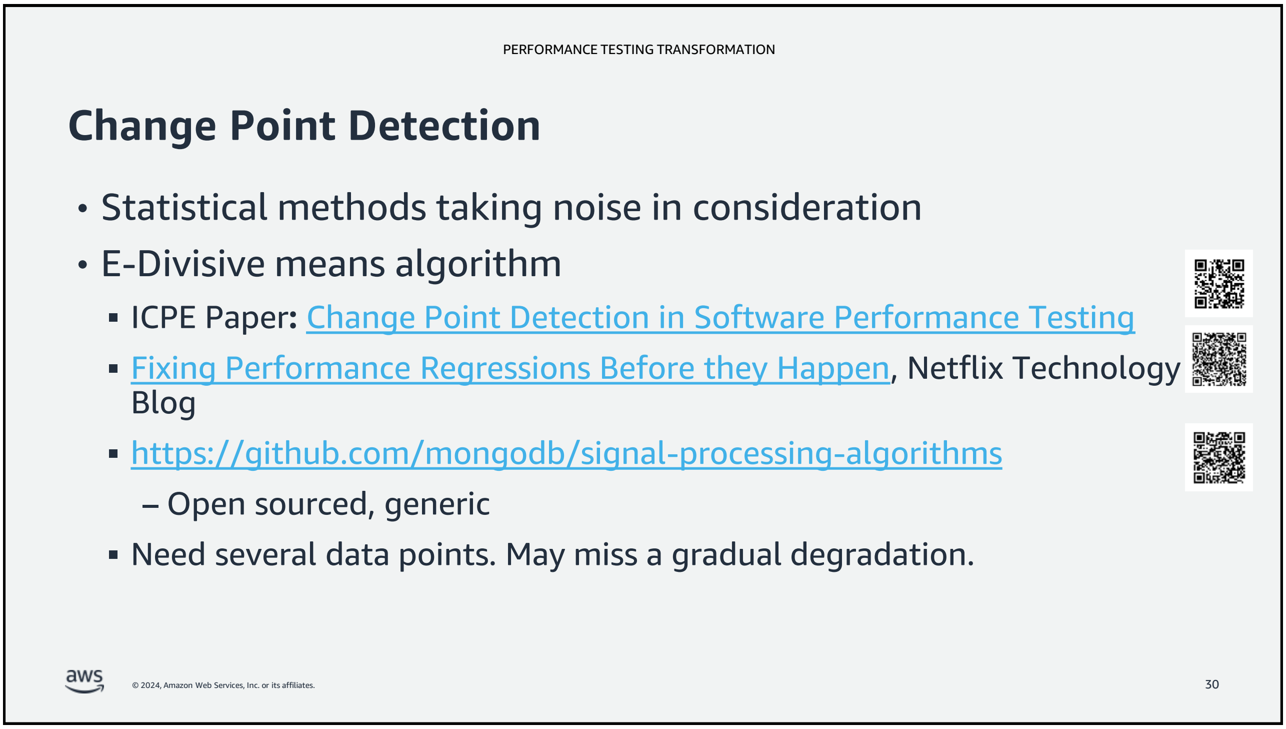
URI	Samples	Samples diff	Average (ms)	Average diff (ms)
001 home	1	0	347	-22
005 login	1	0	2438	-66
157 views	1	0	117	-33
173 open volume view	1	0	84792	3945
261 search 1M balanced viewpoint	1	0	10964	4295
262 navigate 1M balanced viewpoint	1	0	208	-47
268 open 1M flat viewpoint	1	0	17462	-1562
272 open 1M grid	1	0	5040	572
282 search 1M grid	1	0	2247	8
283 navigate 1M grid	1	0	8343	-181
286 open 200k balanced viewpoint	1	0	16890	-3703
289 search 200k balanced viewpoint	1	0	1261	-1027
290 navigate 200k balanced viewpoint	1	0	148	10
296 validate 200k viewpont	1	0	81126	723



keptn.sh

```
---
spec_version: "1.0"
comparison:
  aggregate_function: "avg"
  compare_with: "single_result"
  include_result_with_score: "pass"
  number_of_comparison_results: 1
filter:
objectives:
  - sli: "response_time_p95"
    key_sli: false
    pass:             # pass if (relative change <= 10% AND absolute value is < 600ms)
      - criteria:
          - "<=+10%"  # relative values require a prefixed sign (plus or minus)
          - "<600"    # absolute values only require a logical operator
    warning:          # if the response time is below 800ms, the result should be a warning
      - criteria:
          - "<=800"
    weight: 1
total_score:
  pass: "90%"
  warning: "75%"
```

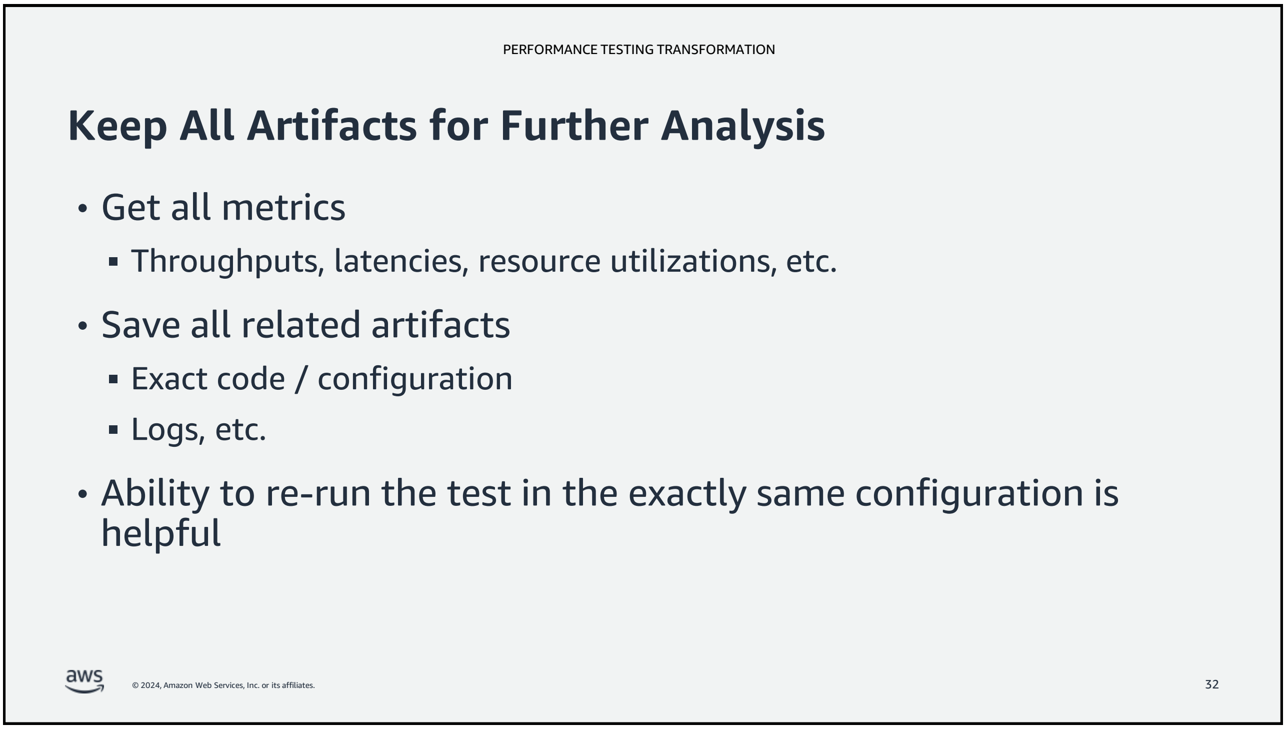
Quality Gates
SLIs / SLOs as code



Change Point Detection

- Statistical methods taking noise in consideration
- E-Divisive means algorithm
  - ICPE Paper: Change Point Detection in Software Performance Testing
  - Fixing Performance Regressions Before they Happen, Netflix Technology Blog
  - https://github.com/mongodb/signal-processing-algorithms
    - Open sourced, generic
  - Need several data points. May miss a gradual degradation.

The Challenge of Advanced Analysis



Keep All Artifacts for Further Analysis

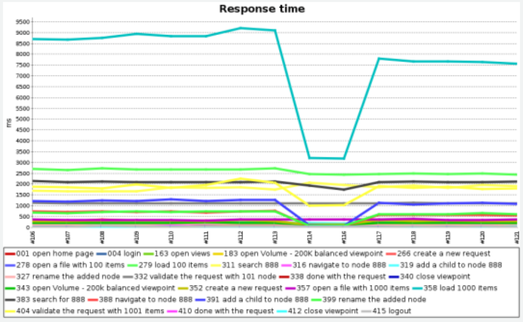
- Get all metrics
  - Throughputs, latencies, resource utilizations, etc.
- Save all related artifacts
  - Exact code / configuration
  - Logs, etc.
- Ability to re-run the test in the exactly same configuration is helpful

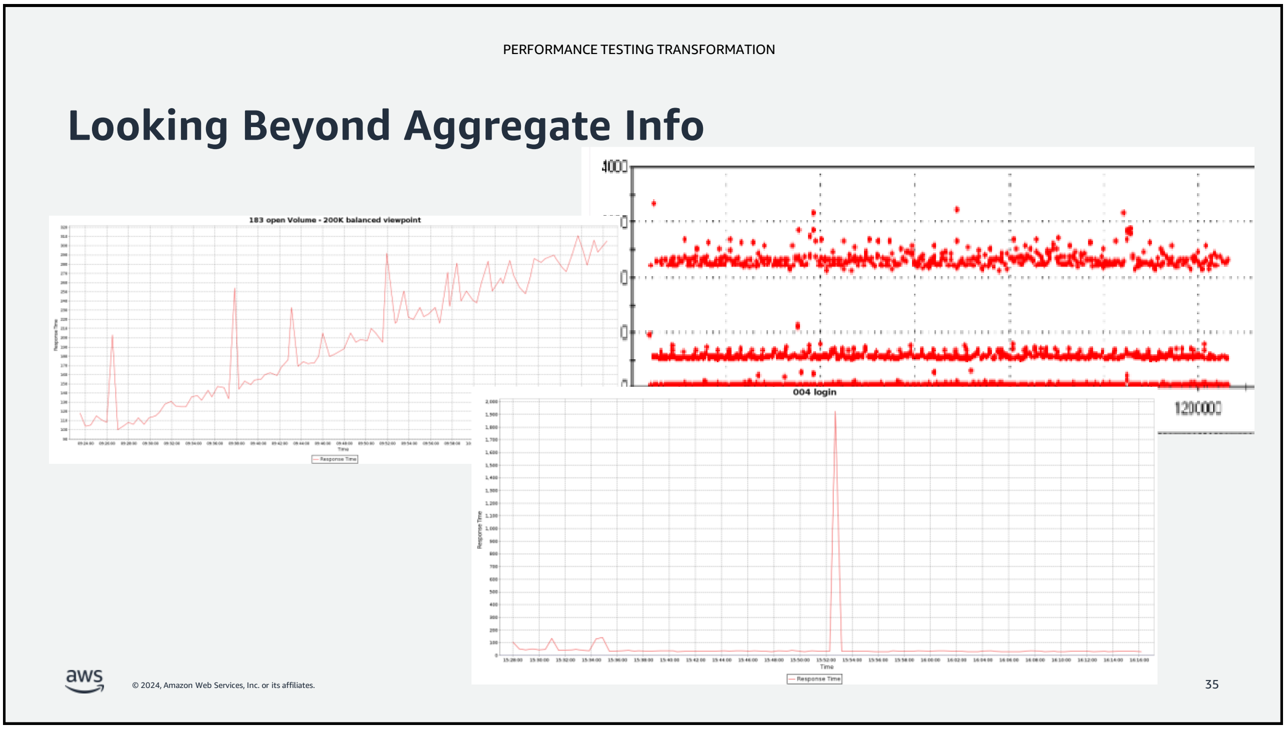
Root Cause Analysis

- Collecting artifacts to do root cause analysis
- Insights snapshots
  - Flamegraphs (perf, eBPF)
- Continuous Profiling
  - Java Flight Recorder
  - APM
  - Tracing
  - Observability
  - eBPF-based tools

Visualization

- Visualizing systems and software performance - Report on the GI-Dagstuhl
- Sometimes helps to catch an issue





PERFORMANCE TESTING TRANSFORMATION

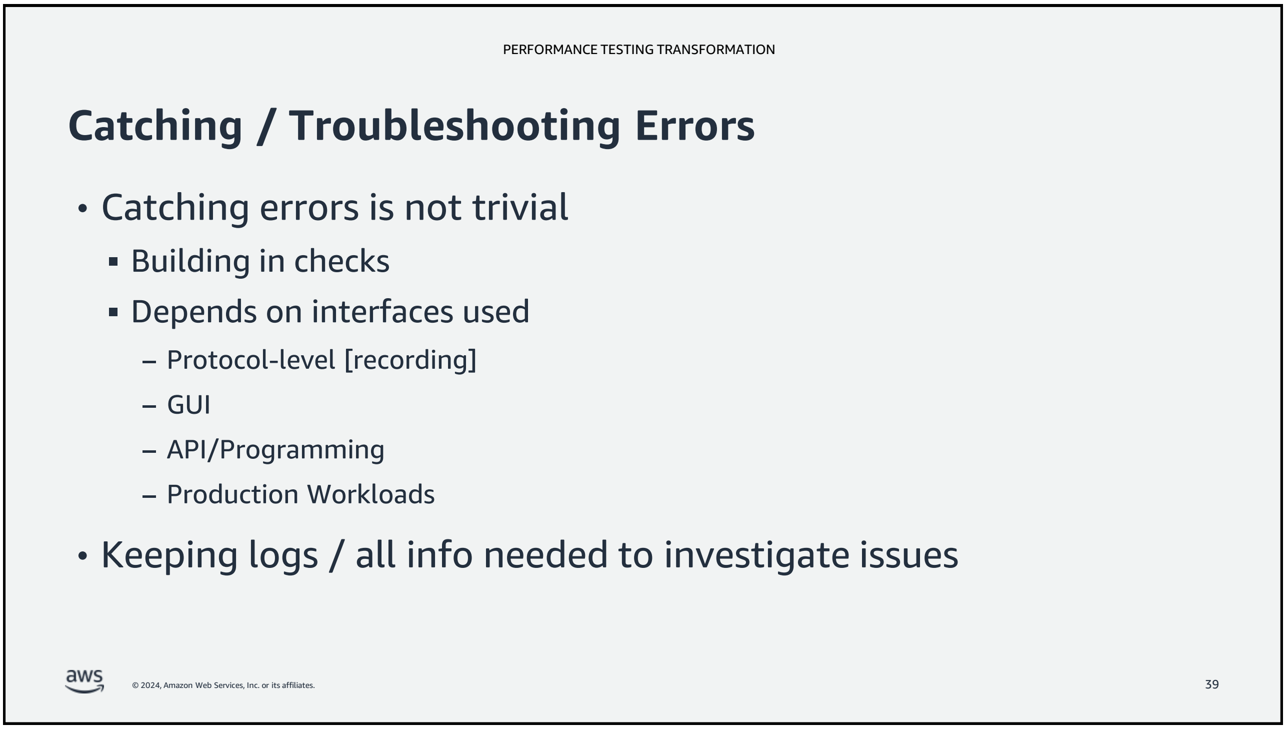
Looking Beyond Aggregate Info

The Challenge of Operations and Maintenance

Operations

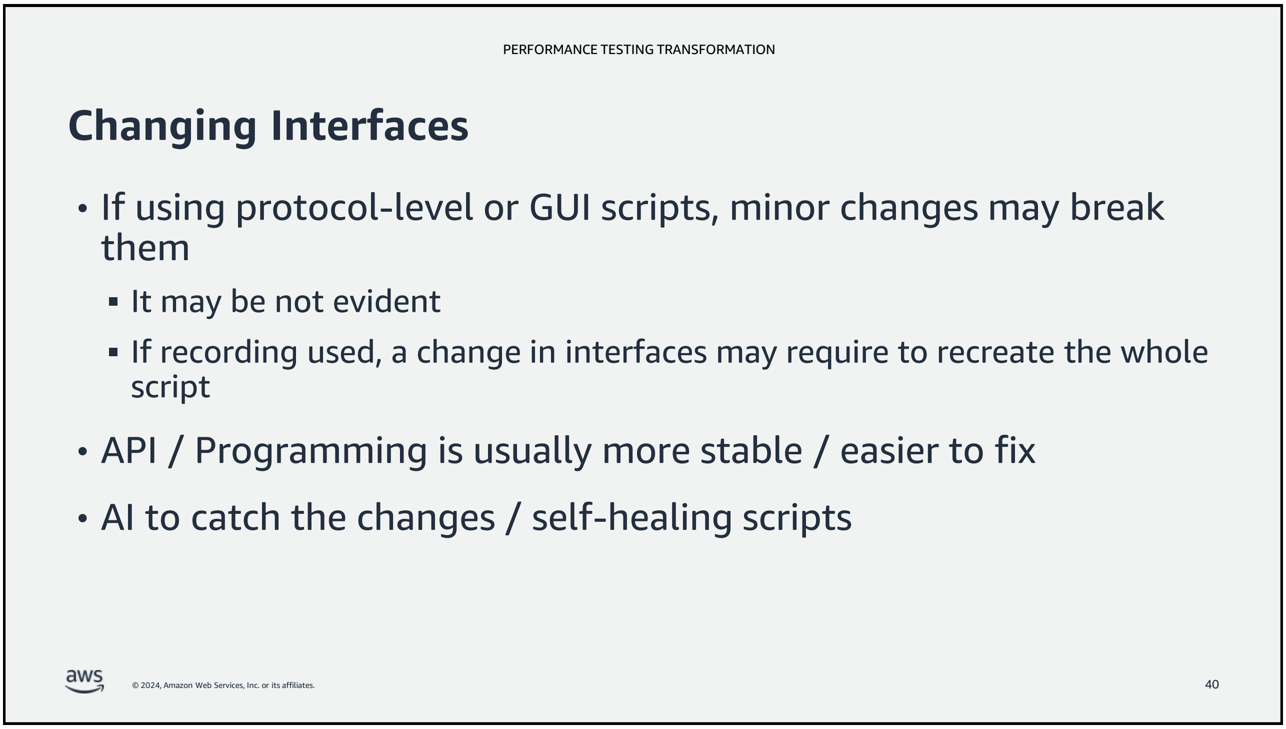
- Scheduling / execution tests
- Results analysis
- Triaging and escalating issues
- Maintenance

Coverage / Maintenance Trade-Off



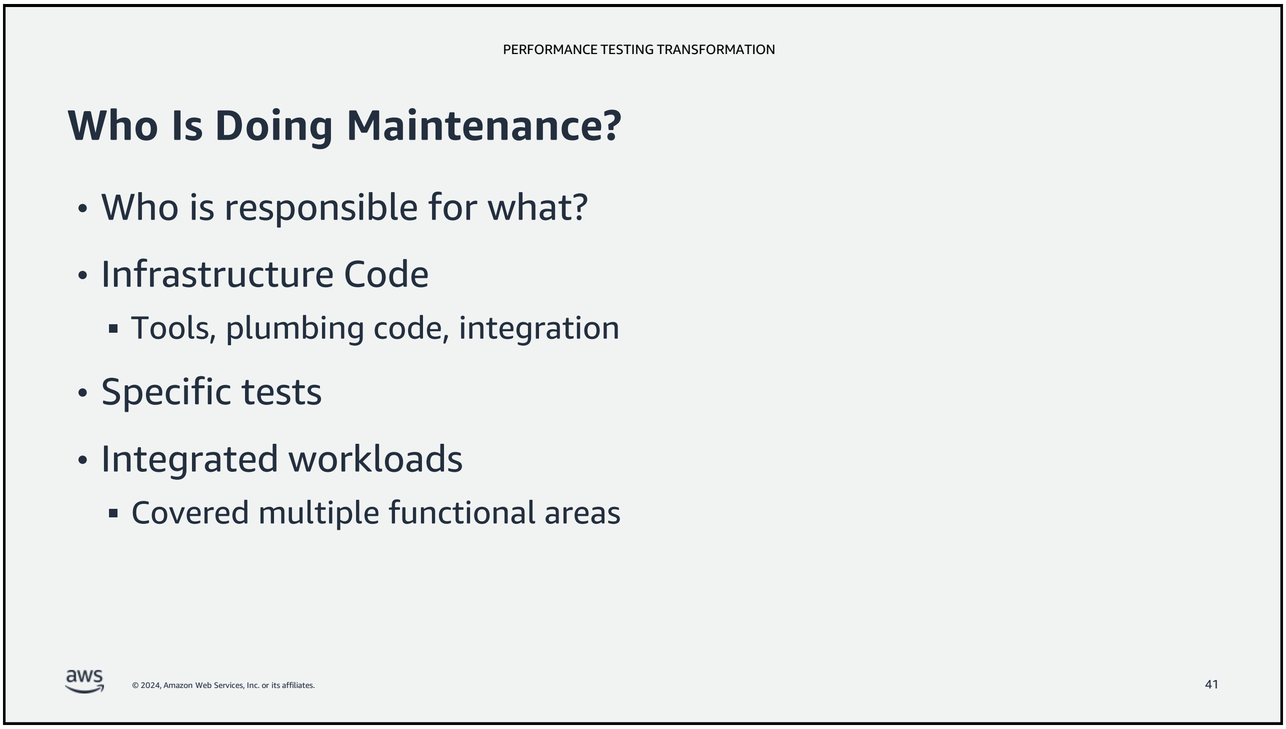
Catching / Troubleshooting Errors

- Catching errors is not trivial
  - Building in checks
  - Depends on interfaces used
    - Protocol-level [recording]
    - GUI
    - API/Programming
    - Production Workloads
- Keeping logs / all info needed to investigate issues



Changing Interfaces

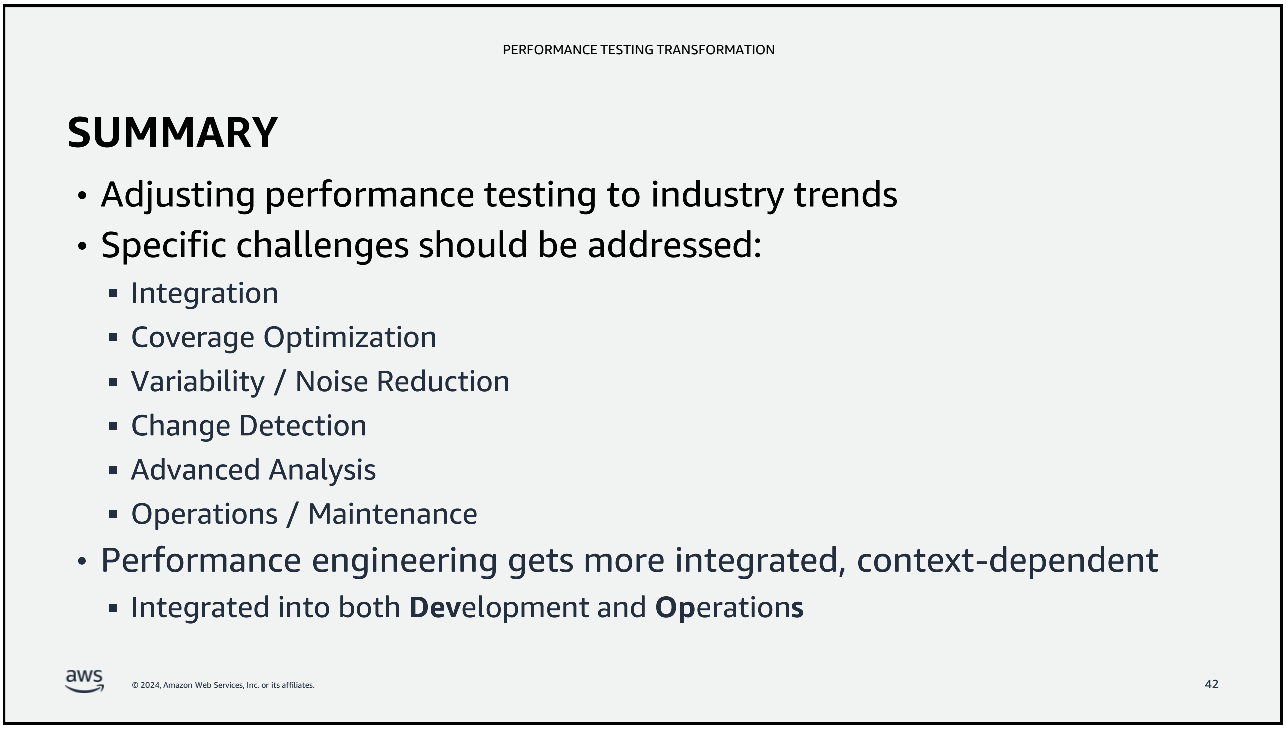
- If using protocol-level or GUI scripts, minor changes may break them
  - It may be not evident
  - If recording used, a change in interfaces may require to recreate the whole script
- API / Programming is usually more stable / easier to fix
- AI to catch the changes / self-healing scripts



PERFORMANCE TESTING TRANSFORMATION

Who Is Doing Maintenance?

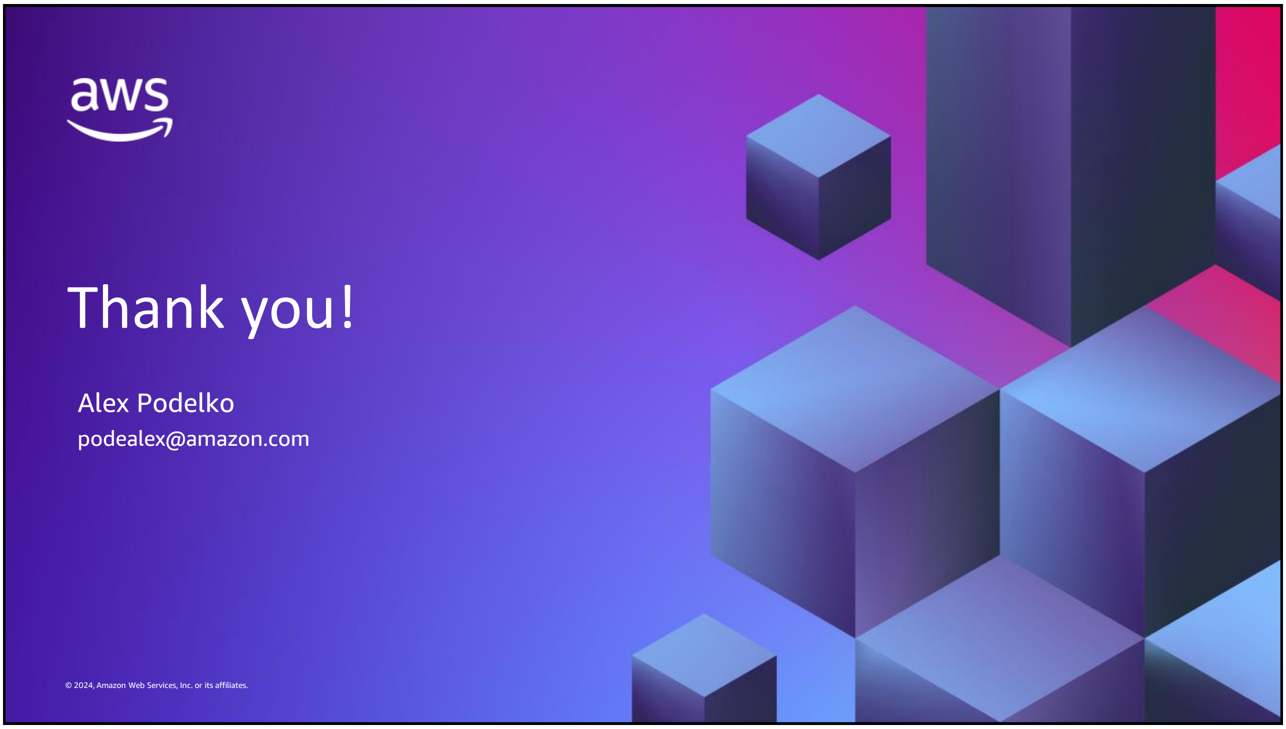
- Who is responsible for what?
- Infrastructure Code
  - Tools, plumbing code, integration
- Specific tests
- Integrated workloads
  - Covered multiple functional areas



PERFORMANCE TESTING TRANSFORMATION

SUMMARY

- Adjusting performance testing to industry trends
- Specific challenges should be addressed:
  - Integration
  - Coverage Optimization
  - Variability / Noise Reduction
  - Change Detection
  - Advanced Analysis
  - Operations / Maintenance
- Performance engineering gets more integrated, context-dependent
  - Integrated into both **Dev**elopment and **Op**eration**s**



Thank you!

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