AWS re:Invent

DOP328

Introducing The Amazon Builders' Library

Andrew Certain
Sr. Principal Engineer
Database Services

Becky Weiss
Sr. Principal Engineer
AWS Identity

Colm MacCárthaigh
Sr. Principal Engineer
EC2 Networking

David Yanacek
Principal Engineer
AWS Lambda

Marc Brooker
Sr. Principal Engineer
AWS Serverless Applications

© 2019, Amazon Web Services, Inc. or its affiliates. All rights reserved.



Amazon DynamoDB



AWS Lambda



Amazon Virtual Private Cloud (Amazon VPC)



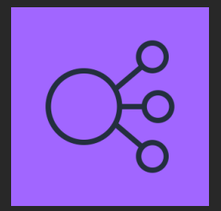
Amazon Elastic Block Store (Amazon EBS)



Amazon Route 53



Amazon CloudFront



Elastic Load Balancing



Amazon Quantum Ledger Database (Amazon QLDB)



5



Lightning talks

Monitoring with percentiles

Static stability

Shuffle sharding

Retries, backoff, and jitter

Meta lesson: Learn from each other

Lightning talks

A. Andrew

B. Becky

C. Colm

D. David

E. Marc

Lightning talks

A. Andrew

B. Becky

C. Colm

D. David

E. Marc



Monitoring with percentiles

© 2019, Amazon Web Services, Inc. or its affiliates. All rights reserved.

@tacertain

http://blog.tacertain.com/p-four-nines/

@tacertain

http://blog.tacertain.com/p-four-nines/



http://blog.tacertain.com/p-four-nines/



“P-four-nines”

=

99.99^{th} percentile

“P-four-nines”

=

99.99^{th} percentile

=

Value that is >= 99.99% of the data points

455	515	126	226	791	865	628	908	663	938
336	262	353	980	330	548	816	779	662	339
342	288	247	553	403	641	465	695	901	568
678	169	600	370	924	136	558	754	784	849
244	463	502	558	234	392	912	625	428	263
729	841	711	477	270	767	311	244	187	221
174	882	592	661	803	520	763	580	443	609
467	326	373	366	260	963	929	549	684	242
286	764	735	876	983	285	910	610	598	406
753	985	721	860	112	583	340	798	393	182

112	126	136	169	174	182	187	221	226	234
242	244	244	247	260	262	263	270	285	286
288	311	326	330	336	339	340	342	353	366
370	373	392	393	403	406	428	443	455	463
465	467	477	502	515	520	548	549	553	558
558	568	580	583	592	598	600	609	610	625
628	641	661	662	663	678	684	695	711	721
729	735	753	754	763	764	767	779	784	791
798	803	816	841	849	860	865	876	882	901
908	910	912	924	929	938	963	980	983	985

112	126	136	169	174	182	187	221	226	234
242	244	244	247	260	262	263	270	285	286
288	311	326	330	336	339	340	342	353	366
370	373	392	393	403	406	428	443	455	463
465	467	477	502	515	520	548	549	553	558
558	568	580	583	592	598	600	609	610	625
628	641	661	662	663	678	684	695	711	721
729	735	753	754	763	764	767	779	784	791
798	803	816	841	849	860	865	876	882	901
908	910	912	924	929	938	963	980	983	985

112	126	136	169	174	182	187	221	226	234
242	244	244	247	260	262	263	270	285	286
288	311	326	330	336	339	340	342	353	366
370	373	392	393	403	406	428	443	455	463
465	467	477	502	515	520	548	549	553	558
558	568	580	583	592	598	600	609	610	625
628	641	661	662	663	678	684	695	711	721
729	735	753	754	763	764	767	779	784	791
798	803	816	841	849	860	865	876	882	901
908	910	912	924	929	938	963	980	983	985

amazon.com

VIEW CART | WISH LIST | YOUR ACCOUNT | HELP

WELCOME | STORE DIRECTORY

TODAY'S FEATURED STORES: BOOKS | ELECTRONICS | KITCHEN & HOUSEWARES | OUTLET | COMPUTER & VIDEO GAMES

INTERNATIONAL | TOP SELLERS | FRIENDS & FAVORITES | FREE E-CARDS | FRIDAY SALE

SEARCH

All Products

GO!

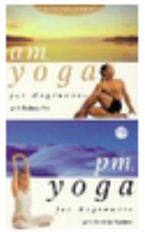
BROWSE

- Your Favorites
- Books
- Electronics
- Music
- DVD
- Kitchen & Housewares
- Health & Beauty
- Computer & Video Games
- Toys & Games

Hello. Sign in to get personalized recommendations. New customer? Start here.

Top Sellers in Video

Living Yoga - A.M./P.M. Yoga for Beginners Set ~ VHS



This yoga set is perfect for those with busy schedules who need to work in a way to relax. On the a.m. tape, Rodney Yee takes you through a 15-minute morning yoga set, while Patricia Walden leads a 20-minute evening routine on the p.m. tape. The a.m. tape was filmed on a beach in Maui at sunrise,...Read more

More Top Sellers:

- Philips DVD710AT DVD-Video Player by Philips
- *The Prayer of Jabez* by David Kopp, Bruce H. Wilkinson
- In Health & Beauty
- Crabtree & Evelyn 51842 Gardener's Salad Bowl by Crabtree & Evelyn

New Releases in Books

Death in Holy Orders

Despite challenges from Ruth Rendell and (more recently) Minette Walters



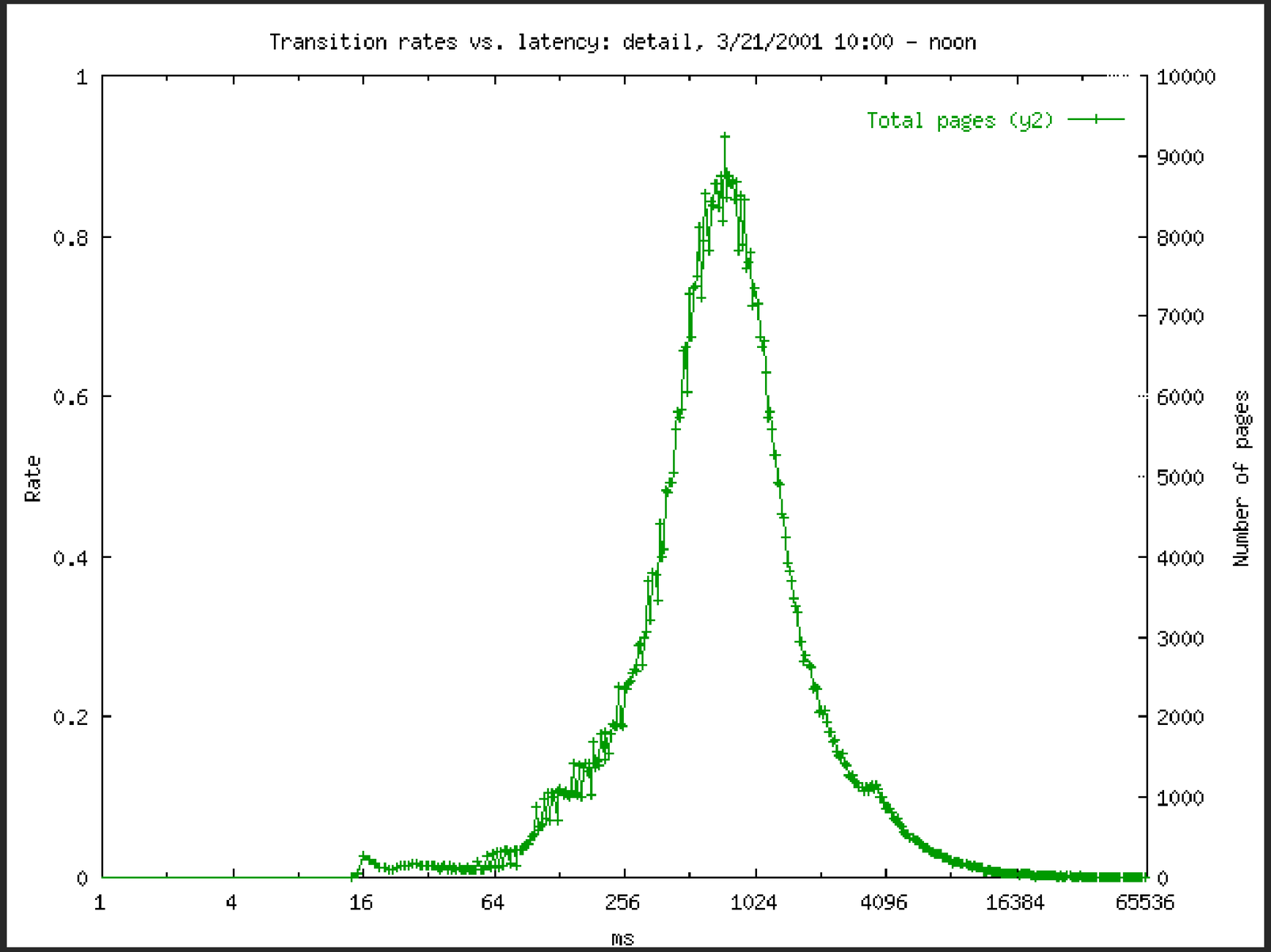
What's new at amazon.com

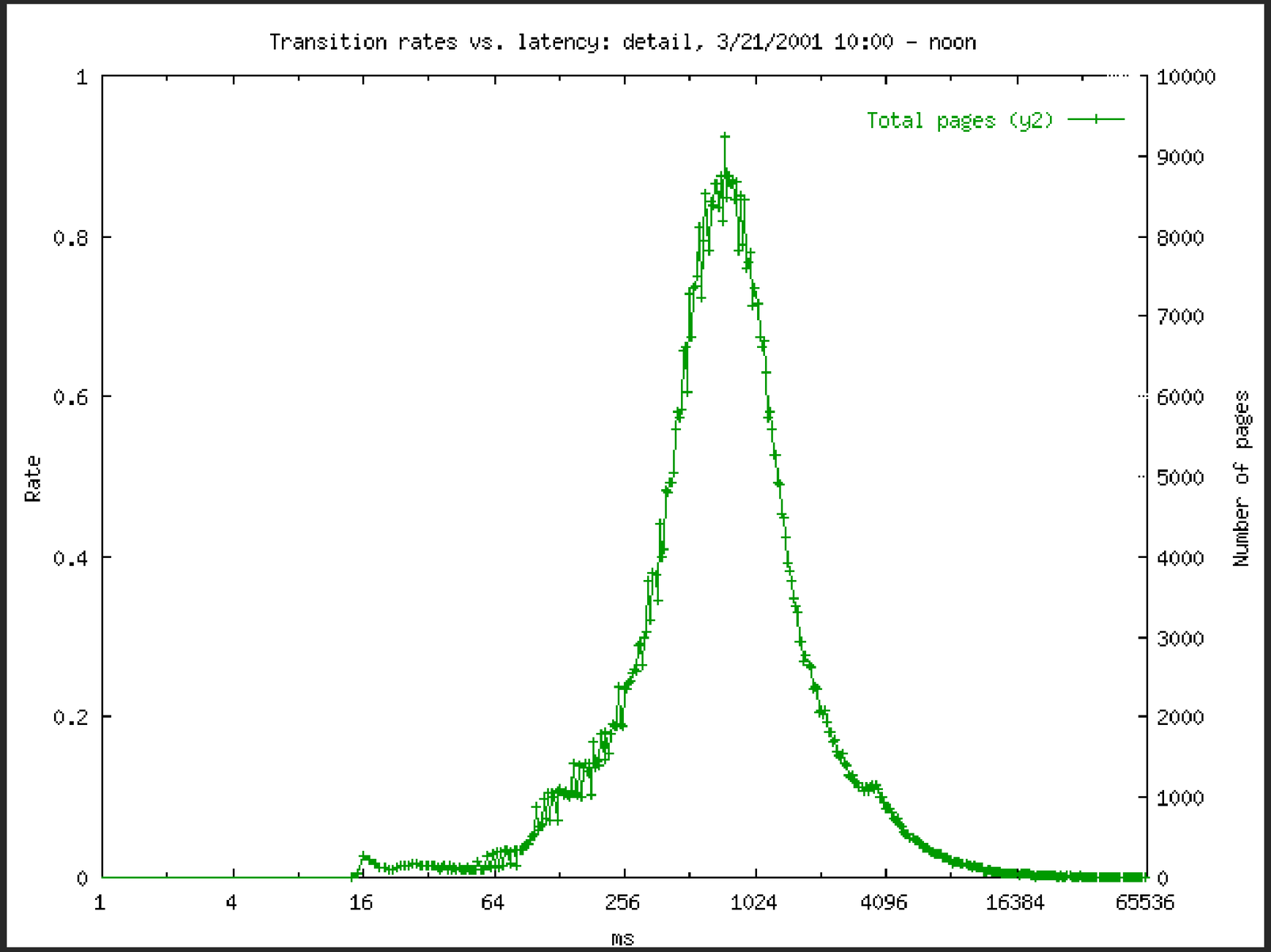
Already a customer?
Sign in to see what's **New for You**.

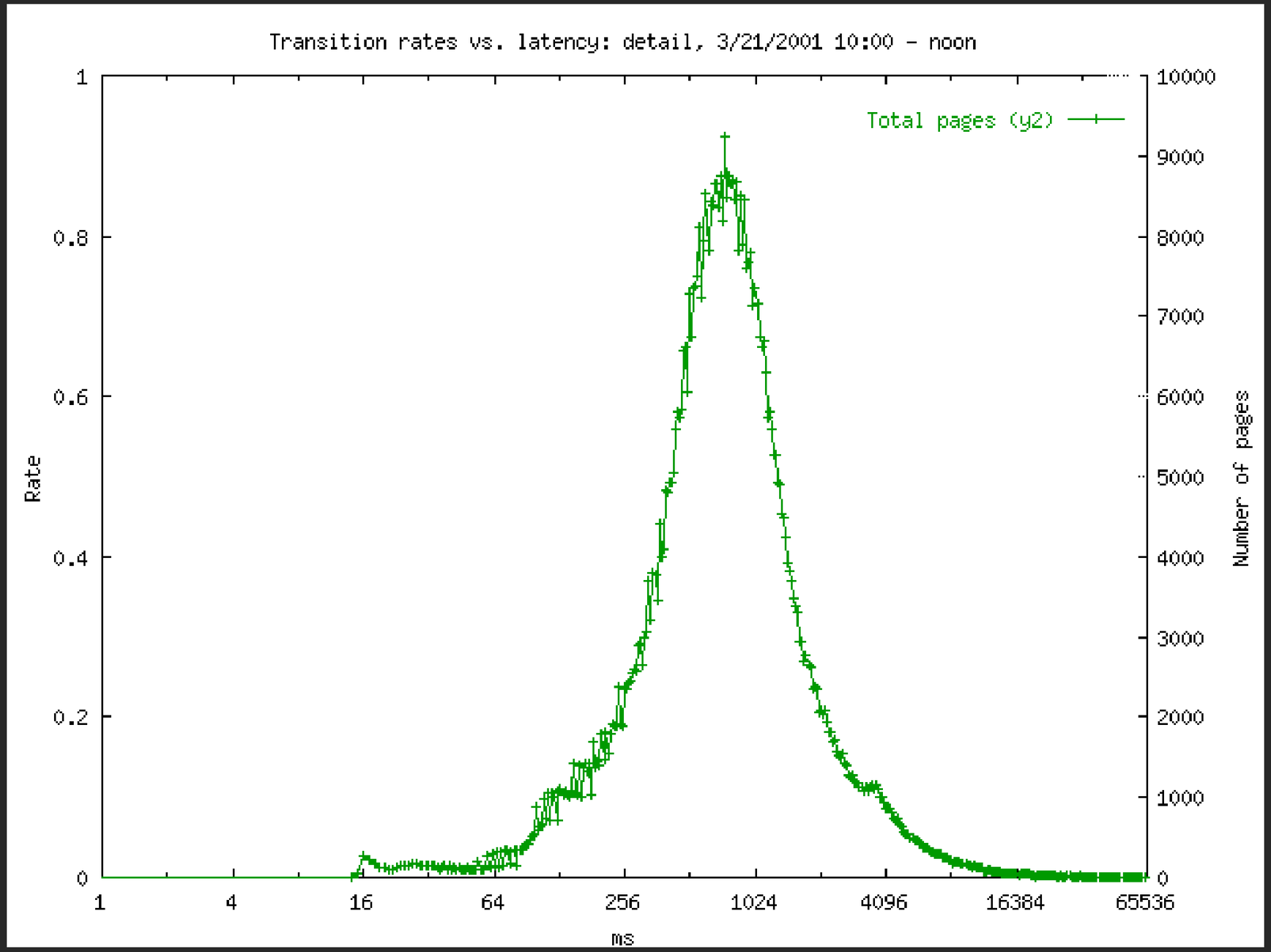
New Releases

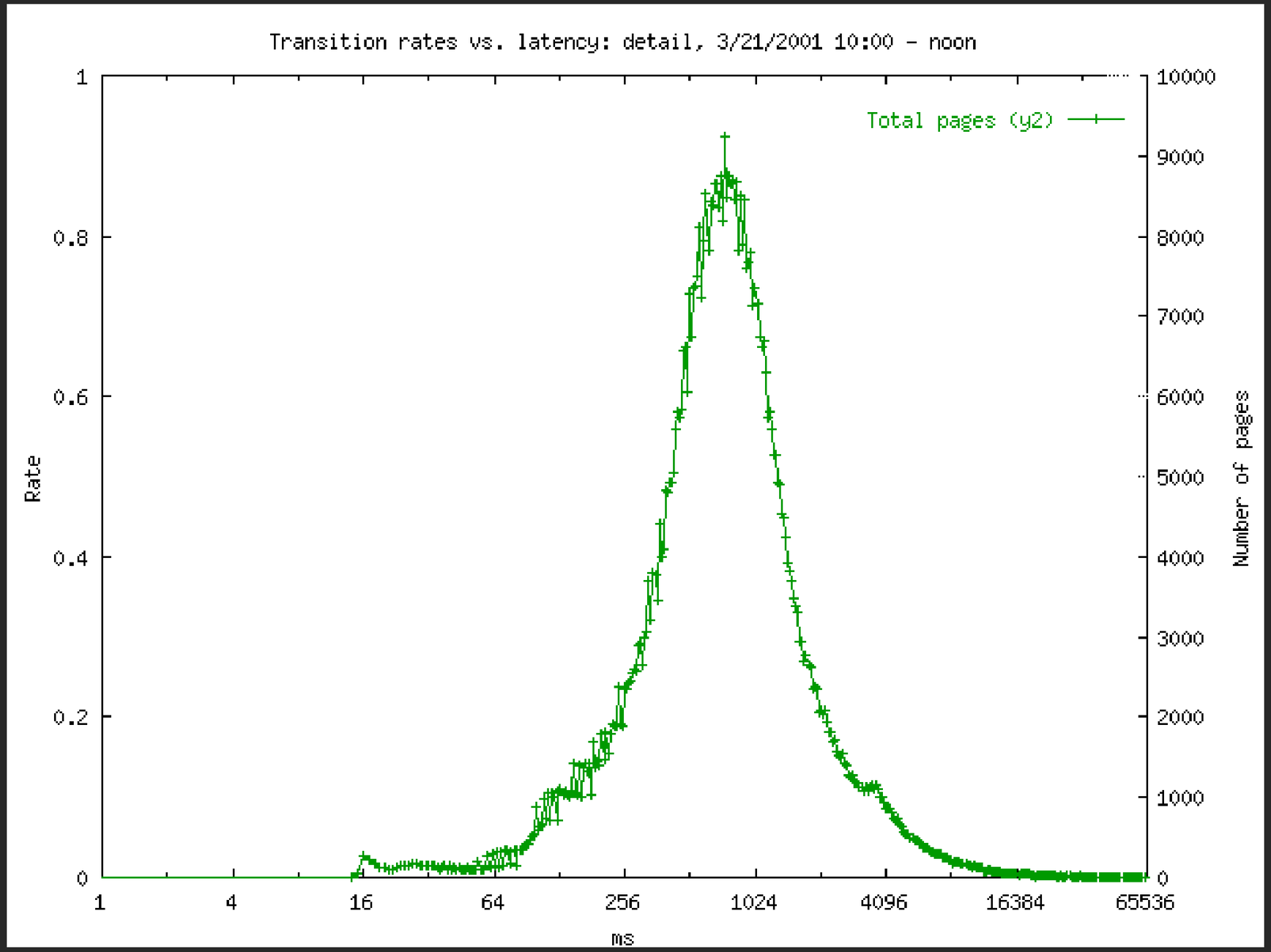
- Baking
- VHS Classics
- Children's Software
- Activities & Learning
- Alternative Rock

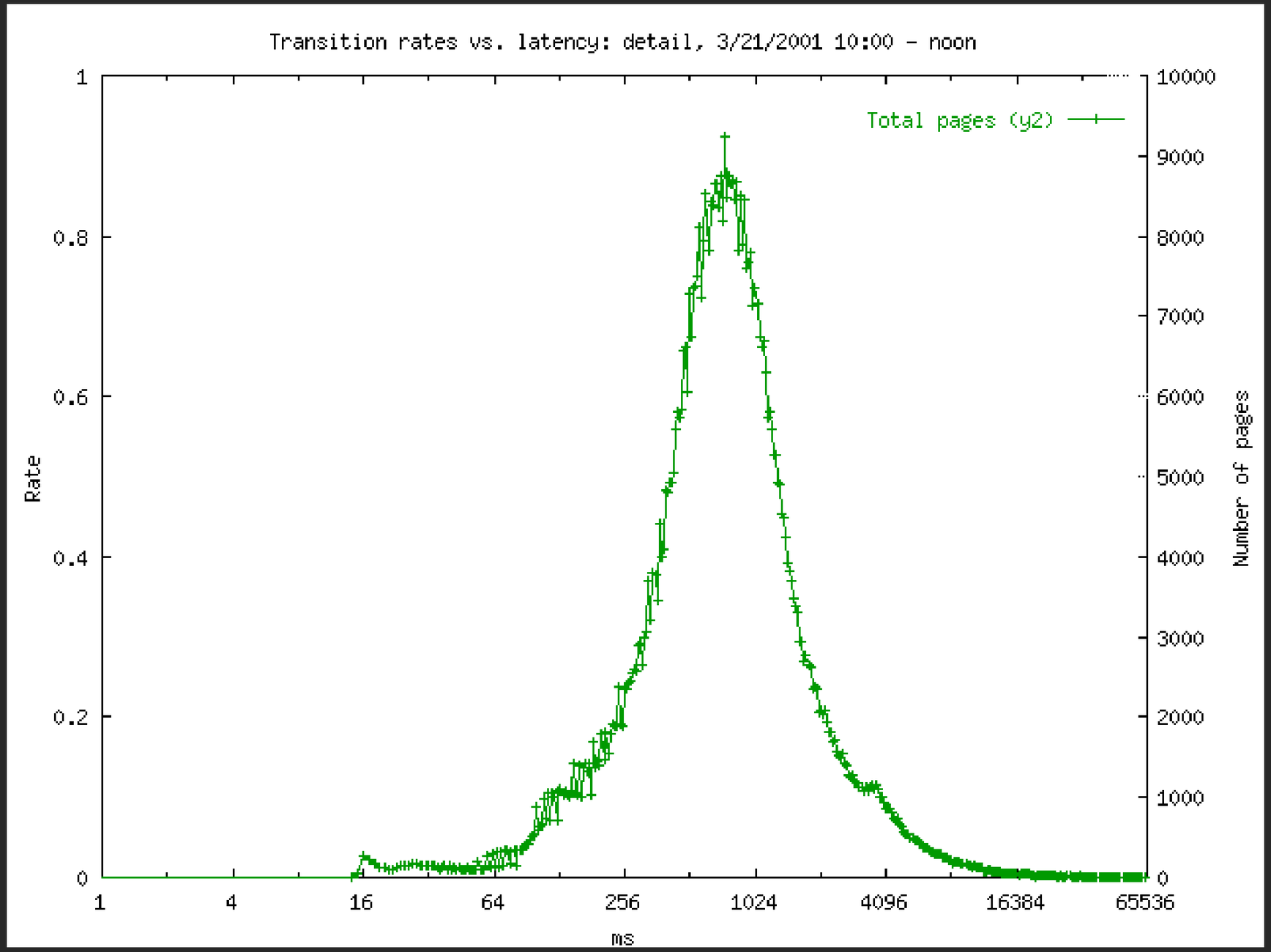
More New Releases

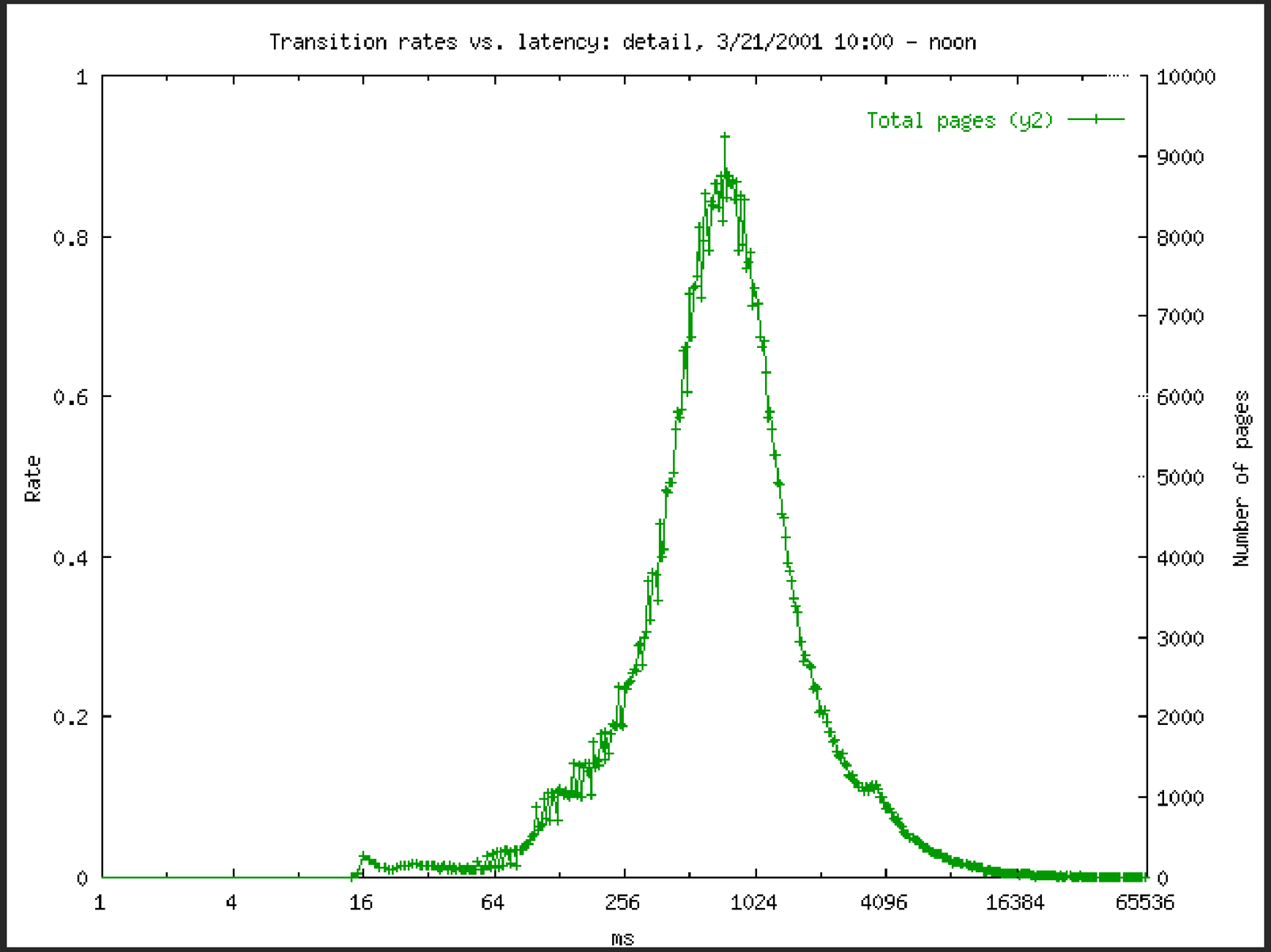

Transition rates vs. latency: detail, 3/21/2001 10:00 - noon
Total pages (y2)
Rate
Number of pages
ms
0
0.2
0.4
0.6
0.8
1
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
1
4
16
64
256
1024
4096
16384
65536

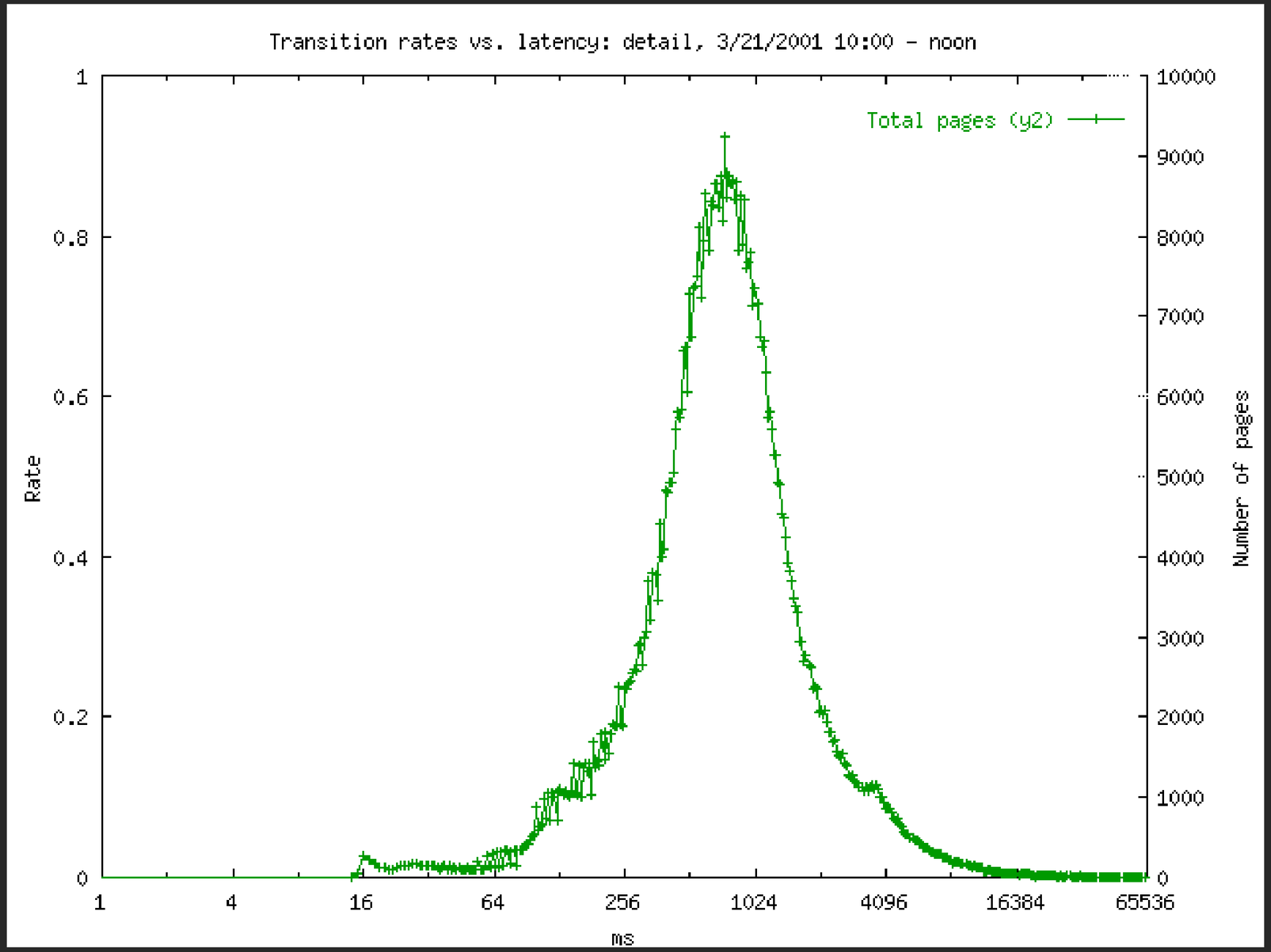

Transition rates vs. latency: detail, 3/21/2001 10:00 - noon
Total pages (y2)
Rate
Number of pages
ms
0
0.2
0.4
0.6
0.8
1
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
1
4
16
64
256
1024
4096
16384
65536

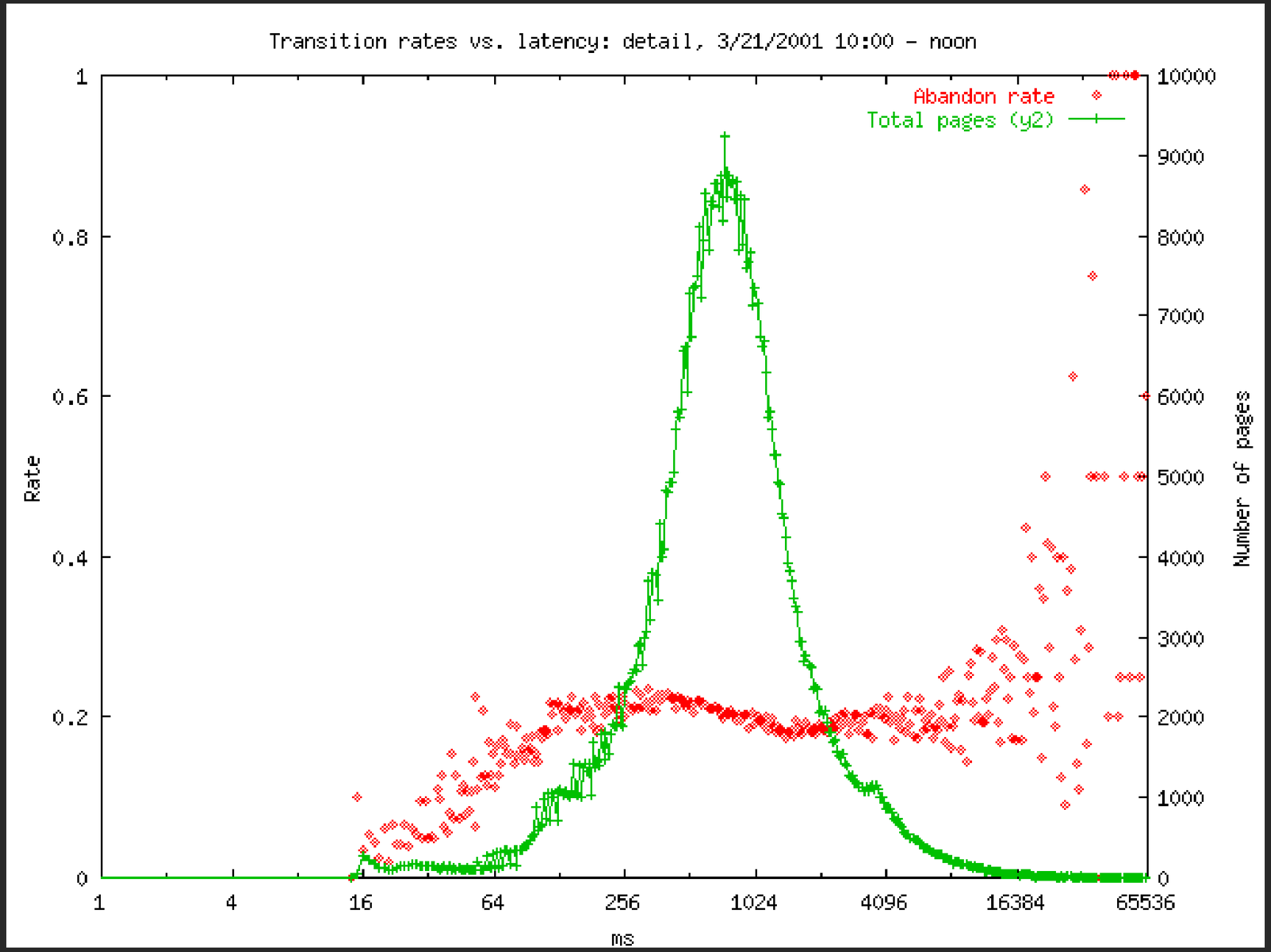

Transition rates vs. latency: detail, 3/21/2001 10:00 - noon
Total pages (y2)
Rate
Number of pages
ms
0
0.2
0.4
0.6
0.8
1
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
1
4
16
64
256
1024
4096
16384
65536

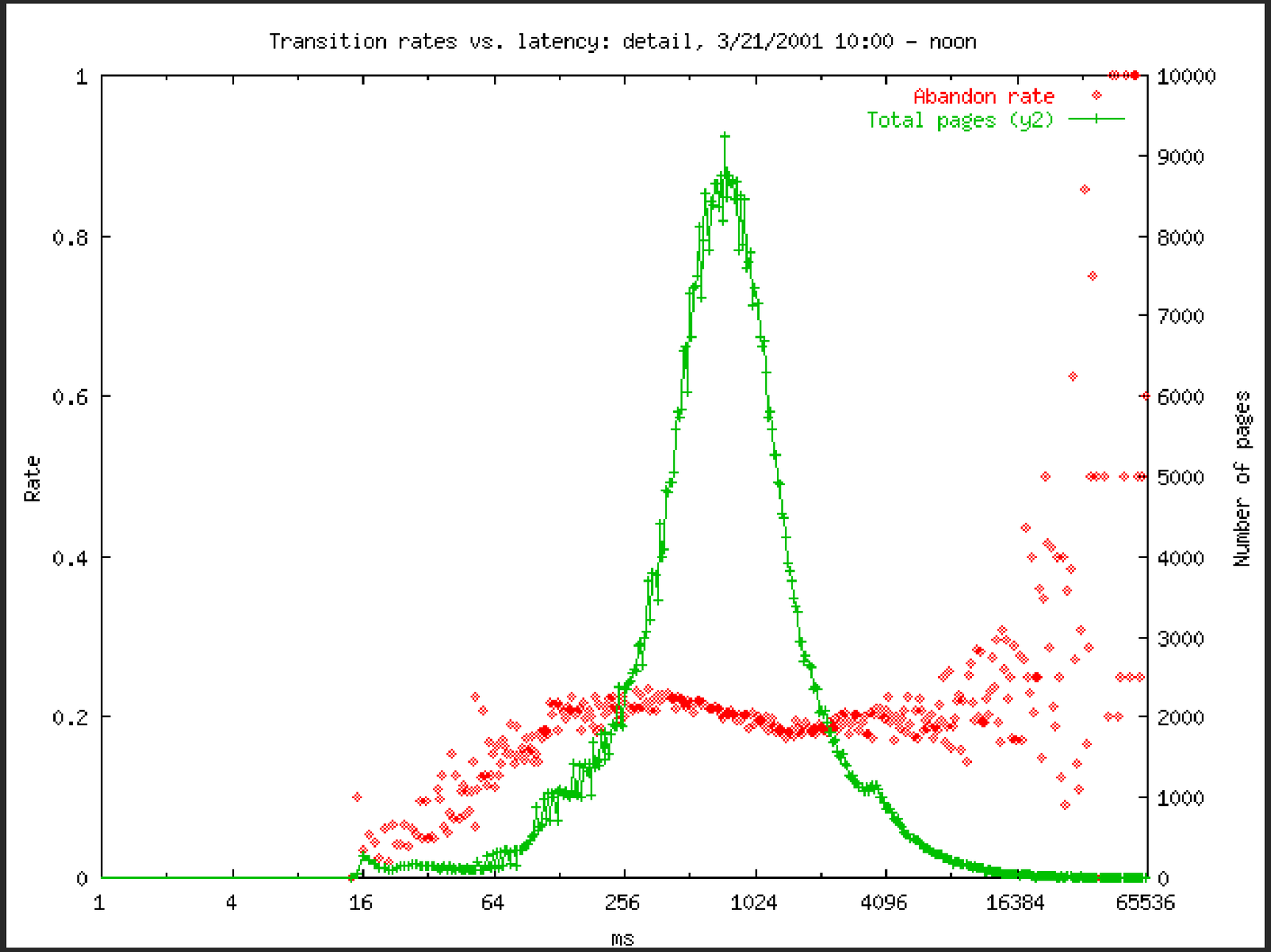

Transition rates vs. latency: detail, 3/21/2001 10:00 - noon
Total pages (y2)
Rate
Number of pages
ms
0
0.2
0.4
0.6
0.8
1
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
1
4
16
64
256
1024
4096
16384
65536

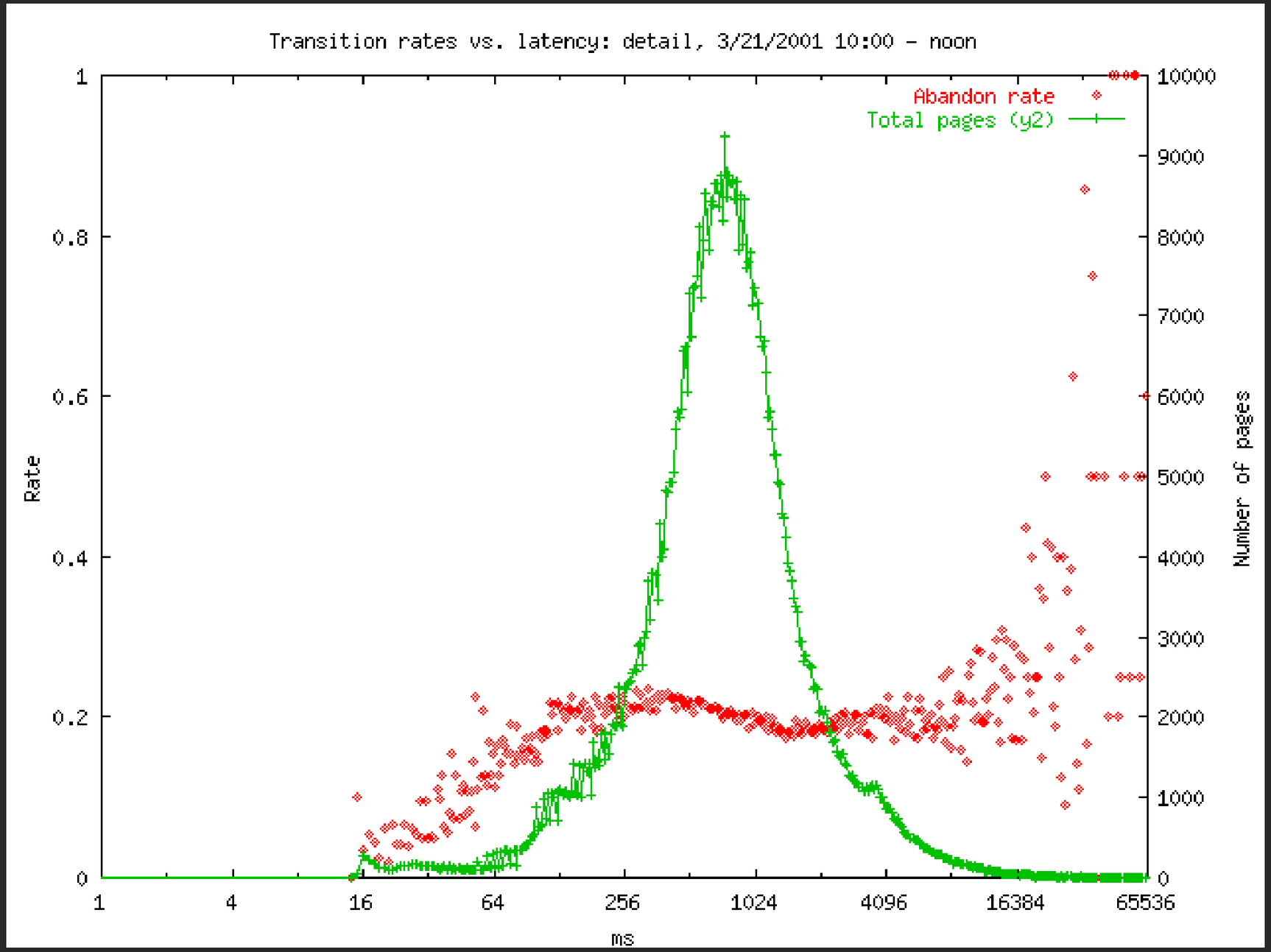

Transition rates vs. latency: detail, 3/21/2001 10:00 - noon
Total pages (y2)
Rate
Number of pages
ms
0
0.2
0.4
0.6
0.8
1
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
1
4
16
64
256
1024
4096
16384
65536

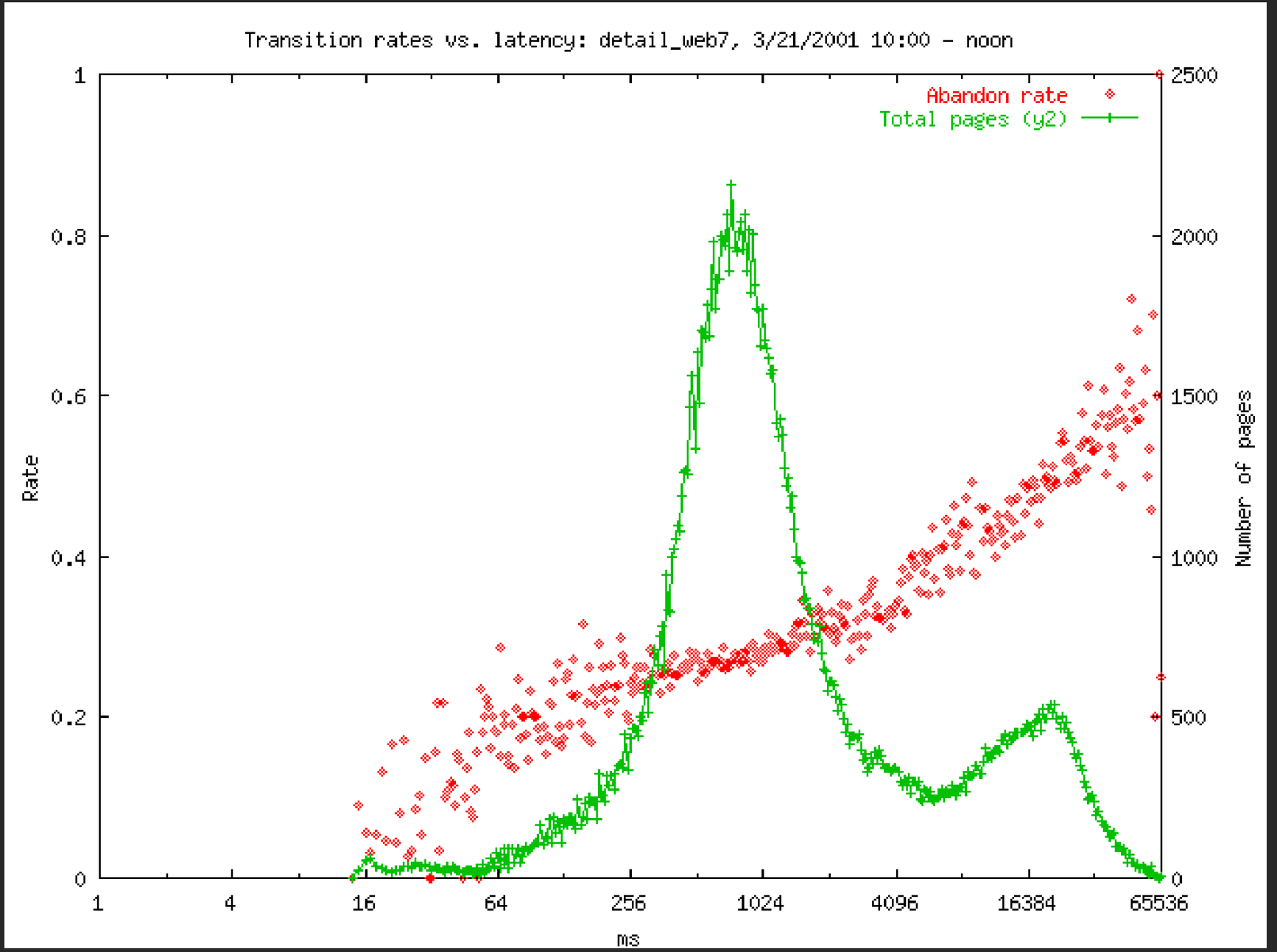

Transition rates vs. latency: detail, 3/21/2001 10:00 - noon
Total pages (y2)
Rate
Number of pages
ms
0
0.2
0.4
0.6
0.8
1
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
1
4
16
64
256
1024
4096
16384
65536

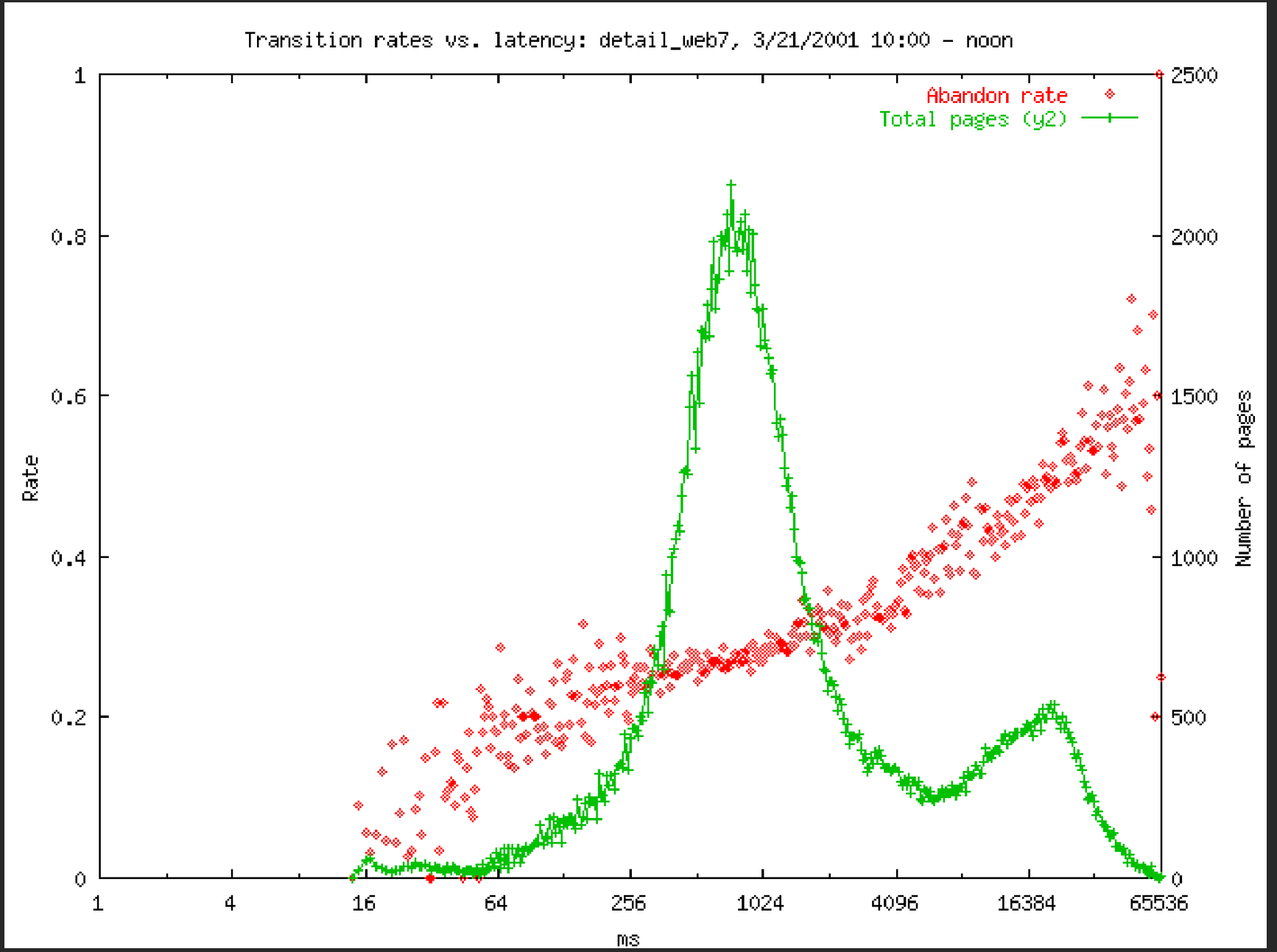

Transition rates vs. latency: detail, 3/21/2001 10:00 - noon
Total pages (y2)
Rate
Number of pages
ms
0
0.2
0.4
0.6
0.8
1
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
1
4
16
64
256
1024
4096
16384
65536

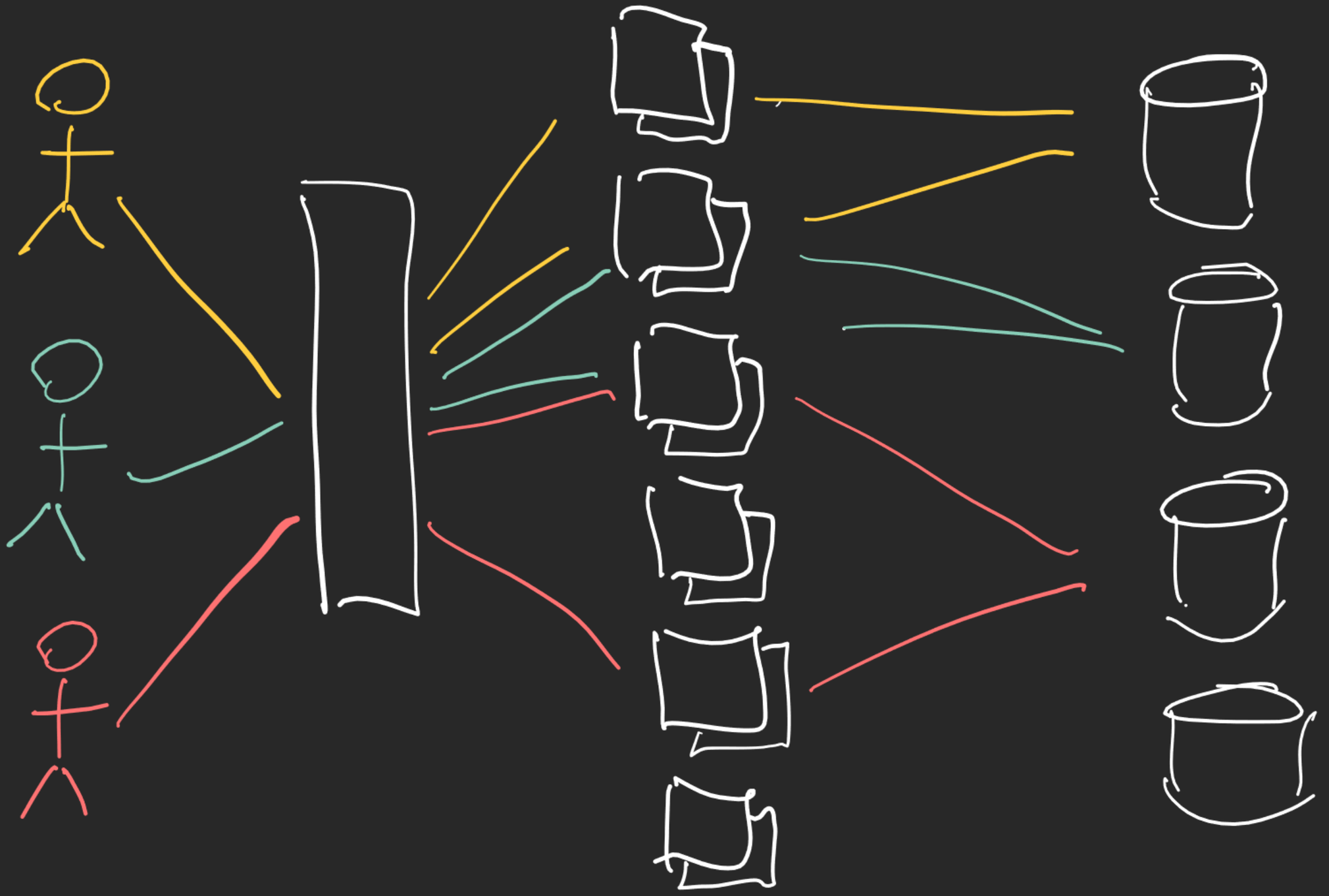

Transition rates vs. latency: detail, 3/21/2001 10:00 - noon
Abandon rate
Total pages (y2)
Rate
Number of pages
ms
0
0.2
0.4
0.6
0.8
1
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
1
4
16
64
256
1024
4096
16384
65536


Transition rates vs. latency: detail, 3/21/2001 10:00 - noon
Abandon rate
Total pages (y2)
Rate
Number of pages
ms
0
0.2
0.4
0.6
0.8
1
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
1
4
16
64
256
1024
4096
16384
65536

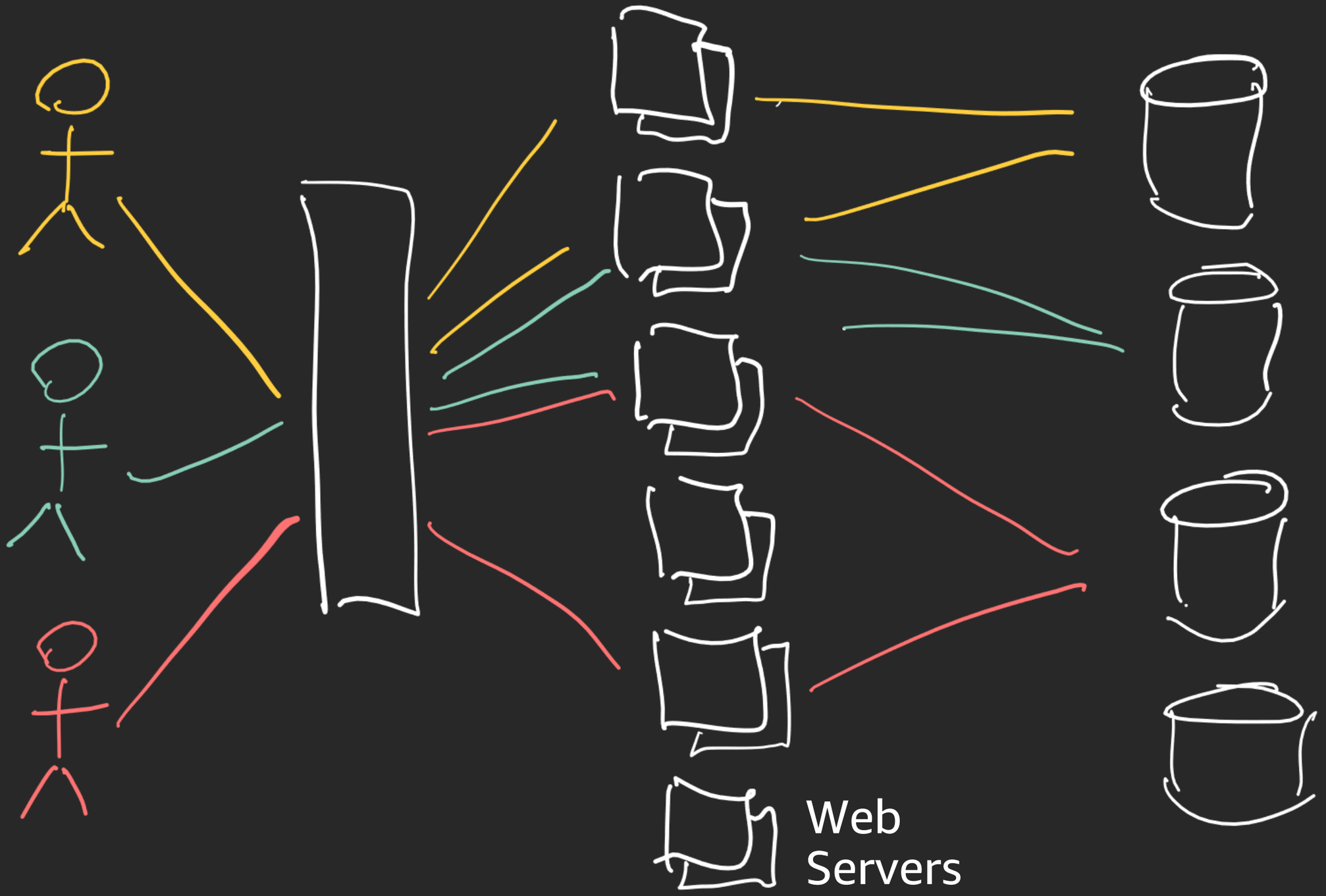

Transition rates vs. latency: detail, 3/21/2001 10:00 - noon
Abandon rate
Total pages (y2)
Rate
Number of pages
ms
0
0.2
0.4
0.6
0.8
1
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
1
4
16
64
256
1024
4096
16384
65536


Transition rates vs. latency: detail_web7, 3/21/2001 10:00 - noon
Abandon rate
Total pages (y2)
Rate
Number of pages
ms
1
0.8
0.6
0.4
0.2
0
2500
2000
1500
1000
500
0
1
4
16
64
256
1024
4096
16384
65536

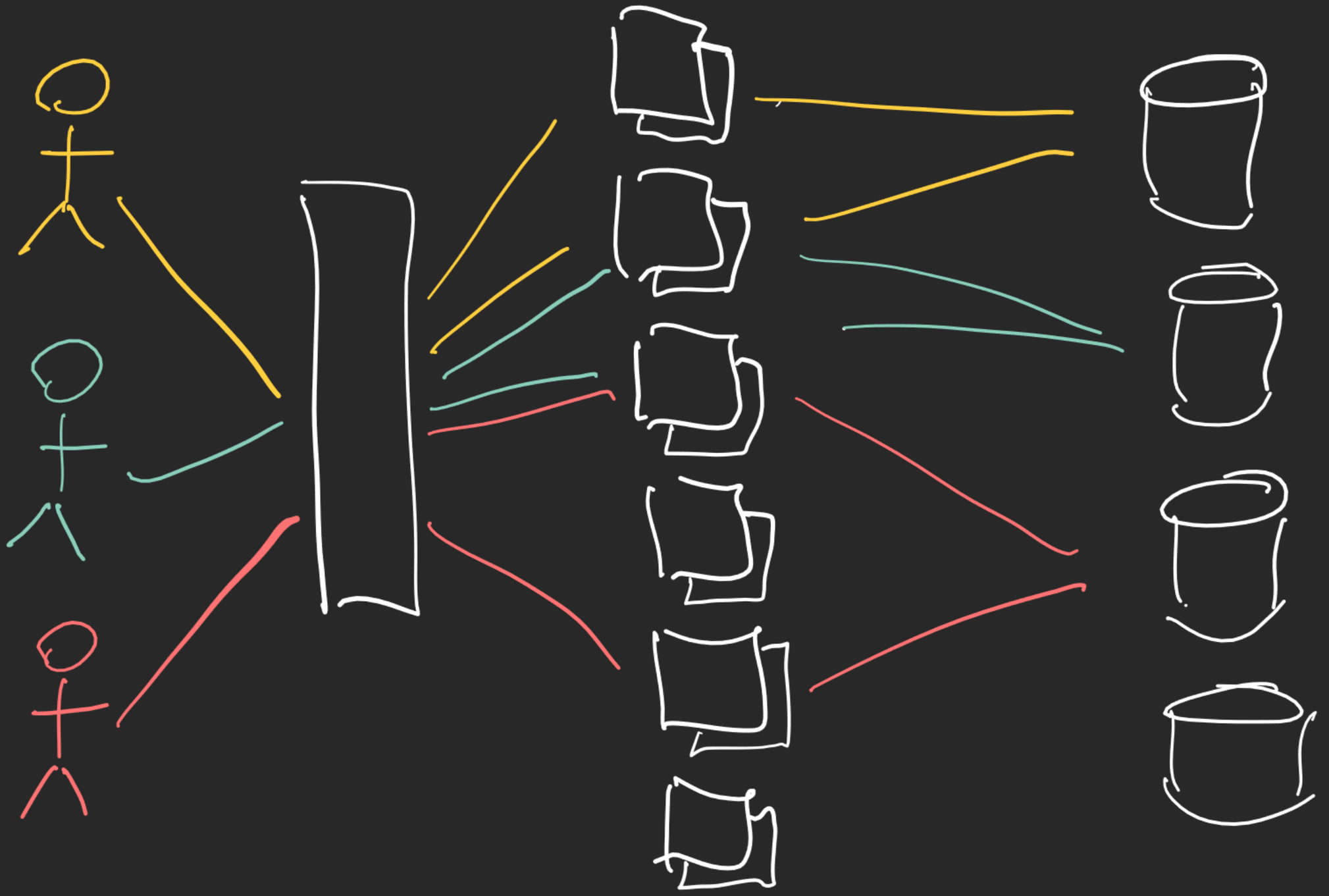

Transition rates vs. latency: detail_web7, 3/21/2001 10:00 - noon
Abandon rate
Total pages (y2)
Rate
Number of pages
ms
1
0.8
0.6
0.4
0.2
0
2500
2000
1500
1000
500
0
1
4
16
64
256
1024
4096
16384
65536

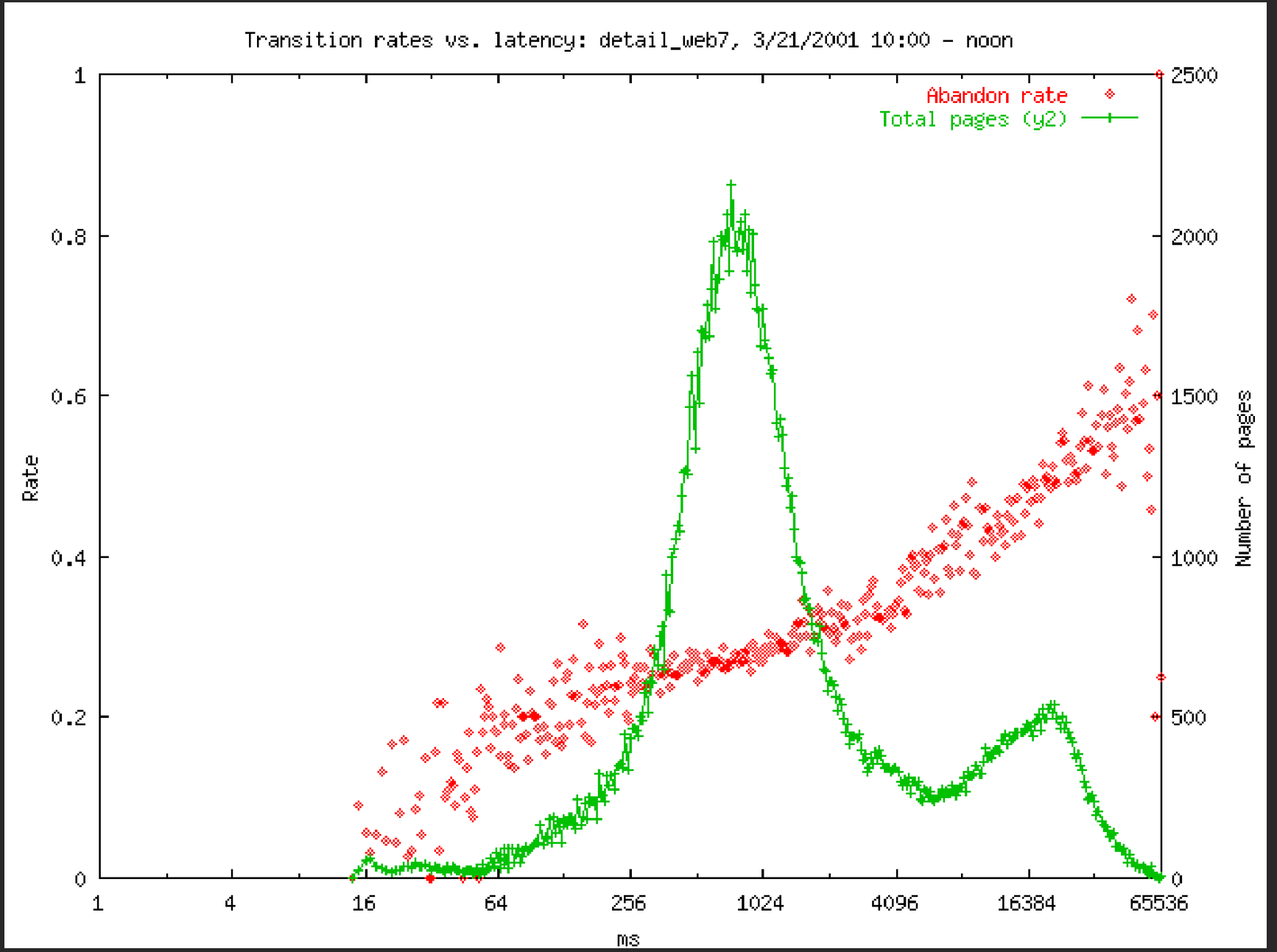


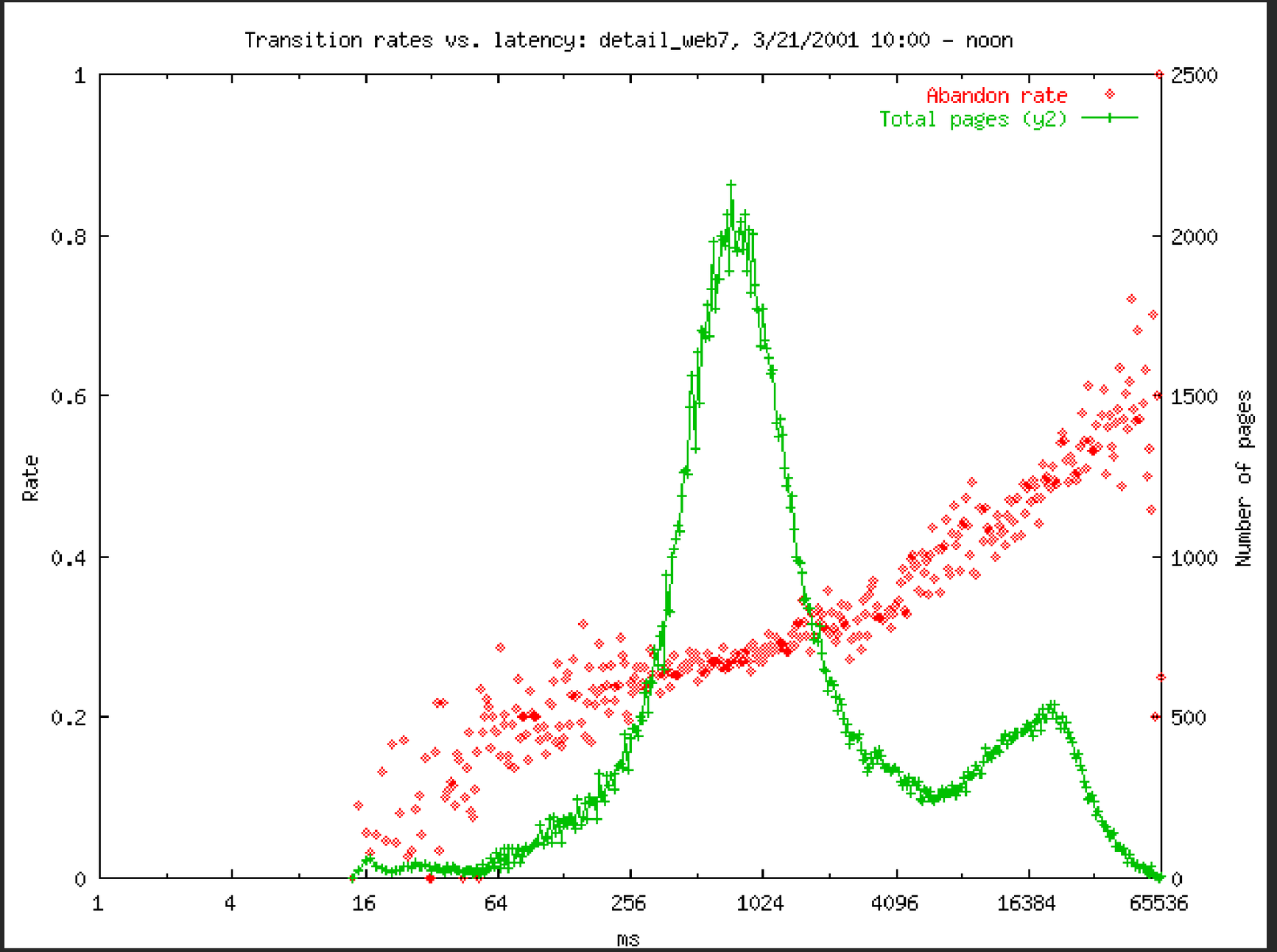

Load
Balancers

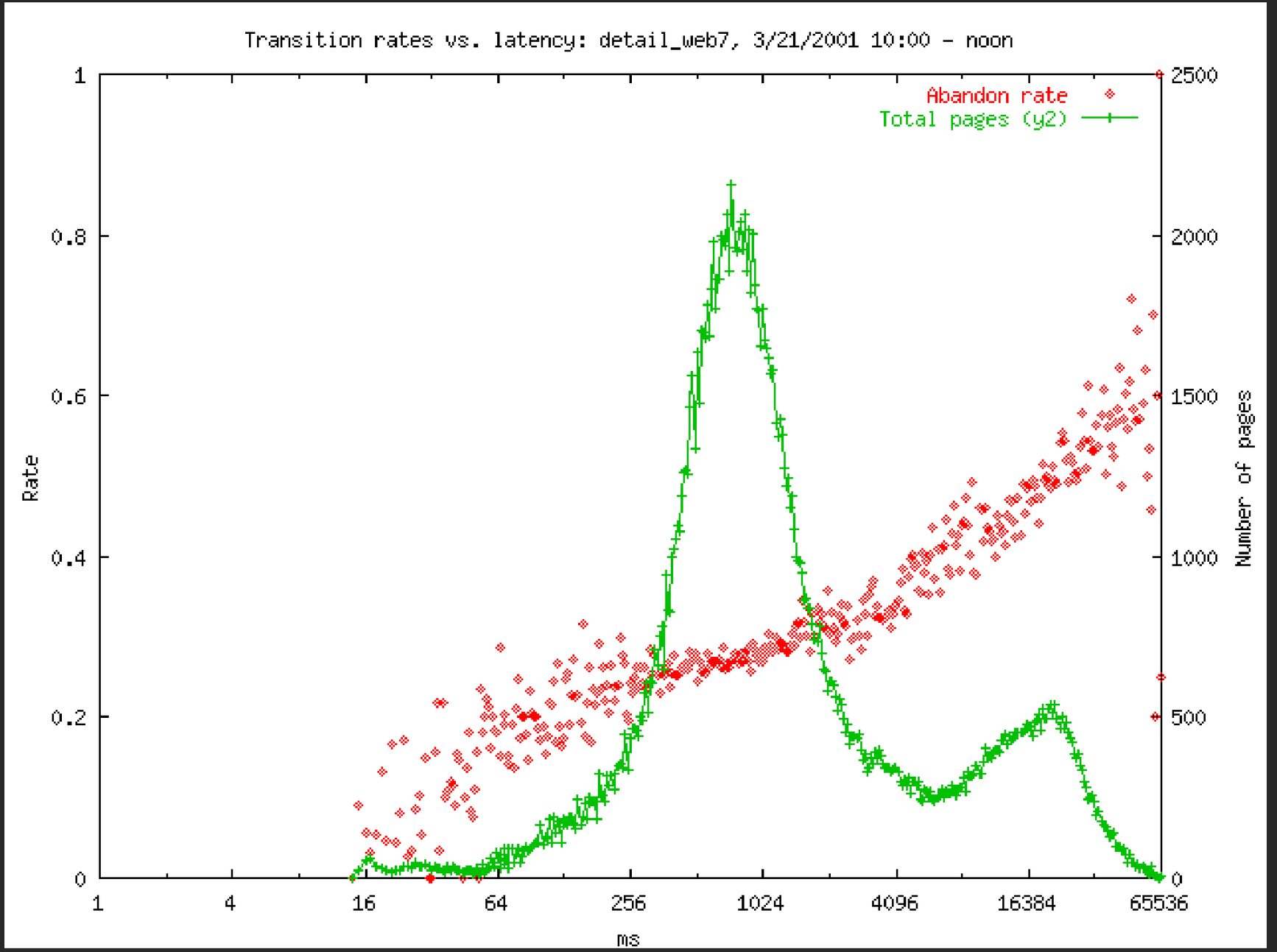

Web
Servers

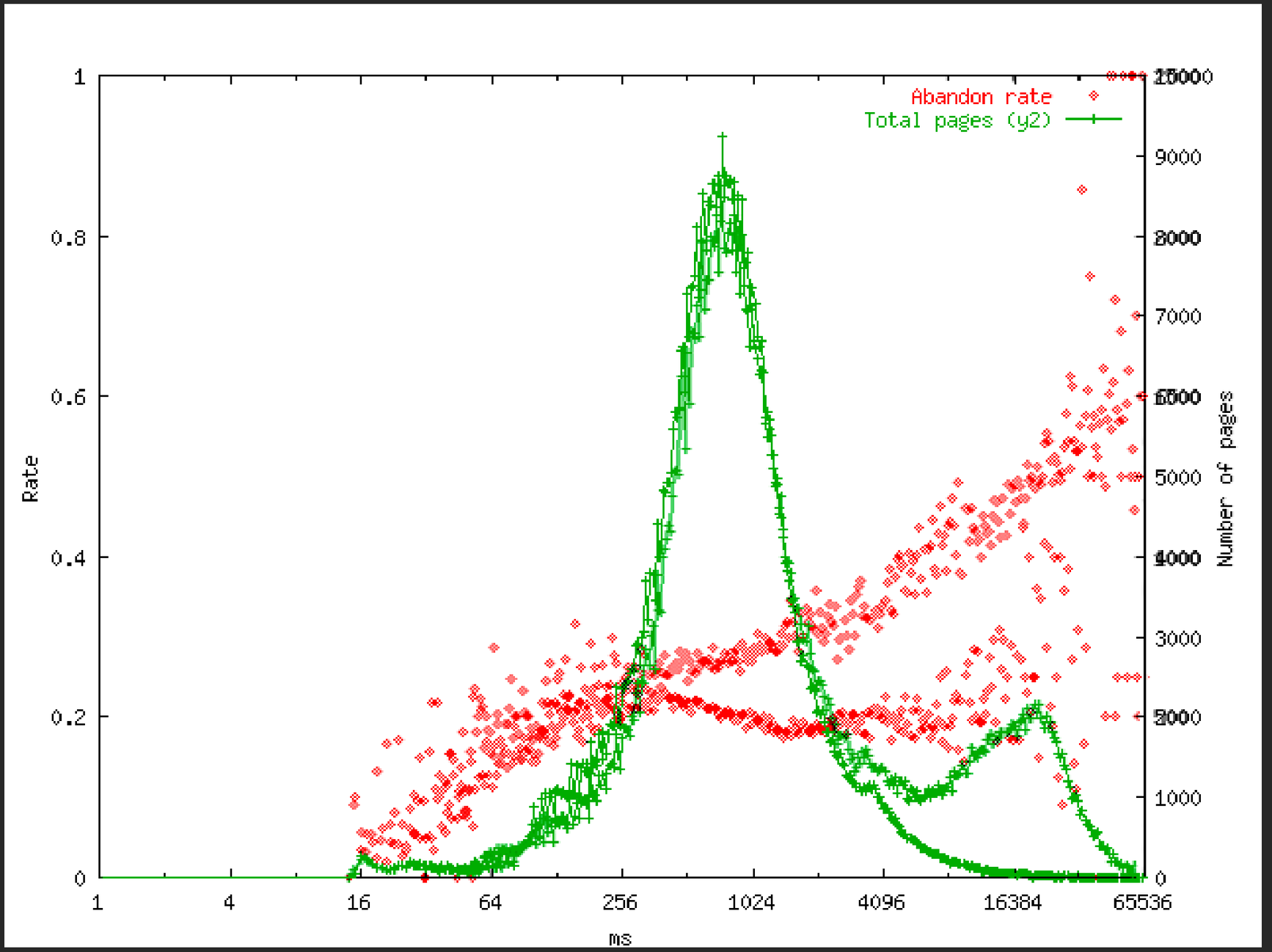

Databases

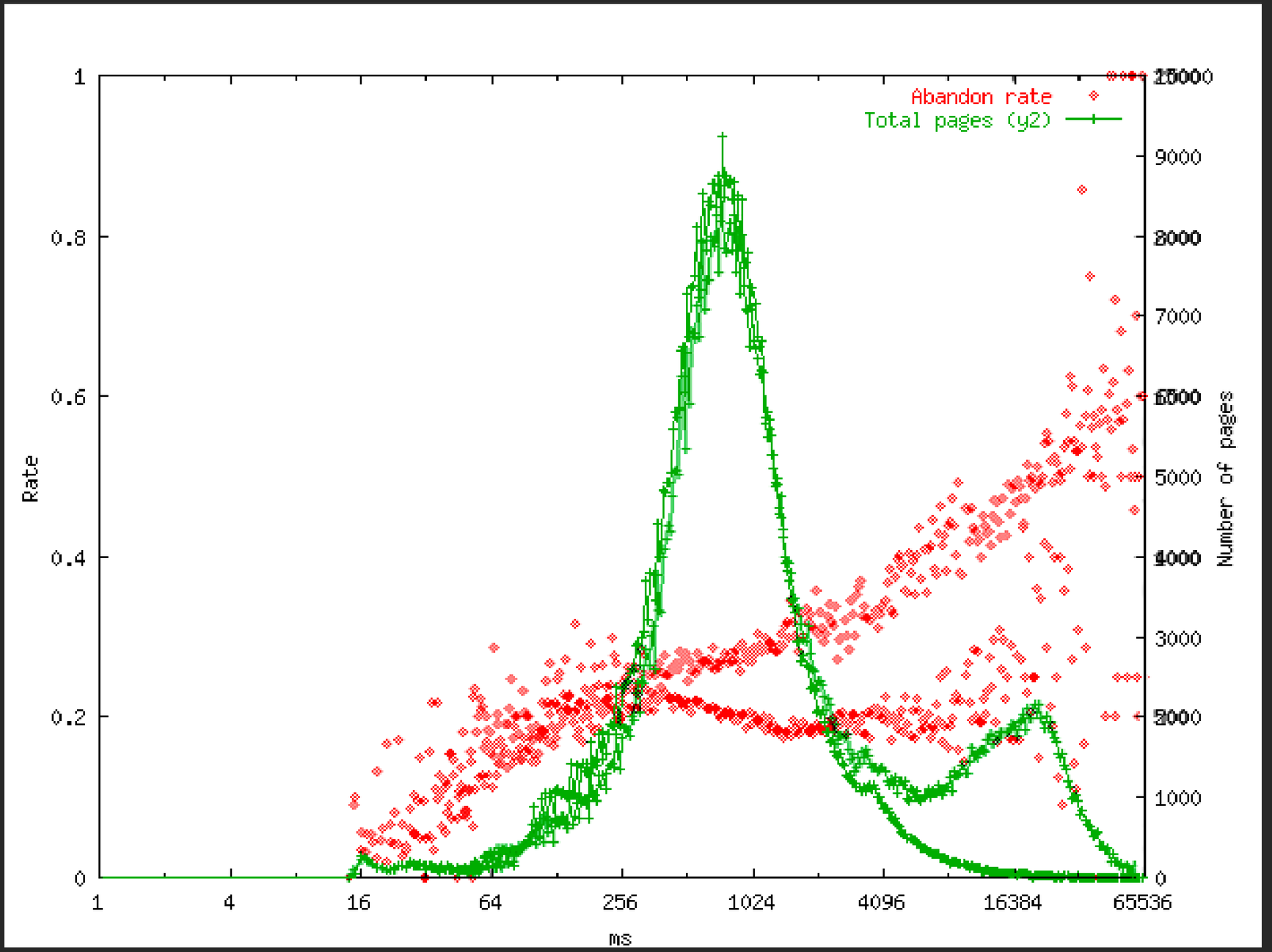


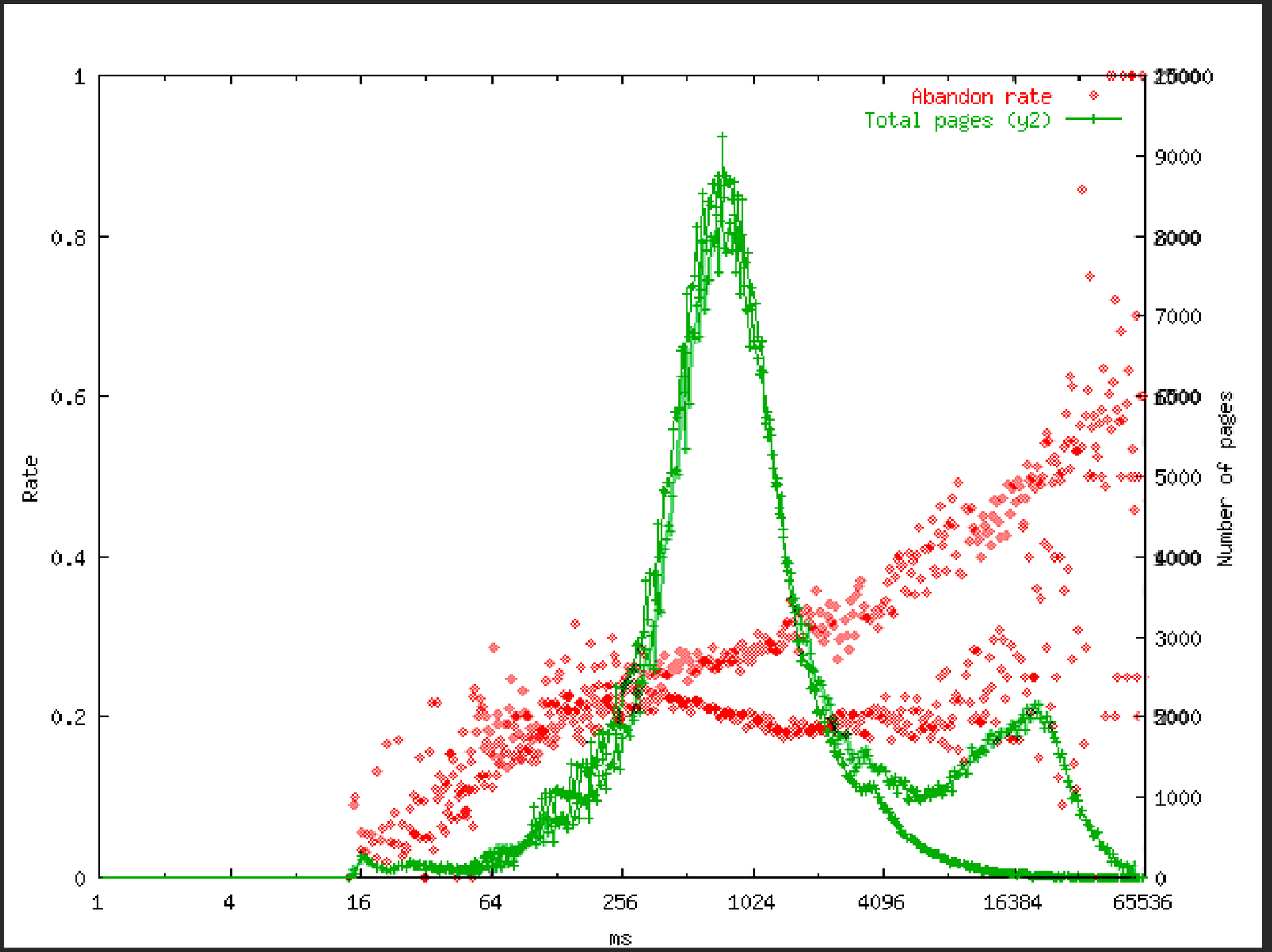

Transition rates vs. latency: detail_web7, 3/21/2001 10:00 - noon
Abandon rate
Total pages (y2)
Rate
Number of pages
ms
1
0.8
0.6
0.4
0.2
0
2500
2000
1500
1000
500
0
1
4
16
64
256
1024
4096
16384
65536

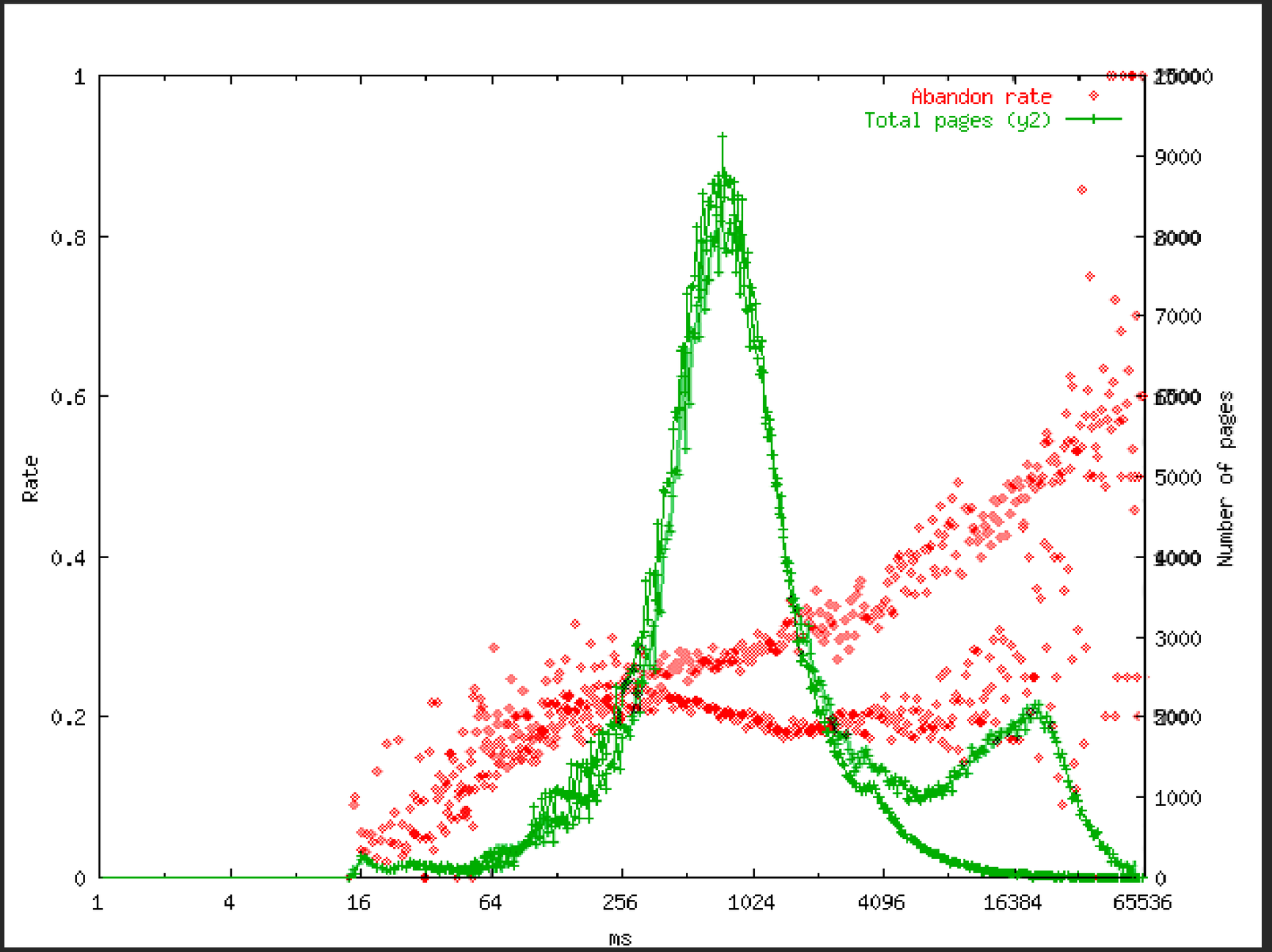

Transition rates vs. latency: detail_web7, 3/21/2001 10:00 - noon
Abandon rate
Total pages (y2)
Rate
Number of pages
ms
1
0.8
0.6
0.4
0.2
0
2500
2000
1500
1000
500
0
1
4
16
64
256
1024
4096
16384
65536

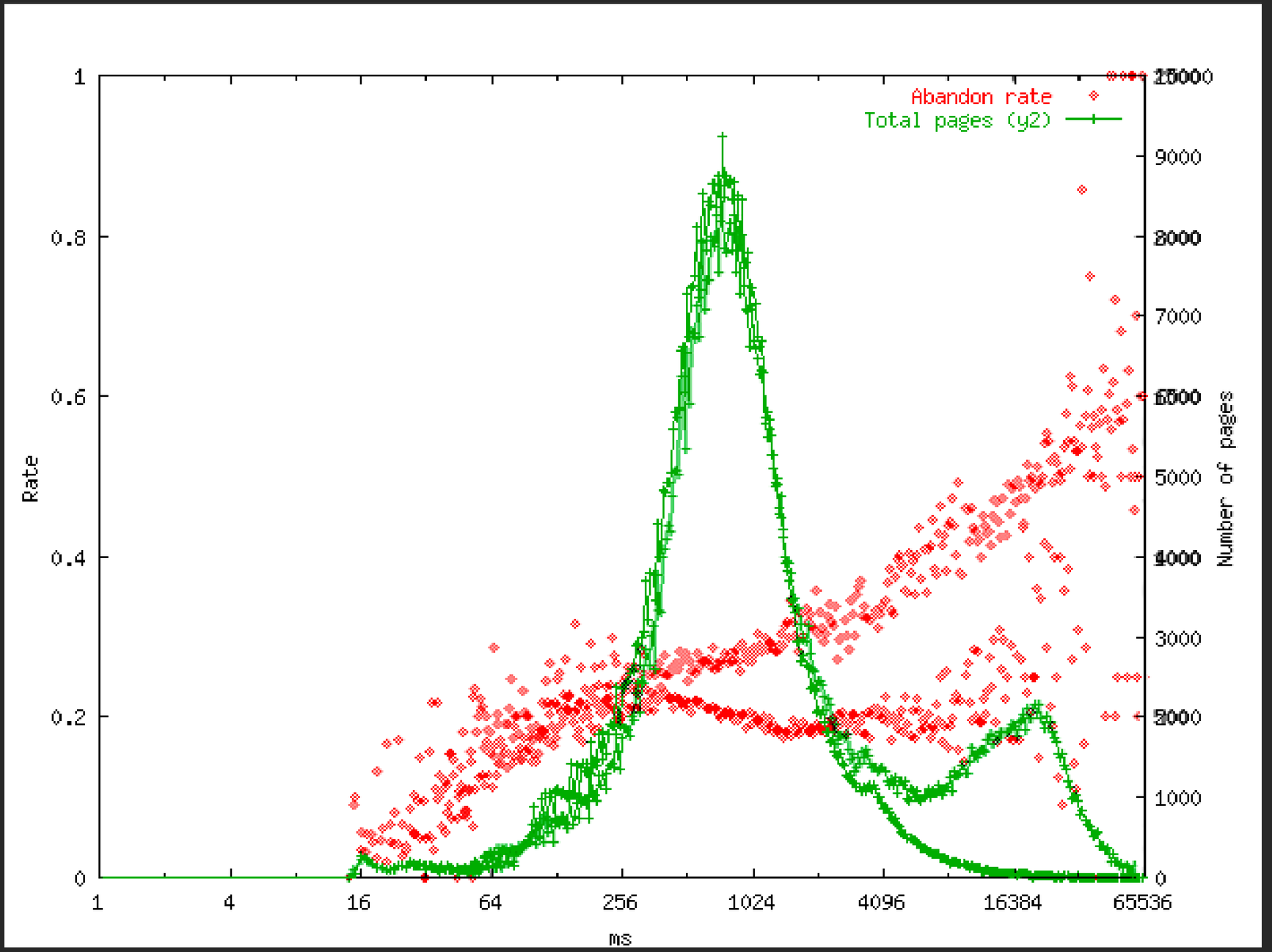

Transition rates vs. latency: detail_web7, 3/21/2001 10:00 - noon
Abandon rate
Total pages (y2)
Rate
Number of pages
ms
1
0.8
0.6
0.4
0.2
0
2500
2000
1500
1000
500
0
1
4
16
64
256
1024
4096
16384
65536


Abandon rate
Total pages (y2)
Rate
Number of pages
ms
0
0.2
0.4
0.6
0.8
1
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
1
4
16
64
256
1024
4096
16384
65536


Abandon rate
Total pages (y2)
Rate
Number of pages
ms
0
0.2
0.4
0.6
0.8
1
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
1
4
16
64
256
1024
4096
16384
65536

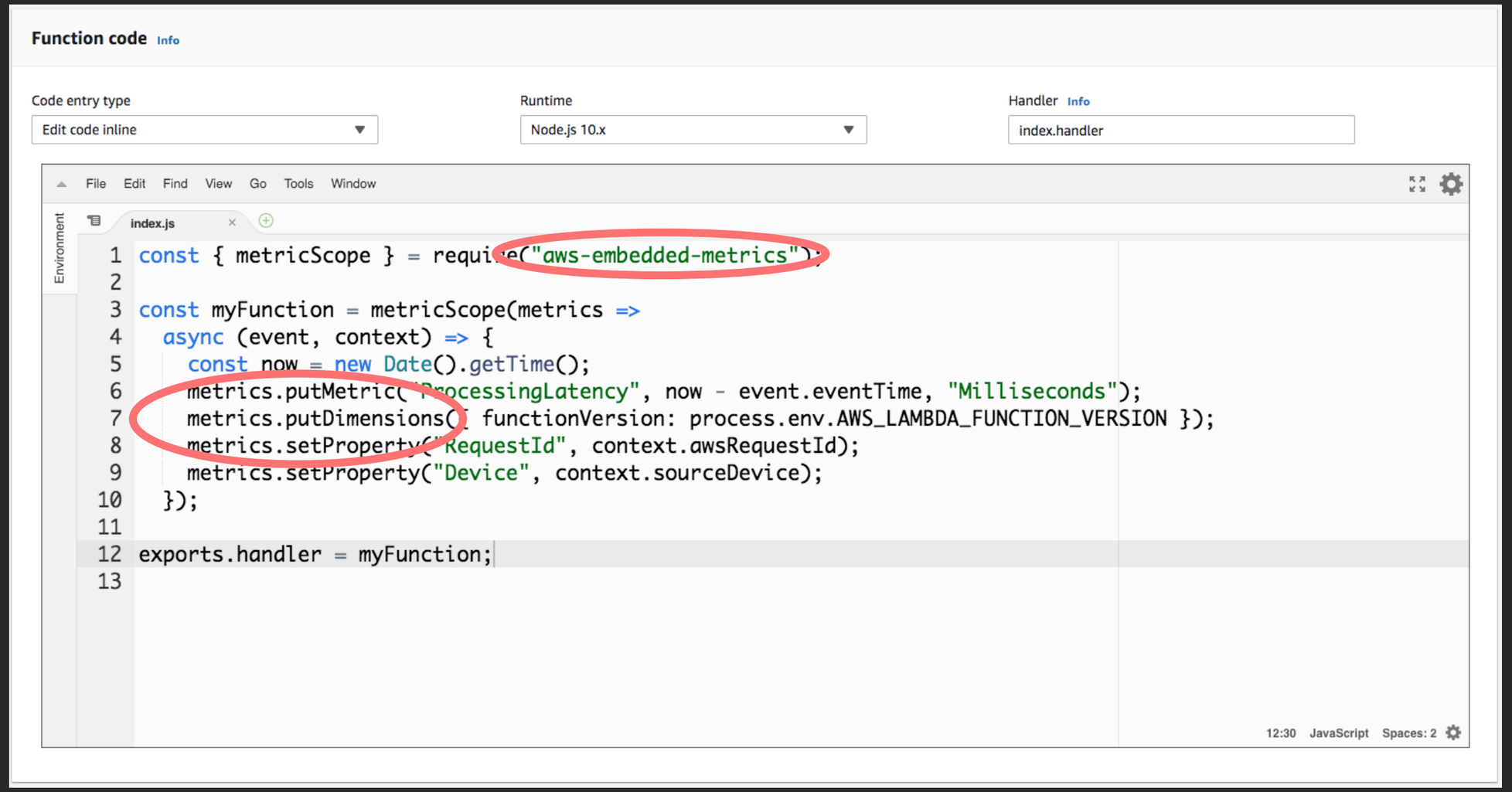

Abandon rate
Total pages (y2)
Rate
Number of pages
ms
0
0.2
0.4
0.6
0.8
1
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
1
4
16
64
256
1024
4096
16384
65536


Abandon rate
Total pages (y2)
Rate
Number of pages
ms
0
0.2
0.4
0.6
0.8
1
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
1
4
16
64
256
1024
4096
16384
65536


Abandon rate
Total pages (y2)
Rate
Number of pages
ms
0
0.2
0.4
0.6
0.8
1
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
1
4
16
64
256
1024
4096
16384
65536

Creating a Embedded Metric Format log in Lambda

Screenshot of Lambda function using the Node.js client library



https://github.com/awslabs/aws-embedded-metrics-node

Example JSON log event

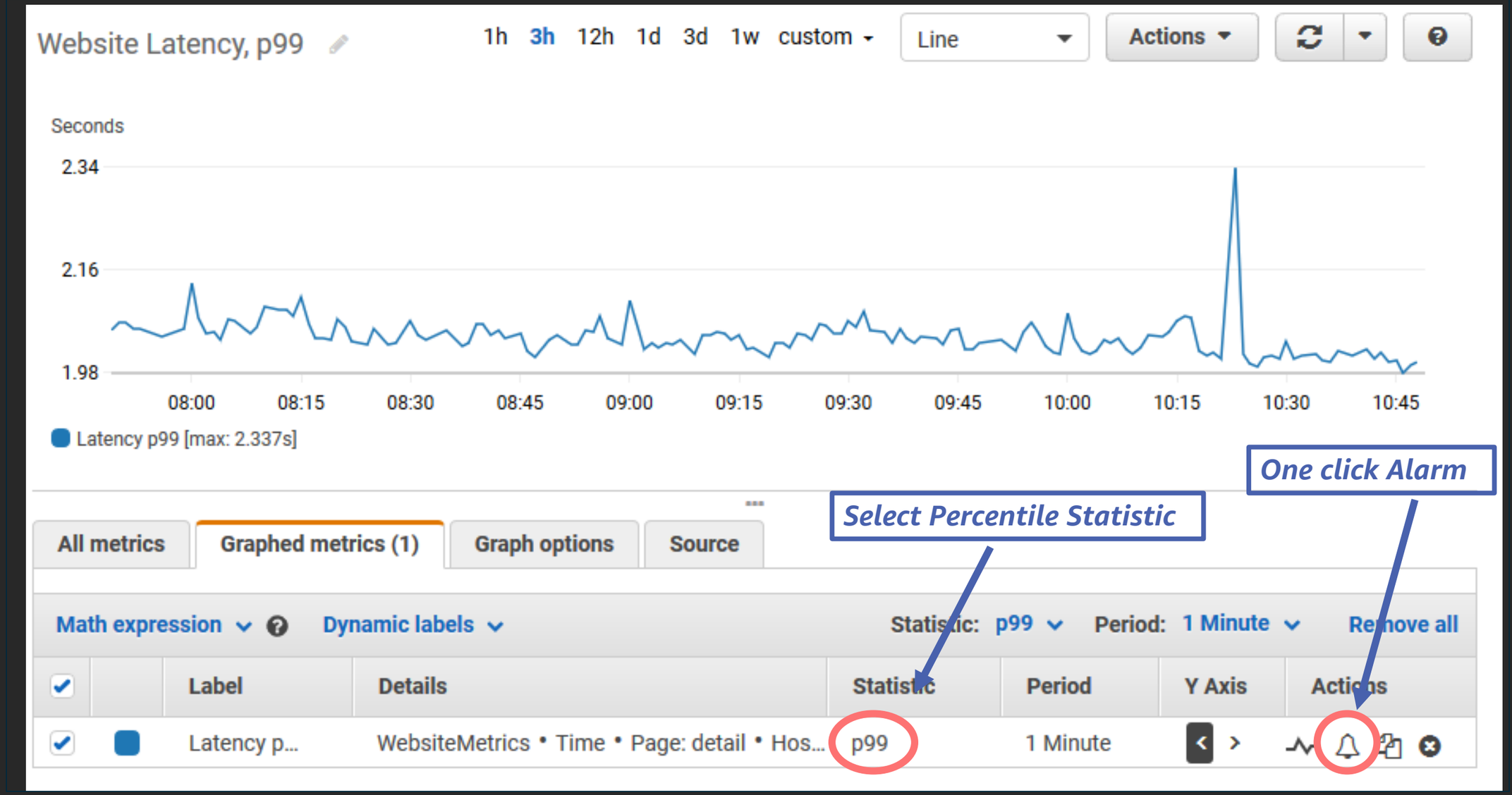
Time (UTC +00:00)	Message
2019-11-22	
	No older events found at the moment. Retry.
23:26:47	START RequestId: eeb90ca1-8ac1-40d5-a56d-84204ff23ec3 Version: $LATEST
23:26:47	2019-11-22T23:26:47.602Z eeb90ca1-8ac1-40d5-a56d-84204ff23ec3 INFO {"LogGroup":"CustomMetricsTest","ServiceNar

```
2019-11-22T23:26:47.602Z        eeb90ca1-8ac1-40d5-a56d-84204ff23ec3    INFO
{
    "LogGroup": "CustomMetricsTest",
    "ServiceName": "CustomMetricsTest",
    "ServiceType": "AWS::Lambda::Function",
    "functionVersion": "$LATEST",
    "RequestId": "422b1569-16f6-4a03-b8f0-fe3fd9b100f8",
    "Device": "61270781-c6ac-46f1-baf7-22c808af8162",
    "executionEnvironment": "AWS_Lambda_nodejs10.x",
    "memorySize": "1216",
    "logStreamId": "2019/11/22/[$LATEST]3bbdddd832d047d2a0d00055a27c6b08",
    "_aws": {
        "Timestamp": 1574465207600,
        "CloudWatchMetrics": [
            {
                "Dimensions": [
                    [
                        "LogGroup",
                        "ServiceName",
                        "ServiceType",
                        "functionVersion"
                    ]
                ],
                "Metrics": [
                    {
                        "Name": "ProcessingLatency",
                        "Unit": "Milliseconds"
                    }
                ],
                "Namespace": "aws-embedded-metrics"
            }
        ]
    },
    "ProcessingLatency": 229.68621283057877
}
```

Environment and resource information included by default

Embedding custom metrics in detailed log event – specify namespace, metric names, dimensions, and units

Viewing percentile information on a Amazon CloudWatch metric



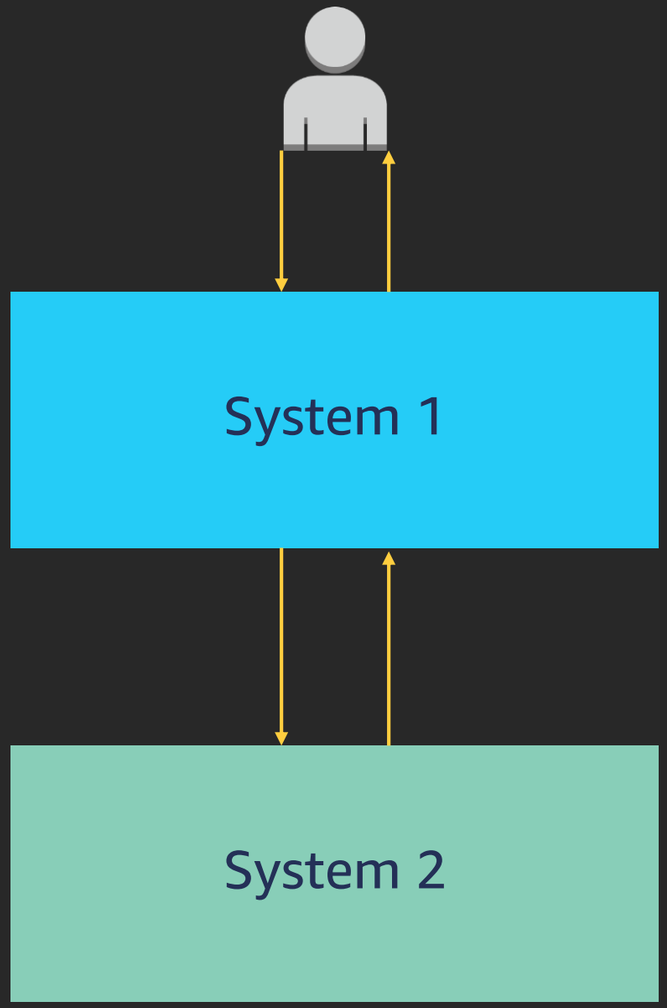
Static stability in AWS: Resilience in the face of impaired dependencies

AWS re:Invent

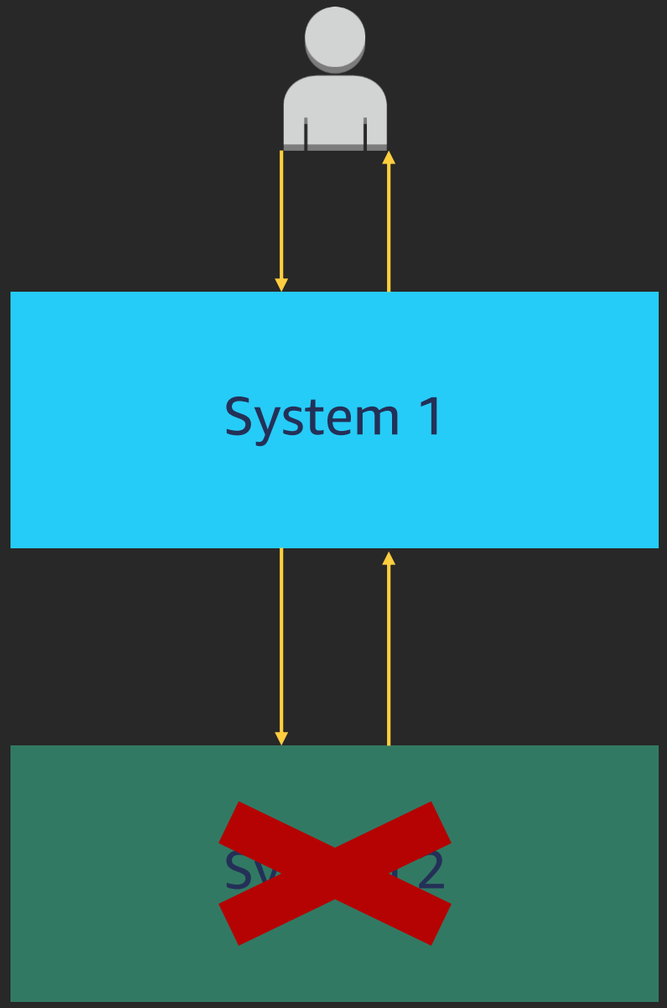
© 2019, Amazon Web Services, Inc. or its affiliates. All rights reserved.

aws

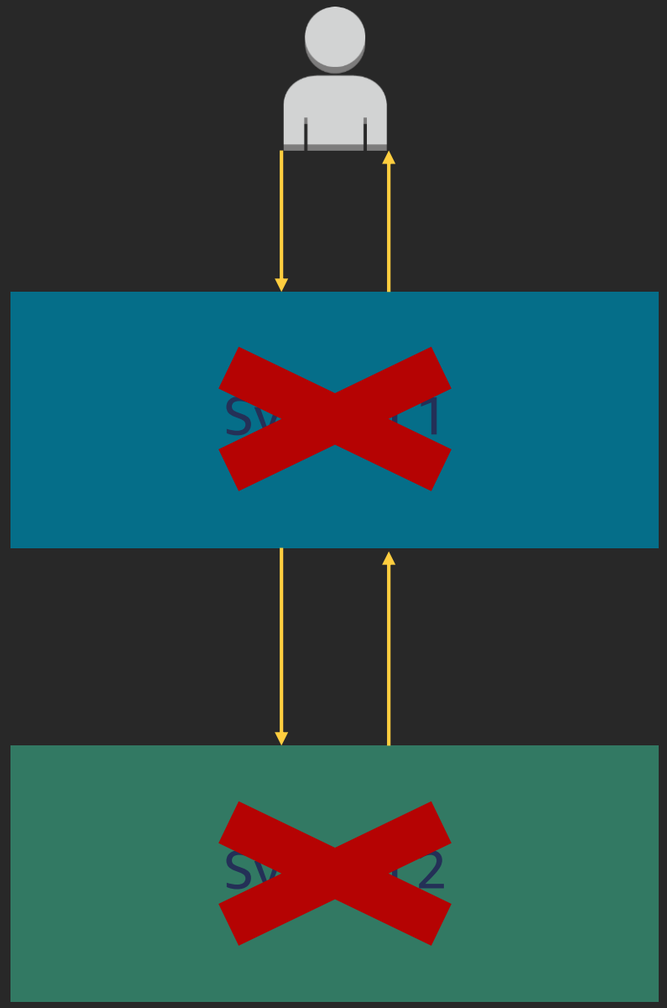
Dependencies: We all have them



Dependencies: We all have them



Dependencies: We all have them



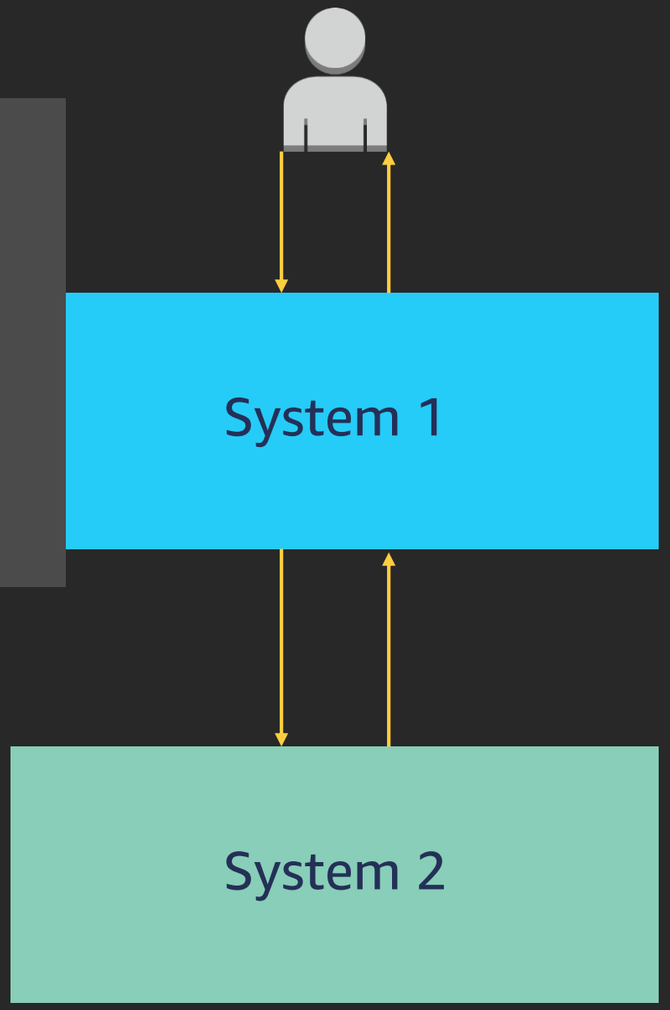
Dependencies: We all have them

Math:

For all p, q < 1:

p * q < p

p * q < q



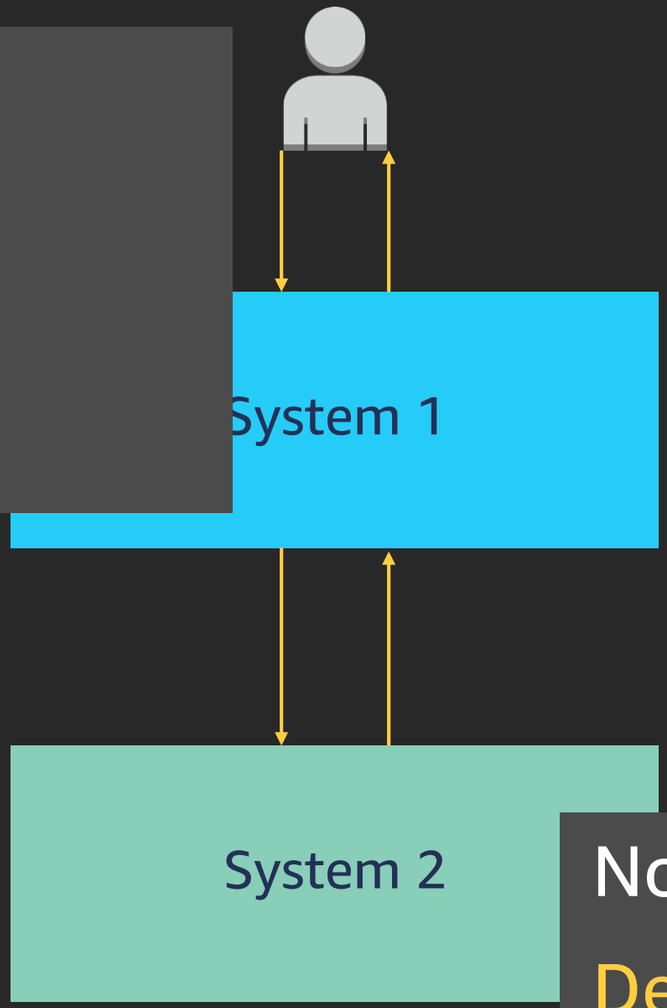
Dependencies: We all have them

Math:

For all 0 < p, q < 1:

p * q < p

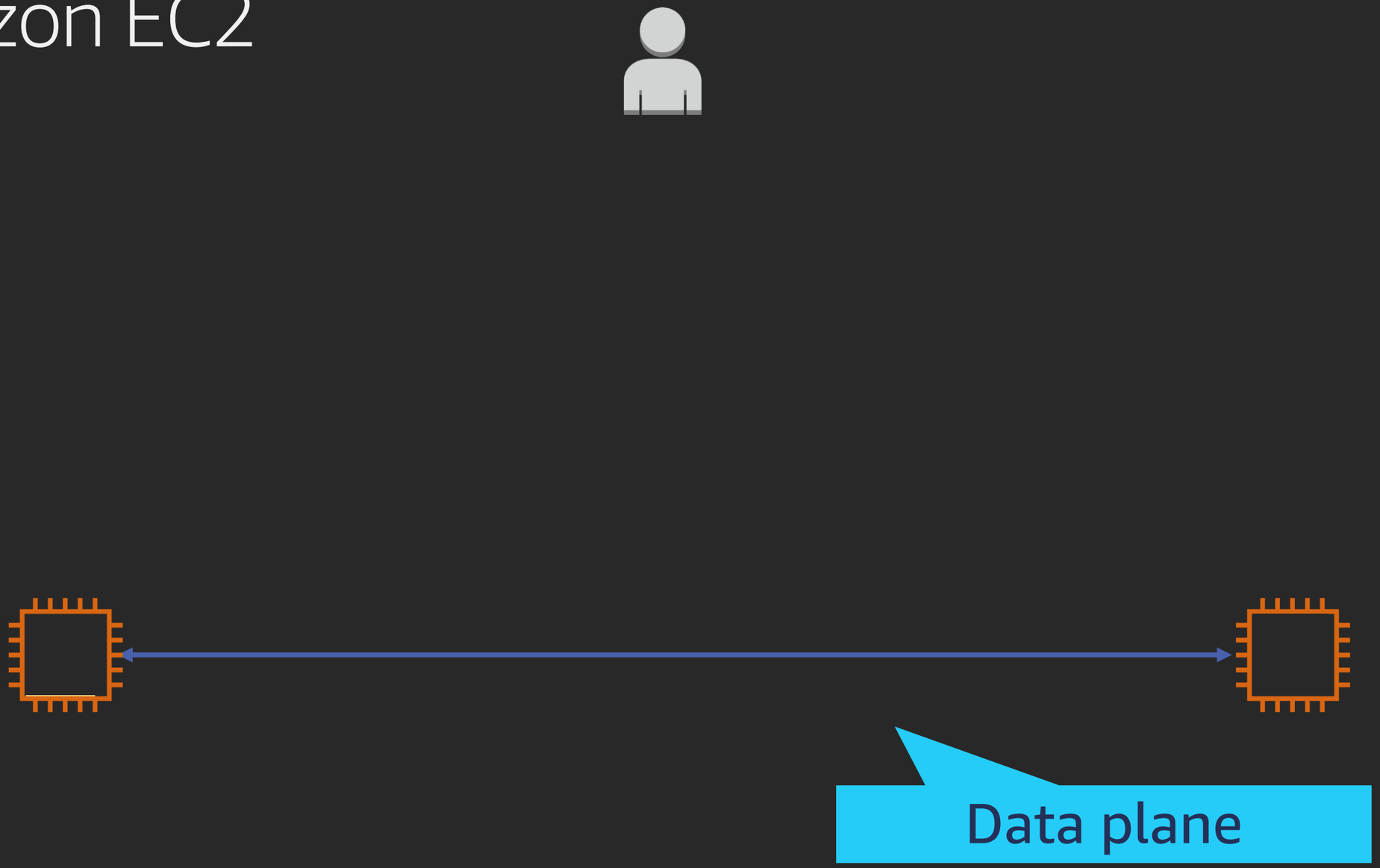
p * q < q



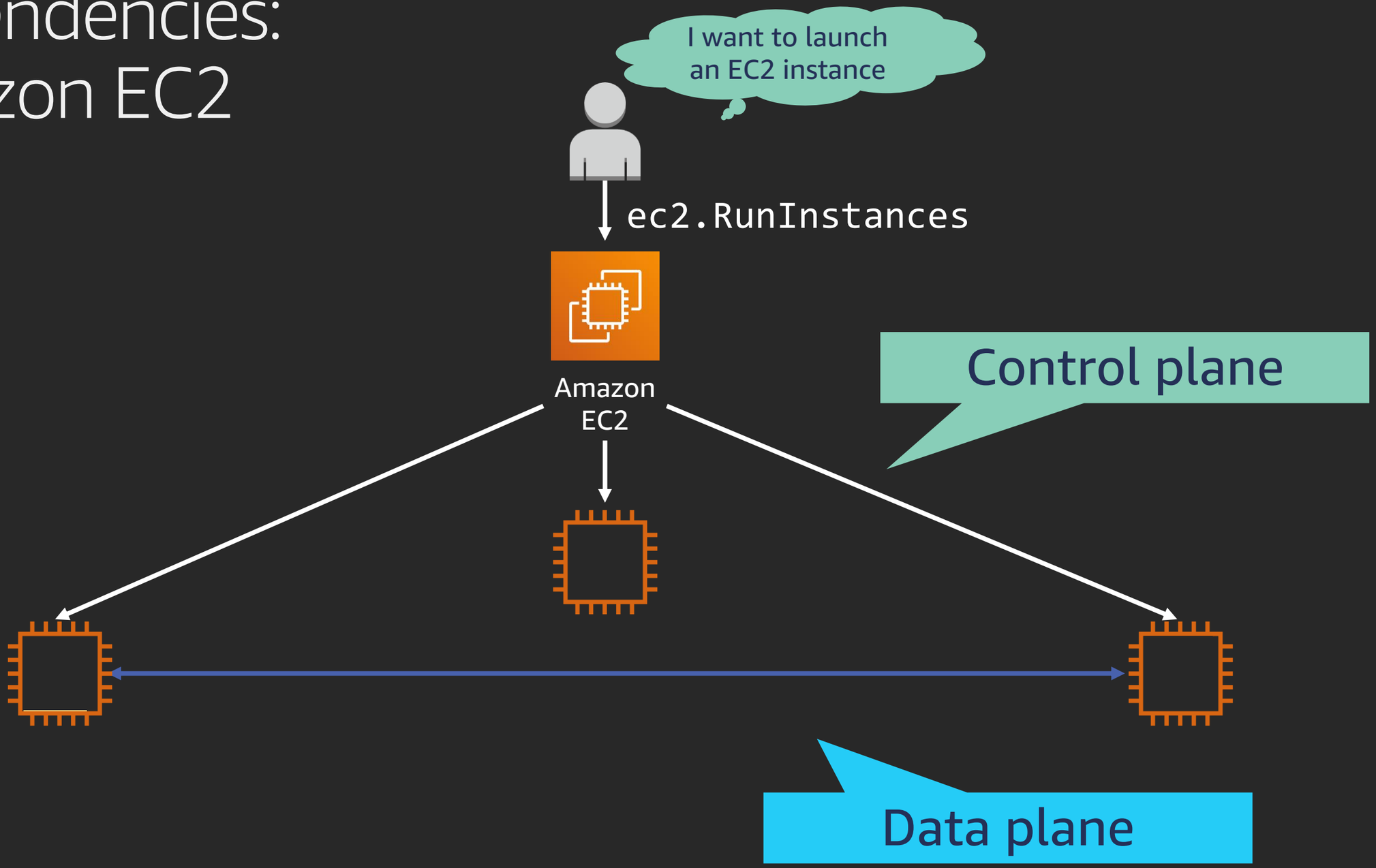
Not math:

Dependencies reduce availability

Dependencies: Amazon EC2



Dependencies: Amazon EC2

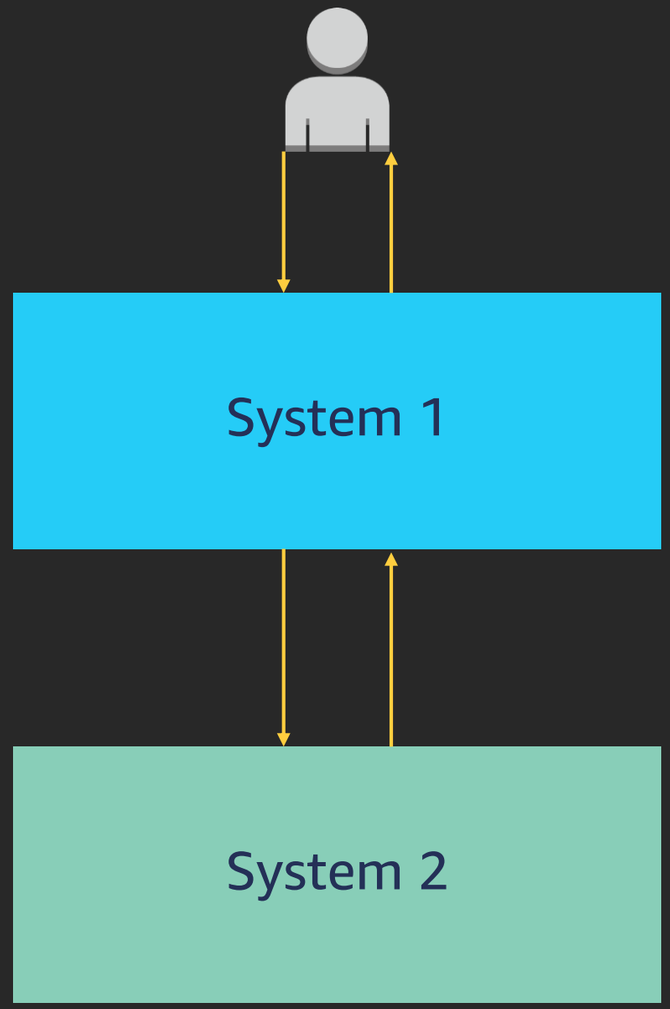


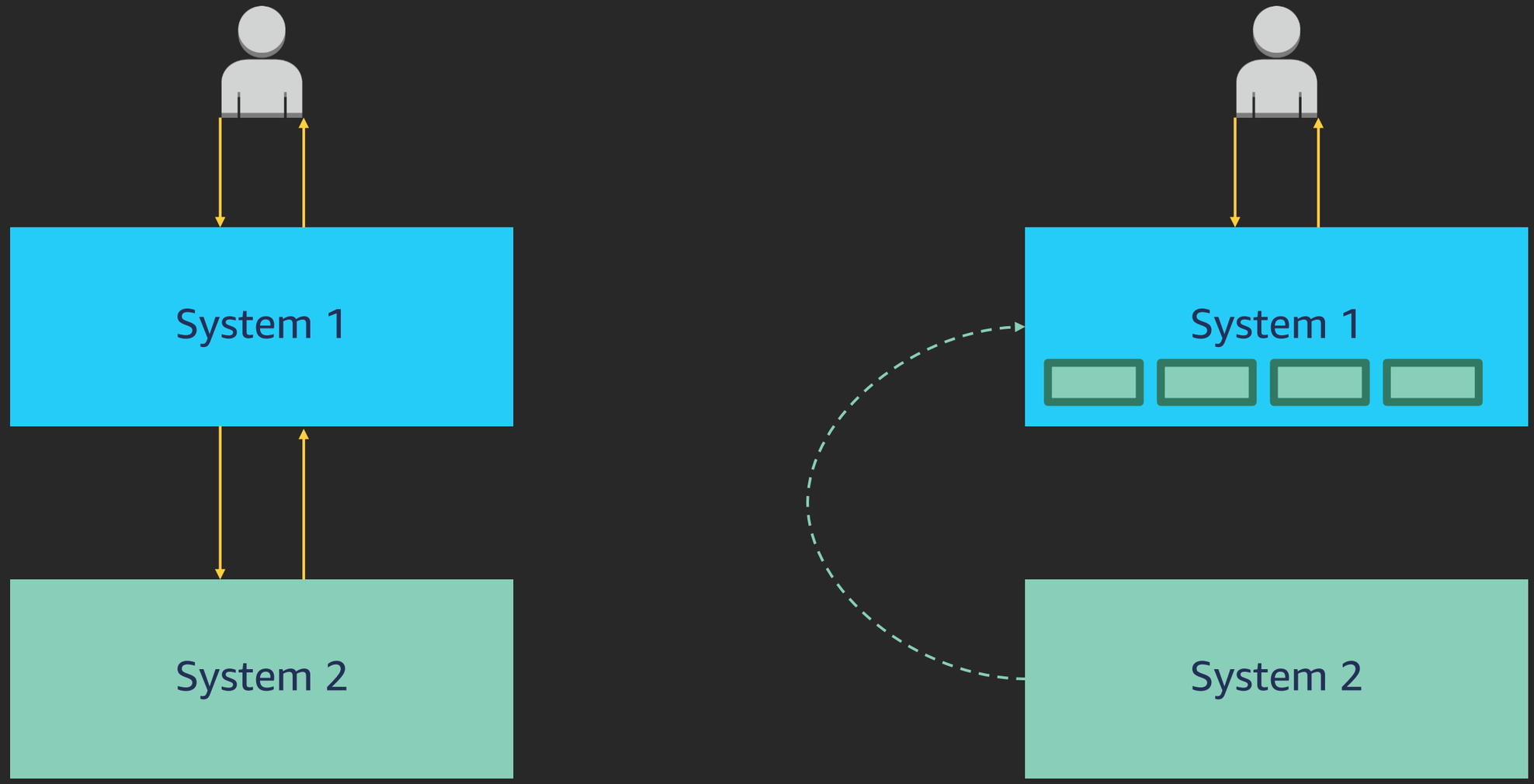
Question 1: Which of these systems is more important to the success of your customers?

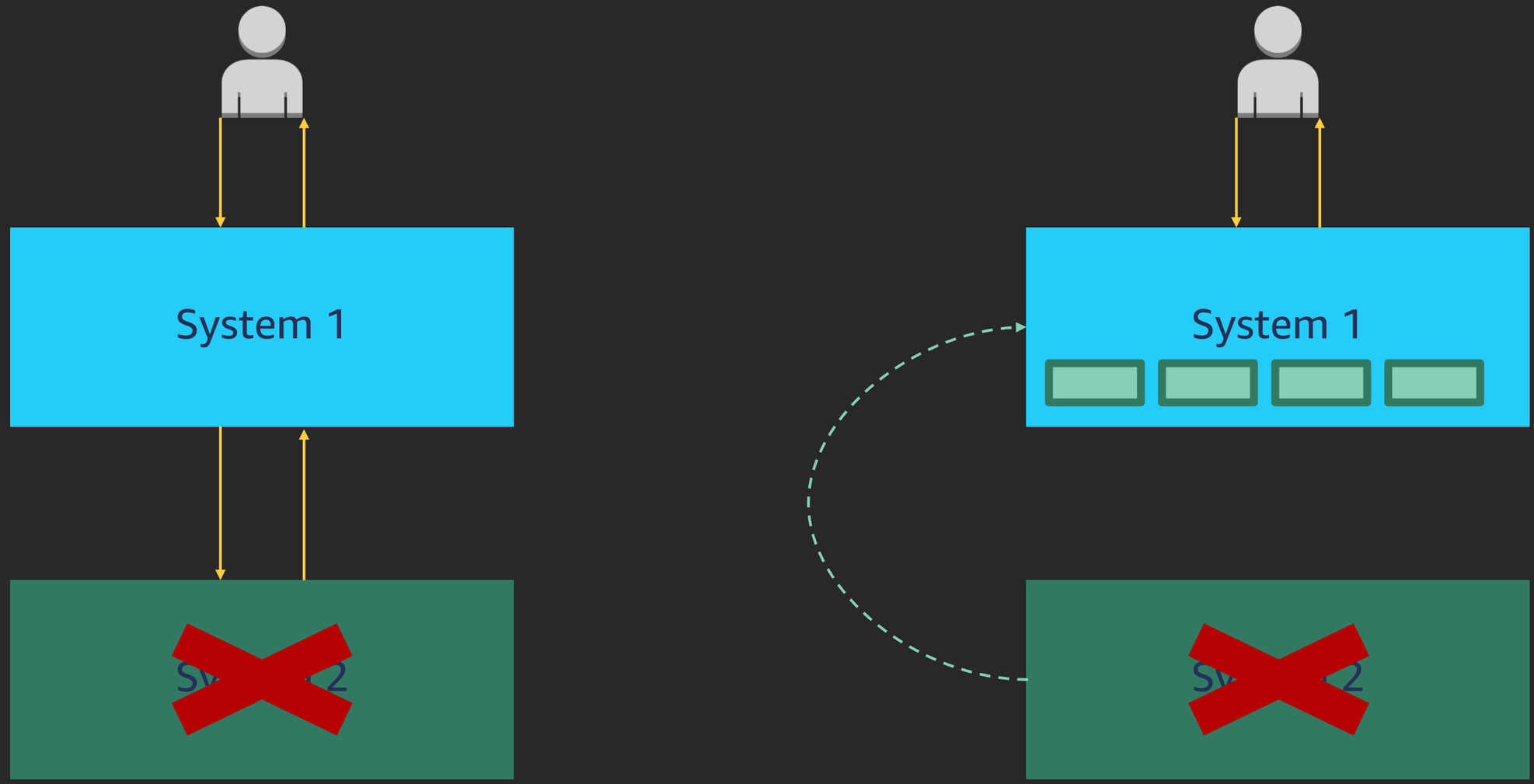
© 2019, Amazon Web Services, Inc. or its affiliates. All rights reserved.

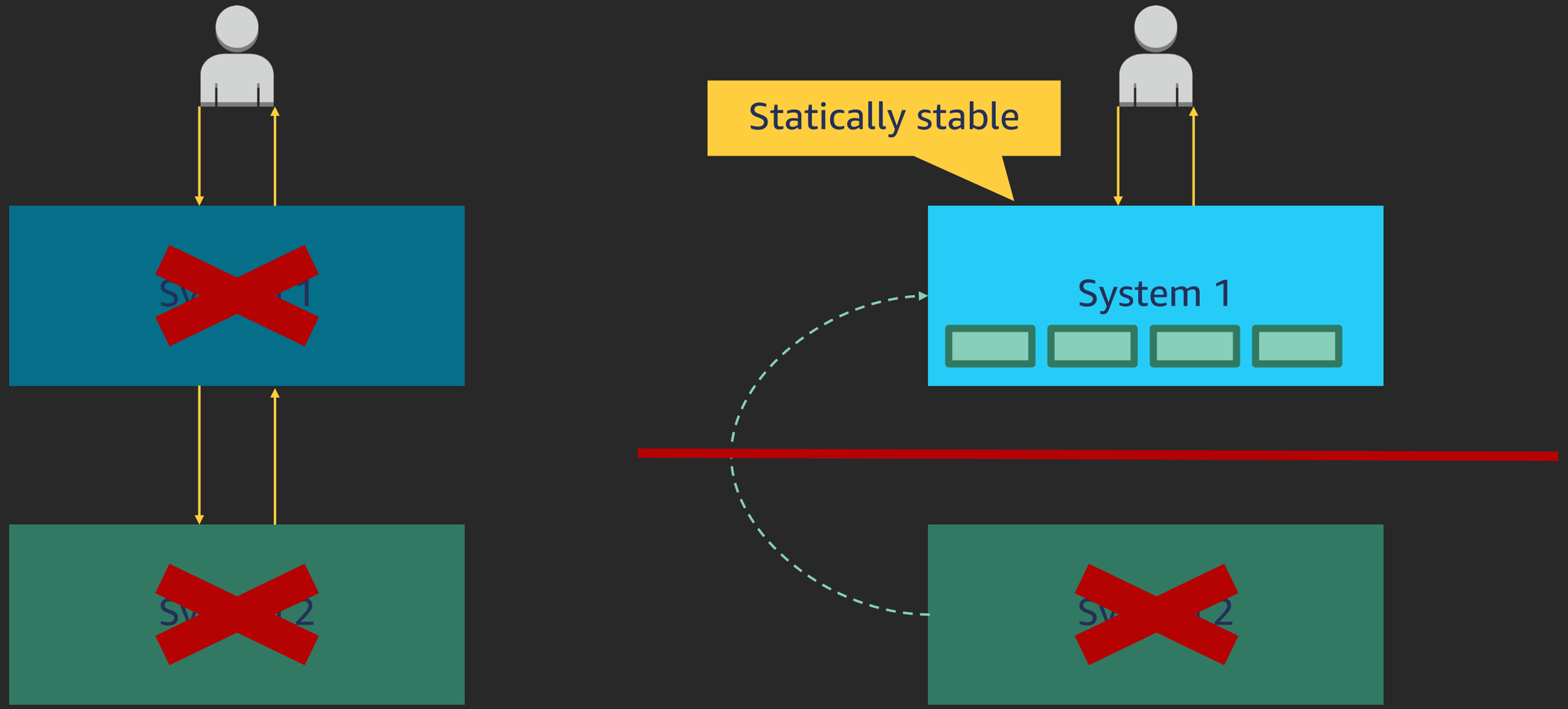
Question 2: Which of these systems has higher complexity?

© 2019, Amazon Web Services, Inc. or its affiliates. All rights reserved.

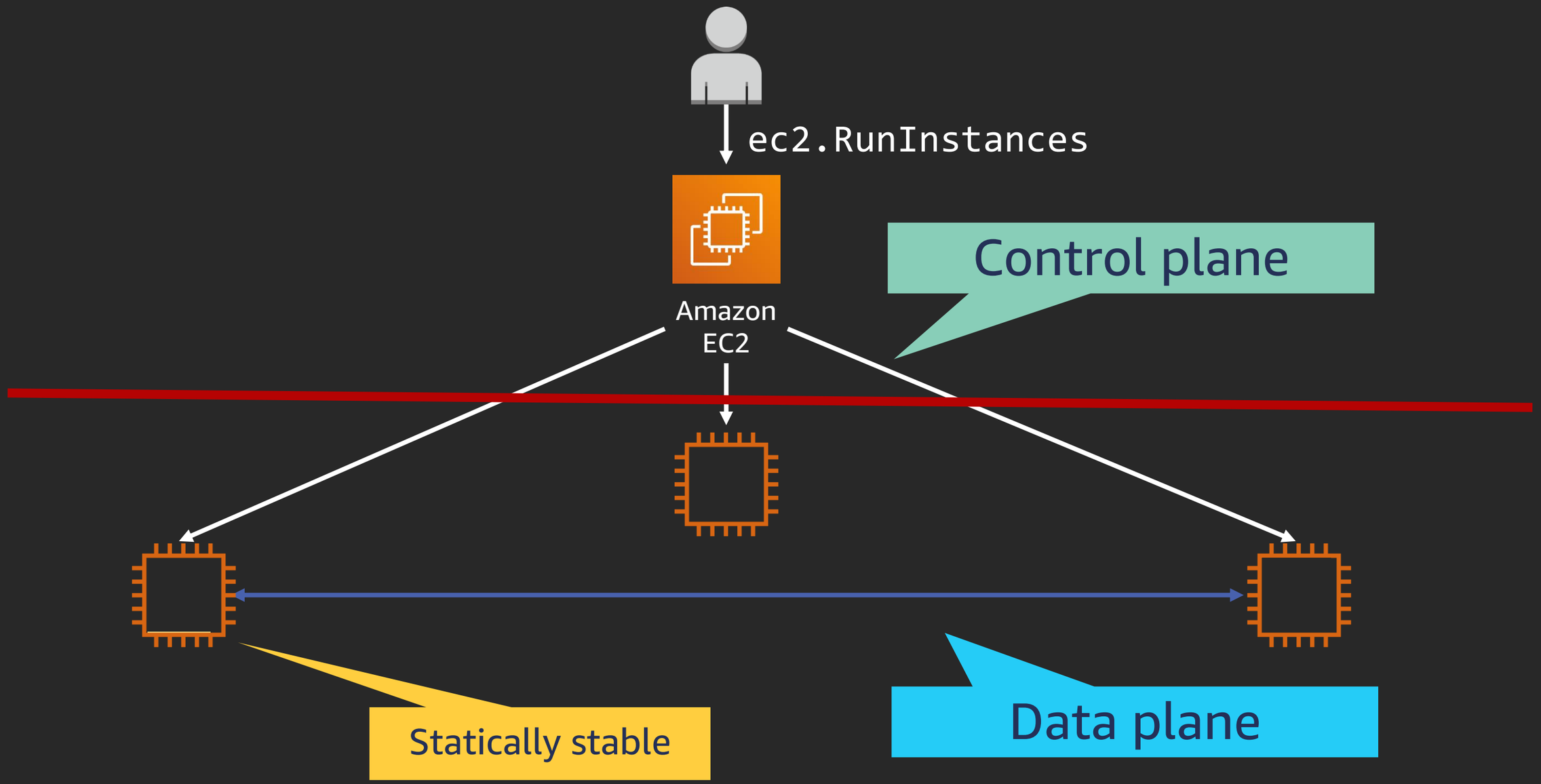

System 1
System 2


System 1
System 2
System 1
System 2

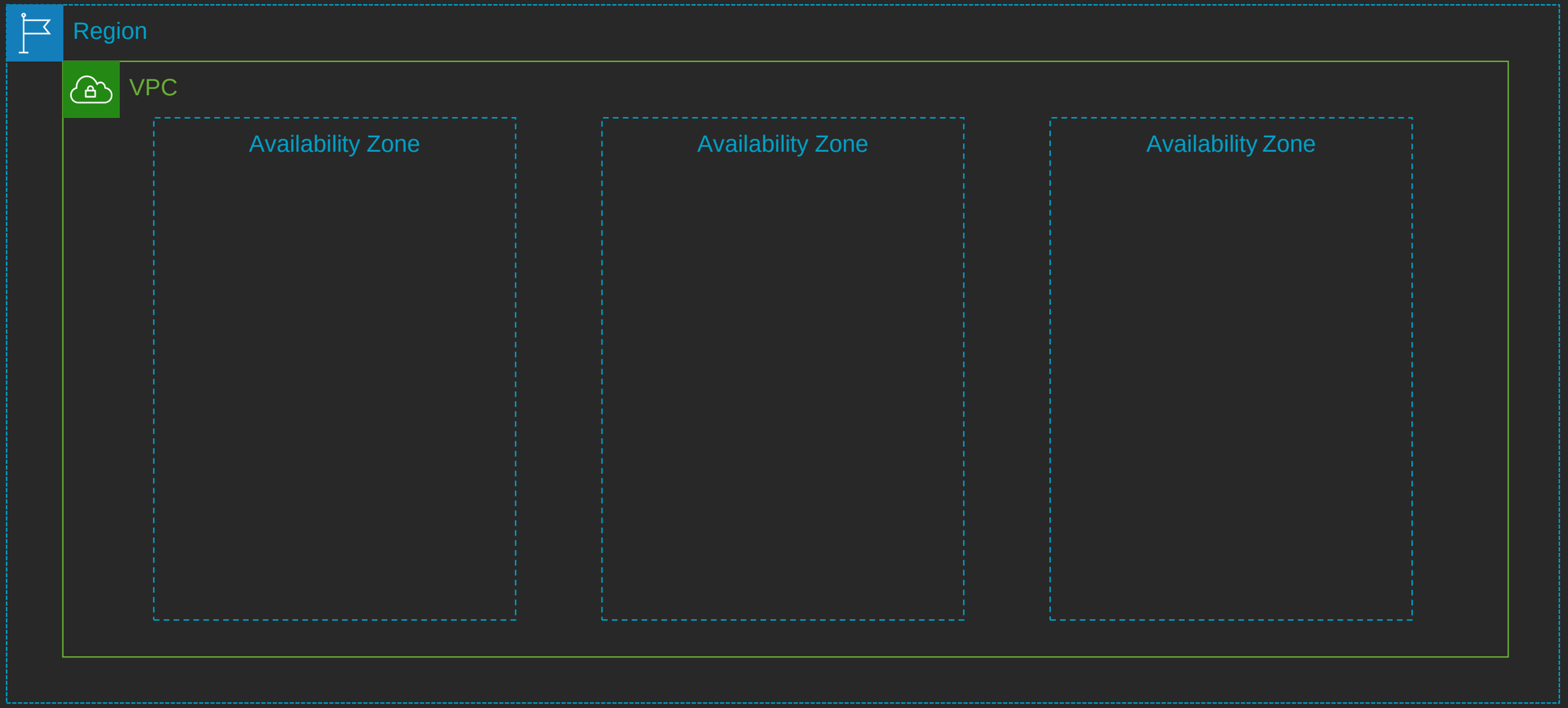

System 1
System 1


Statically stable
System 1

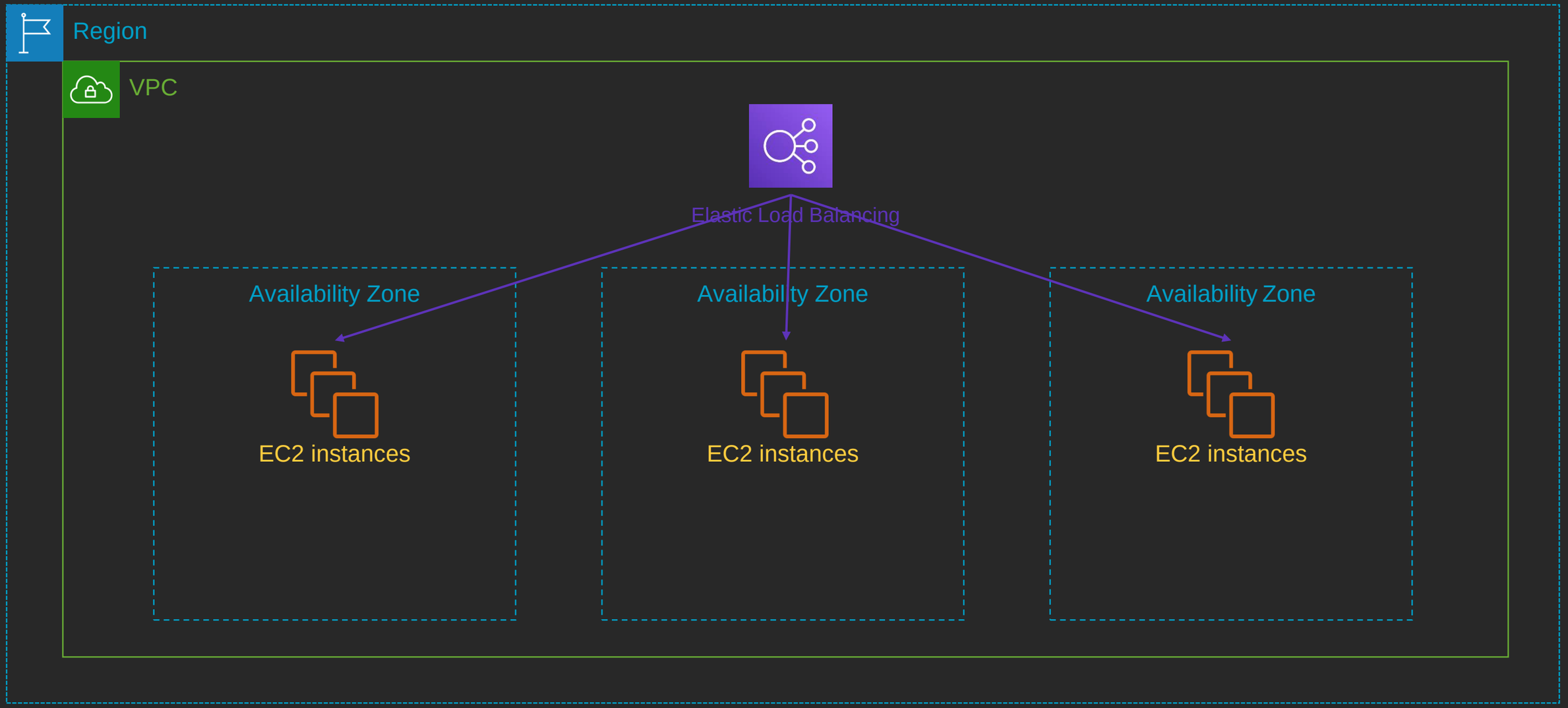
Static stability in practice: Amazon EC2



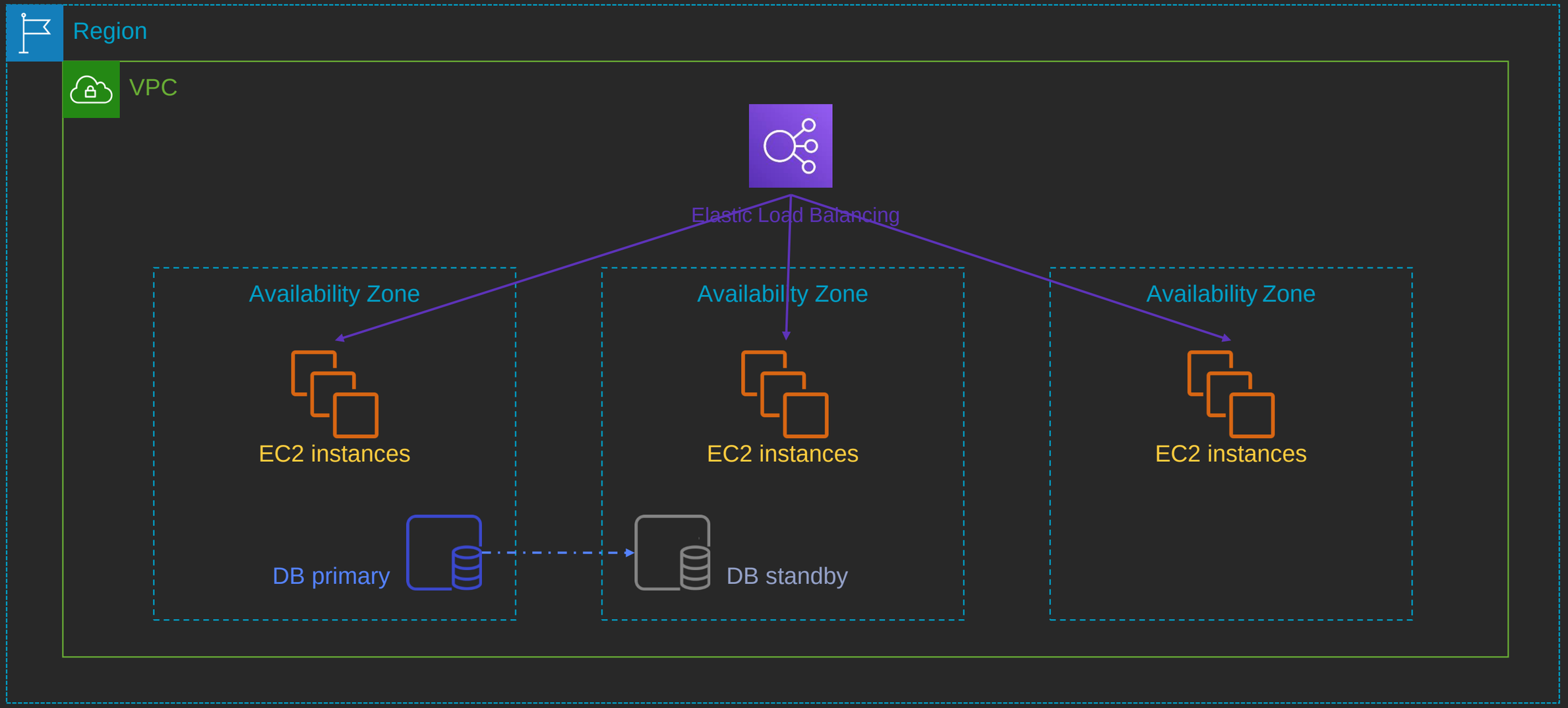
Static stability in practice: Your high-availability workloads



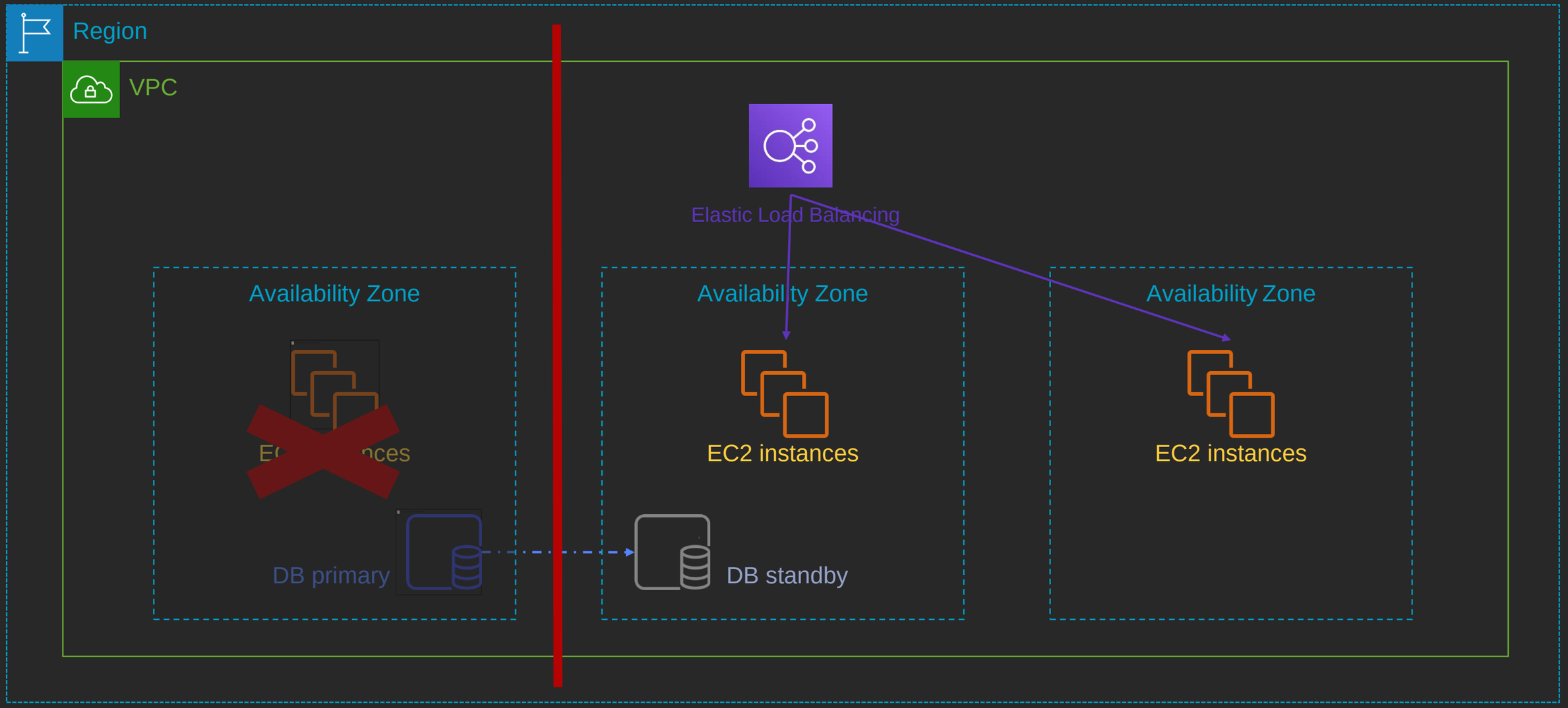
Static stability in practice: Your high-availability workloads



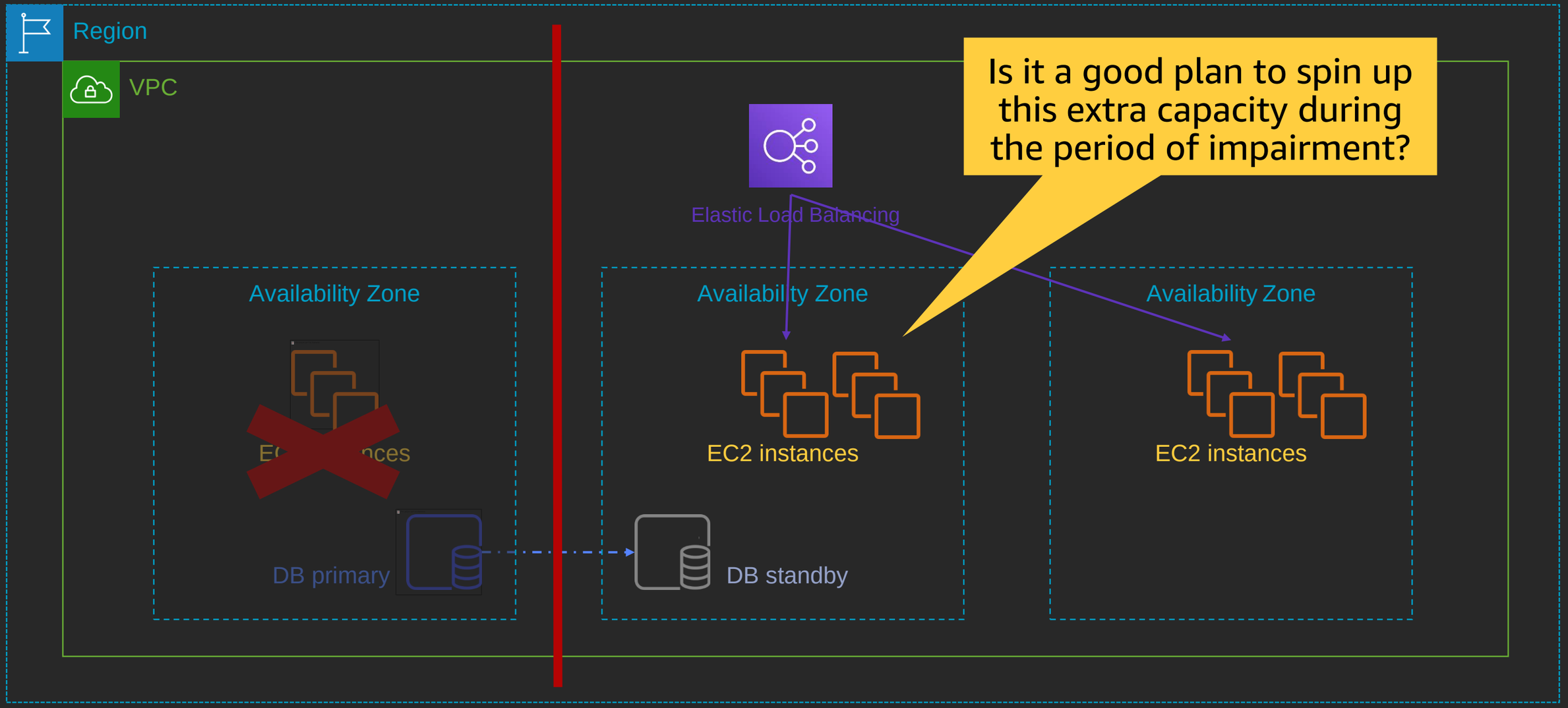
Static stability in practice: Your high-availability workloads



Static stability in practice: Your high-availability workloads

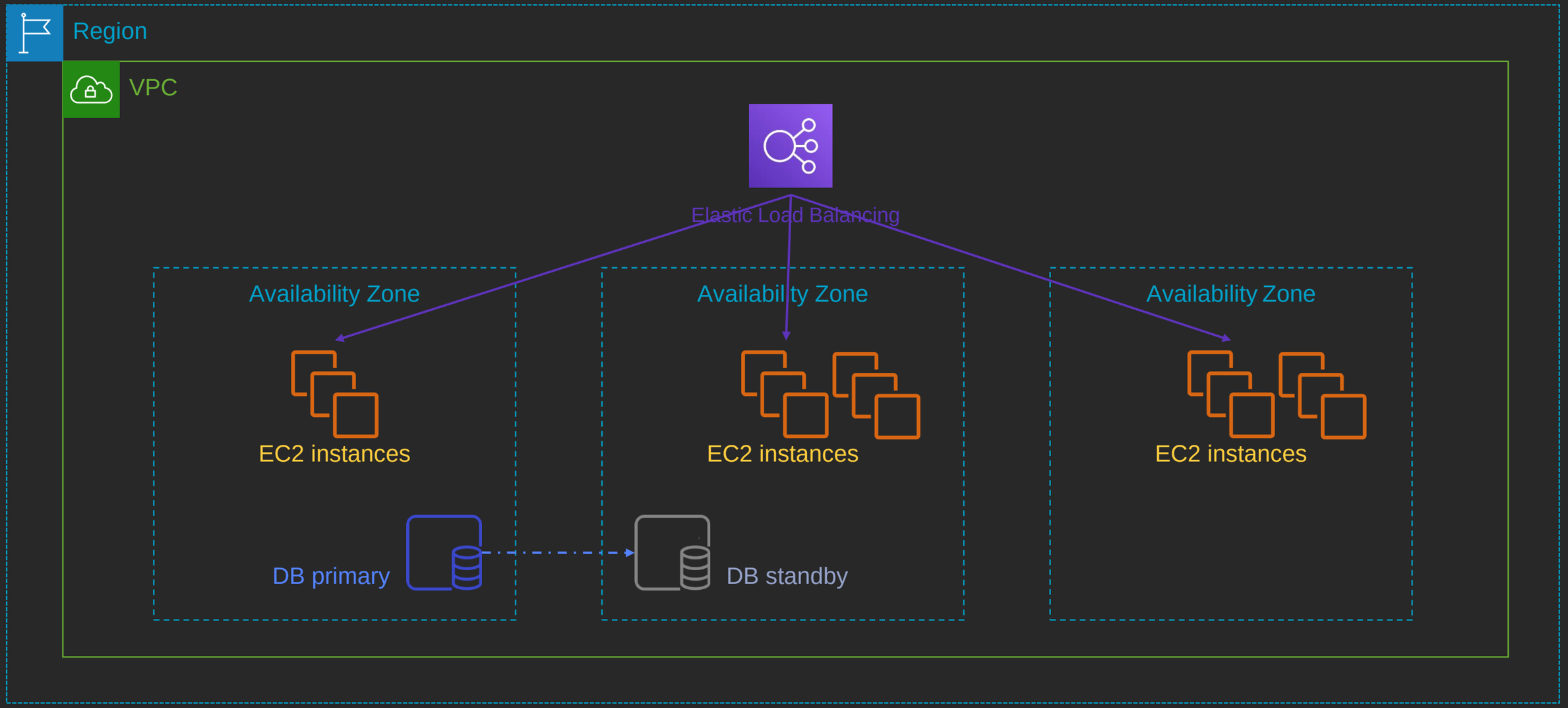


Static stability in practice: Your high-availability workloads

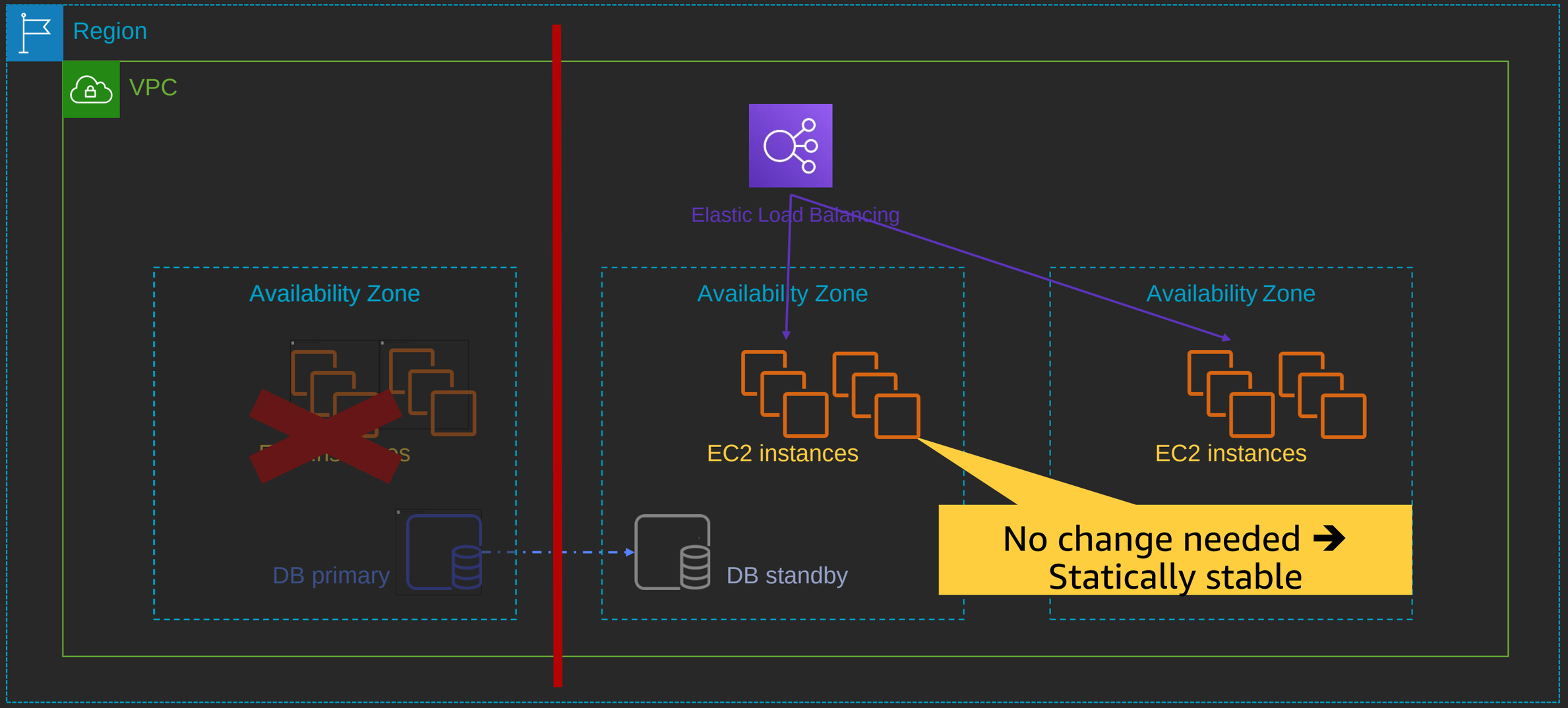




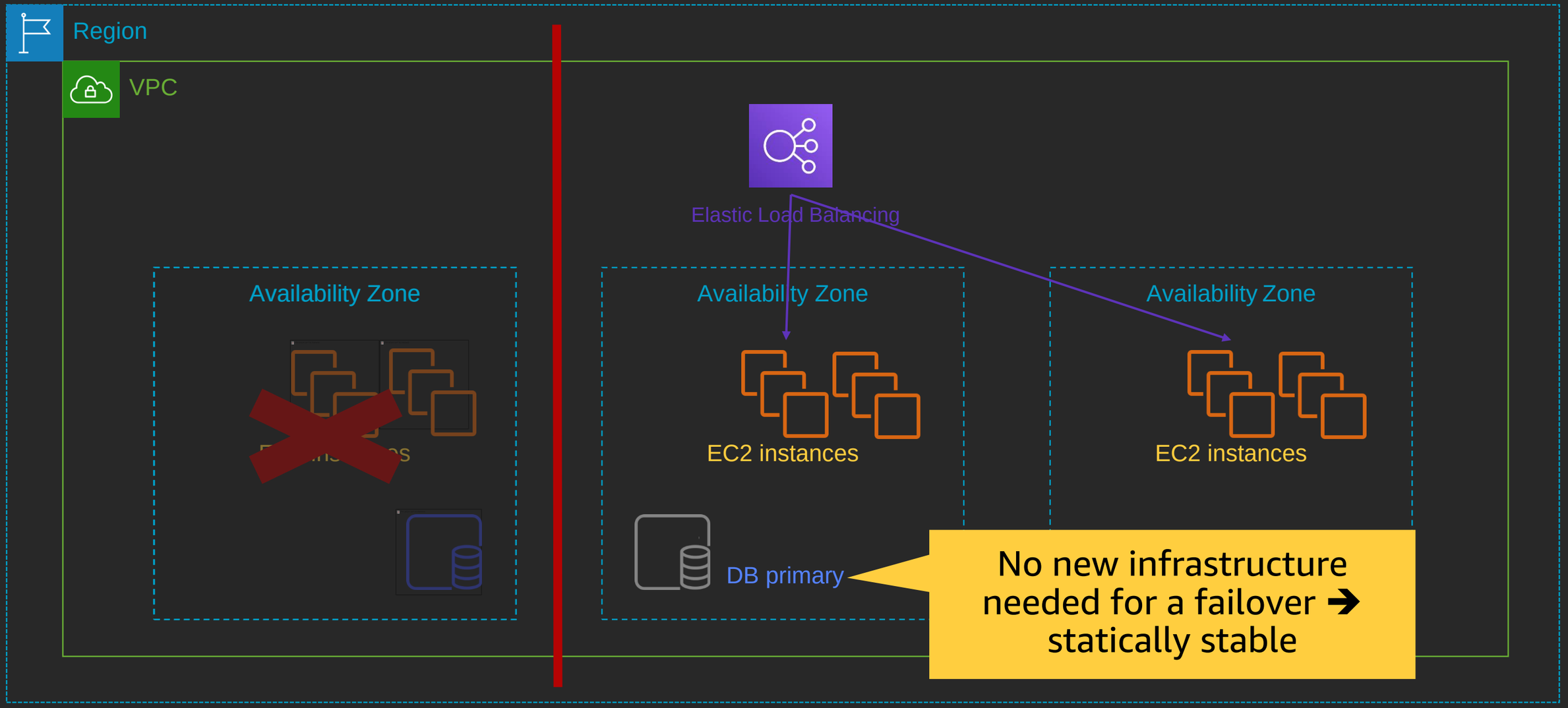
Static stability in practice: Your high-availability workloads



Static stability in practice: Your high-availability workloads



Static stability in practice: Your high-availability workloads



Static stability: Takeaways

- Consider the availability targets of your dependencies
- Use static stability techniques to avoid changing behavior during an impairment of your dependency
- Dependency != Destiny

Shuffle-sharding

© 2019, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Private data center land

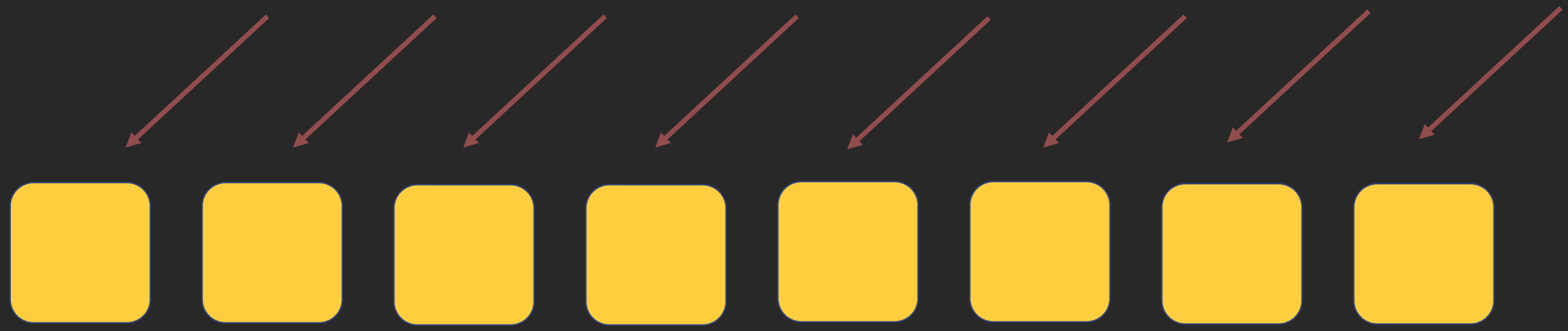




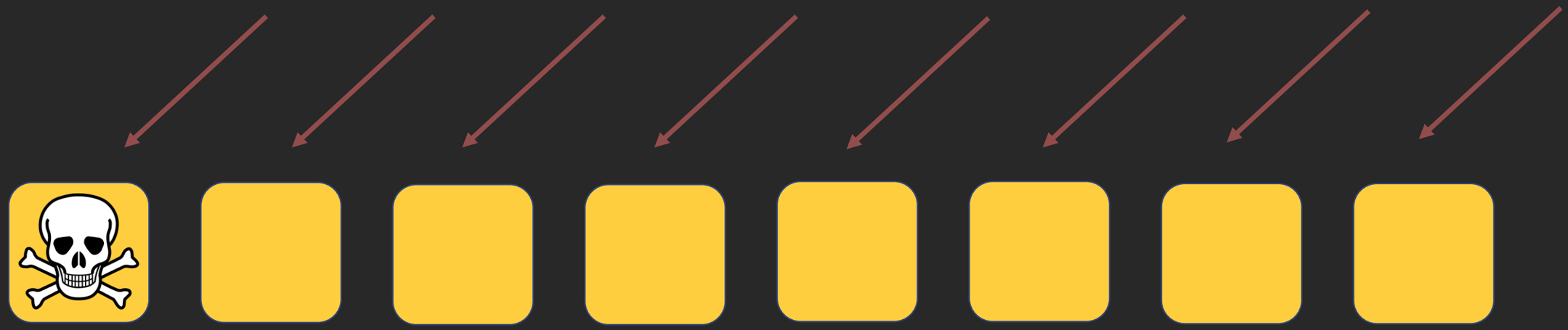
Shuffle sharding



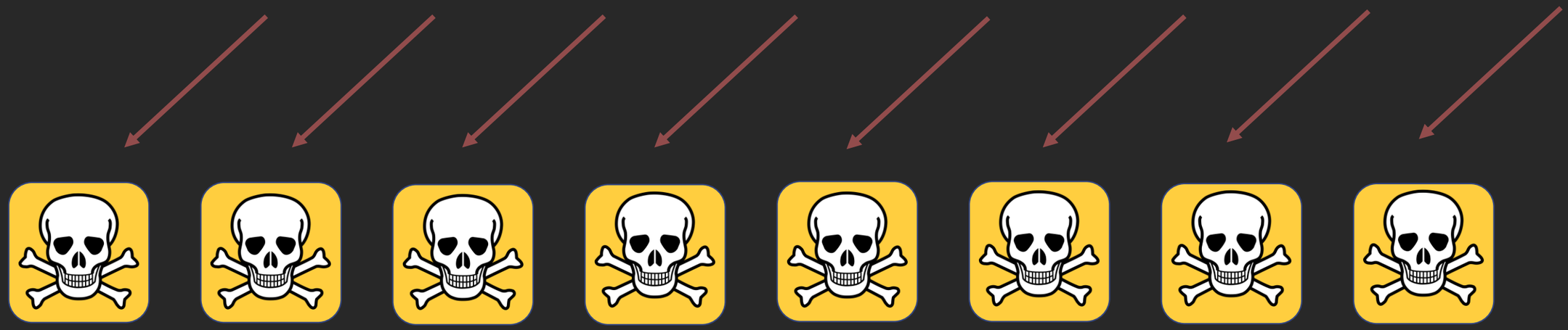
Shuffle sharding



Shuffle sharding



Shuffle sharding

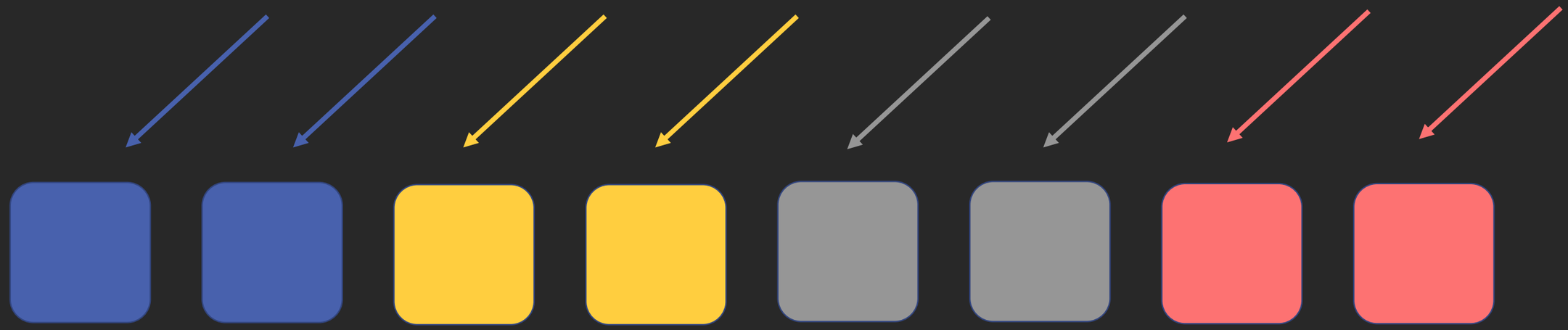


Shuffle sharding

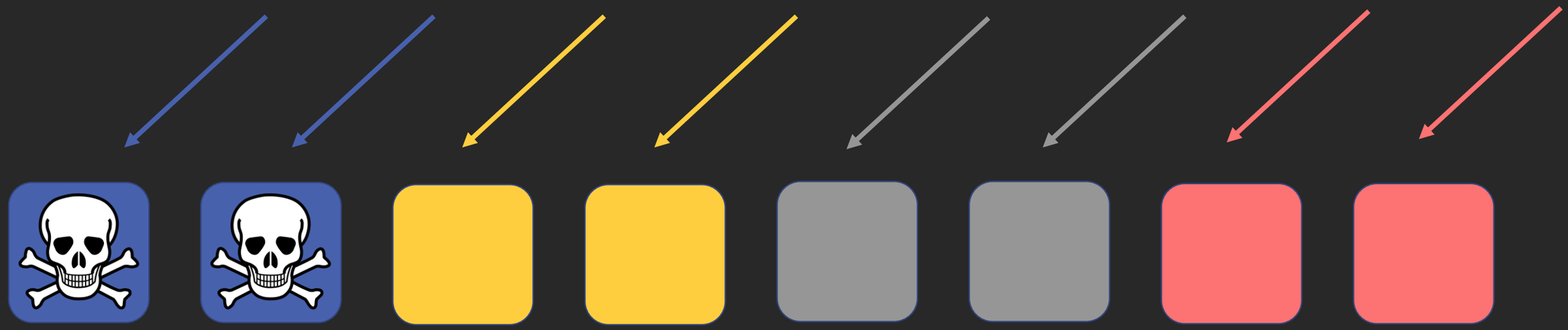


= |customers|

Shuffle sharding



Shuffle sharding

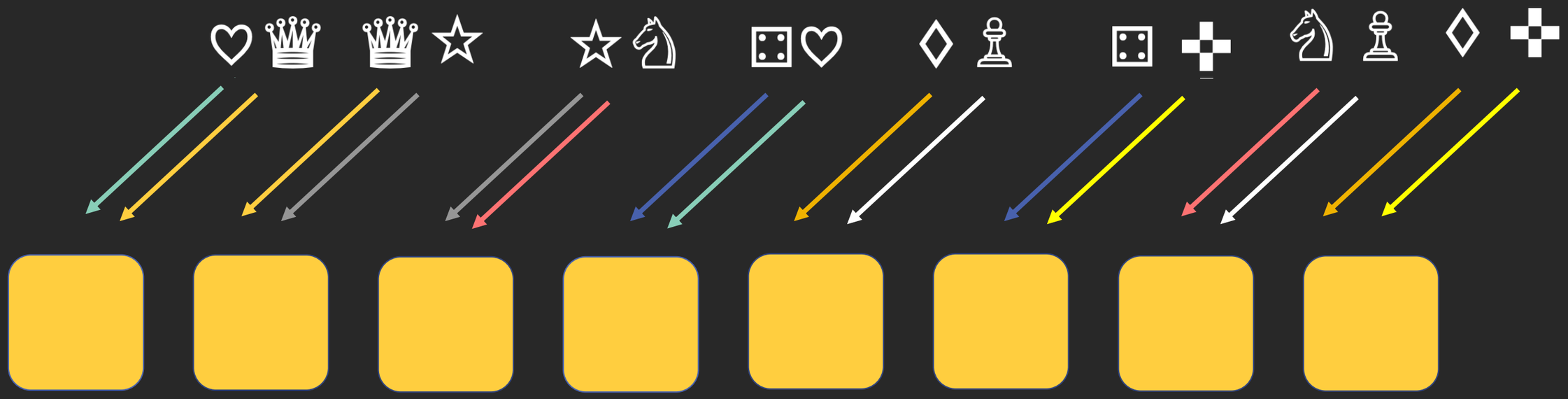


Shuffle sharding

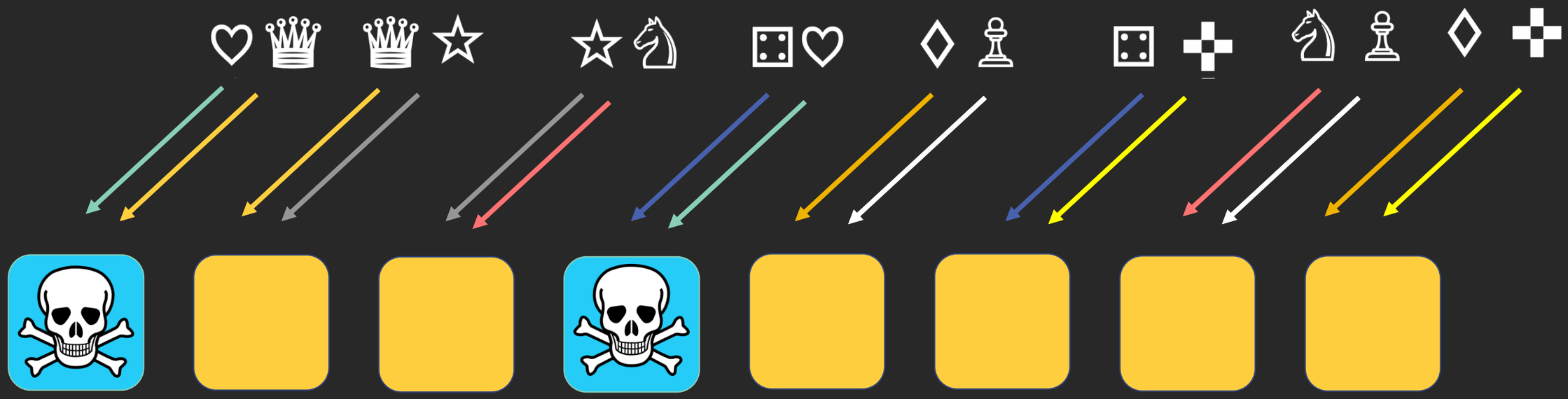


$$= \frac{|\text{customers}|}{|\text{shards}|}$$

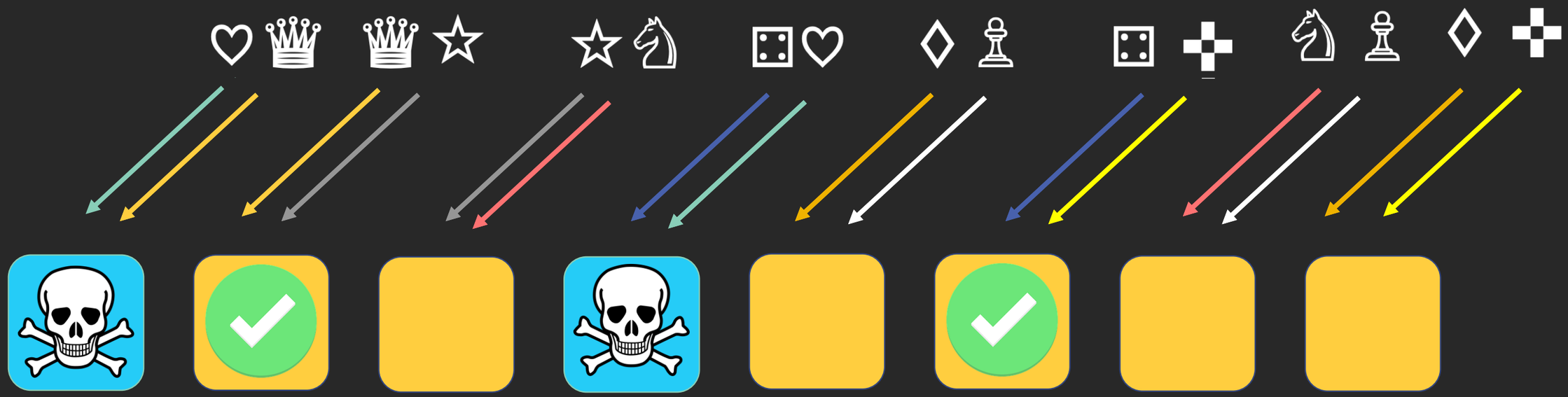
Shuffle sharding



Shuffle sharding



Shuffle sharding



Shuffle sharding



$$\approx \frac{\text{shardsize}!}{|\text{nodes}|!}$$

Shuffle sharding



Nodes = 8
Shard size = 2

Overlap	Probability
0	53.6%
1	42.8%
2	3.6%

Shuffle sharding

Nodes = 100 Shard size = 5



Overlap	Probability
0	77%
1	21%
2	1.8%
3	0.06%
4	0.0006%
5	0.0000013%

Shuffle sharding

Needs a client that retries or is fault-tolerant

Works for servers, queues, and other resources

Needs a routing mechanism: Per-customer DNS names, pre-resource DNS names, or a shuffle sharding-aware router

Retry, backoff, and jitter

© 2019, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Failures happen

Resilience through redundancy

Retries

Need availability?



DoS your own service!

Thread#sleep()



jeffreyw CC-BY-2.0 on wikimedia

12:00

12:15

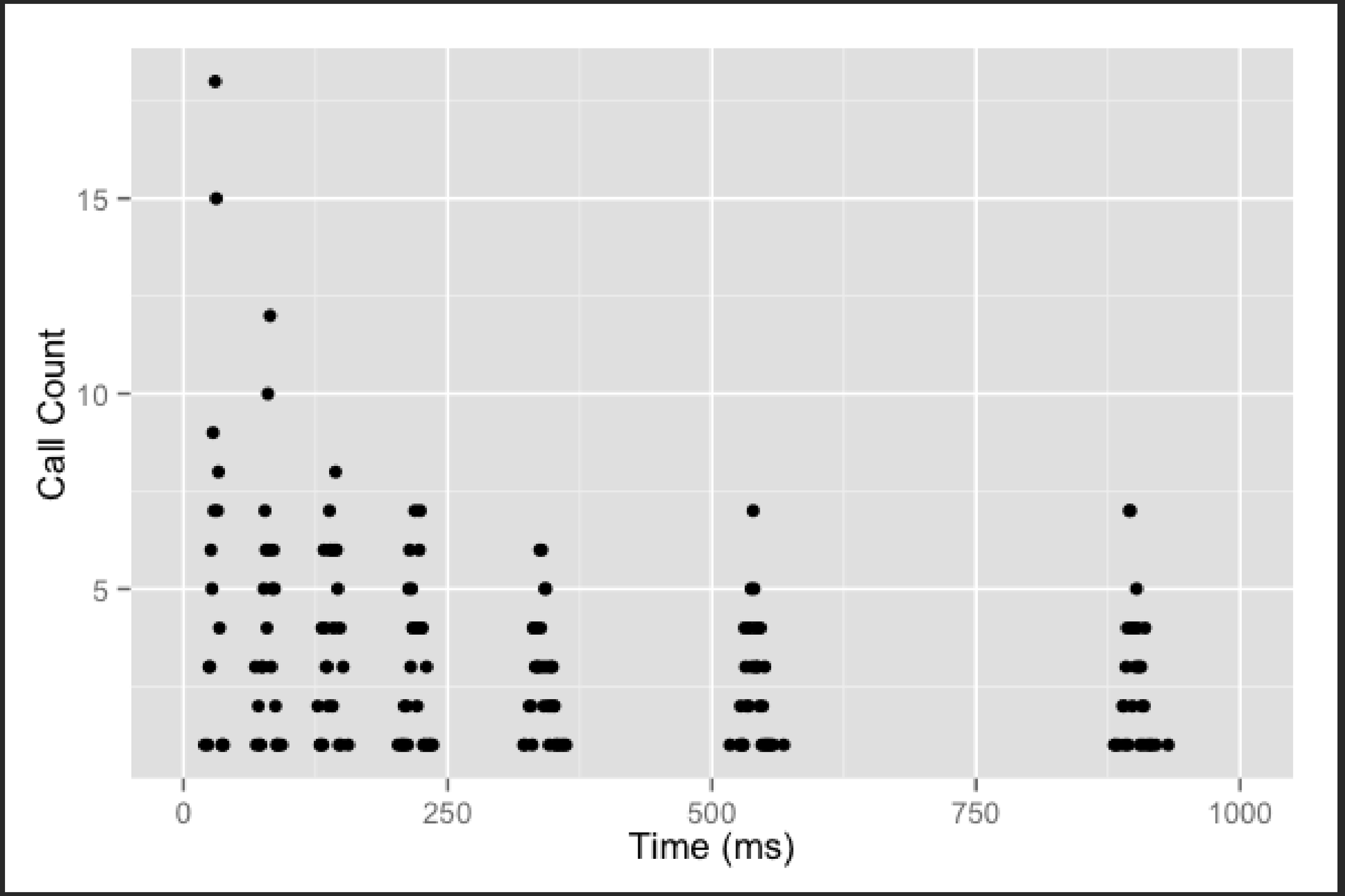
12:30

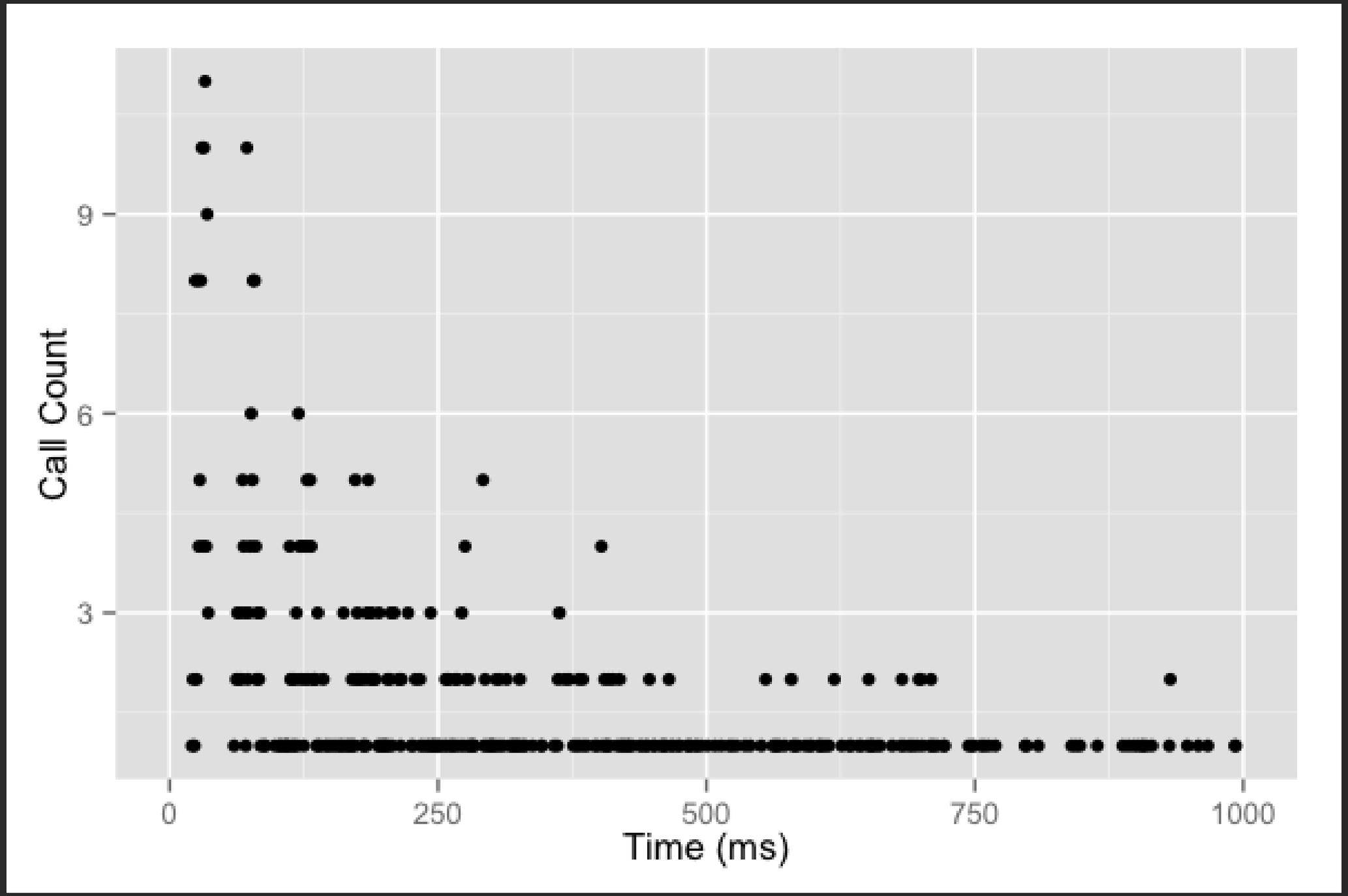
Distributed systems
have the
same problem

Jitter



Dados_4_a_20_caras.jpg: es:Usuario:Sabbut*derivative work: SharkD Talk CC BY-SA 3.0


Call Count
15
10
5
0
250
500
750
1000
Time (ms)


Call Count
9
6
3
0
250
500
750
1000
Time (ms)

```
randint(0, base * 2 ** attempt)
```

How we do this at AWS

Always jitter when using backoff

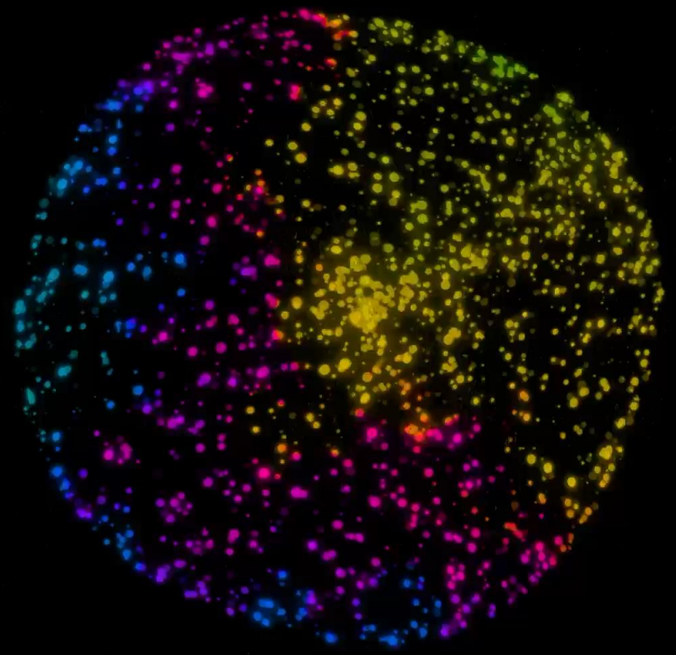
Always jitter periodic work (timers, cron, etc.)

Consider adding jitter to all work

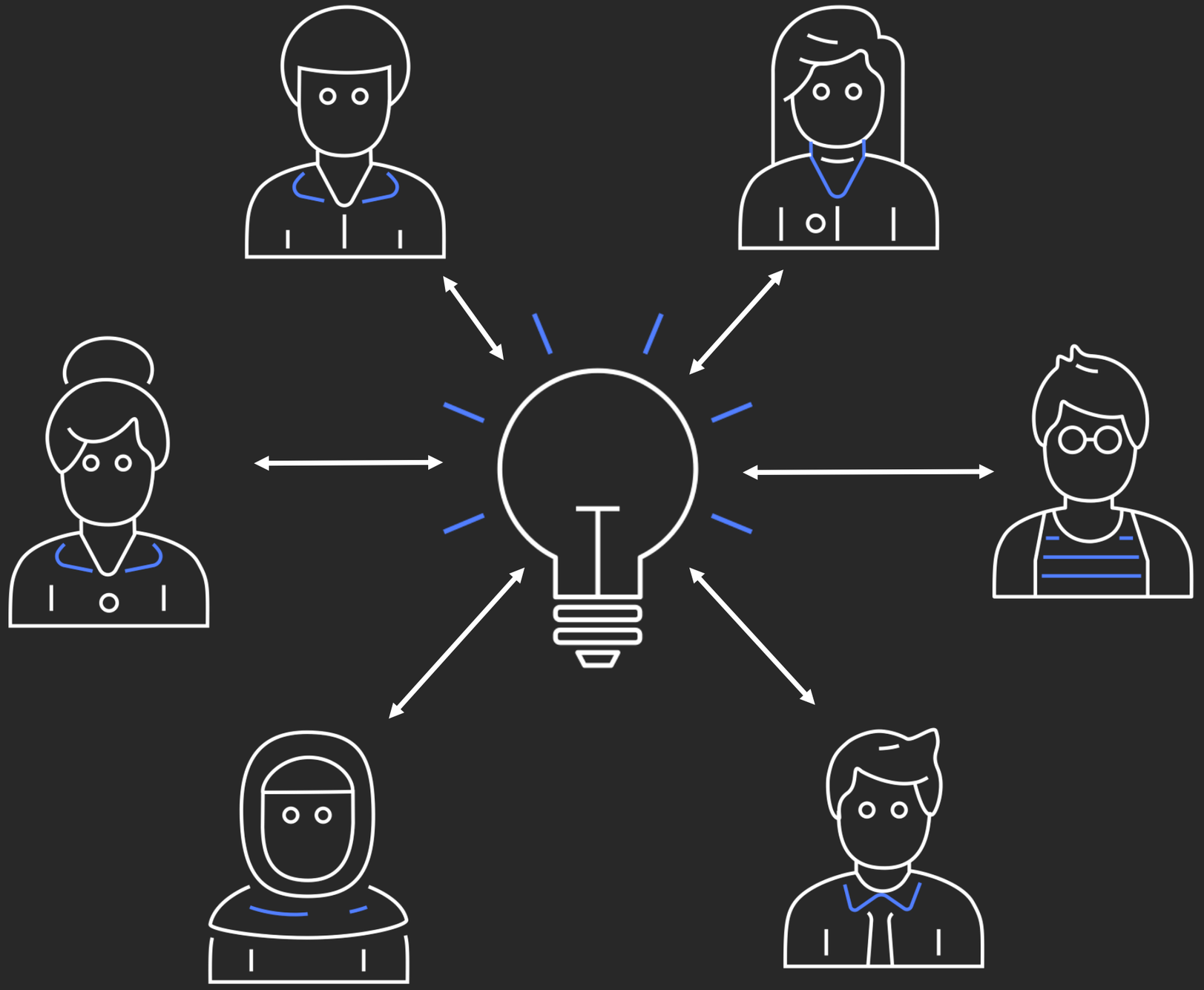
Meta lesson: Learn from each other

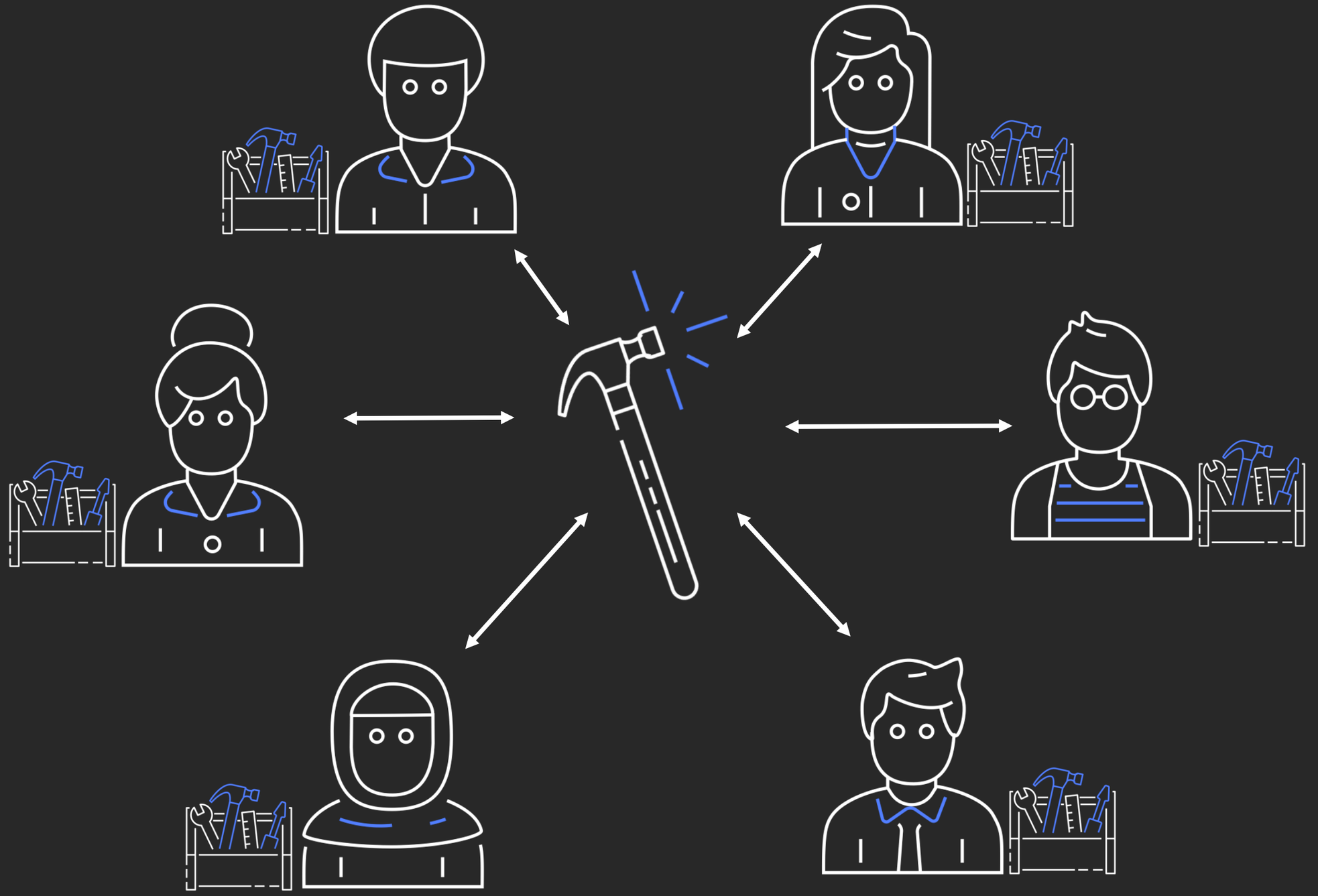
© 2019, Amazon Web Services, Inc. or its affiliates. All rights reserved.

How does Amazon…

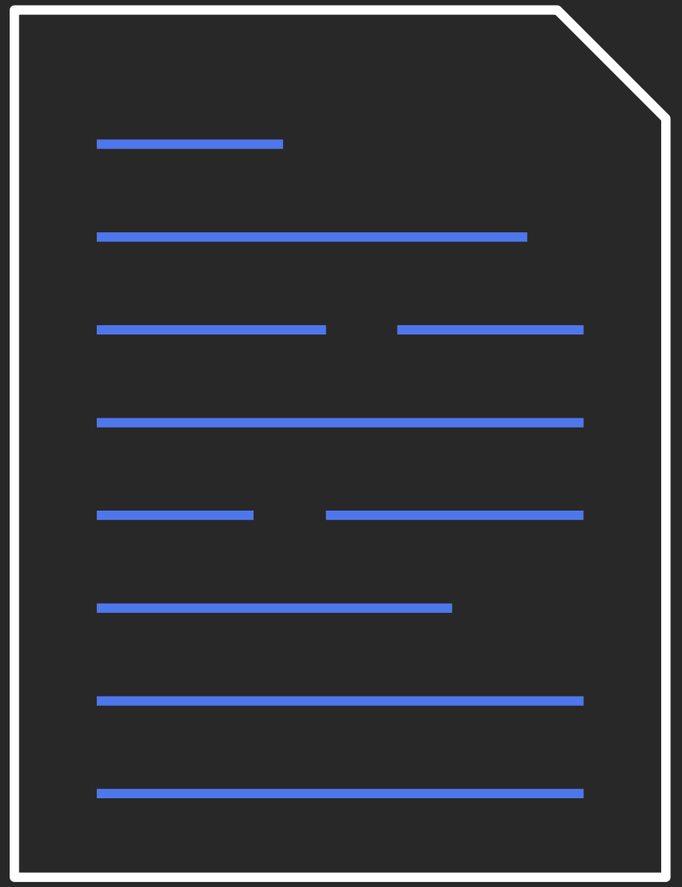


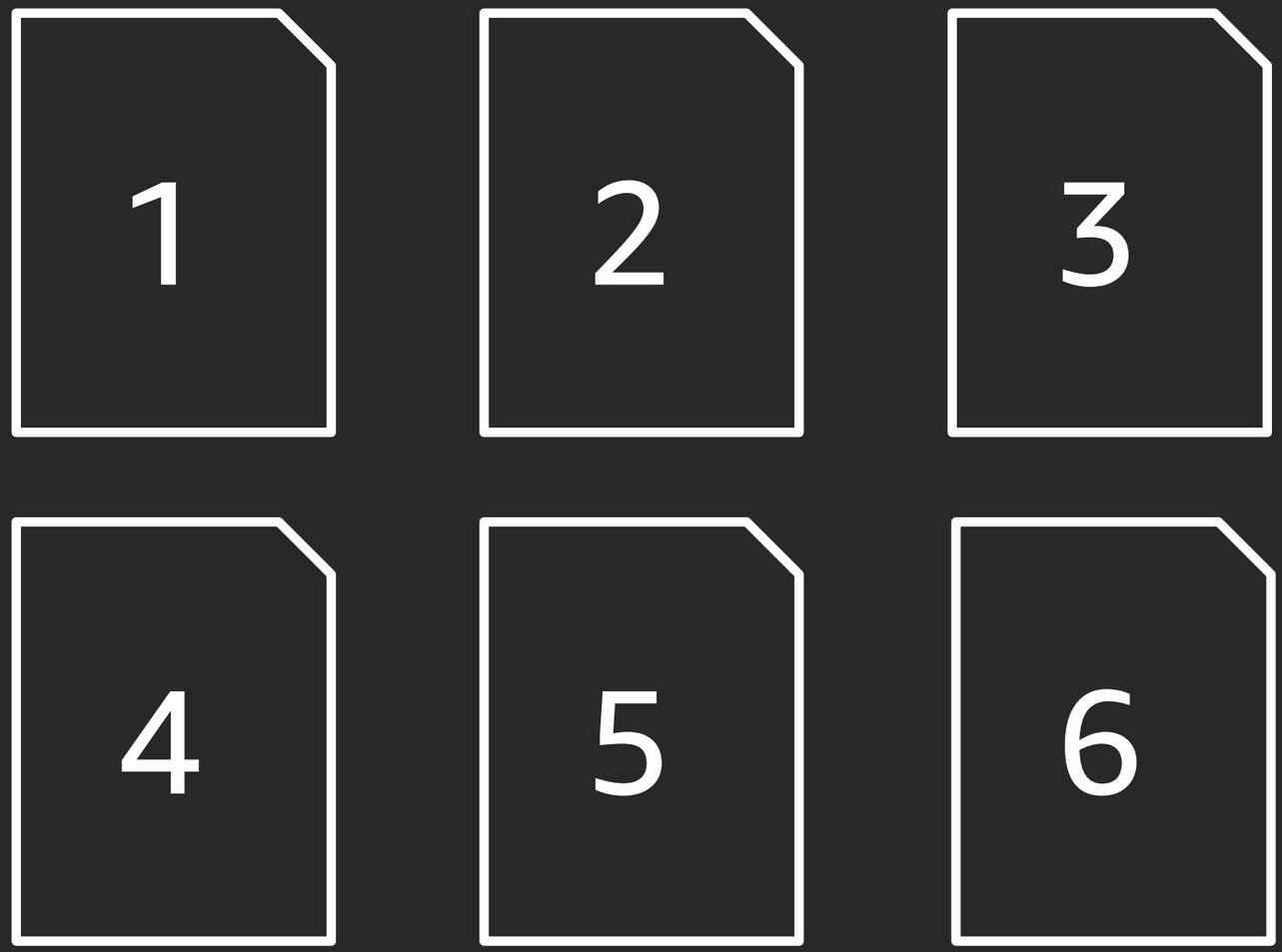
build resilient systems?





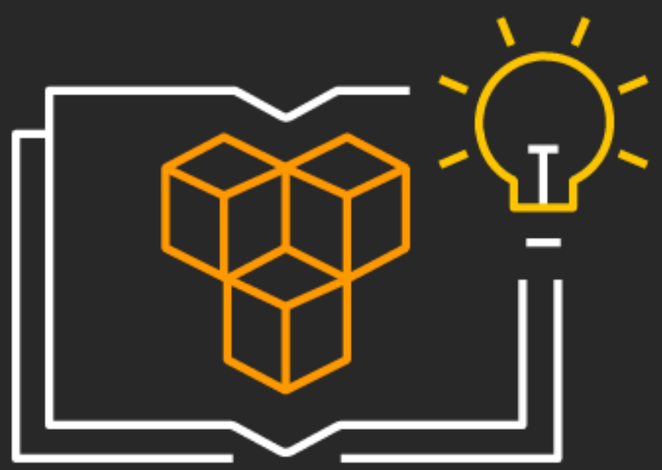





1
2
3
4
5
6

The Amazon Builders' Library

How Amazon builds and operates software



Architecture, software delivery, and operations

By Amazon's senior technical executives and engineers

Real-world practices with detailed explanations

Content available for free on the website

The Amazon Builders' Library

ARCHITECTURE

LEVEL 300



Leader election in distributed systems

Author: Marc Brooker

Improving efficiency, reducing coordination, and simplifying architectures by using leader election.

SOFTWARE DELIVERY AND OPERATIONS

LEVEL 300



Going faster with continuous delivery

Author: Mark Mansour

Automating the software testing and deployment process for speed and reliability

SOFTWARE DELIVERY AND OPERATIONS

LEVEL 400



Implementing health checks

Author: David Yanacek

Automatically detecting and mitigating server failures without unintended consequences from fleet-wide false positives.

ARCHITECTURE

LEVEL 400



Workload isolation using shuffle-sharding

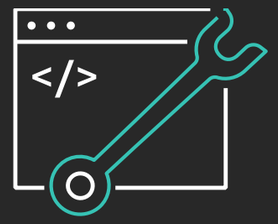
Author: Colm MacCarthaigh

Shuffle Sharding is one of our core techniques for drastically limiting the scope of impact of operational issues

Many more at aws.amazon.com/builders-library

Learn DevOps with AWS Training and Certification

Resources created by the experts at AWS to propel your organization and career forward



Take free digital training to learn best practices for developing, deploying, and maintaining applications



Classroom offerings, like DevOps Engineering on AWS, feature AWS expert instructors and hands-on activities



Validate expertise with the **AWS Certified DevOps Engineer - Professional** or **AWS Certified Developer - Associate** exams

Visit aws.amazon.com/training/path-developing/

© 2019, Amazon Web Services, Inc. or its affiliates. All rights reserved.

aws training and certification

Thank you!

Andrew Certain
@tacertain

Becky Weiss
becky@amazon.com

Colm MacCárthaigh
@colmmacc

David Yanacek
@dyanacek

Marc Brooker
@MarcJBrooker

© 2019, Amazon Web Services, Inc. or its affiliates. All rights reserved.



Please complete the session survey in the mobile app.

© 2019, Amazon Web Services, Inc. or its affiliates. All rights reserved.