
AWS
re:Invent
NOV. 27 – DEC. 1, 2023 | LAS VEGAS, NV

WPS305

1.5 million requests per second—a story from the Brazilian elections

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Agenda

TSE and the elections

e-Título app

Results distribution

Results and takeaways

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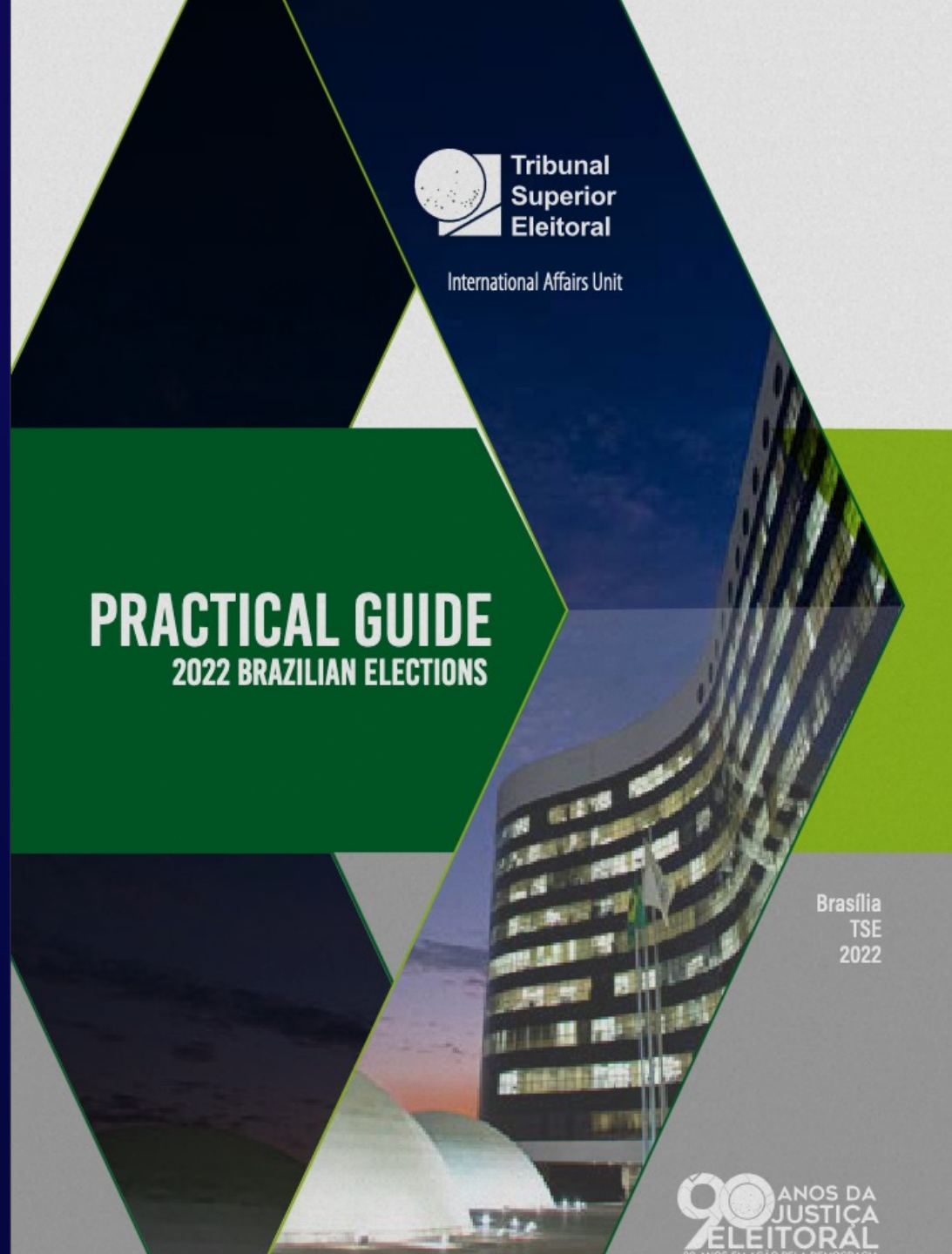
Superior Electoral Court: TSE

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Superior Electoral Court

TSE

Mission responsibilities



aws

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2022 general elections

President, senators, governors, and representatives

5,570 cities
27 states
181 countries



156 million
voters

577 thousand
Voting machines

2.2 million
Poll workers

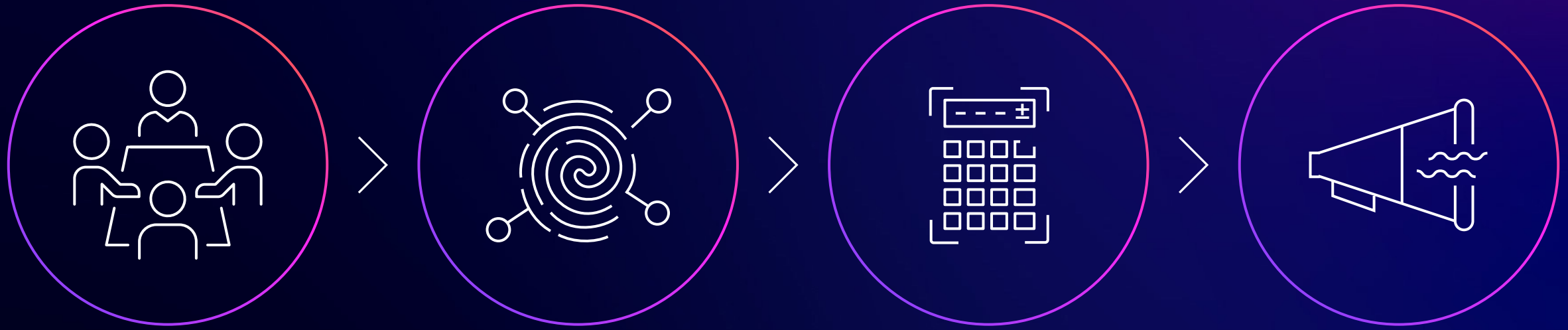
460 thousand
Polling stations

aws

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Electoral process

HIGH-LEVEL OVERVIEW



Preparation

Voting

Computing

Distribution

aws

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Electoral process

HIGH-LEVEL OVERVIEW



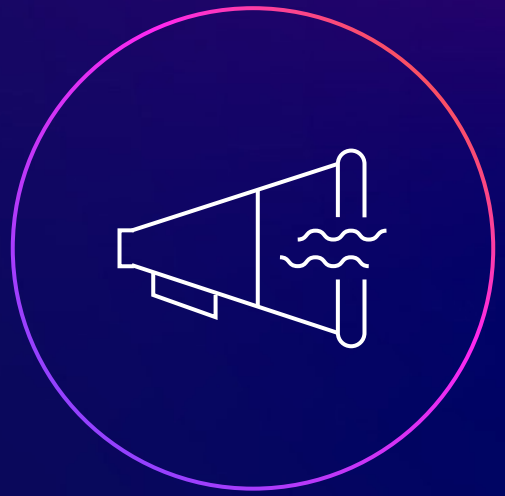
Preparation



Voting



Computing



Distribution

1

2

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AWS 2022 scope

1



e-Título mobile app

100M simultaneous users

100% availability

14K requests per second

New services – absence justification

2



Results distribution

500K concurrent requests

150K files in real time

4 hrs computing time

100% availability

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e-Título: Mobile app

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Digital voter ID official app



Disponível na App Store

DISPONÍVEL NO Google Play

DISPONÍVEL PARA CELULAR OU TABLET

Why should we have a digital voting ID?

DIFFERENT PERSPECTIVES AND BENEFITS



Voters

ID damage and theft

Less rides

Quicker access



Financial

Reduce ID duplicates

Office supplies

Energy bill
and maintenance



Environment

Cut paper usage

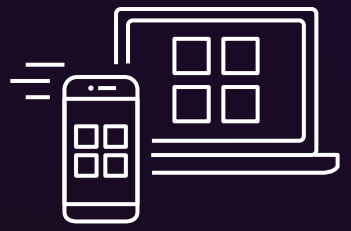
Reduce fuel
consumption

aws

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Challenges

OFFER NEW SERVICES AND SUPPORT LARGE SCALE



Business

- ✓ Support 156M voters
- ✓ Optimize spend
- ✓ Better voter experience
- ✓ Expand communication
- ✓ Offer new services – absence justification



Technology

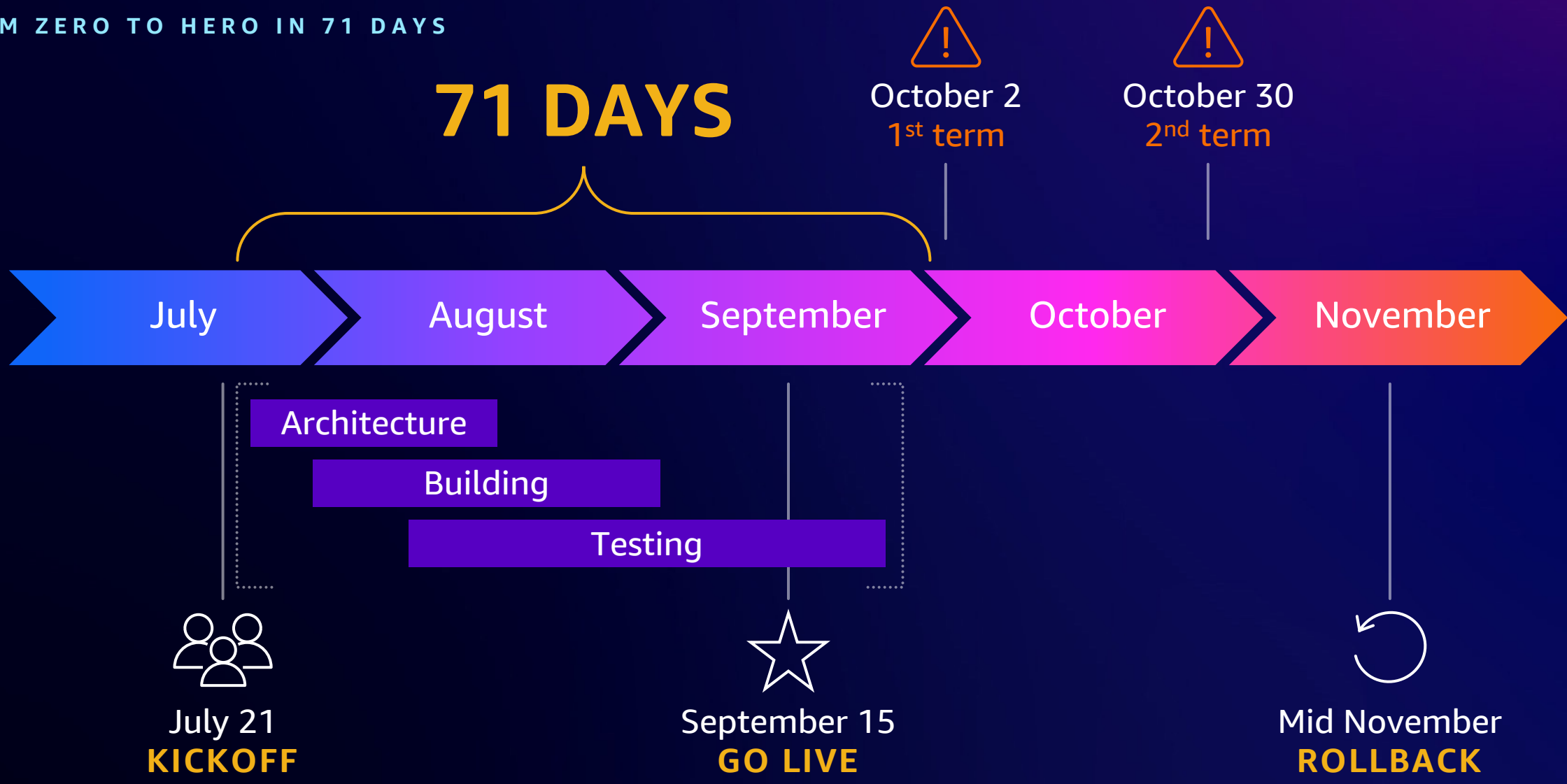
- ✓ Technology lock in
- ✓ Decouple services
- ✓ Massive scale and high RPS expectation
- ✓ Security by design
- ✓ Business continuity/DR

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Timeline: e-Título on AWS

FROM ZERO TO HERO IN 71 DAYS

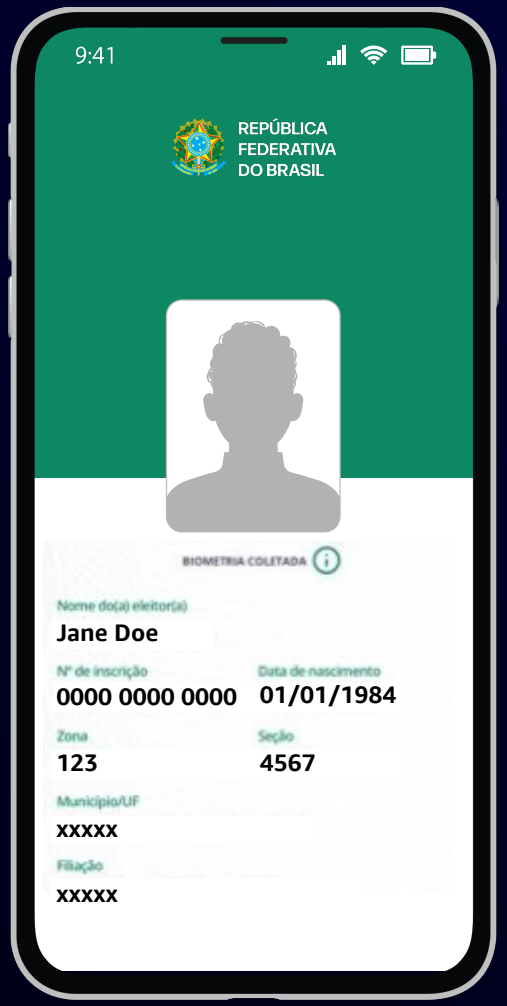


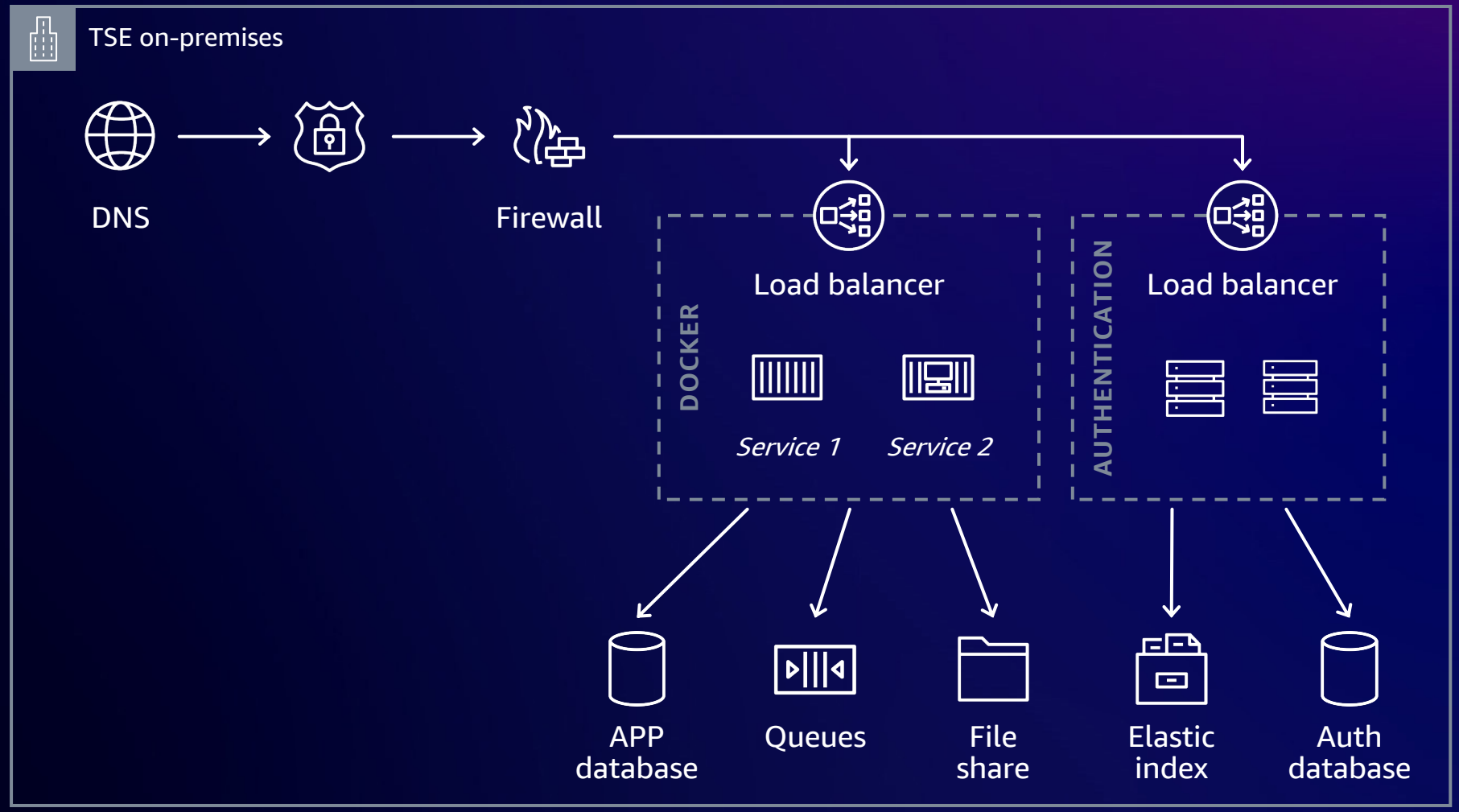
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e-Título: Technical backaground

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e-Título: On-premises reference architecture



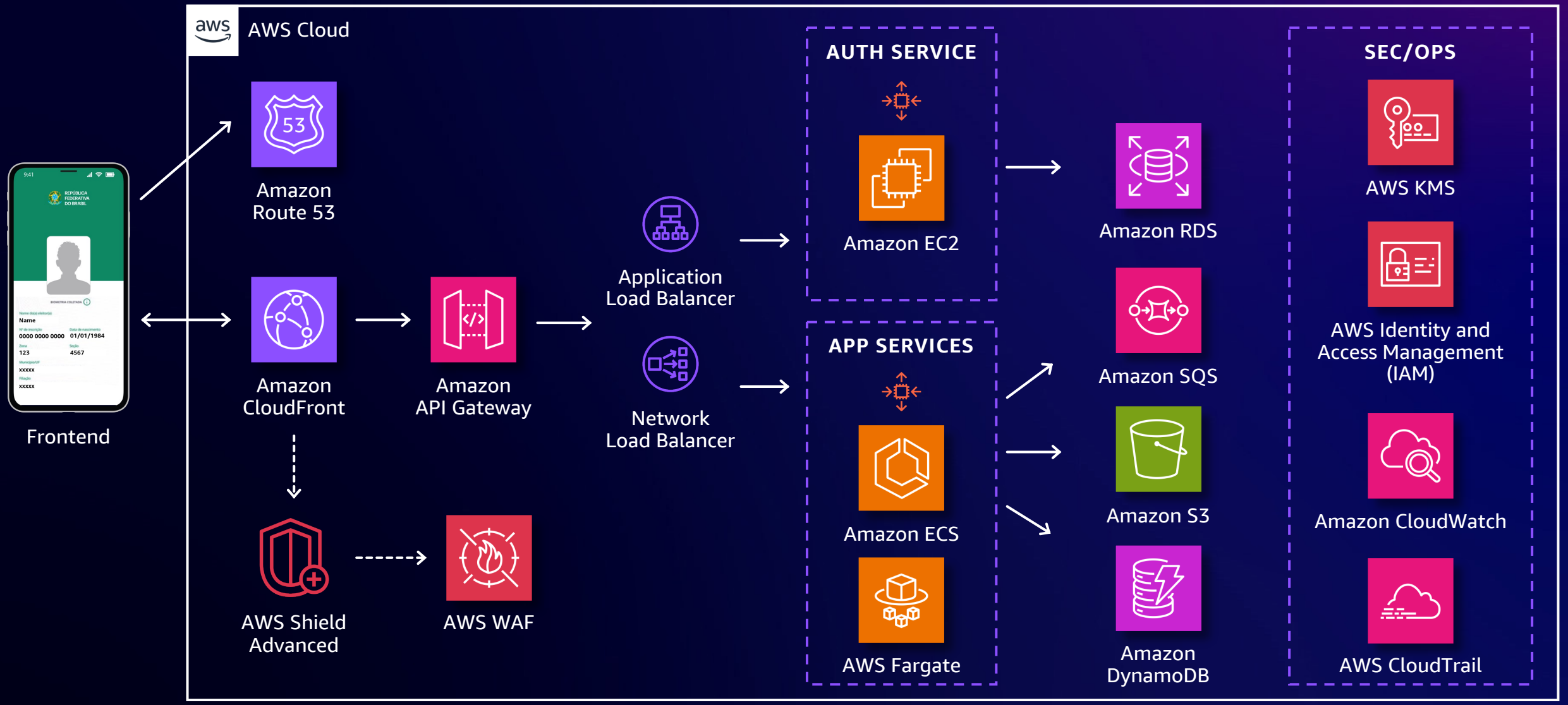


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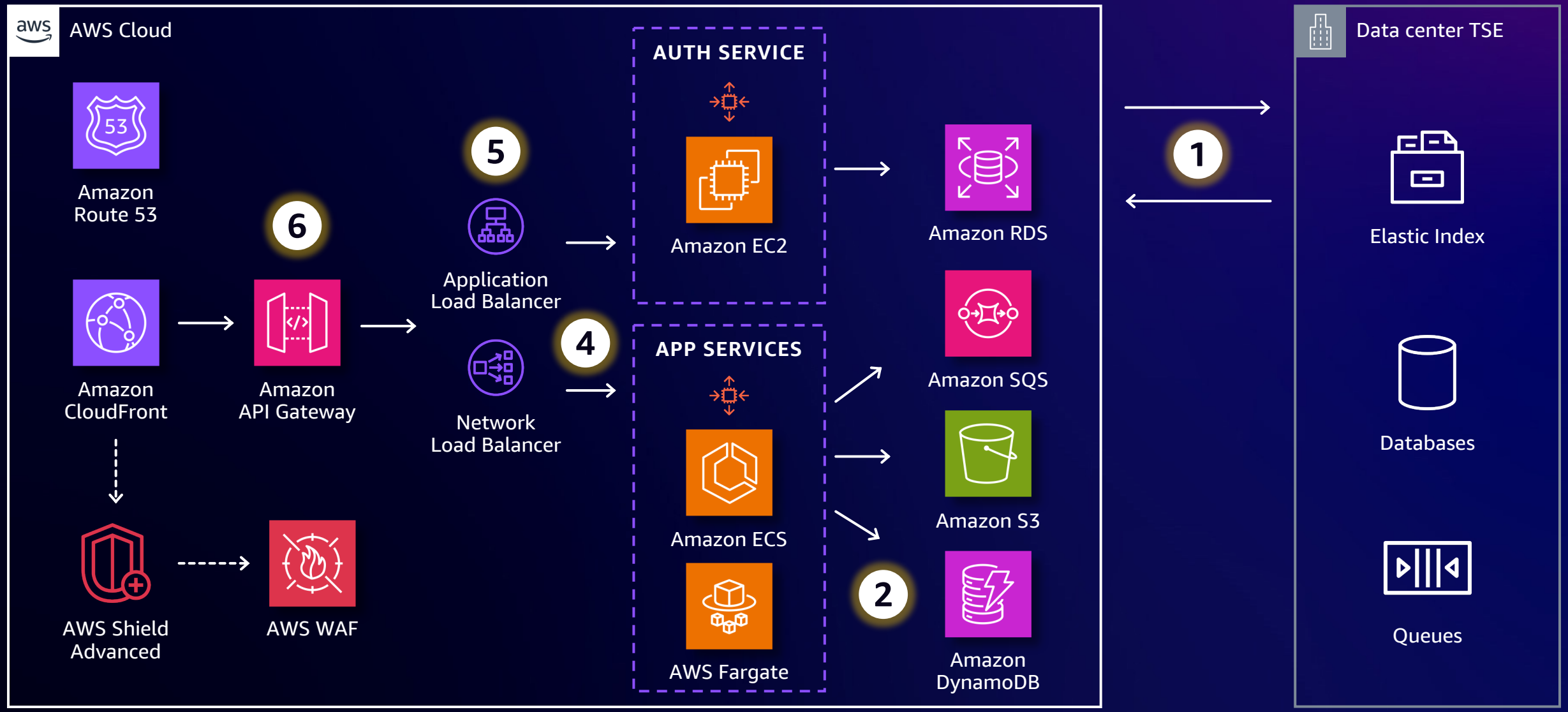
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e-Título reference architecture on AWS



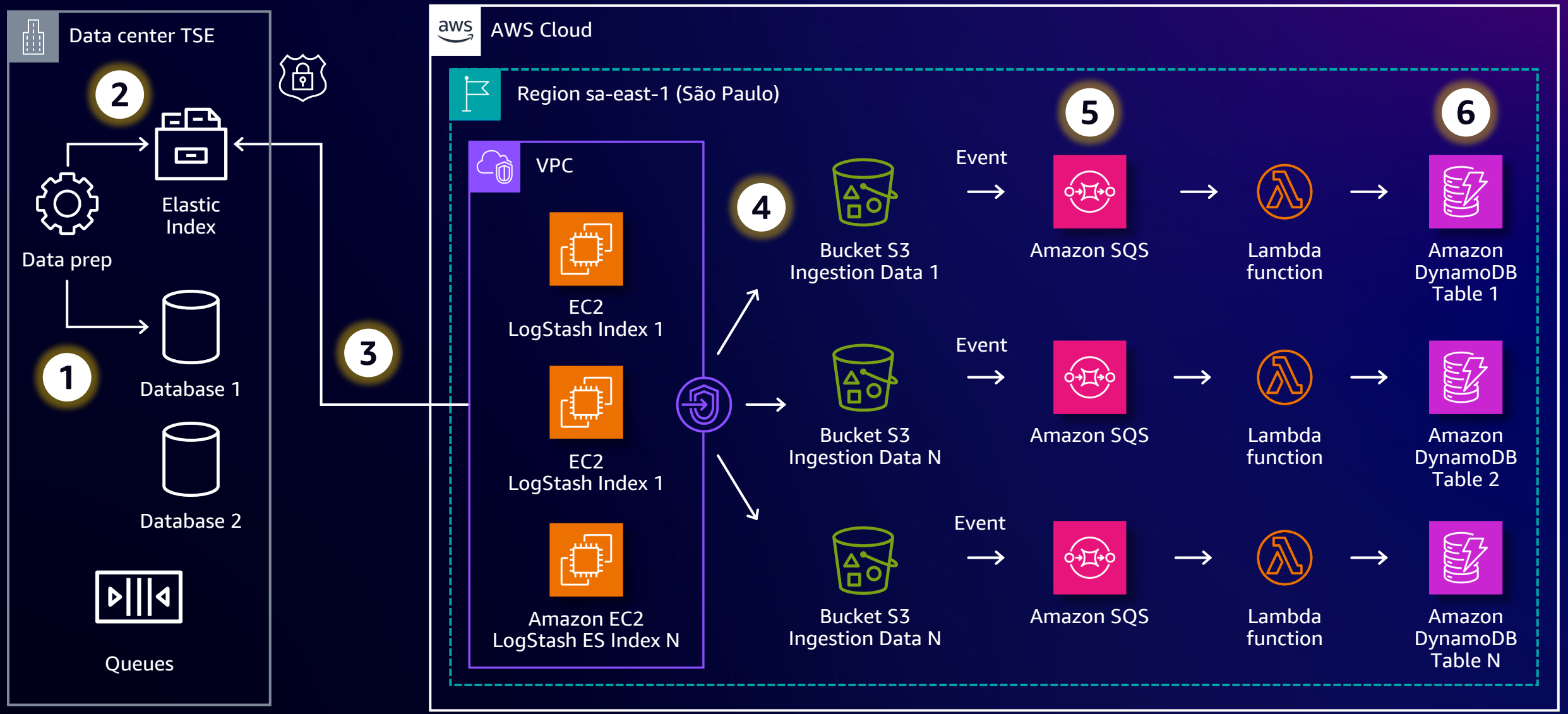
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e-Título on AWS: Challenges and gotchas



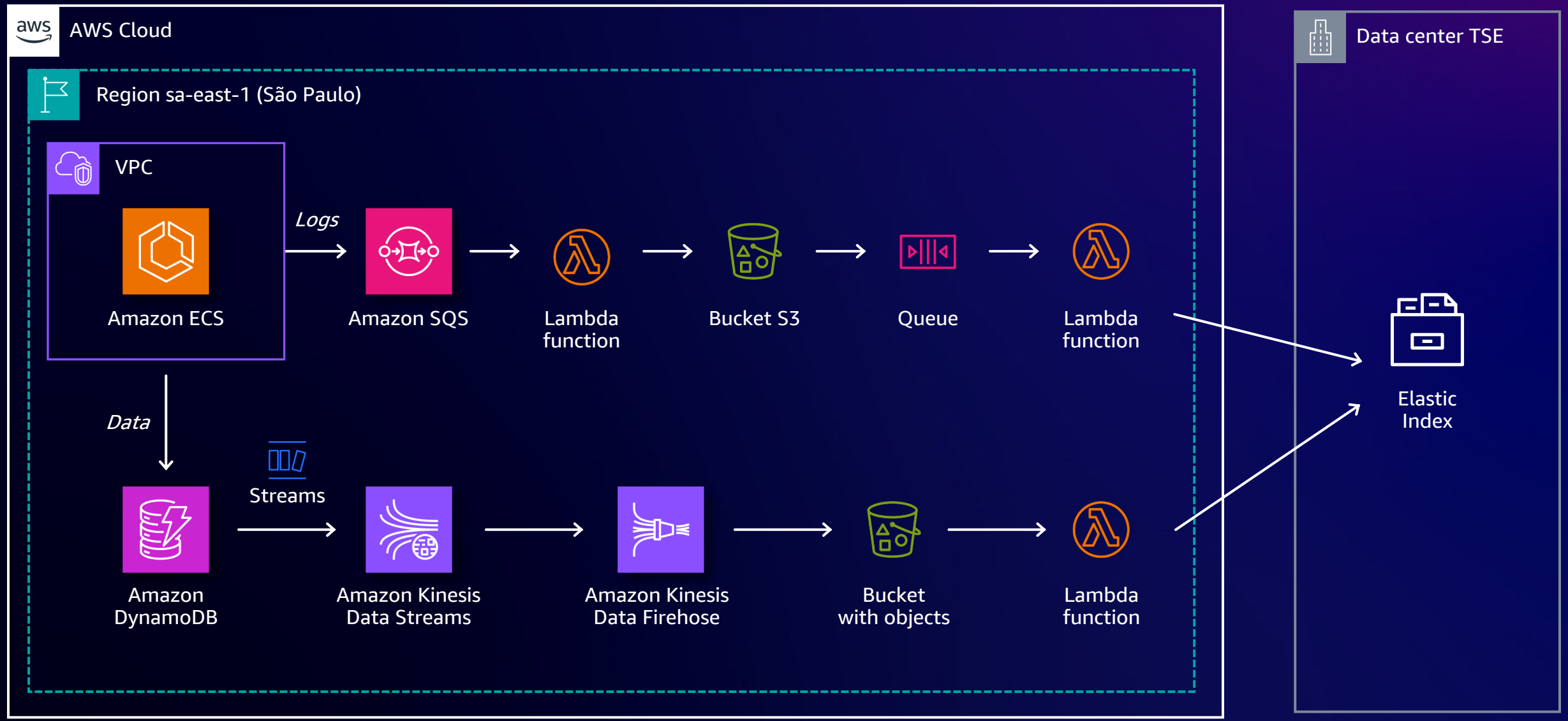
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Challenge 1: Data migration and rollback



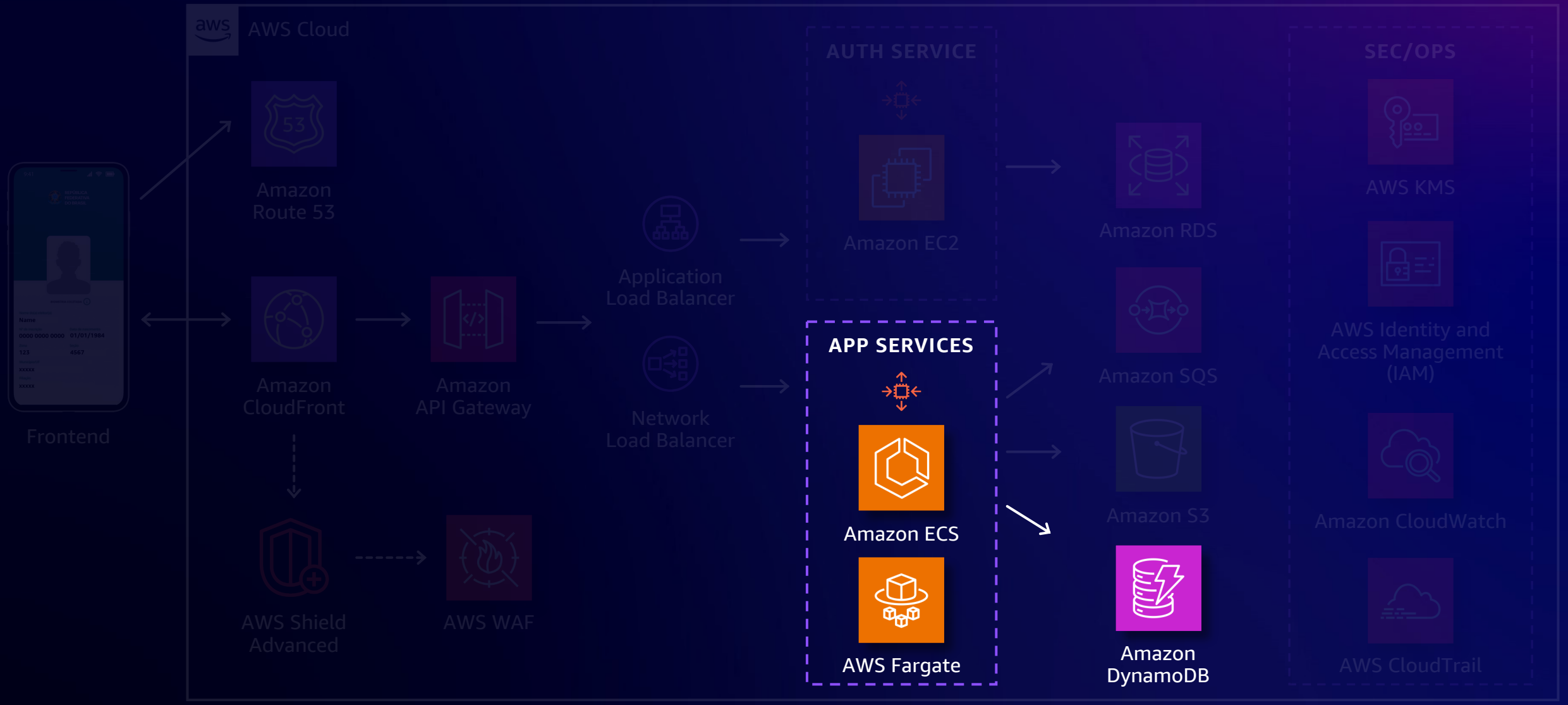
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Challenge 1: Data migration and rollback



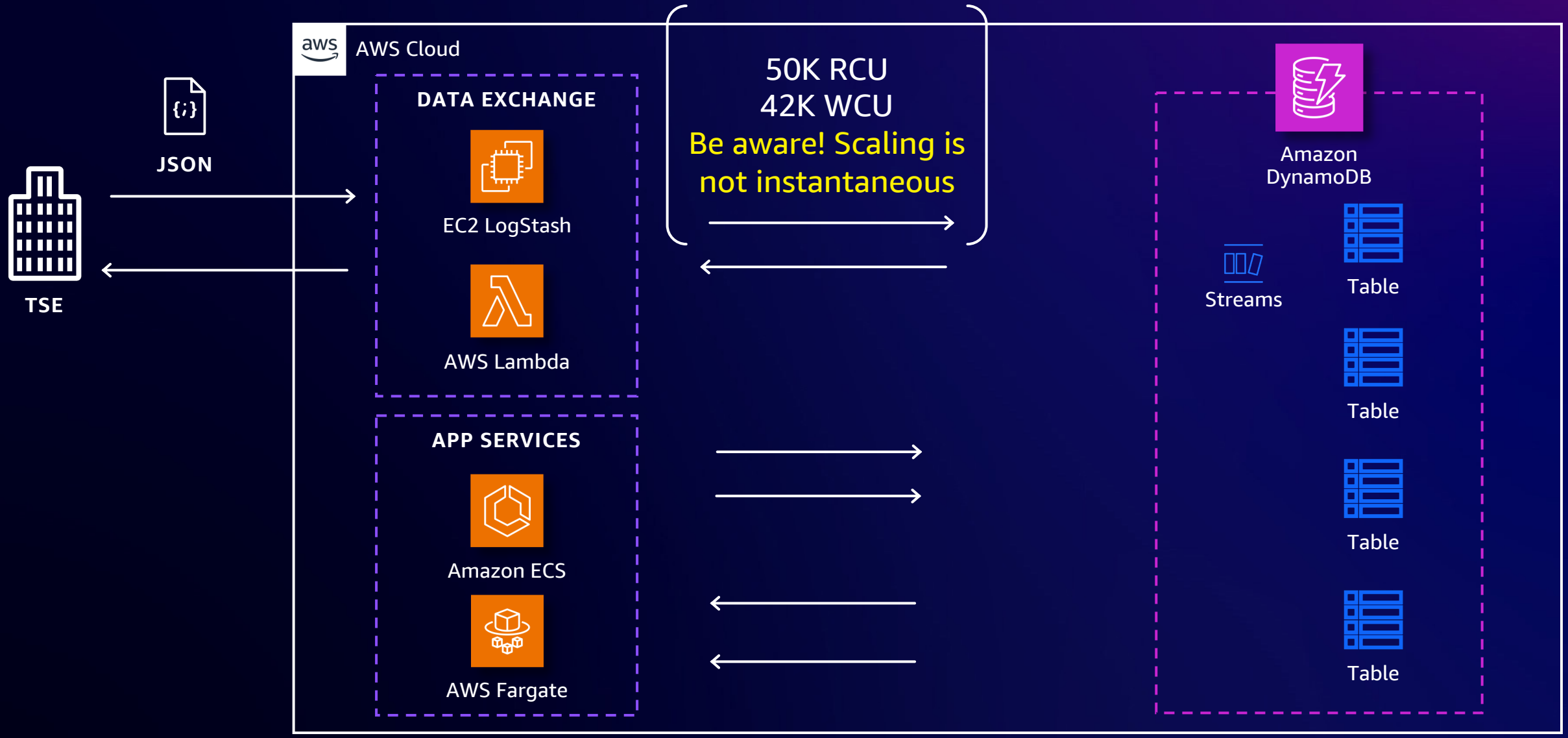
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Challenge 2: DynamoDB scaling



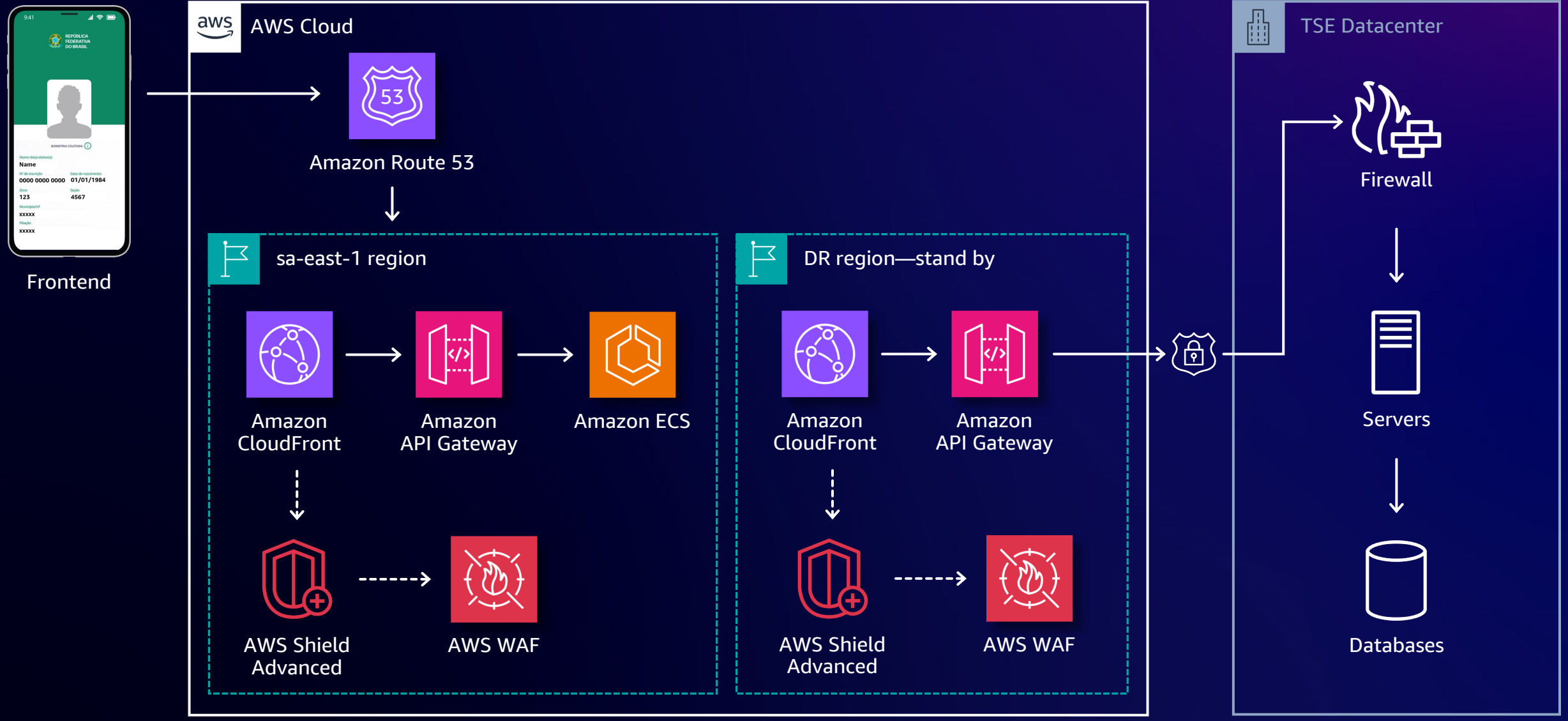
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Challenge 2: DynamoDB scaling



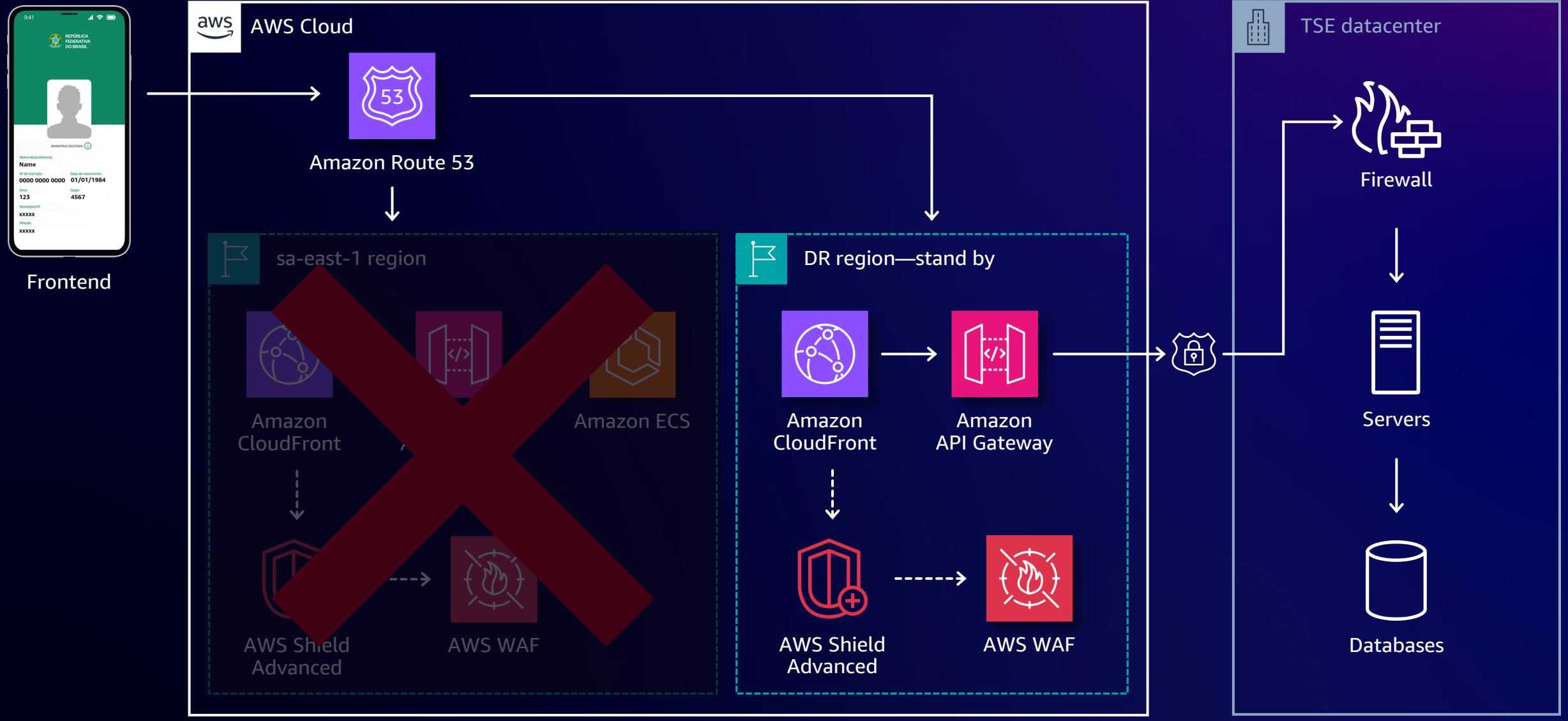
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Challenge 3: Disaster recovery



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Challenge 3: Disaster recovery



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How about security?

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Security by design

The TSE architecture was segregated by different accounts:

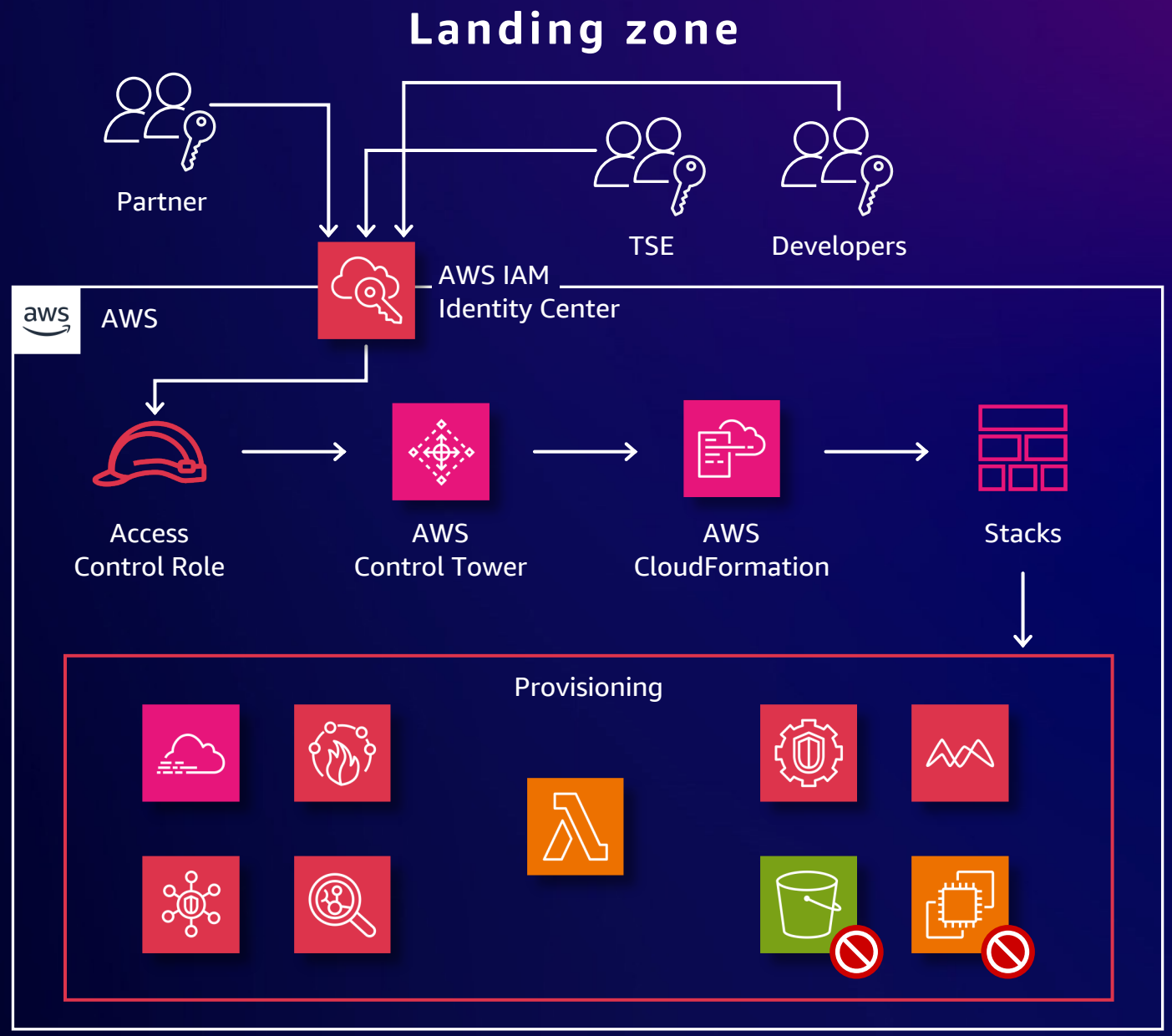
TSE Management

Audit

Log Archive

Security Account

Network



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What services and processes are important to implement within a project with such sensitive data?

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Deployment and testing

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Testing strategy

HOW WE ACHIEVED THOUSANDS OF RPS

14K RPS target

Voter journey-based

15 test cases

Top RPS = 40K

Fastest response time = 0.1139s

Max. error rate = 1.63%



aws

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Critical success factors

Solutions and patterns



Proof of concepts and tests



aws professional services

All teams working sharing the same objective



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What we achieved

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Results

E-TÍTULO

0

ZERO

Incidents on D-Day

+40

MILLIONS

e-Título issued

3.3

MILLIONS

Absence justifications

+60

NOTIFICATIONS

Sent directly to voters

***Including voting place updates*

aws

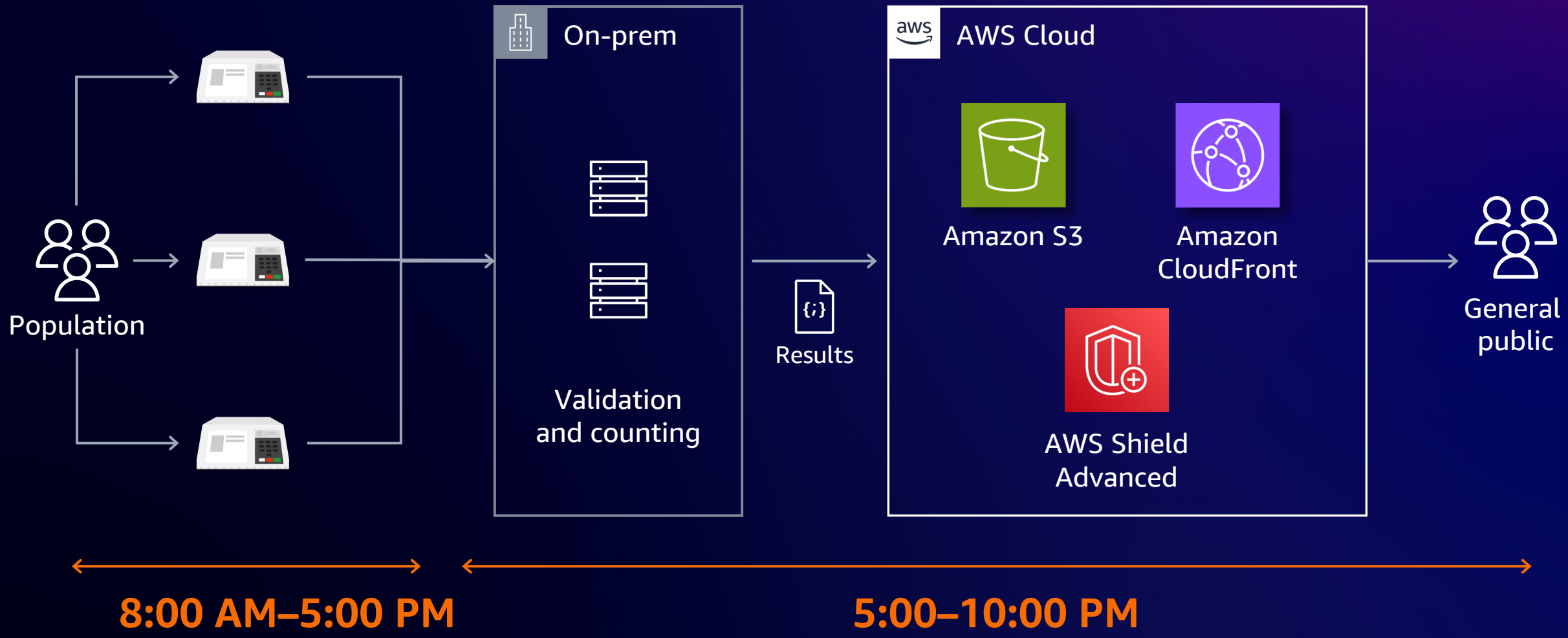
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Voting results: Handling 1.5 million requests per second

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Voting days

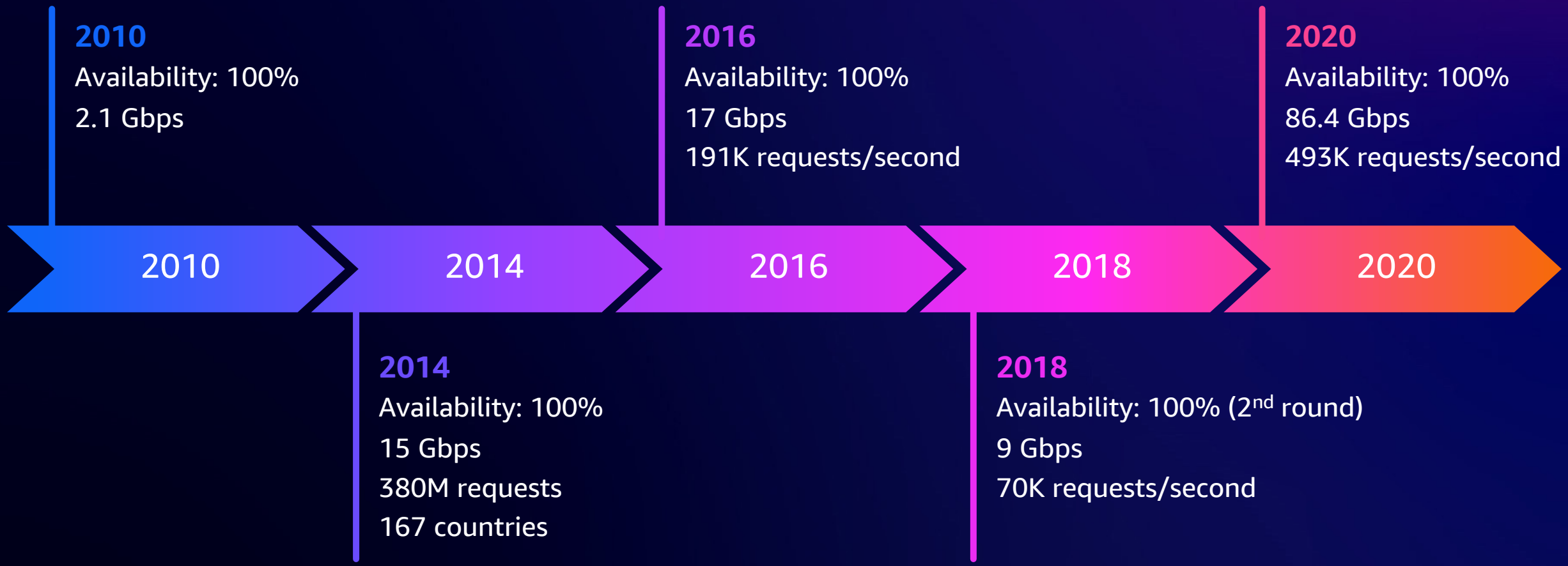
OVERVIEW



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Voting results distribution

HISTORICAL DATA



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Technical challenges

500K

requests per second

150K

files available in real-time

4 hrs

of peak time

100%

availability

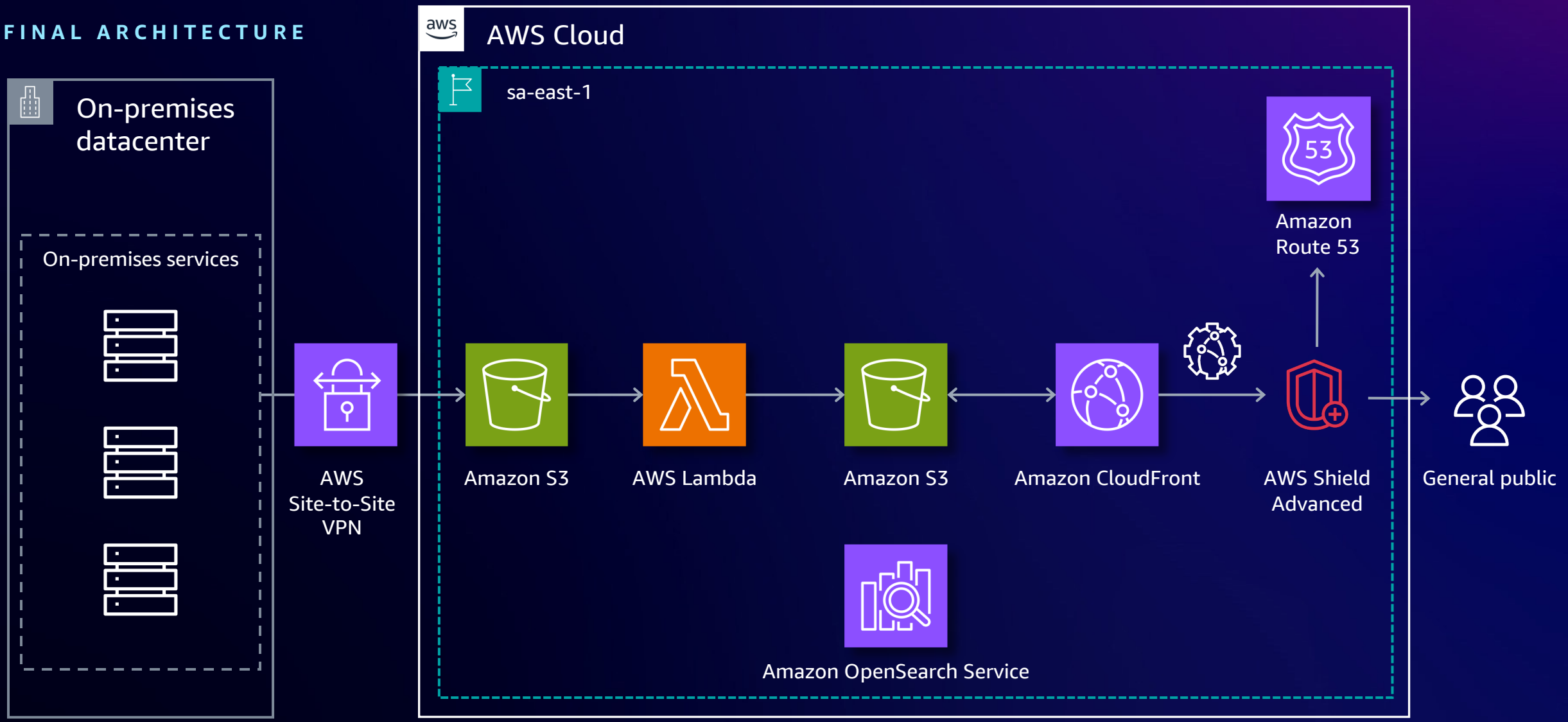
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Technical deep dive voting results distribution

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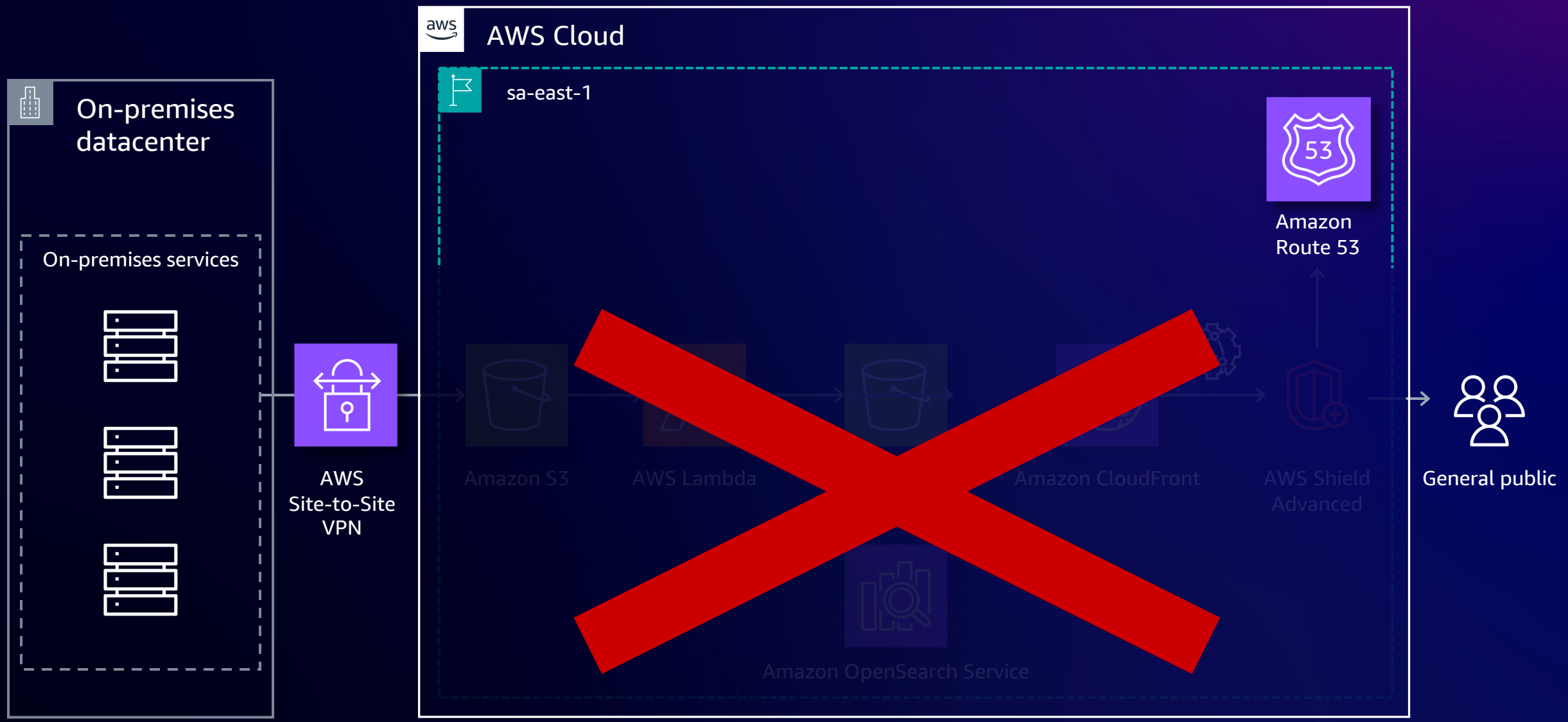
Distribution

FINAL ARCHITECTURE



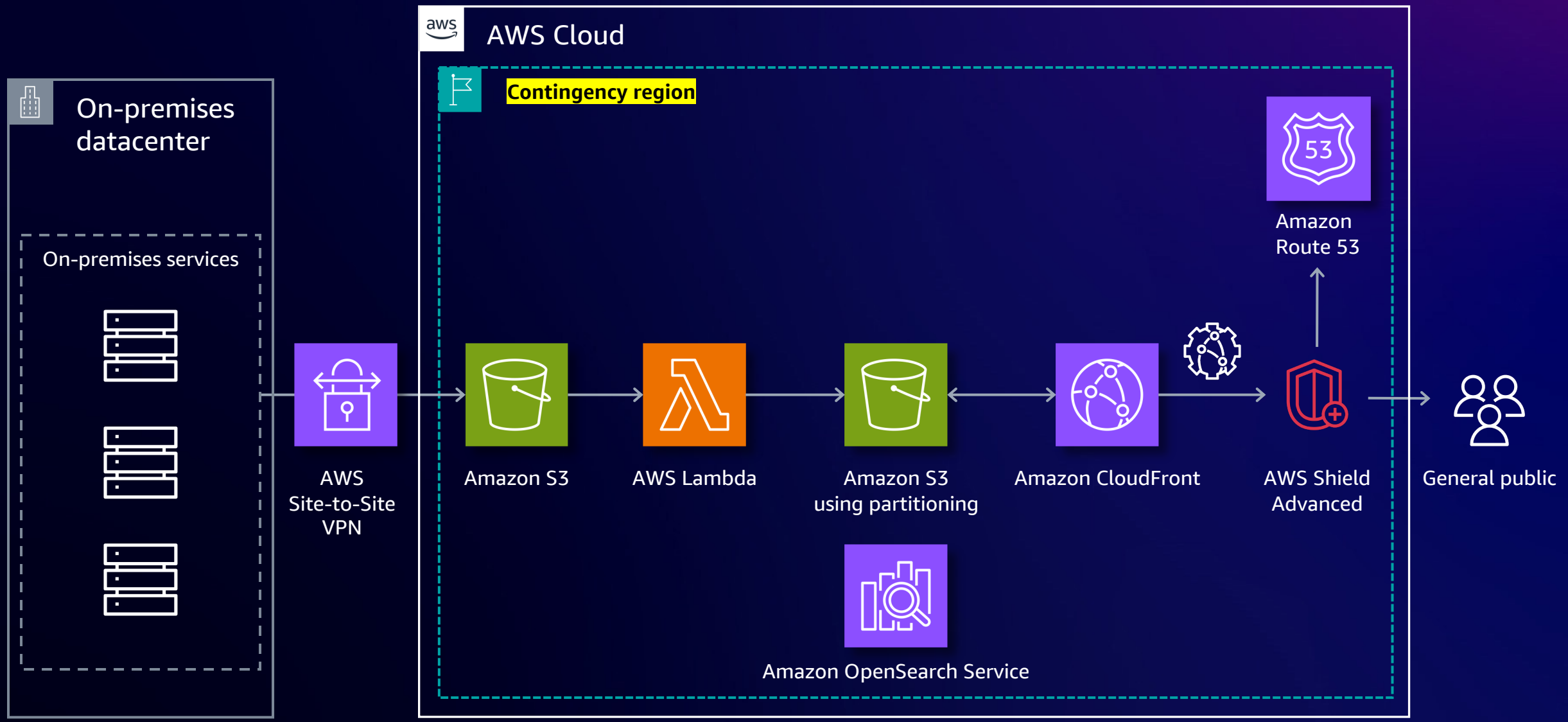
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Resilience



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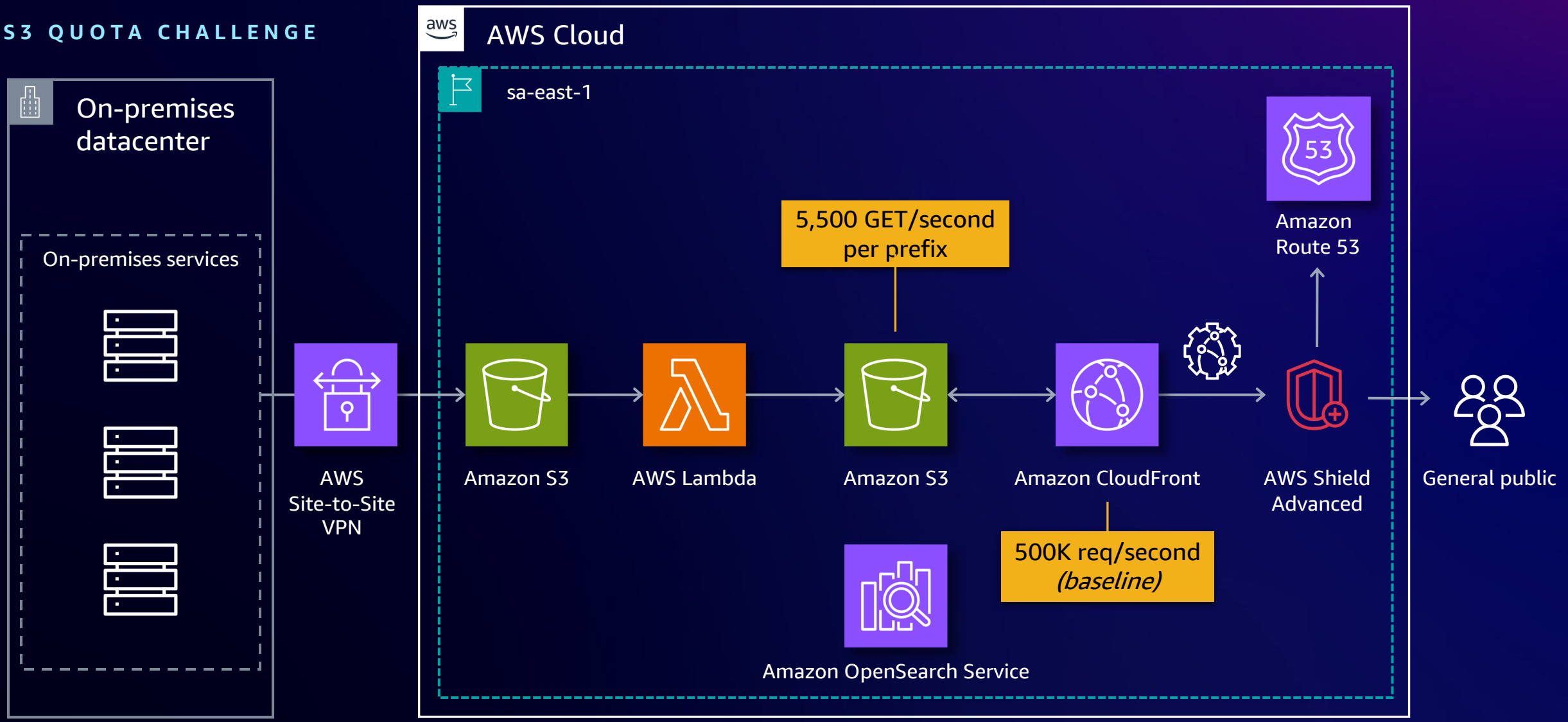
Resilience



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Distribution

S3 QUOTA CHALLENGE



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Distribution

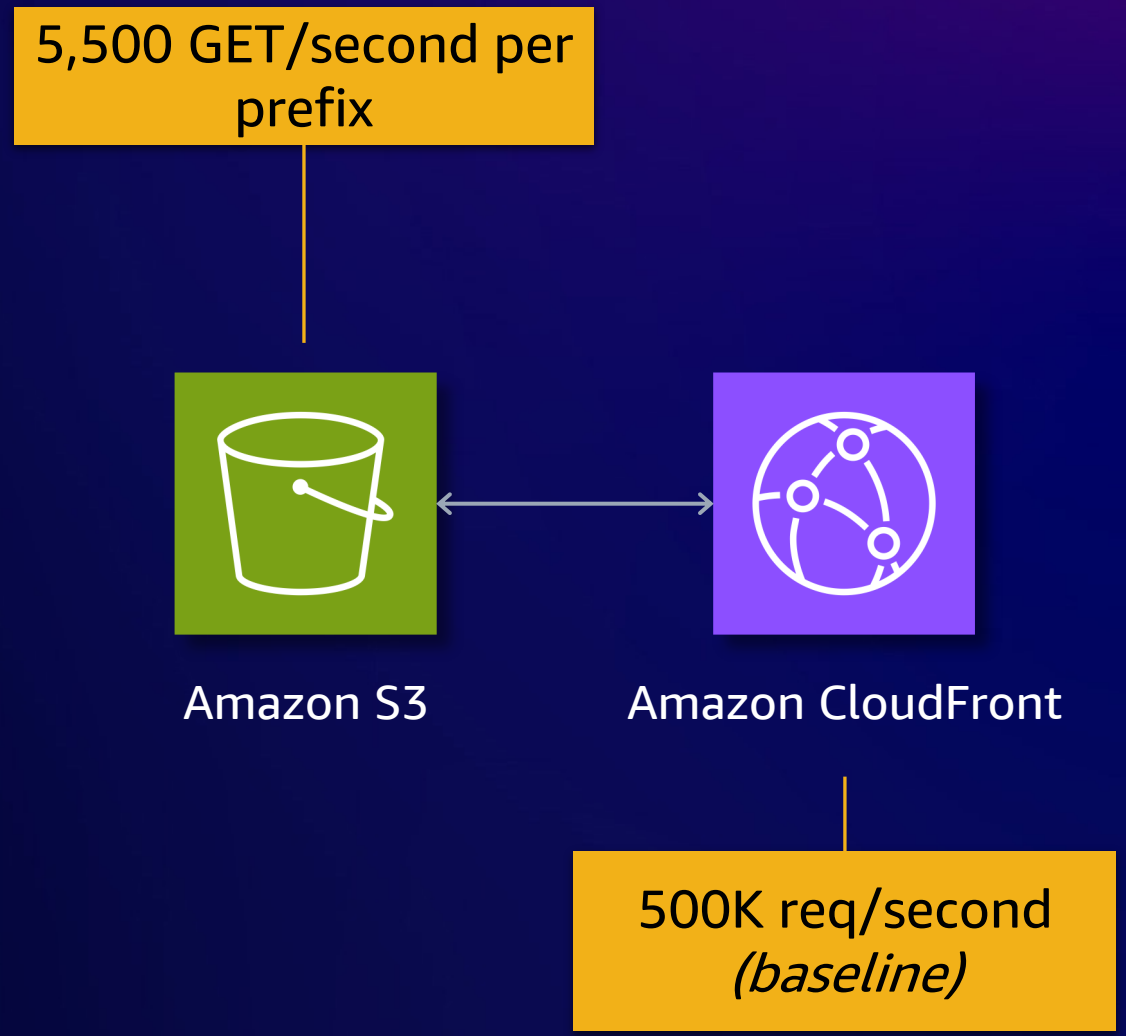
S3 QUOTA CHALLENGE

Near-zero cache in CloudFront (*low TTL*)

At least 500K requests per second

5,500 requests/second is the limit per prefix in S3

100% availability



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Static patterns

AMAZON S3



Results-bucket

Bucket name/prefix	Throughput/second
results-bucket/br/br-001.json	5,500 GET/HEAD
results-bucket/ac/ac-001.json	5,500 GET/HEAD
results-bucket/ap/ap-001.json	5,500 GET/HEAD – same prefix
results-bucket/ap/ap-002.json	

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Partitioning and entropy

AMAZON S3



Results-bucket

Bucket name/prefix	Throughput/second
results-bucket/br/<dynamic hash>/br-001.json	5,500 GET/HEAD

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Partitioning and entropy

AMAZON S3



Results-bucket

Bucket name/prefix	Throughput/second
results-bucket/br/8ac6dd56d96a2d/br-001.json	5,500 GET/HEAD

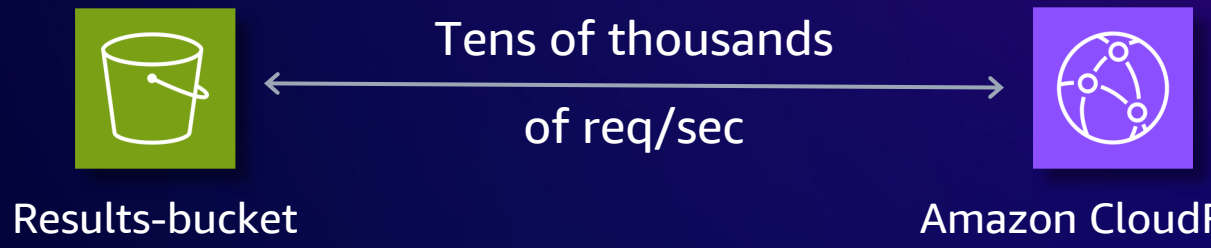
Entropy

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Partitioning: Auto partitioning

AMAZON S3



Bucket name/prefix	Throughput/second
results-bucket/br/8ac6dd56d96a2d/br-001.json	
results-bucket/br/8a/br-001.json	5,500 GET/HEAD
results-bucket/br/ac/br-001.json	5,500 GET/HEAD
results-bucket/br/c6/br-001.json	5,500 GET/HEAD

On demand: Up to 60 minutes to finish

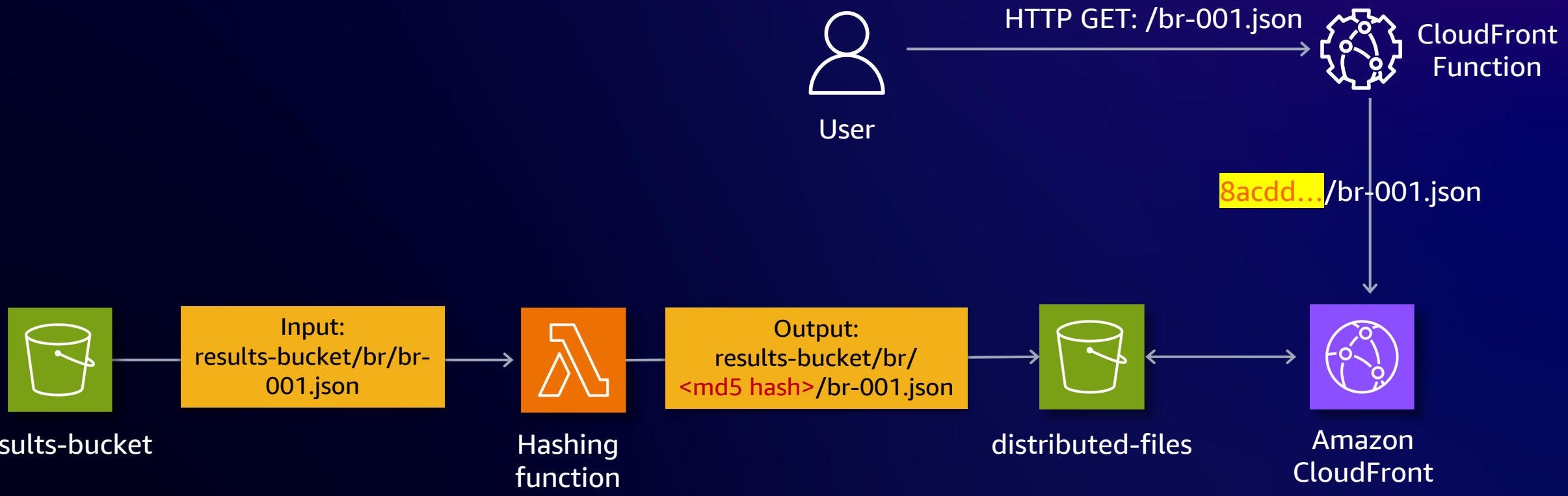
In advance: Partitions can be generated manually, ahead of time. Please contact your AWS account team or AWS support.

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Partitioning: Entropy – implementation

AMAZON S3



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Performance and horizontal scaling



- Amazon S3 is **massively horizontally scalable**
- Parallelize access **across endpoints**
- Parallelize **individual operations**
  - Multipart uploads
  - Ranged GETs
- Scale workloads **across prefixes**
  - **Entropy** can help **for bursts**

aws

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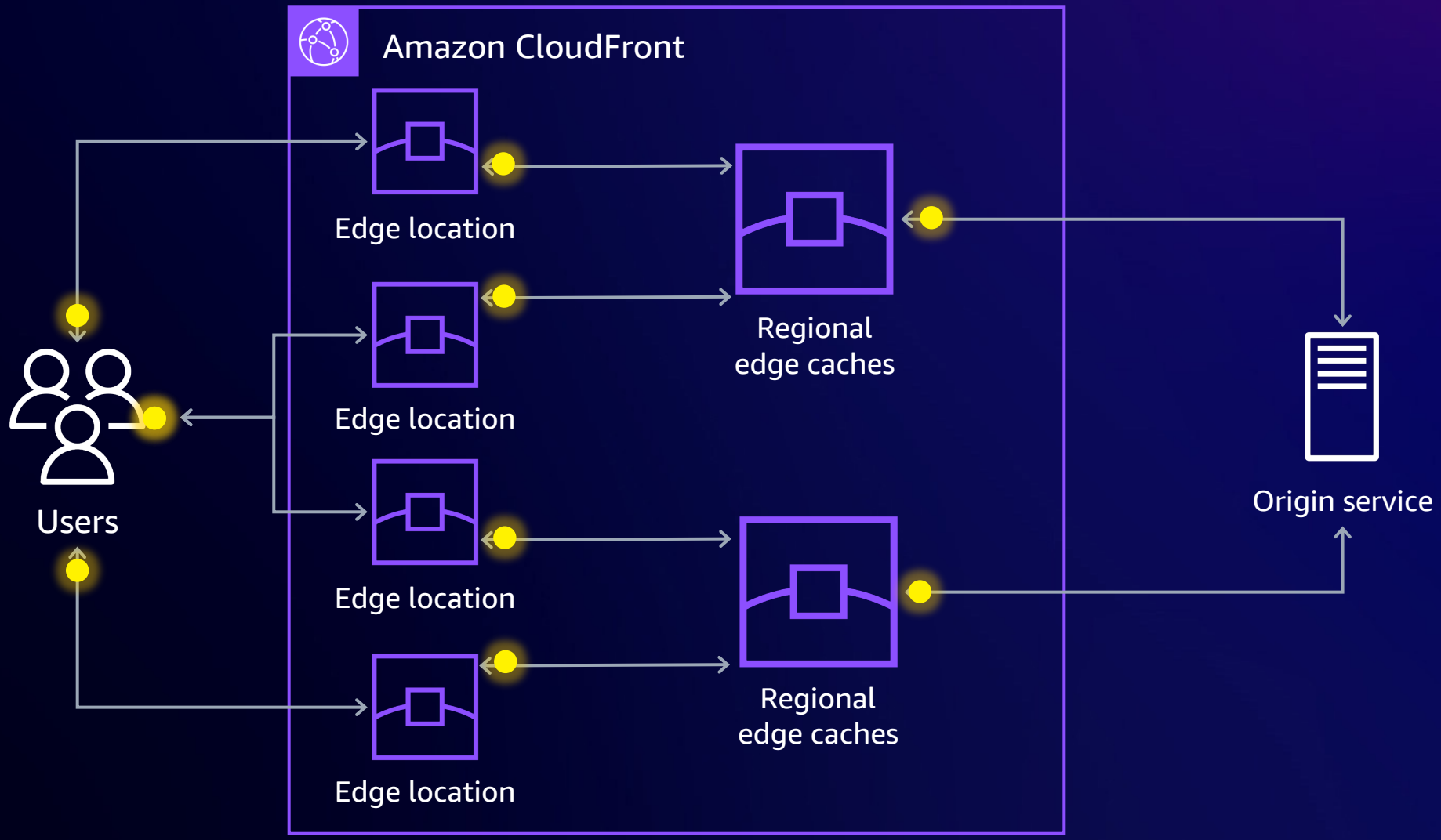
A global content distribution network



Amazon CloudFront has **450+ POPs** distributed in **90+ cities** and **48 countries**

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Bring content closer to the user



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DDoS protection

AWS SHIELD ADVANCED

Integration



Amazon CloudFront



Elastic Load Balancing



AWS Global Accelerator



Elastic IP Address

Key points

L3–L7 DDoS premium protection for mission critical workloads

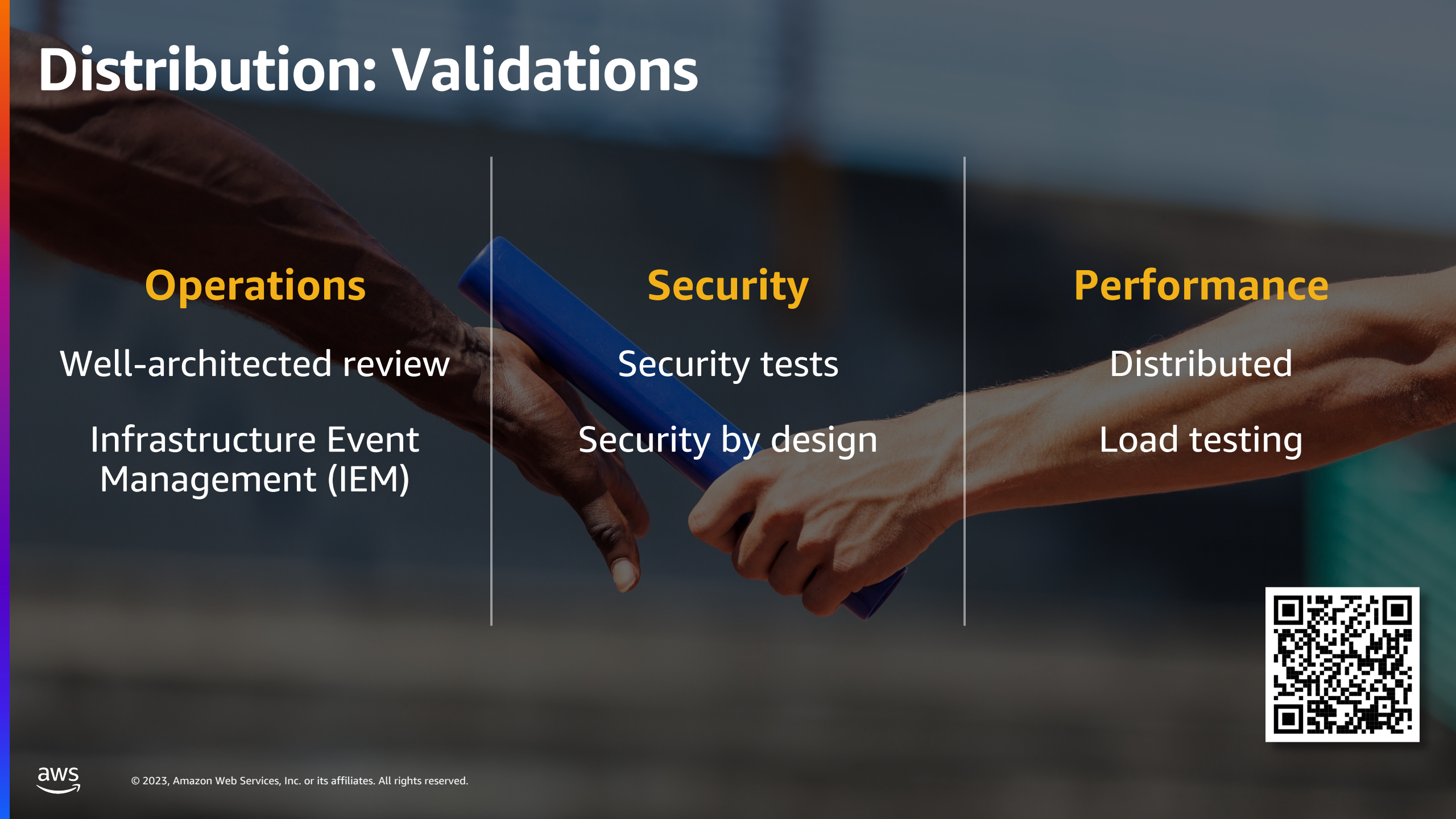
24x7 support with AWS Shield Response Team (SRT)

L3–L4 adaptative protection, L7 anomaly detection, integrity checks and automatic mitigations

AWS WAF, Firewall Manager, and cost protection for usage spike during DDoS

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Distribution: Validations



Operations

Well-architected review

Infrastructure Event Management (IEM)

Security

Security tests

Security by design

Performance

Distributed

Load testing

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Amazon Infrastructure Event Management

ASSESS OPERATIONAL READINESS, IDENTIFY AND MITIGATE RISKS, AND EXECUTE YOUR EVENT CONFIDENTLY WITH AWS EXPERTS BY YOUR SIDE

Applications launch

Datacenter migration

Marketing event

Initiation

AWS Support works with you to understand your success criteria and business outcome

Planning

We assess the readiness of your AWS environment, help identify and mitigate risks, and document your plan

Your event

Confidently execute with AWS experts by your side

Post event review

We help analyze results and scale services to normal operating levels so you can prepare for your next event

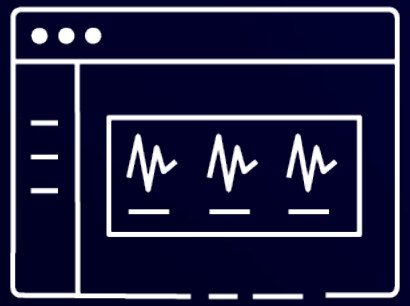
6–8 weeks

1–2 weeks

- Scalability
- Reduced risk
- Acceleration
- Performance
- Availability

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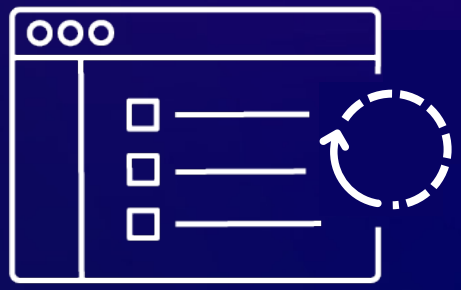
Security validations



Volumetric tests



Application layer



Low and slow

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DDoS and security validation



[AWS Distributed Load Testing]

Automate software applications testing at scale and at load to help identify potential performance issues



[DDoS Testing Policy]

DDoS simulation testing uses a controlled DDoS attack to enable the owner of an application to evaluate the resiliency of the application and to practice event response



[AWS Best Practices for DDoS Resiliency]

Prescriptive DDoS guidance to improve the resiliency of applications running on AWS

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Final results

1.5M	90TB	Zero	4h10m
requests per second	distributed data	Incidents	peak time

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Recap

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What we've learned

Planning and coordination

Test everything
(several times)

Be prepared to change

Study and plan your solution's baseline metrics

Know your service limits



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Thank you!



Please complete the session survey in the mobile app

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Vinicius Soares Batista
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