

The background features a dark navy blue field with abstract, overlapping shapes in vibrant magenta and deep red. Two thin, light blue lines intersect diagonally across the upper right portion of the image. The text is positioned on the left side.

AWS re:Invent

DECEMBER 2 – 6, 2024 | LAS VEGAS, NV

NET403

Planet-scale networking: How AWS powers the world's largest networks

Stephen Callaghan

Senior Principal Network Engineer
Amazon Infrastructure

Jorge Vasquez

Senior Principal Software Engineer
Amazon Infrastructure



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Agenda

Role of the AWS network

Design goals and principles

Deep ownership

What's next?

Continuing the series

2022

NET402

Dive deep on AWS networking infrastructure

Stephen Callaghan (he/him)
Sr. Principal Engineer
AWS

JR Rivers (he/him)
Sr. Principal Engineer
AWS

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2023

NET401-R

AWS journey towards intent-driven network infrastructure

Stephen Callaghan
(he/him)
Senior Principal Engineer
Amazon Infrastructure Services

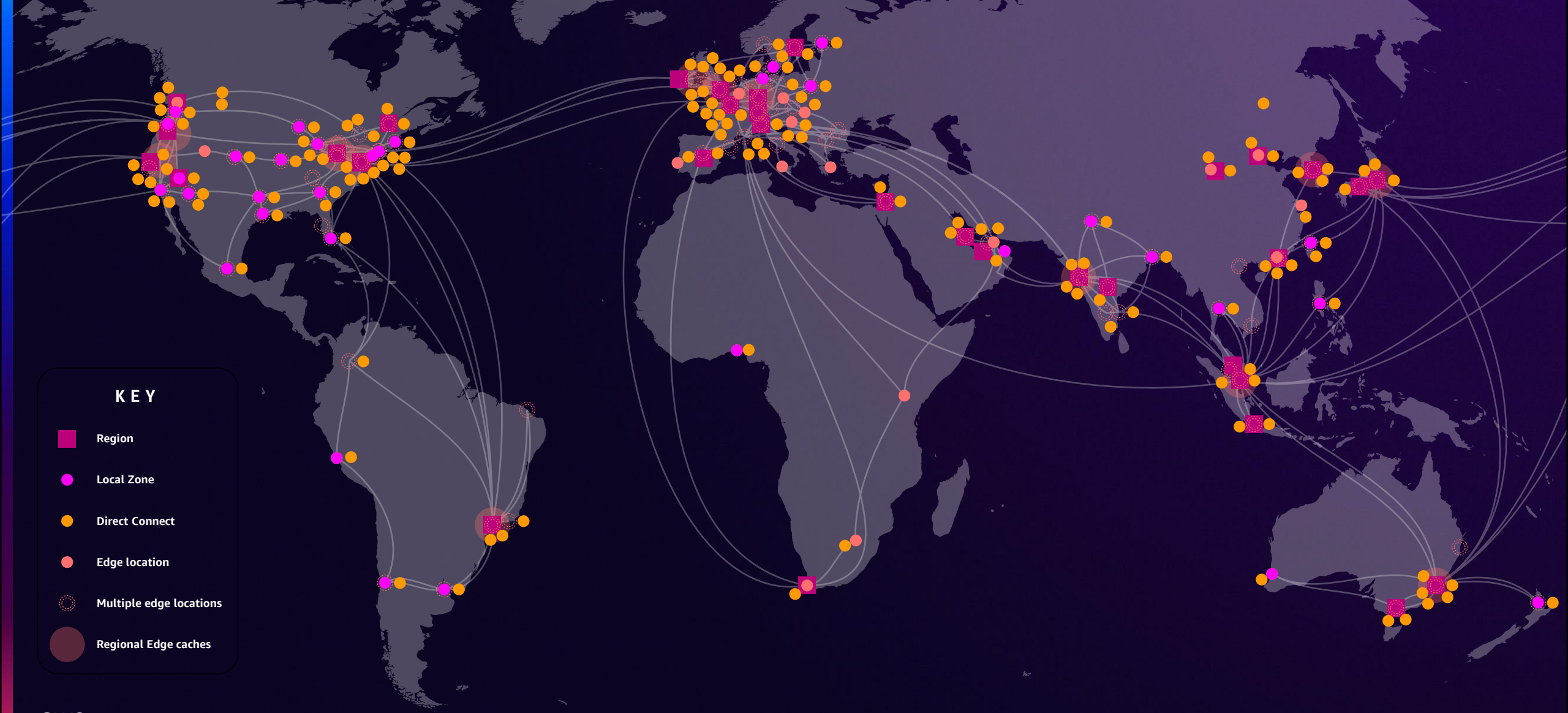
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AWS networking

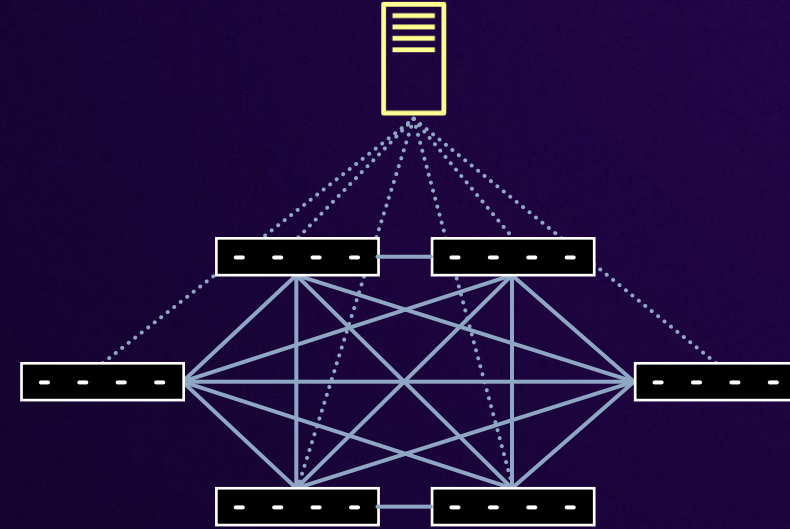
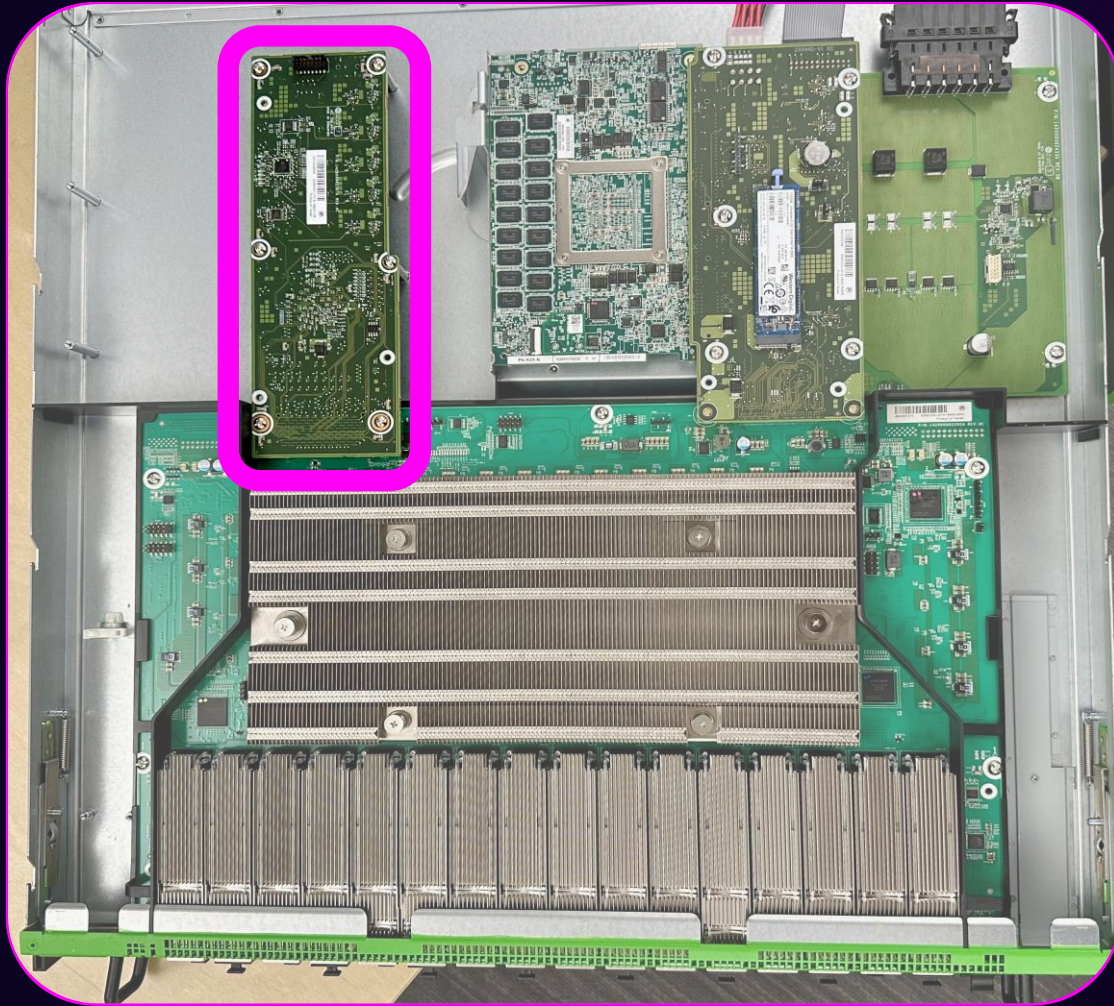
Infrastructure networking	Amazon EC2 networking	Edge networking
Routers/Switches	Amazon Virtual Private Cloud (Amazon VPC)	Amazon Route 53
Copper/Optical cables	Elastic network interface	AWS Global Accelerator
Datacenters	AWS NAT gateway	Amazon CloudFront
Inter-Region backbone	Elastic Fabric Adapter (EFA)	AWS Direct Connect
Internet peering/transit	Placement groups	AWS Cloud WAN

Planet scale networking





AWS custom network hardware



Statically stable

Deterministic

Highly visible

Low scope of impact

Hybrid control plane

Role of the AWS network

Be so performant and reliable that we're out of the way of your workloads

Design goals



Flexible

amazon

Q Search

Who We Are

What We Do

Our Workplace

Our Impact

Our Planet

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News / AWS

6 min

June 26, 2024

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o

4 ways AWS is engineering infrastructure to power generative AI

Written by Prasad Kalyanaraman, VP of Infrastructure Services at AWS

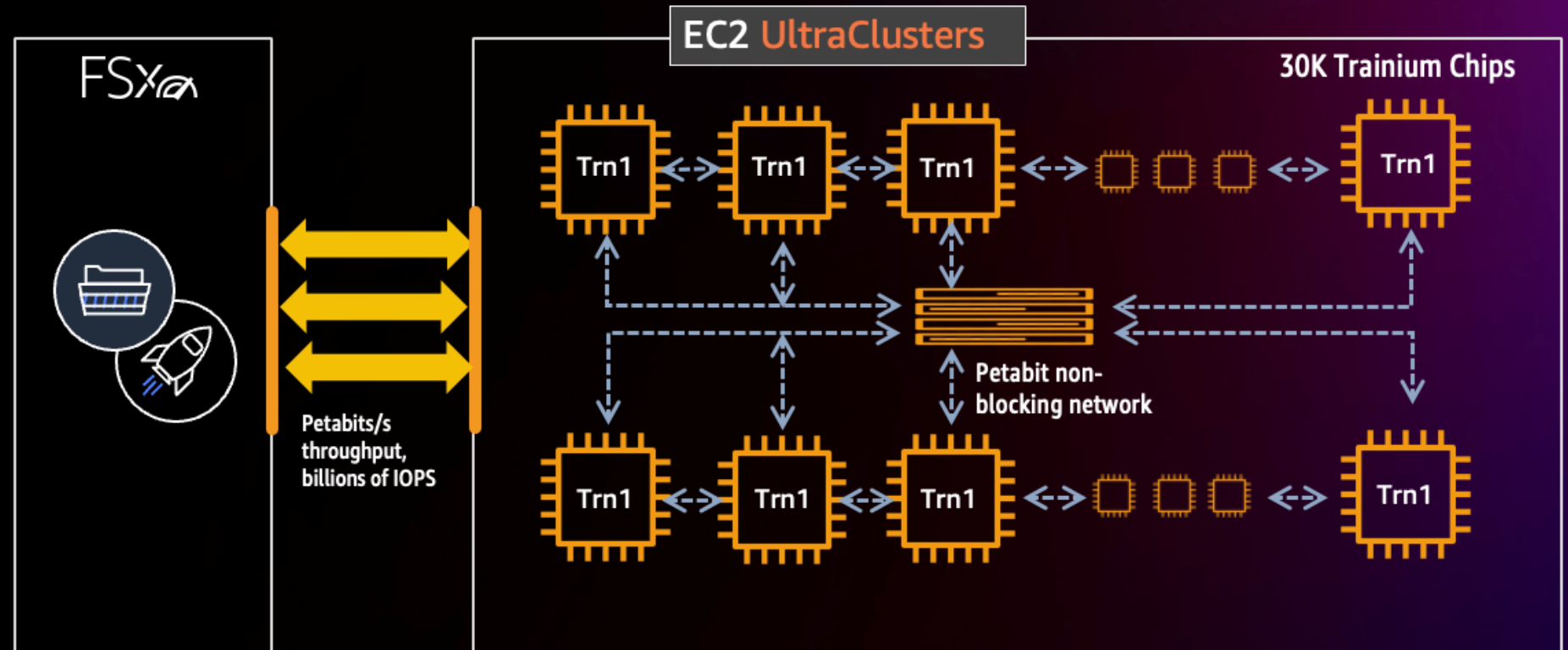




Flexible

UltraCluster scale out for ultra-large models

30K TRAINIUM ACCELERATORS, 6 EXAFLOPS



On-demand access to a world-class supercomputer

AI training and inference



COMPANY NEWS

Amazon and Anthropic deepen their shared commitment to advancing generative AI



AWS

AWS can help reduce the carbon footprint of AI workloads by up to 99%. Here's how.



AWS

AWS and NVIDIA extend their collaboration to advance generative AI



AI training and inference



Anthropic's Claude 3.5 Sonnet on Amazon Bedrock



AWS

Amazon Bedrock introduces Anthropic's Claude 3.5 Sonnet to customers, their most powerful AI model to date



Llama 3.2 models from Meta on AWS



AWS

Llama 3.2 models from Meta are now available on AWS, offering more options for building generative AI applications

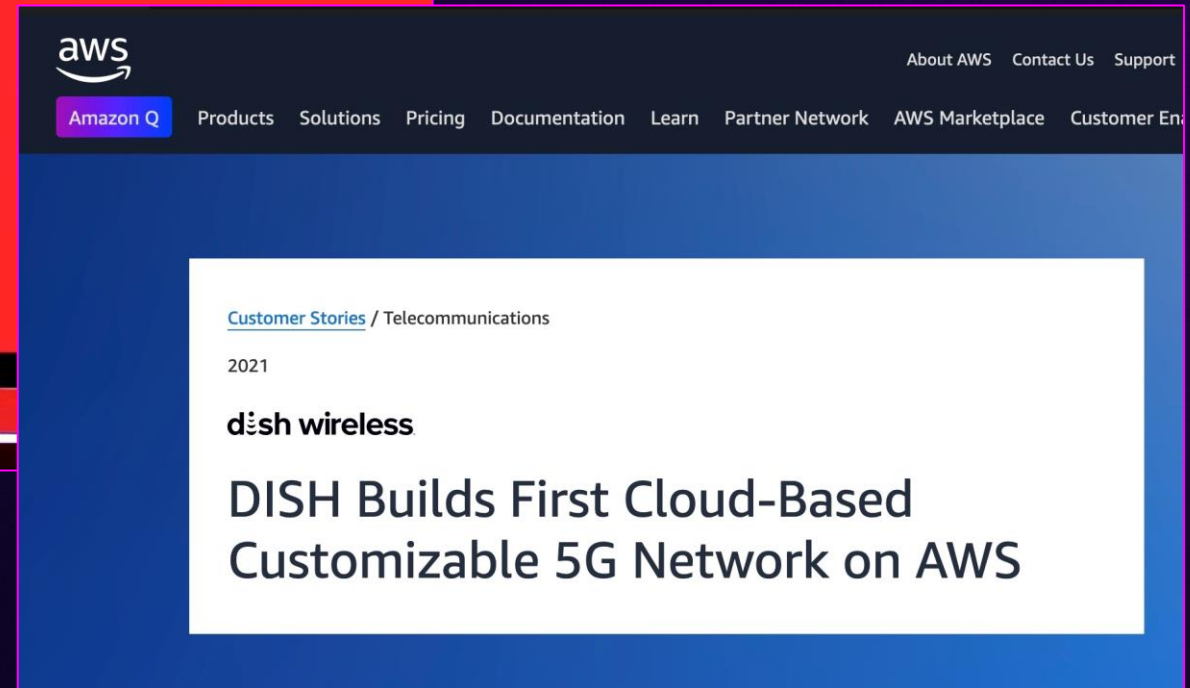
Available now on Amazon Bedrock: Mistral Large

AWS

Amazon Bedrock customers have more choice in AI models with Mistral Large now available



Local zones



Video streaming



ENTERTAINMENT

'Thursday Night Football' behind-the-scenes: How Prime's NFL coverage comes to life



AWS

How AWS is using AI to bring Formula 1 fans closer to the race



ENTERTAINMENT

Prime Video reaches a landmark 11-year streaming deal with the NBA and the WNBA



“The stack”



Subset of design goals

Security

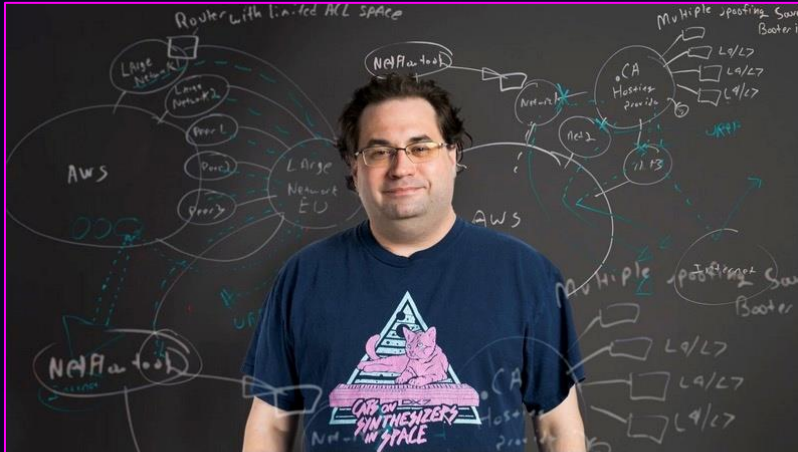
Availability

Features



Security

Internet security



AWS

How one Amazon engineer is making the internet a safer place for all of us (and cats, too)



AWS

Amazon helps the US Department of Justice thwart international cybercriminal group Anonymous Sudan



Availability



aws

Contact Us

Support

My Account

AWS Health Dashboard

Updated less than 1 minute ago

Service health

View the current and historical status of all AWS services.

View your account health

Get a personalized view of events that affect your AWS account or organization.

Open your account health

Open and recent issues (1)

Service history

Service history

List of servicesList of events

The following table is a running log of AWS service interruptions for the past 12 months. Choose a status icon to see status updates for that service. All dates and times are reported in Pacific Daylight Time (PDT). To update your time zone, see [Time zone settings](#).

Find an AWS service or Region

2024/10/23

North America	South America	Europe	Africa	Asia Pacific	Middle East	All locales	< 1 2 3 4 5 6 7 ... 23 >			
Service	RSS	⏪	Today	22 Oct	21 Oct	20 Oct	19 Oct	18 Oct	17 Oct	⏩
Amazon API Gateway (Calgary)	📡		✅	✅	✅	✅	✅	✅	✅	
Amazon API Gateway (Canada-Central)	📡		✅	✅	✅	✅	✅	✅	✅	
Amazon API Gateway (N. California)	📡		✅	✅	✅	✅	✅	✅	✅	
Amazon API Gateway (N. Virginia)	📡		✅	✅	✅	✅	✅	✅	✅	
Amazon API Gateway (Ohio)	📡		✅	✅	✅	✅	✅	✅	✅	
Amazon API Gateway (Oregon)	📡		✅	✅	✅	✅	✅	✅	✅	
Amazon AppFlow (Canada-Central)	📡		✅	✅	✅	✅	✅	✅	✅	

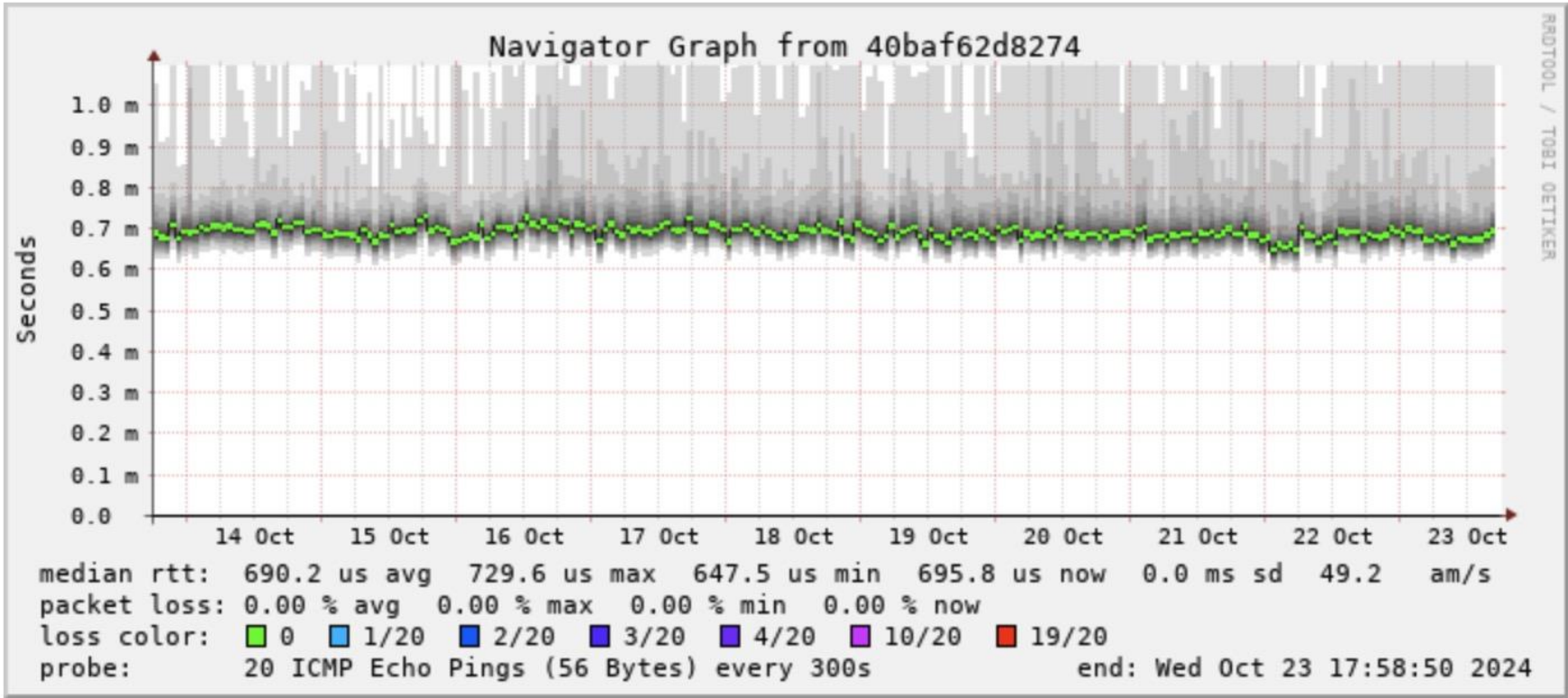


Consistency

SMOKEPING

us-west-2 18.236.0.0/15

Time range: 2024-10-13 17:58 to now Generate!



Resiliency

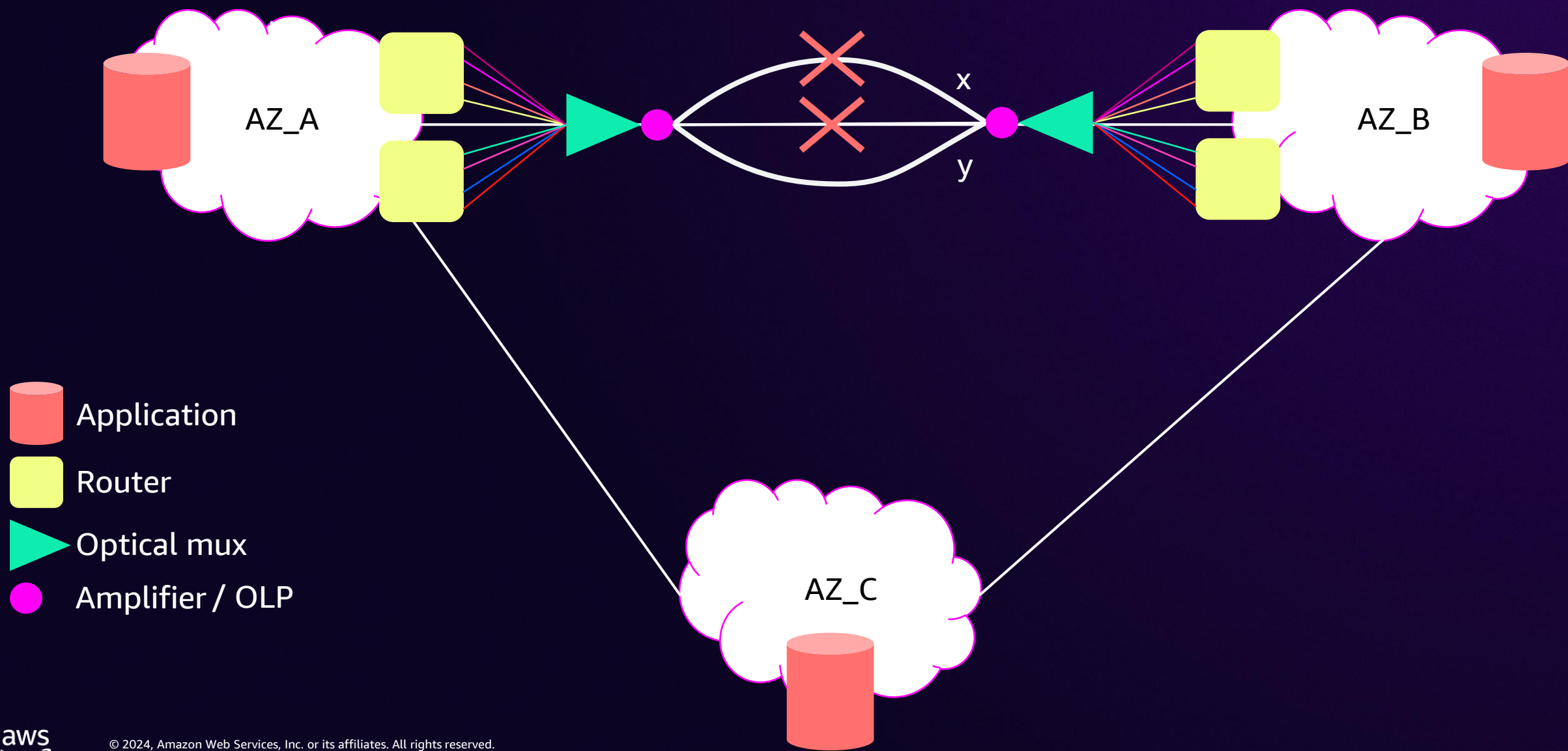
Plan for failure

Create multiple options

Choose the best place



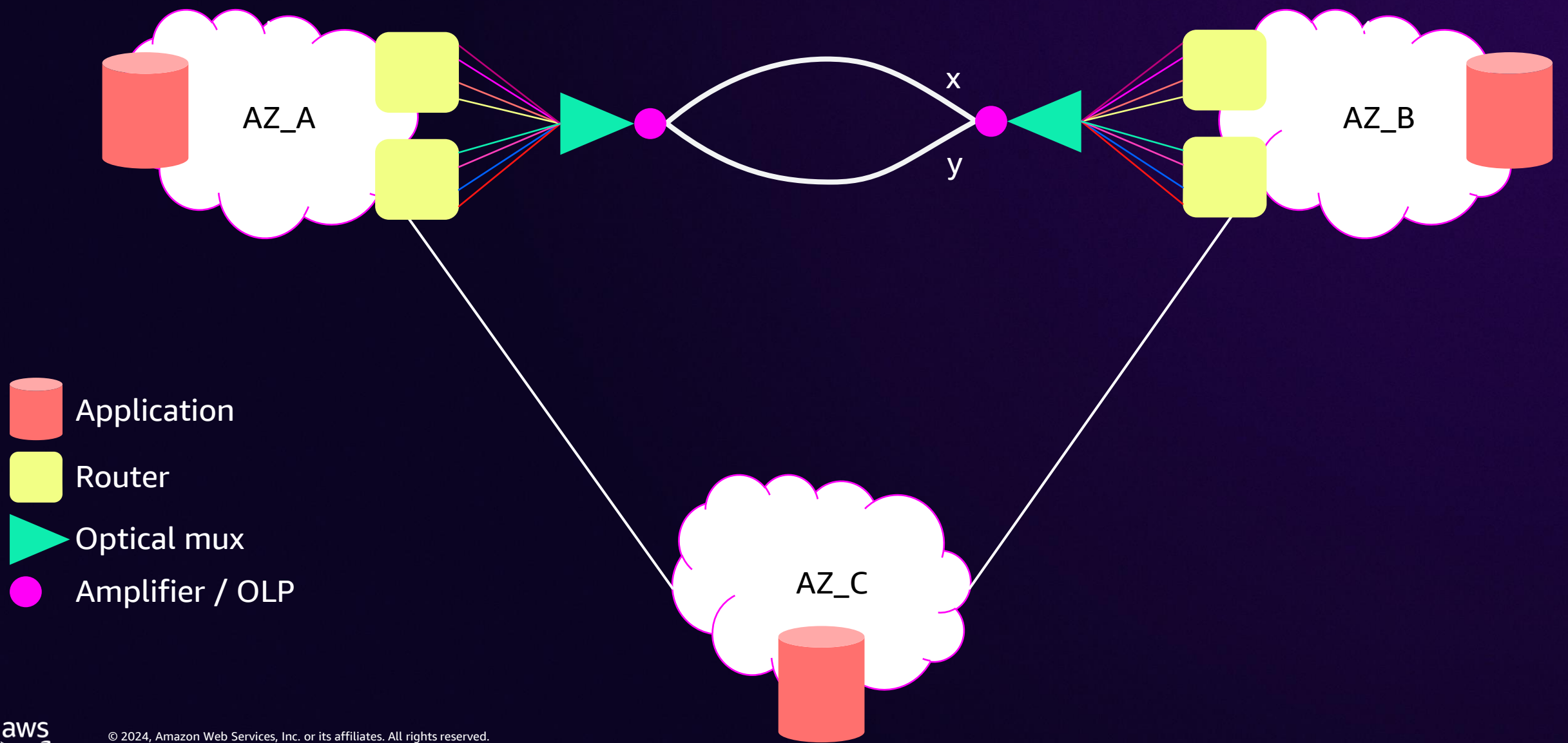
Resiliency example



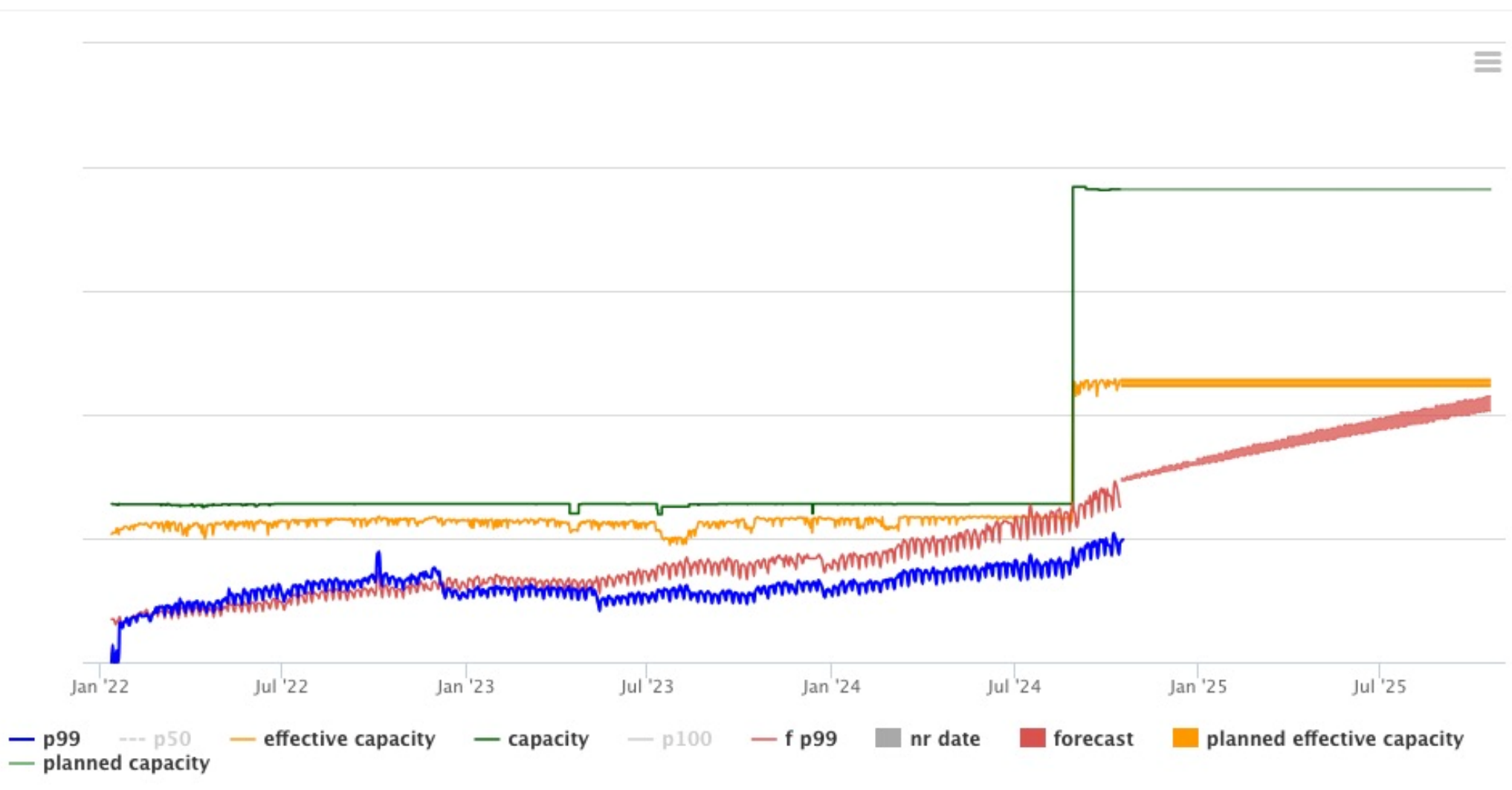
Resiliency



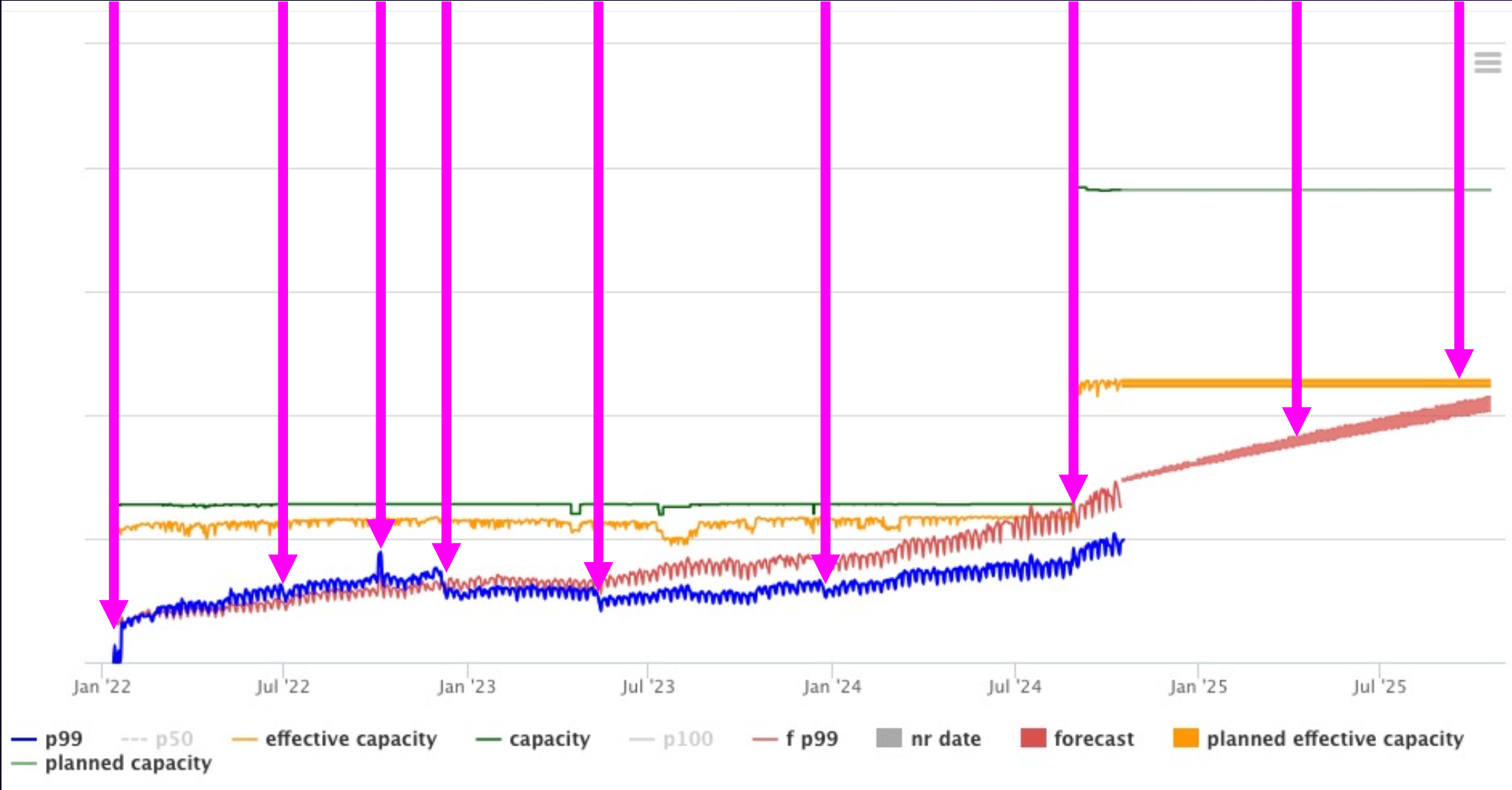
Robustness



Capacity management



Capacity management



Features

aws

Amazon Q

Products

Solutions

Pricing

Documentation

Learn

Partner Network

AWS Marketplace

Customer Enablement

Events

Explore More

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Create an AWS Account

Amazon EC2

Overview

Features

Pricing

Instance Types

FAQs

Getting Started

Resources

Compute

Amazon EC2

UltraClusters

Amazon EC2 UltraClusters

Run HPC and ML applications at scale

Get started with P5 UltraClusters

Get started with Trn1 UltraClusters

Why Amazon EC2 UltraClusters?

Amazon Elastic Compute Cloud (Amazon EC2) UltraClusters can help you scale to thousands of GPUs or purpose-built ML accelerators, such as AWS Trainium, to get on-demand access to a supercomputer. They democratize access to supercomputing-class performance for machine learning (ML), generative AI, and high performance computing (HPC) developers through a simple pay-as-you-go usage model without any setup or maintenance costs. Amazon EC2 P5 instances, Amazon EC2 P4d instances, and Amazon EC2 Trn1 instances are all deployed in Amazon EC2 UltraClusters.

EC2 UltraClusters consist of thousands of accelerated EC2 instances that are co-

aws

Amazon introduces Graviton4

annapurnatrace

787350, 1, 4034 2147 TB

ALC13B00-AL-A0-8-C-ES

annapurnatrace

787350, 1, 4034 2147 TB

ALC13B00-AL-A0-8-C-ES

annapurnatrace

787350, 1, 4034 2147 TB

ALC14C00-AL-A0-8-C-ES

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Network design principles

1. Automate as much as possible



1. Automate as much as possible

Configuration

Telemetry

Traffic engineering



1. Automate as much as possible

850 raw events per second

2.4 human engagements per hour



**2. We should fail
seldomly and in a
predictable way**



2. We should fail seldomly and in a predictable way

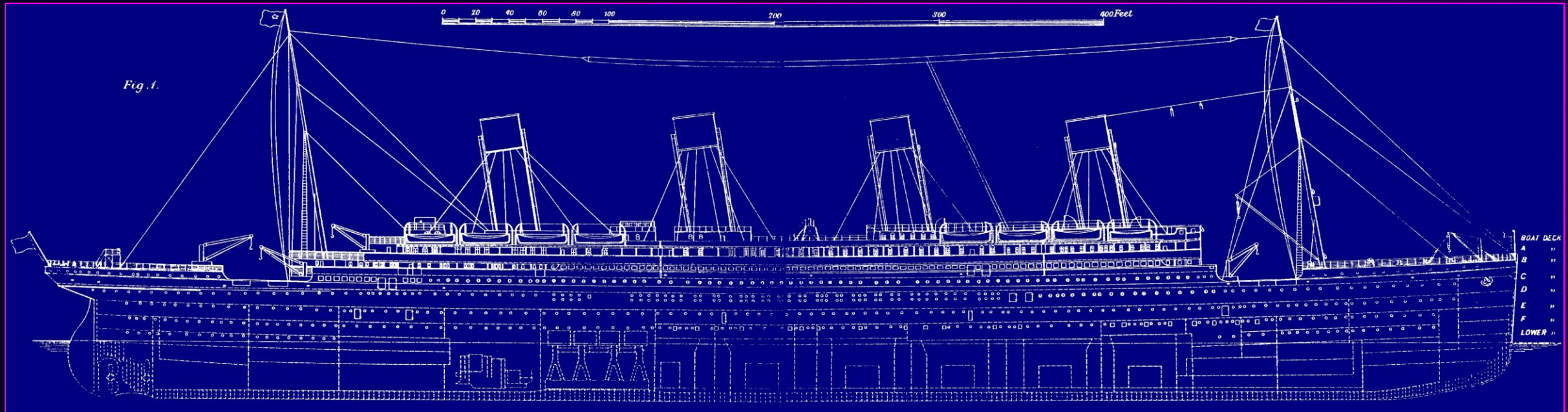


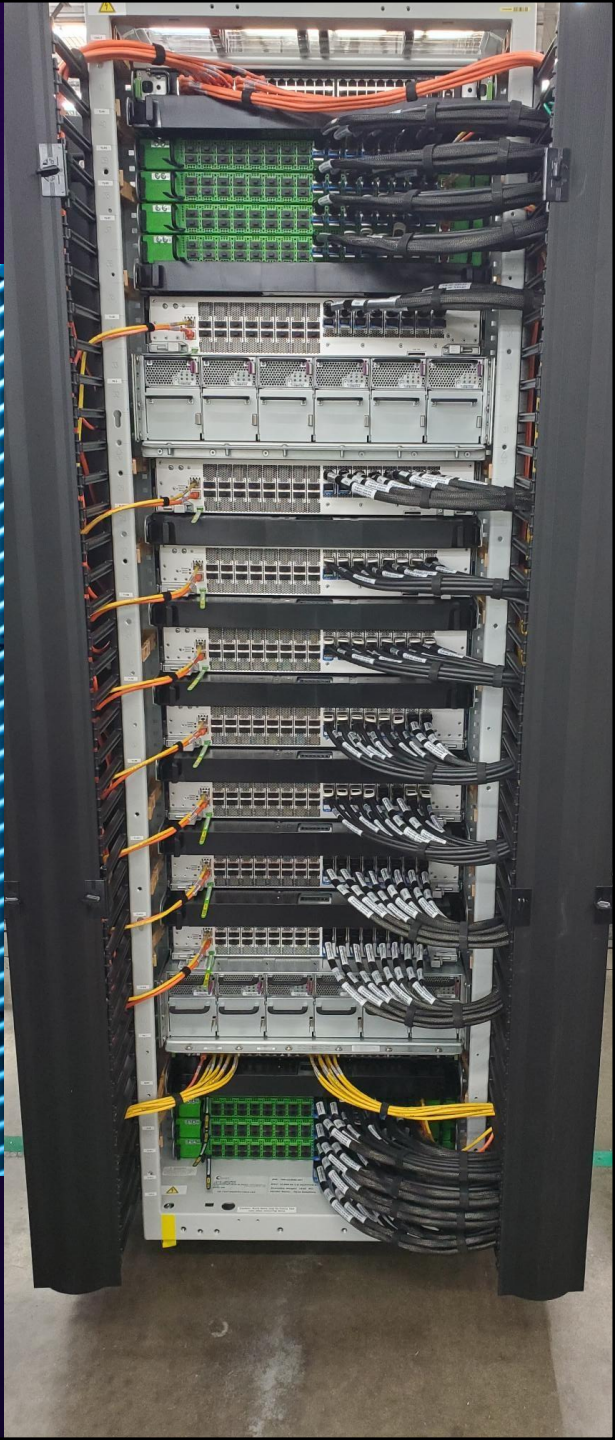
Image © by Mr Aquitania

3. Don't reach unprecedented scale



Photo © by Björn Strey

3. Don't reach unprecedented scale



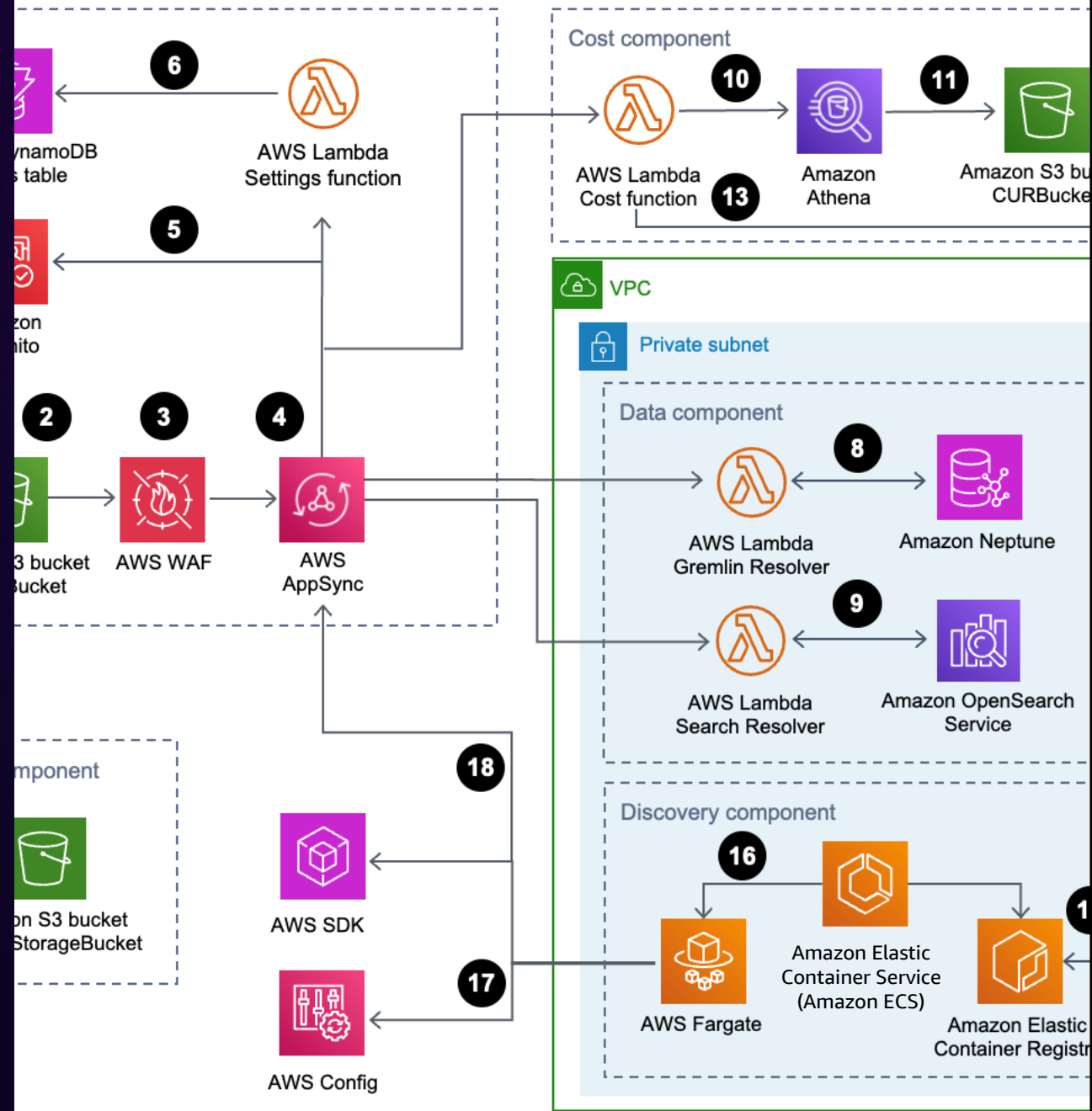
3. Don't reach unprecedented scale



Network designs

=

Distributed systems designs



Design for fallible humans by using Intents (2023)

NET401-R

AWS journey towards intent-driven network infrastructure

Stephen Callaghan

(he/him)

Senior Principal Engineer

Amazon Infrastructure Services



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Design for fallible humans by using Intents

EC2 to internet
40X improvement

SDN journey

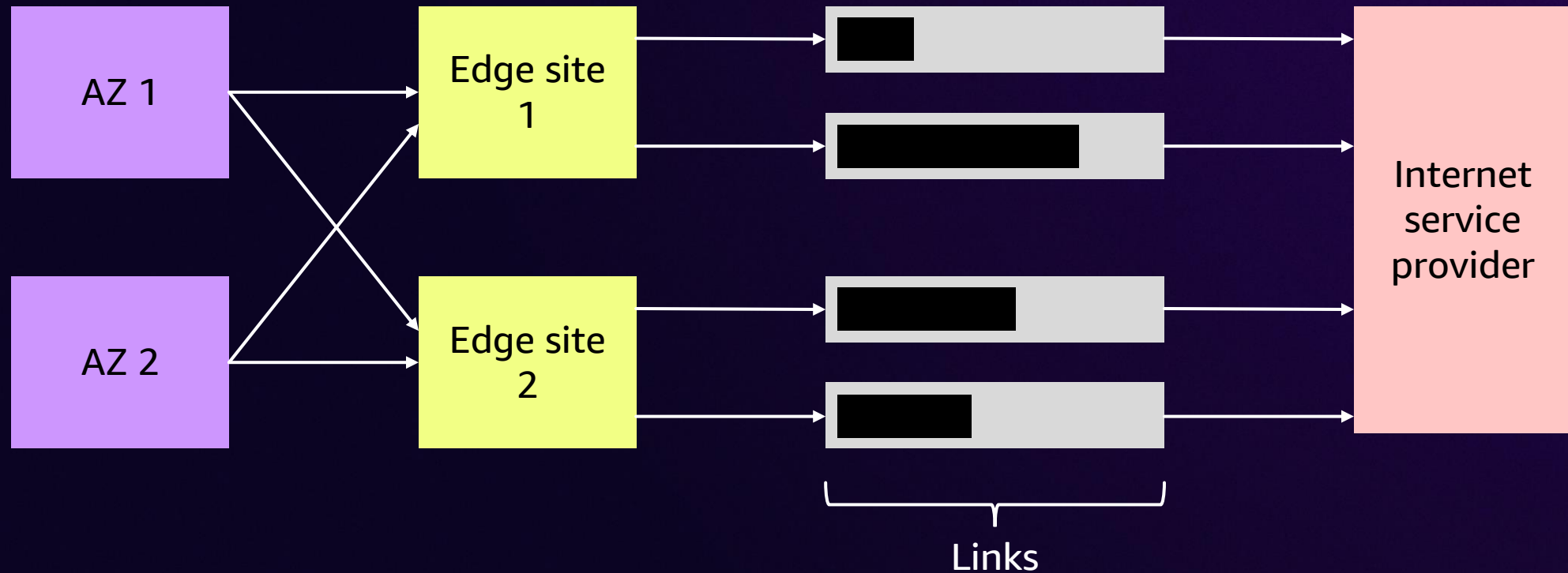
1. Monitoring, alarming,
triangulation

2. Automation

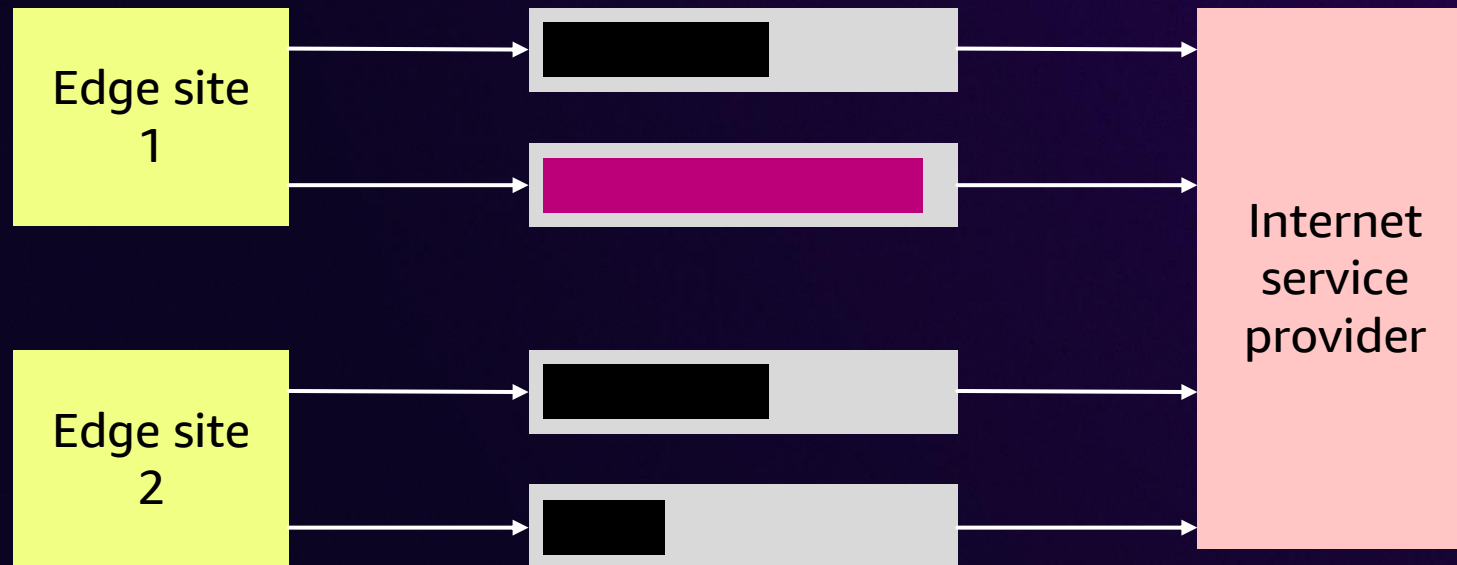
3. Closed-loop controllers



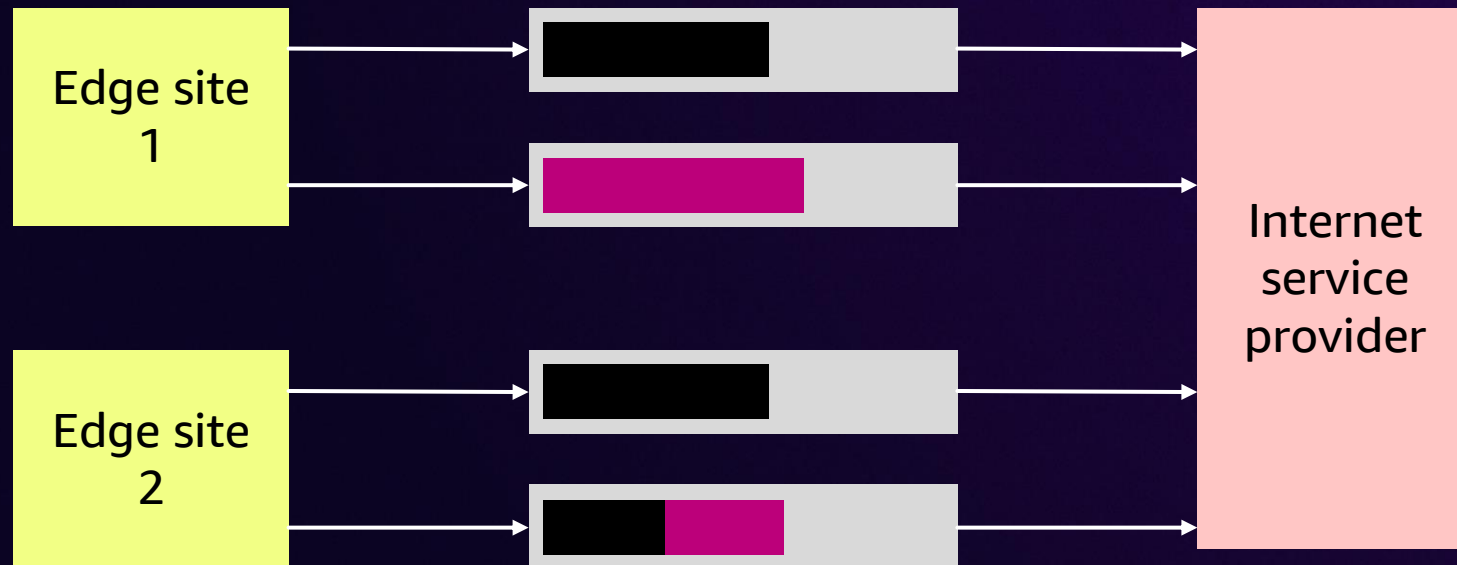
Outbound traffic engineering



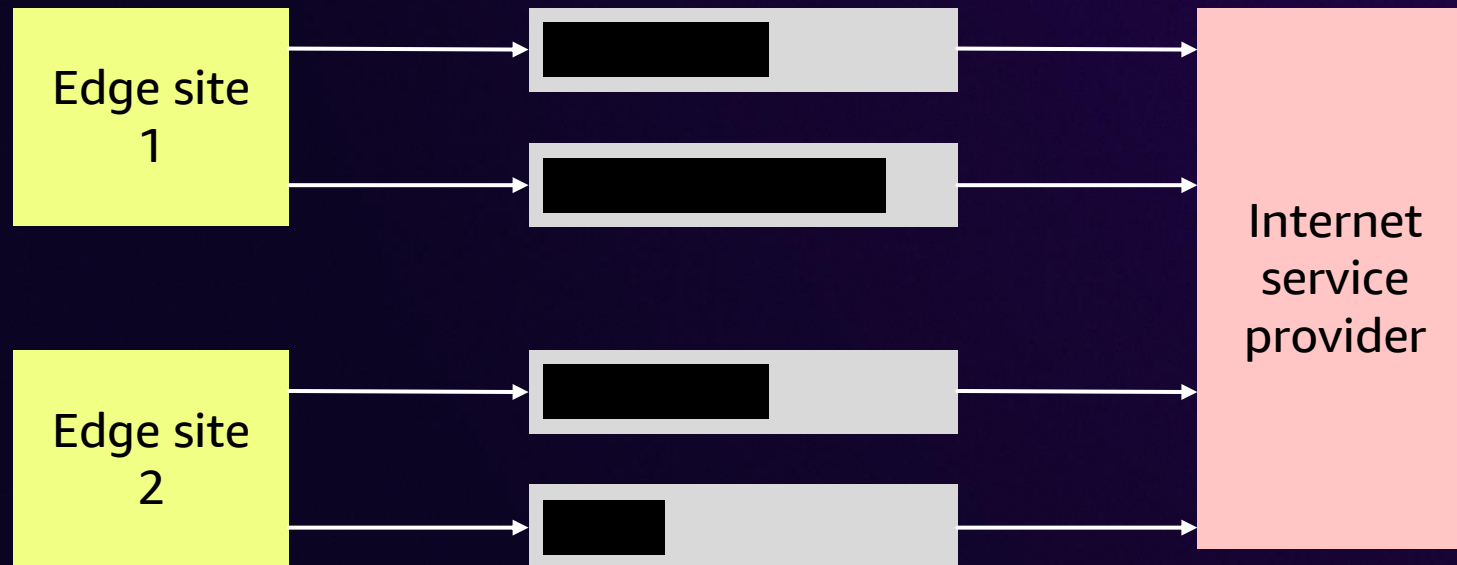
Congestion mitigation



Congestion mitigation



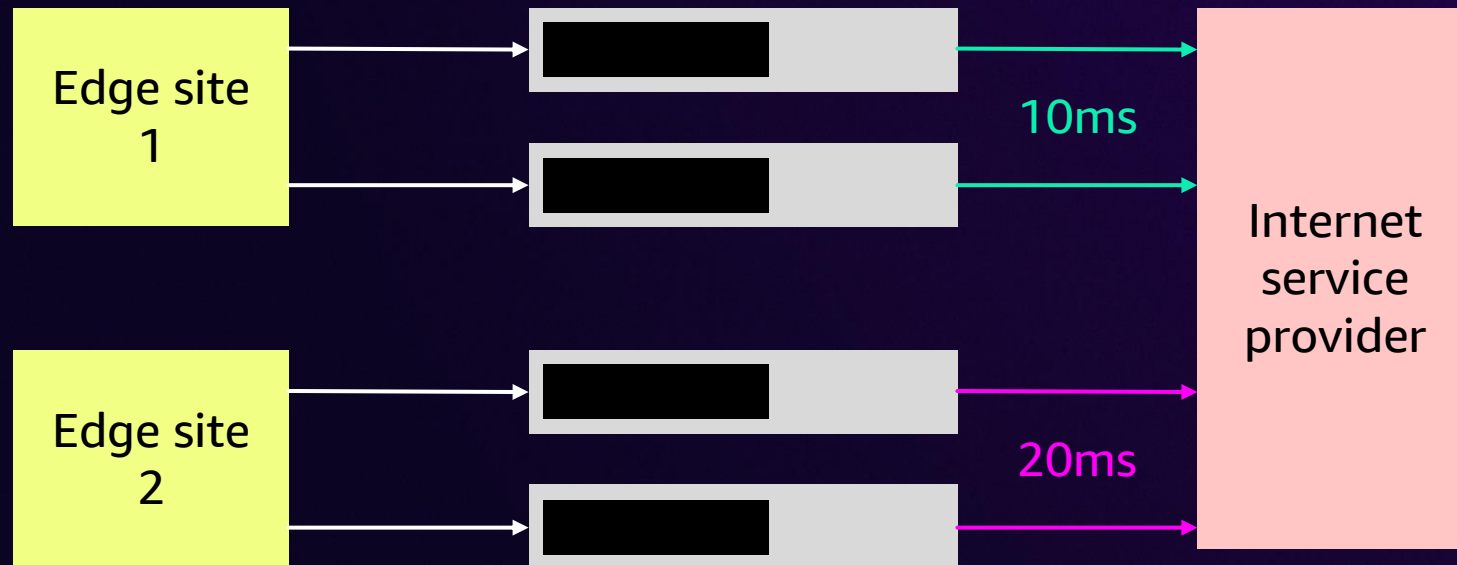
Link balancing



Link balancing



Performance optimization



Performance optimization



AZ independence



AZ independence

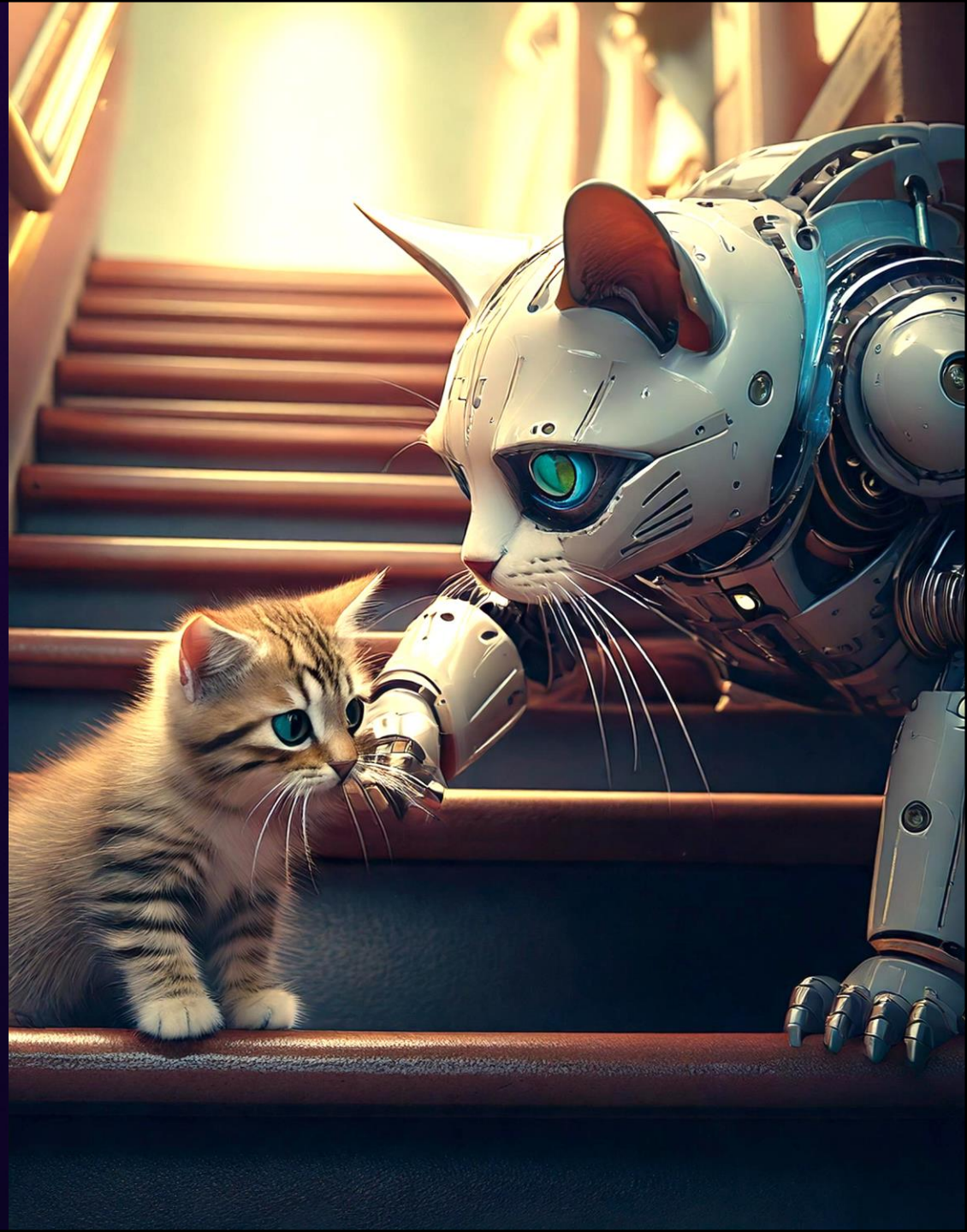


Inbound traffic engineering

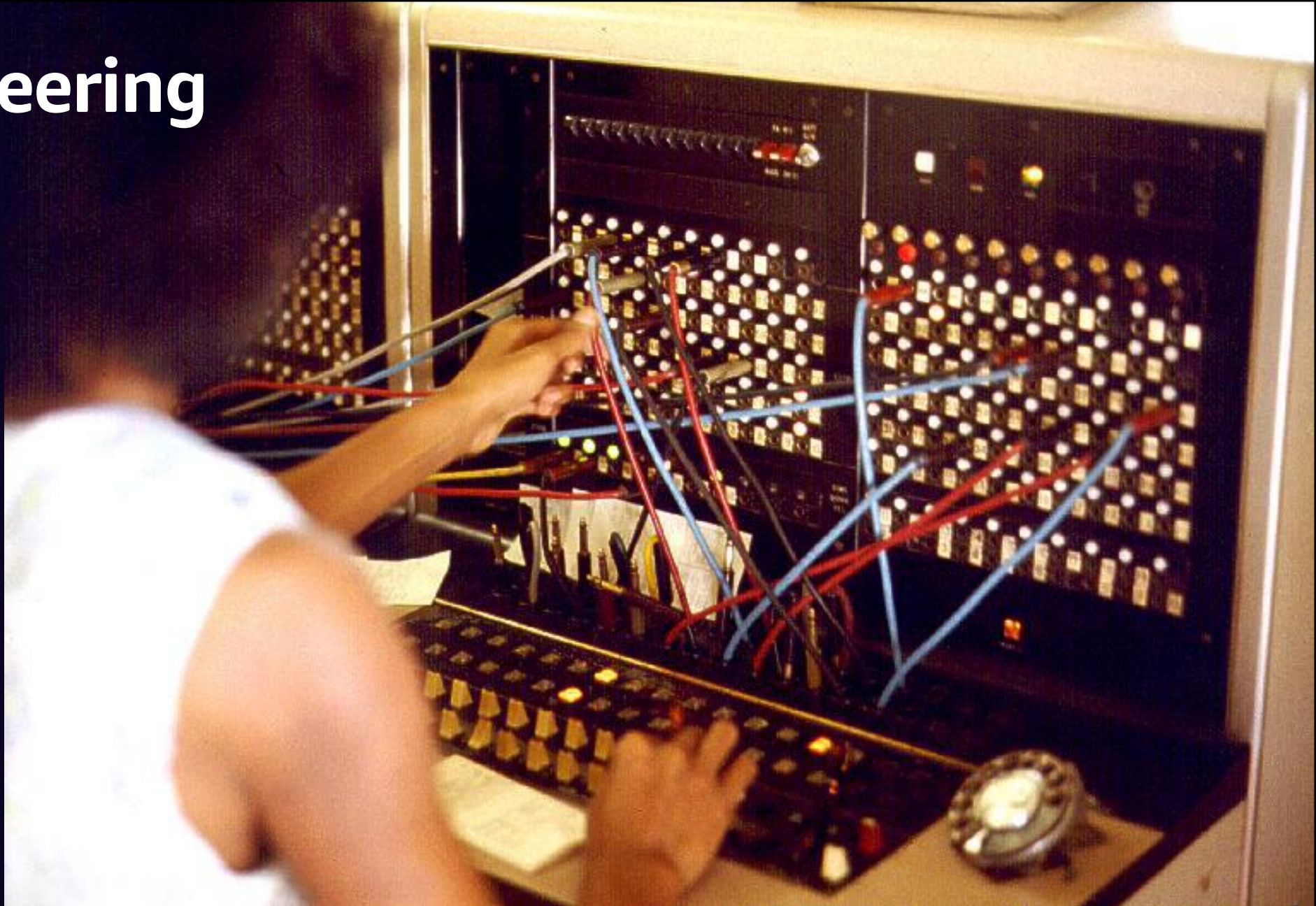


Inbound traffic engineering

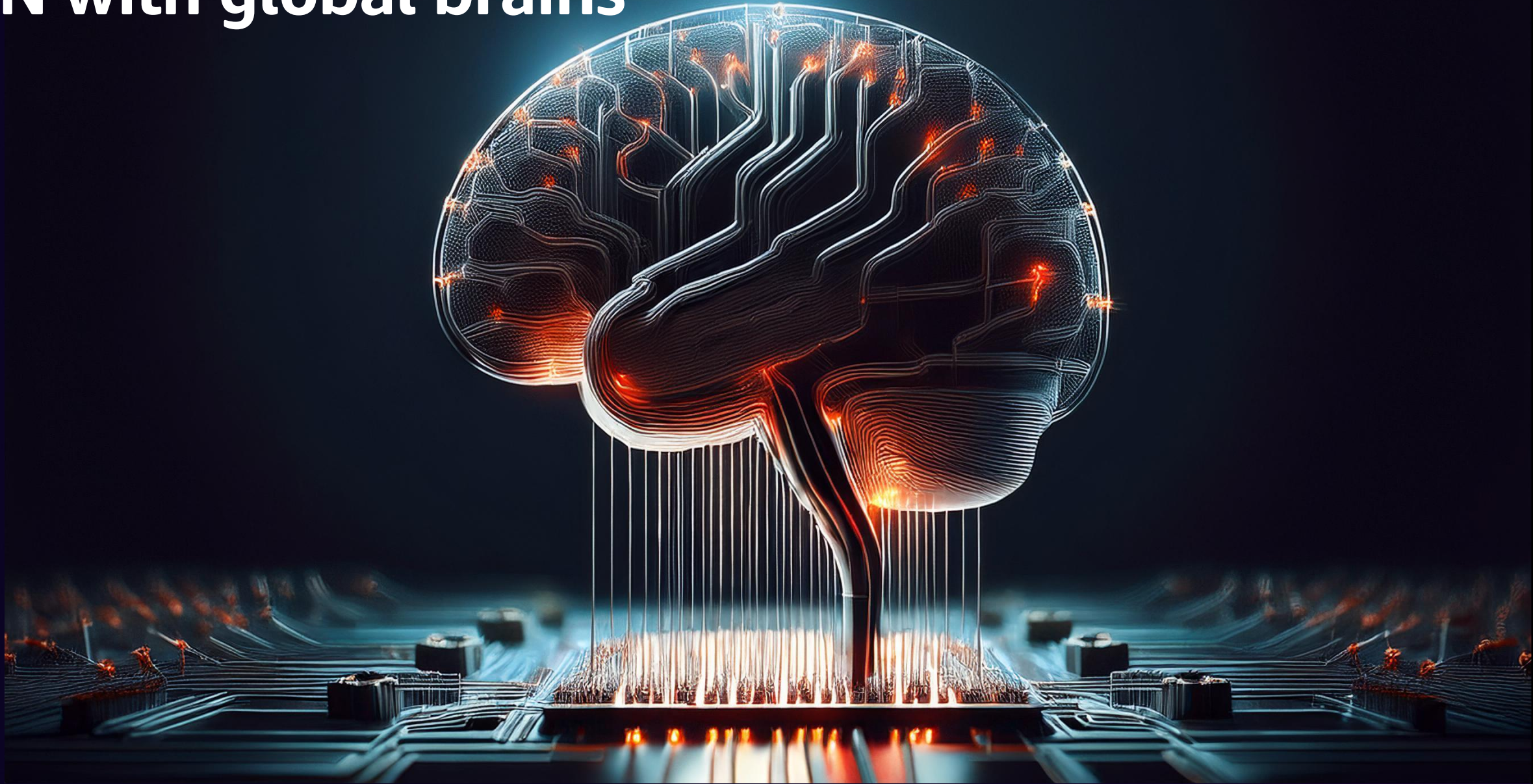
7X faster
mitigations for
inbound congestion



Traffic engineering on the WAN



SDN with global brains



Distributed and optimal SDN

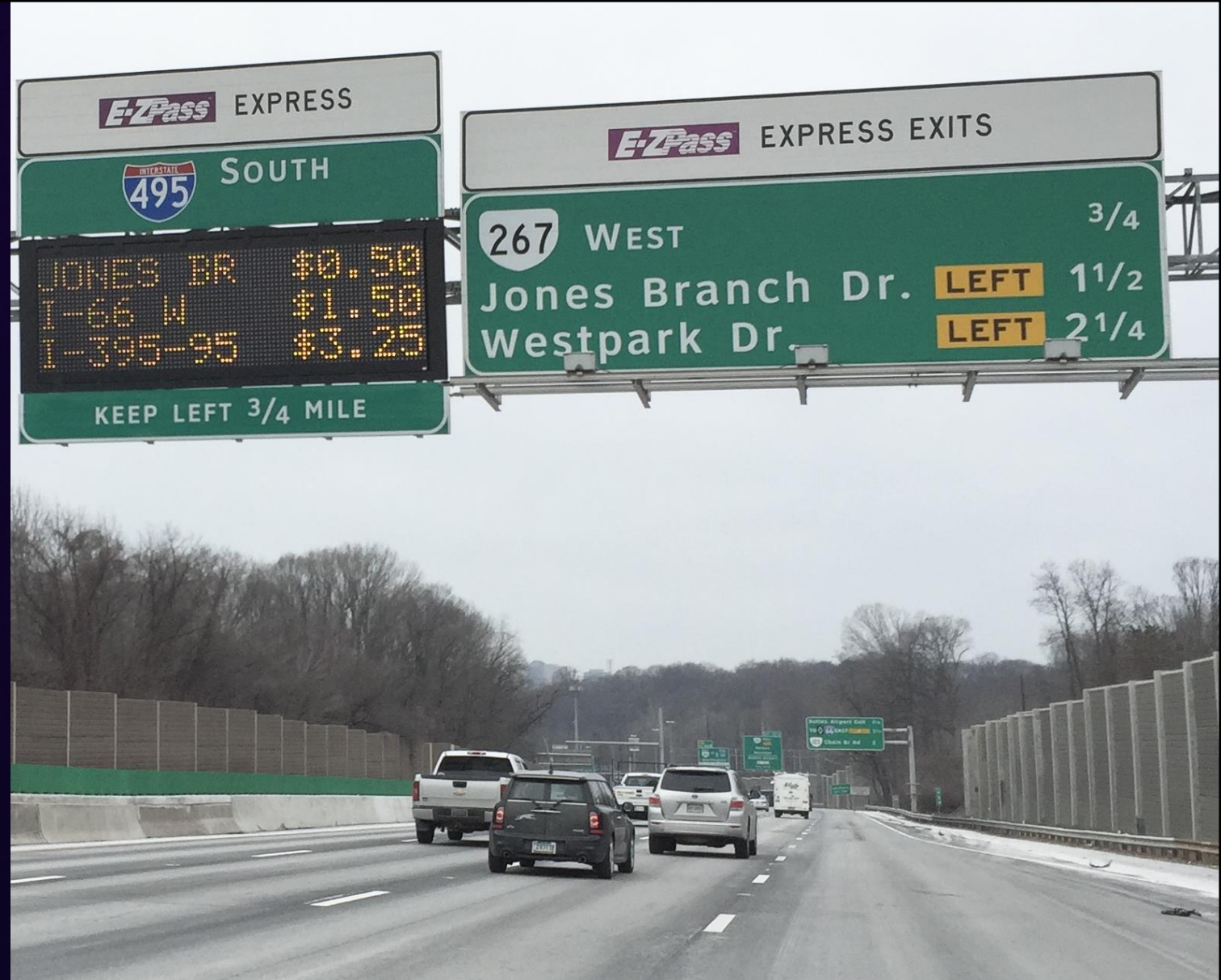
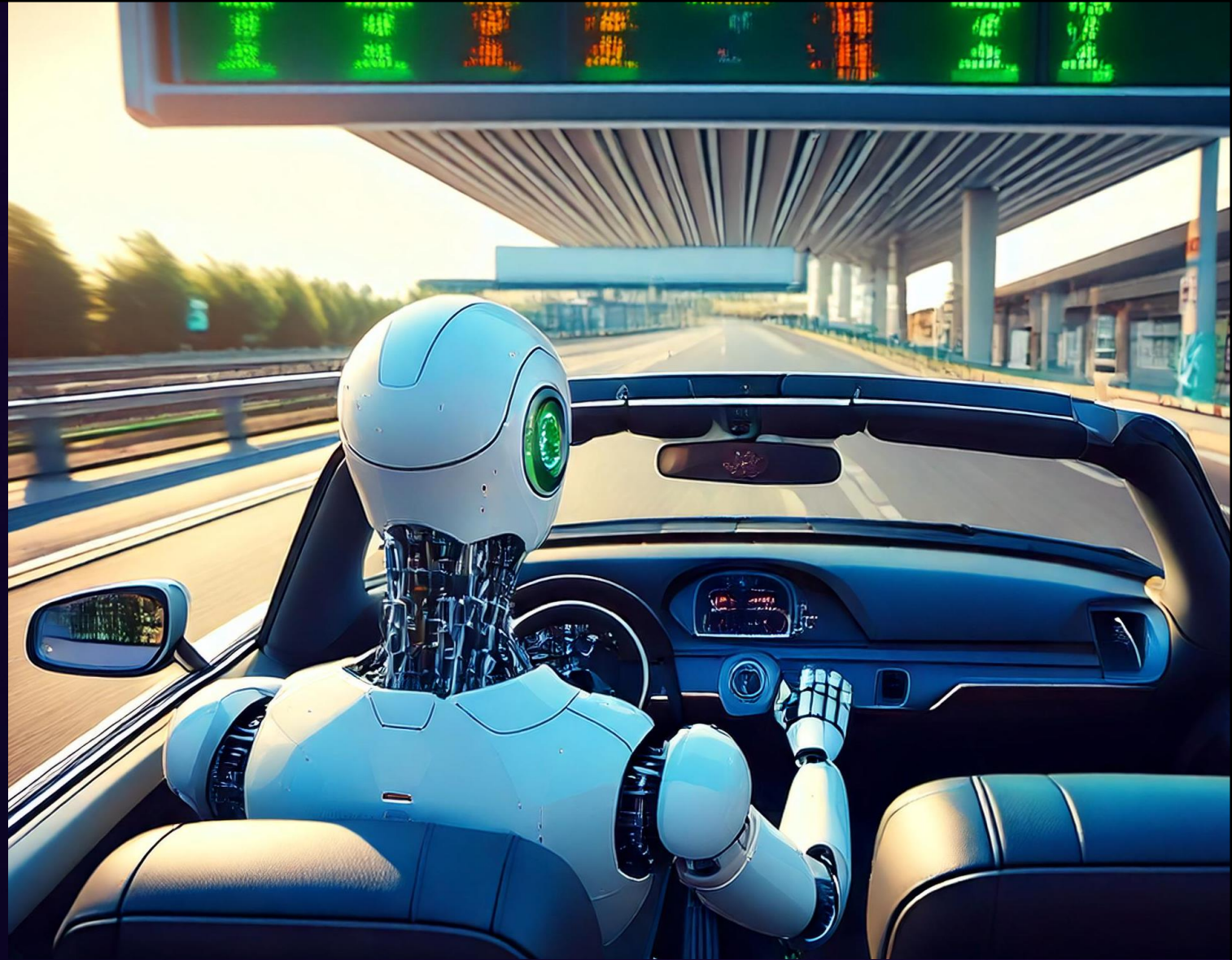
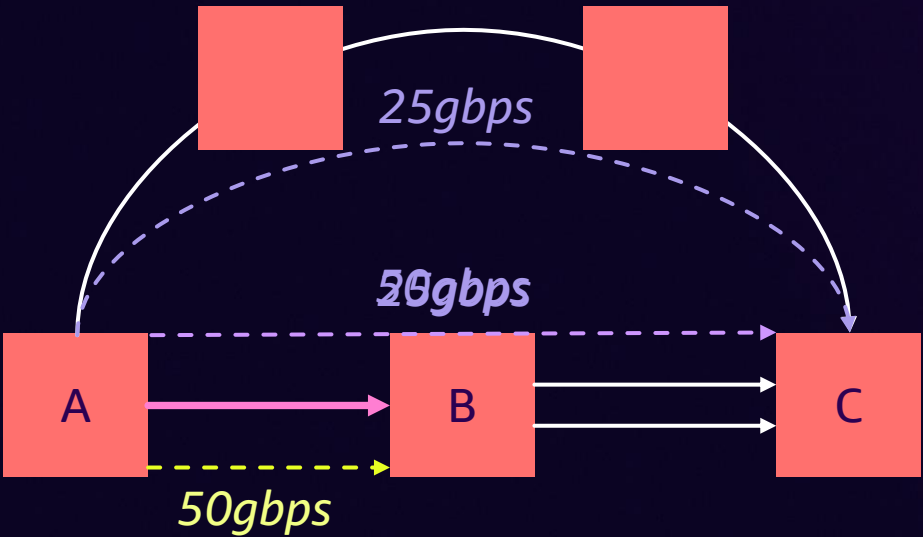


Photo © by Famartin

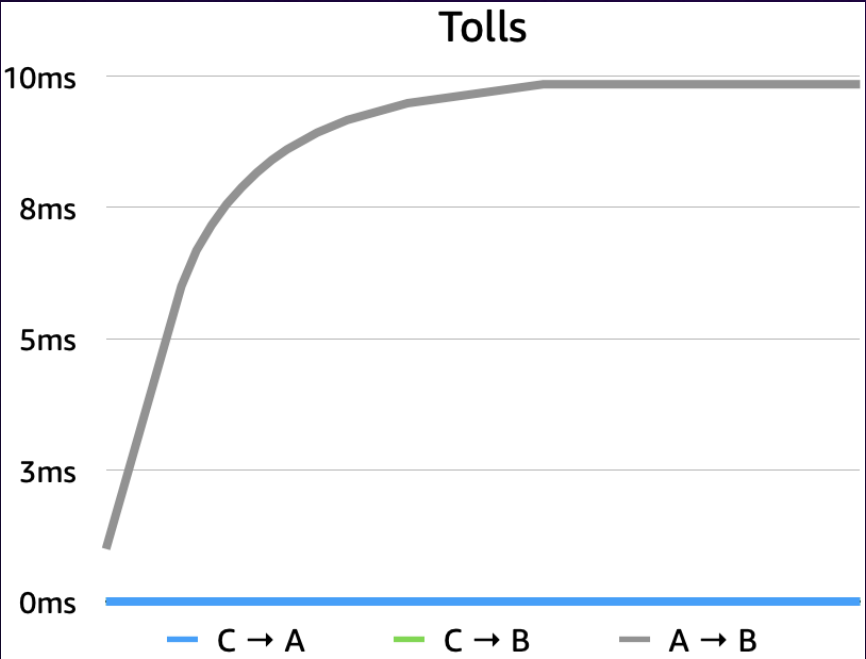
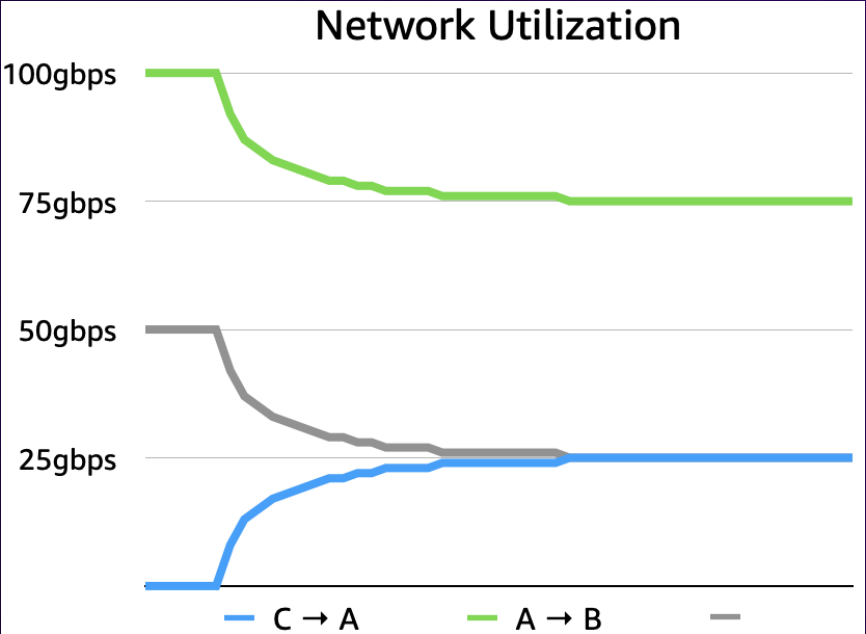
Distributed and optimal SDN



Example



Each link: 10ms, 75gbps



Demand-driven innovation

Purpose-built

Incremental



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Ownership

(And tiny plastic connectors)



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The full hardware package

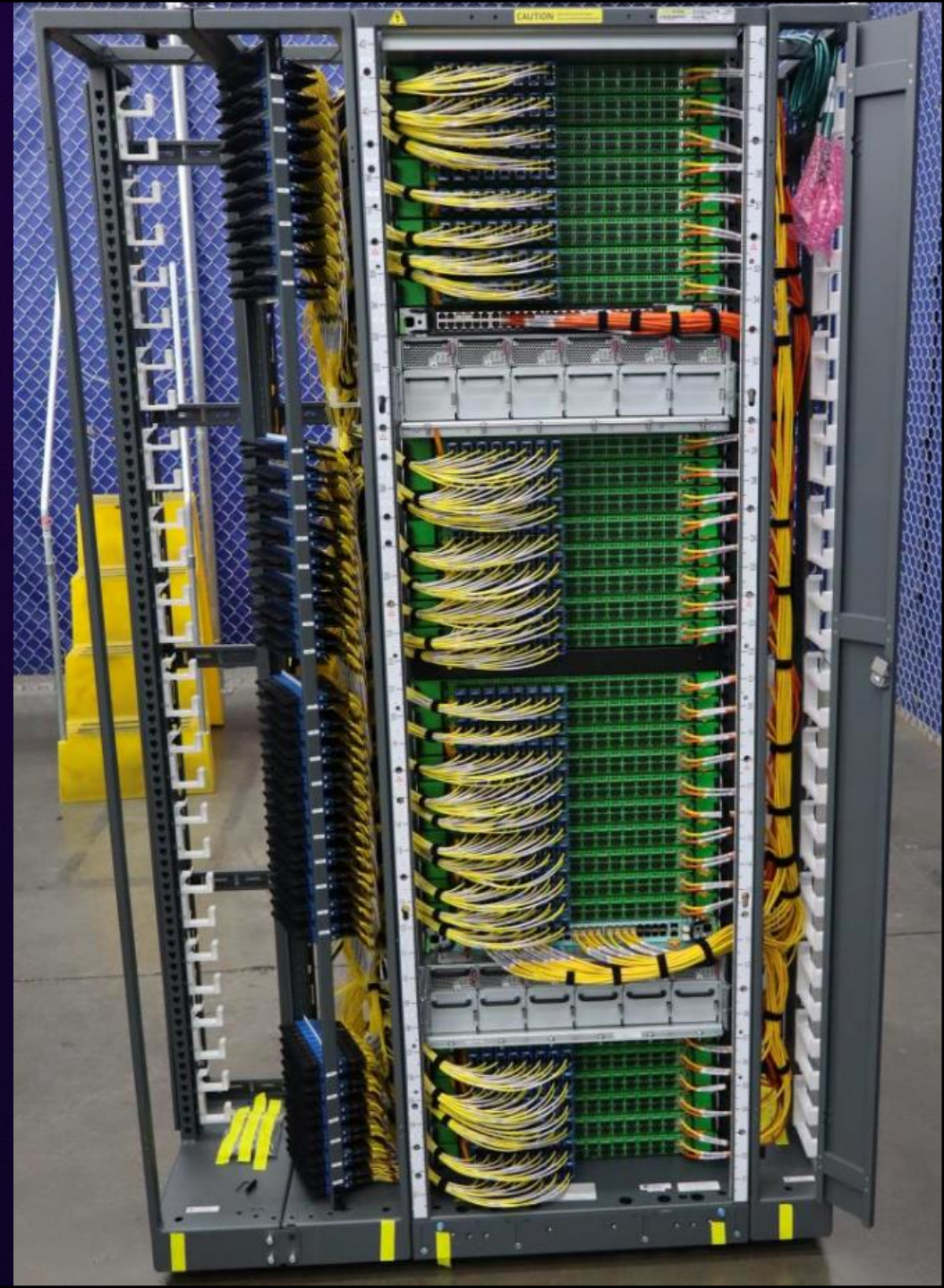


Racks

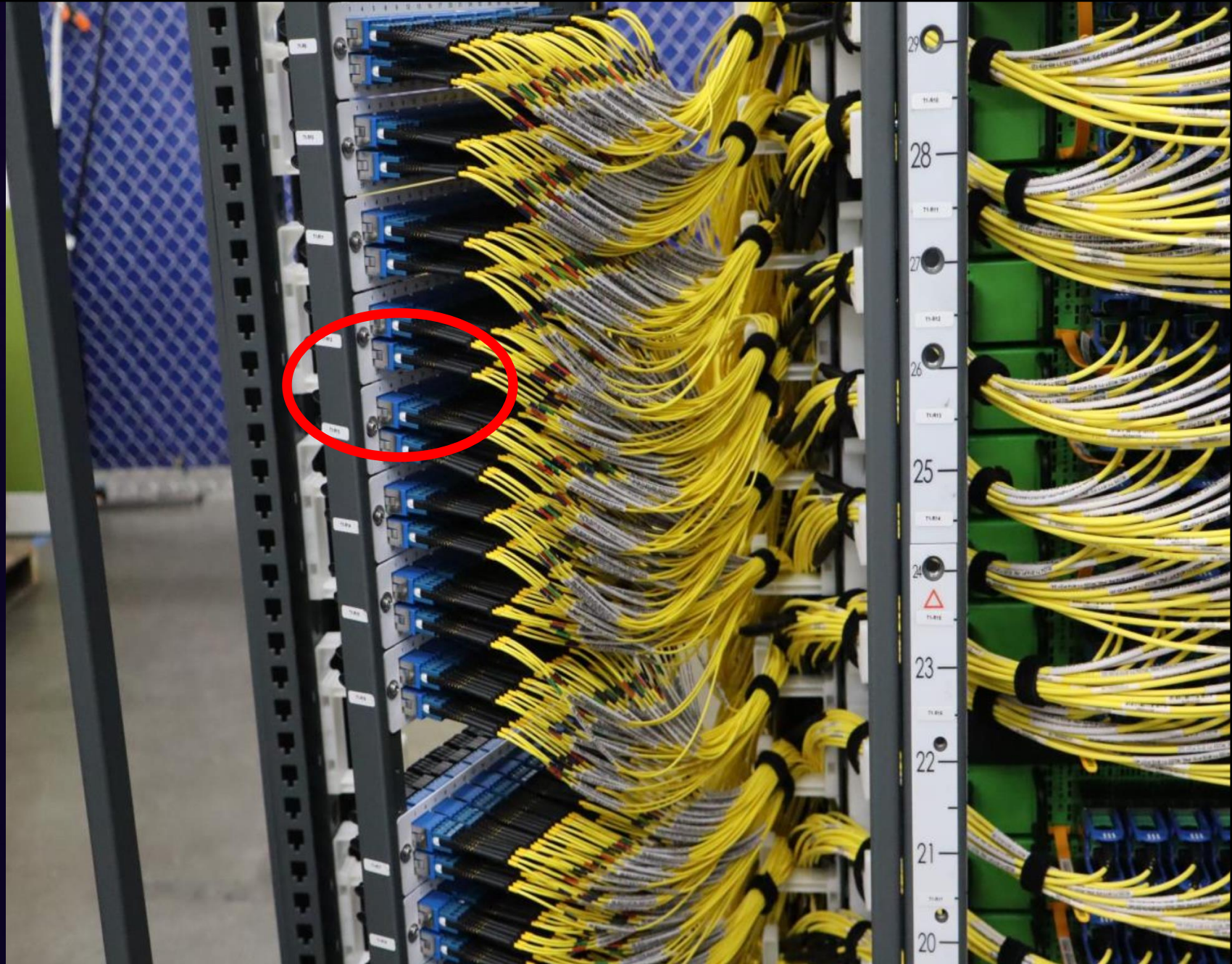
Amazon rack 1

Similar to outpost - AWS Expo

Standardized building blocks



Cabling



Cabling

Pre-wired positions

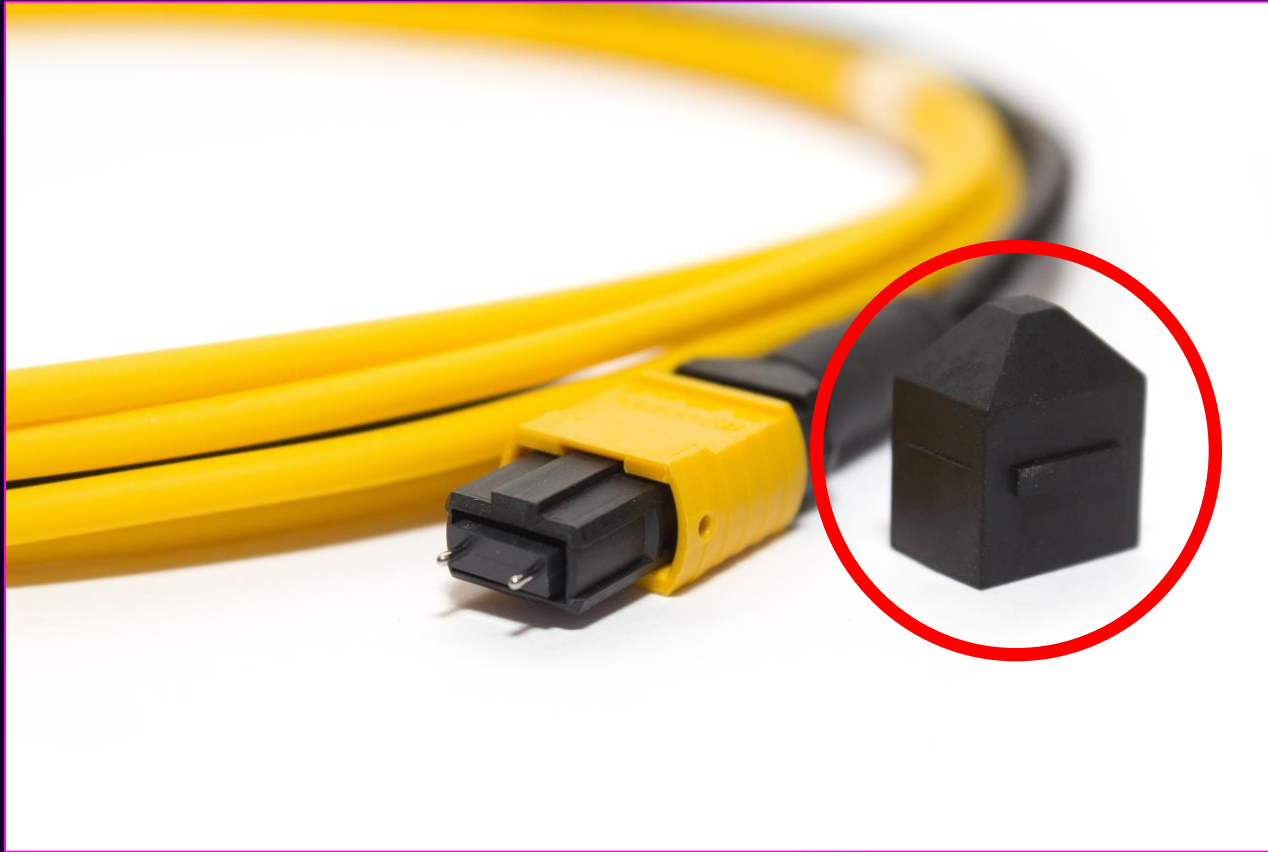
144-fiber trunk cables

SN to MPO connectors

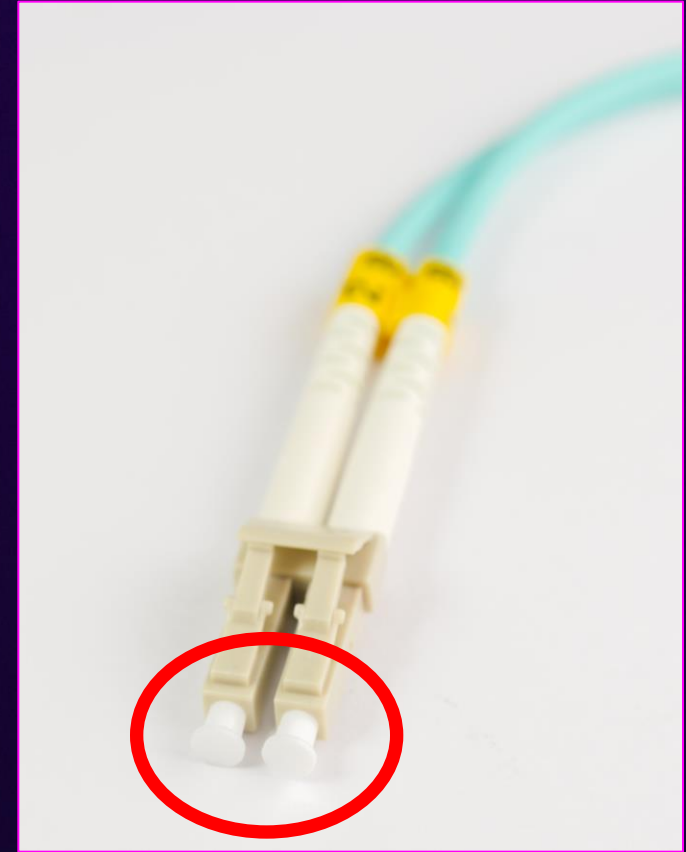
Network <> Host racks



Connectors

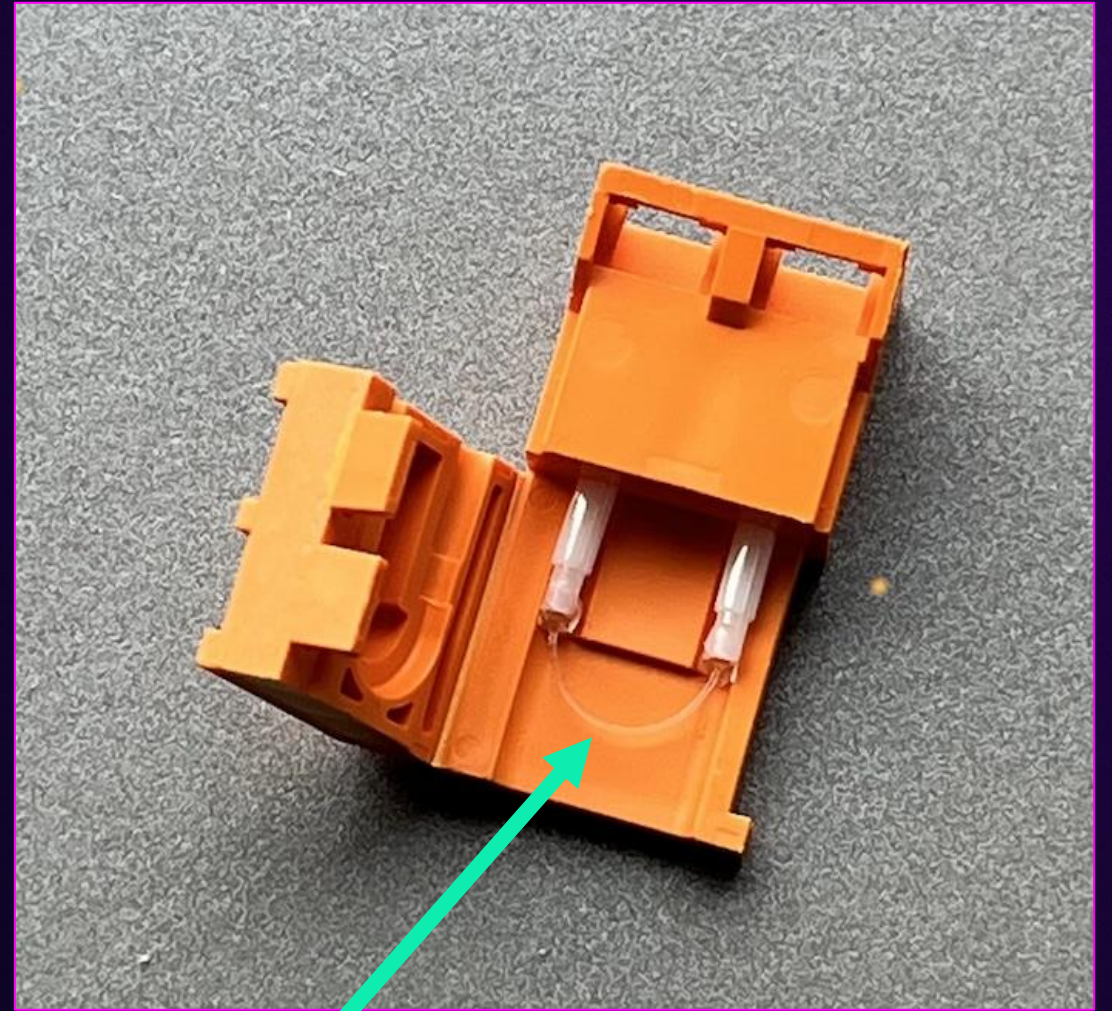
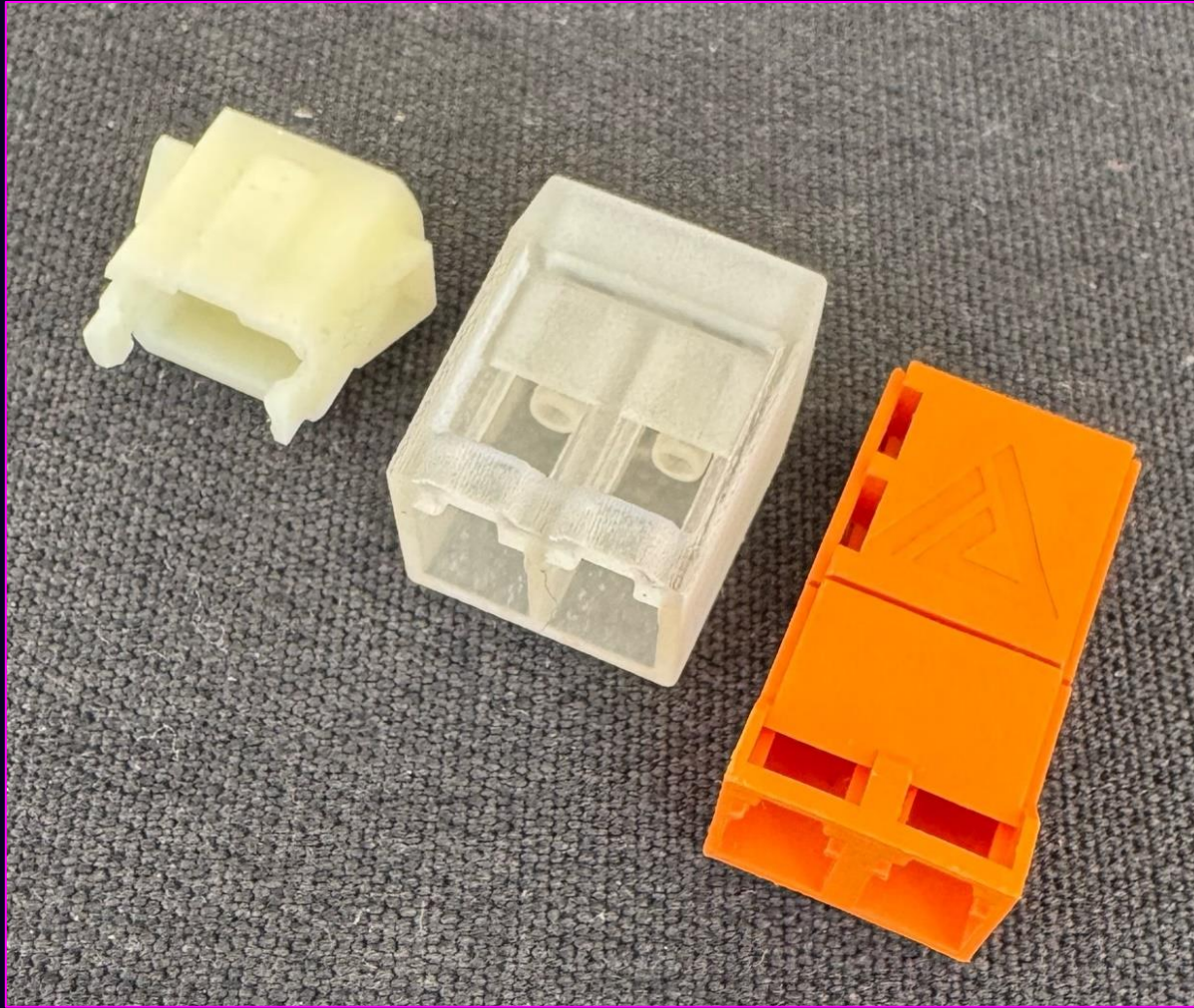


MPO



LC

Connectors



Monitoring



Telemetry

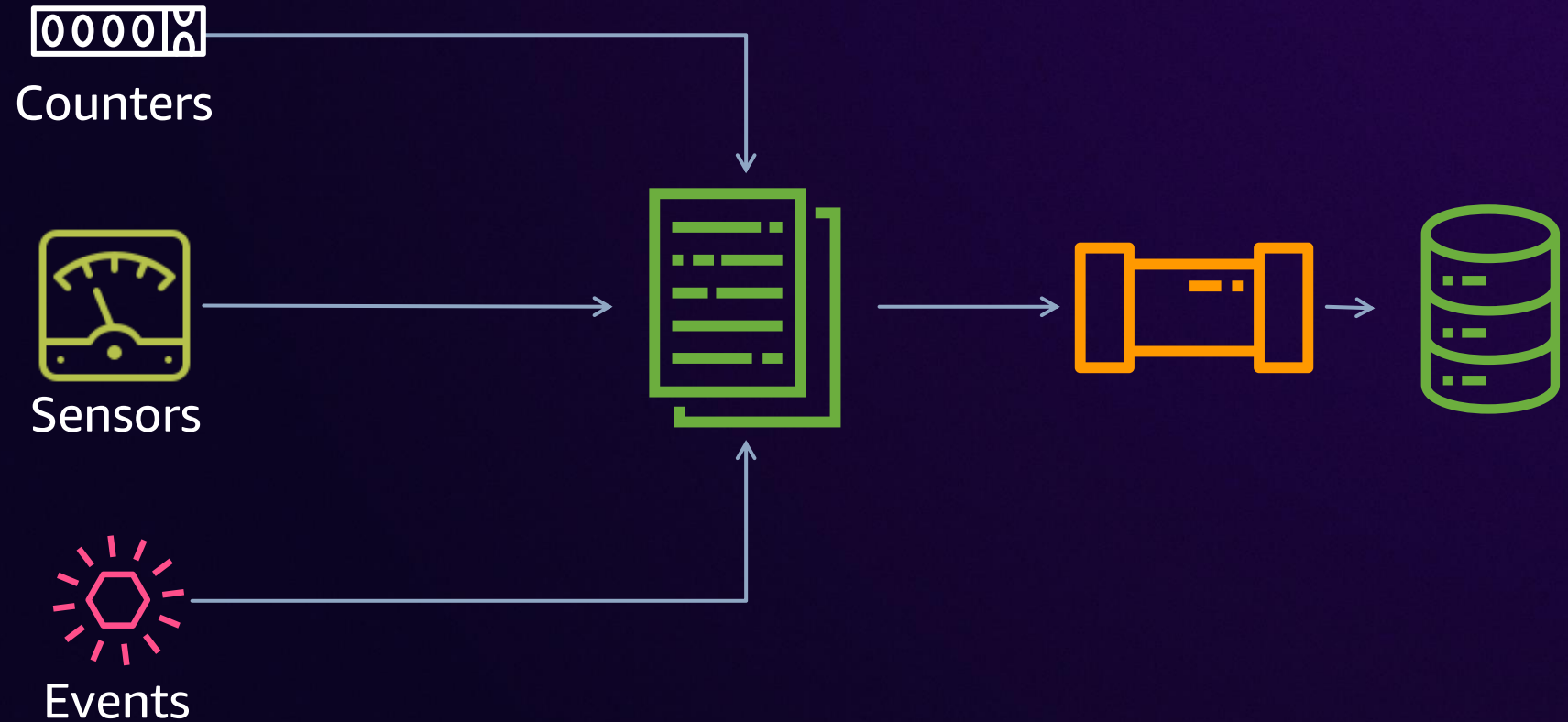
Active probing

Correlation

Remediation

Monitoring

PASSIVE TELEMETRY



7 billion observations per minute

Monitoring

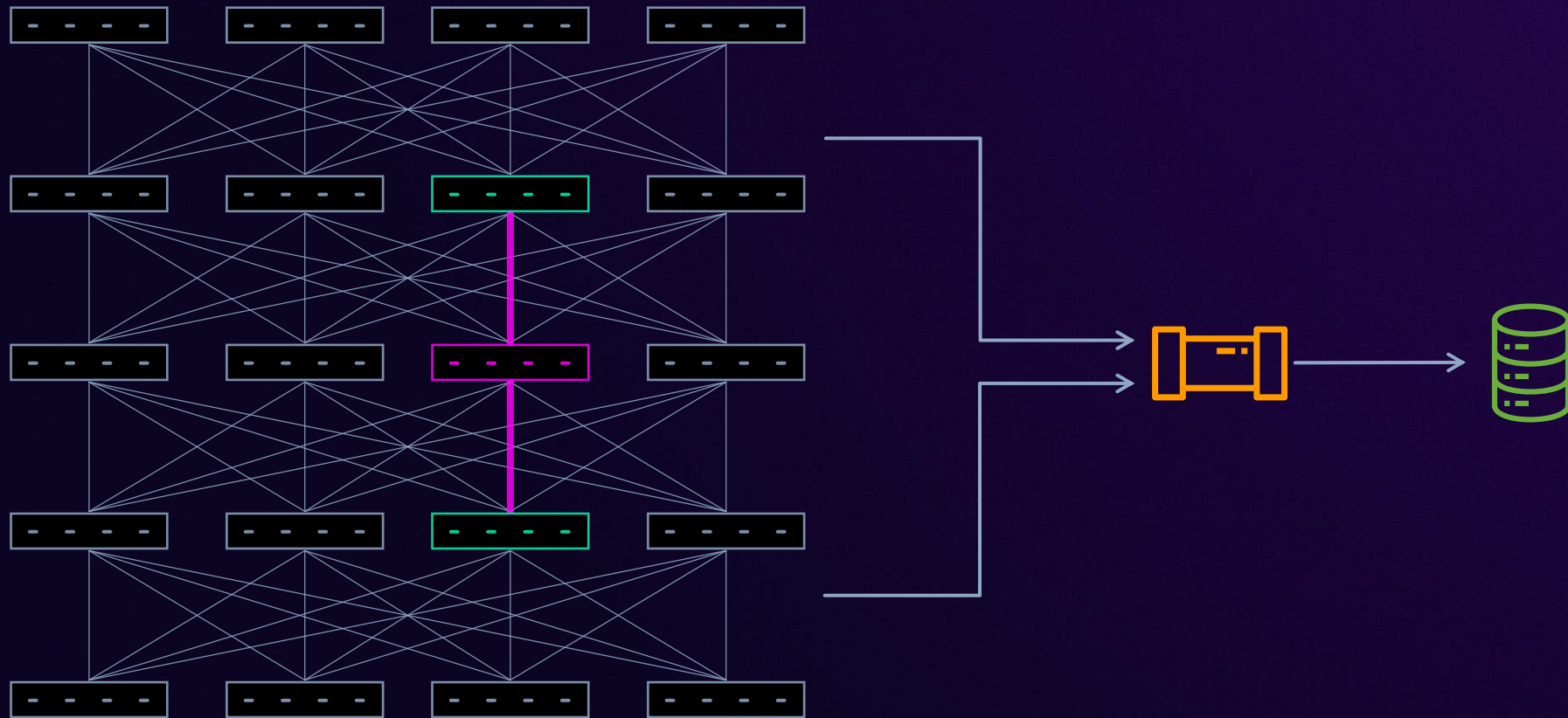
ACTIVE MONITORING



>1.5B probes per minute

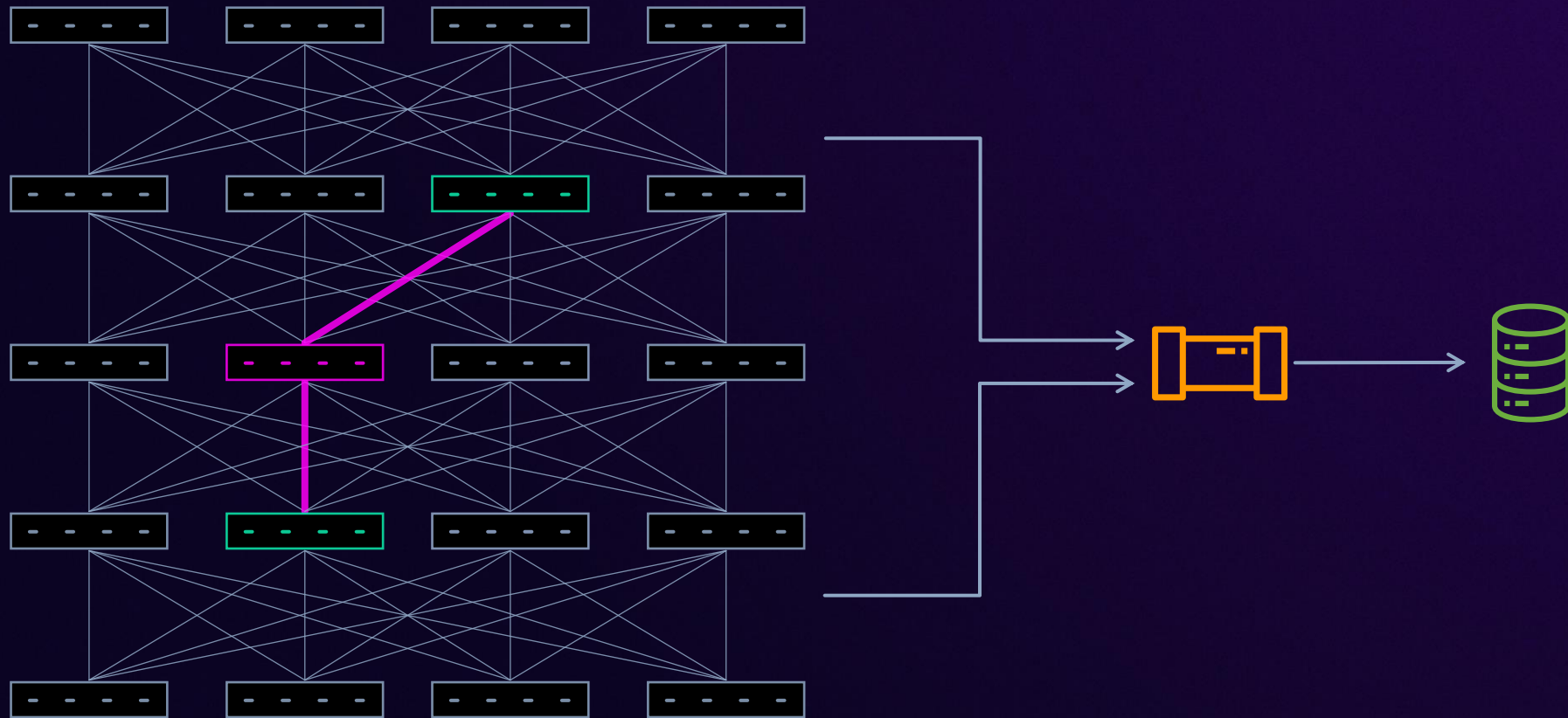
Monitoring

ACTIVE MONITORING



Monitoring

ACTIVE MONITORING



Monitoring



25B alerts per year

>1B actionable

>3M distinct events

98% fully-automated actions

2% escalated

What's next?



Power and connectivity



Space and power



AWS

AWS plans to invest \$1.5 billion in Mississippi, the largest investment in the state's history

[Read more](#)

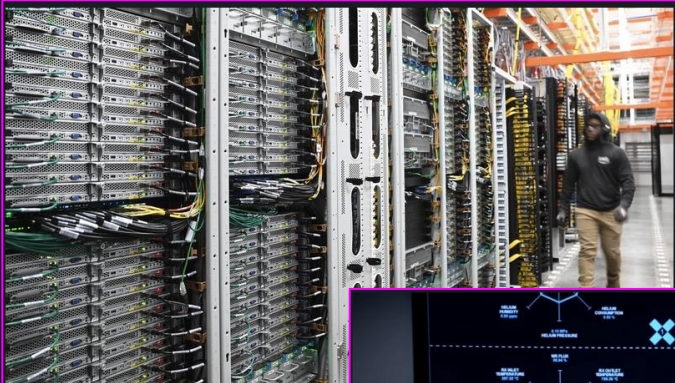


SUSTAINABILITY

How Amazon is supporting farmers through solar and wind farm investments

[Read more](#)

September 18, 2024



AWS

AWS plans to invest \$1.5 billion in Indiana, the largest investment in the state's history

[Read more](#)



SUSTAINABILITY

Amazon signs agreements for innovative nuclear energy projects to address growing energy demands

[Read more](#)

October 16, 2024



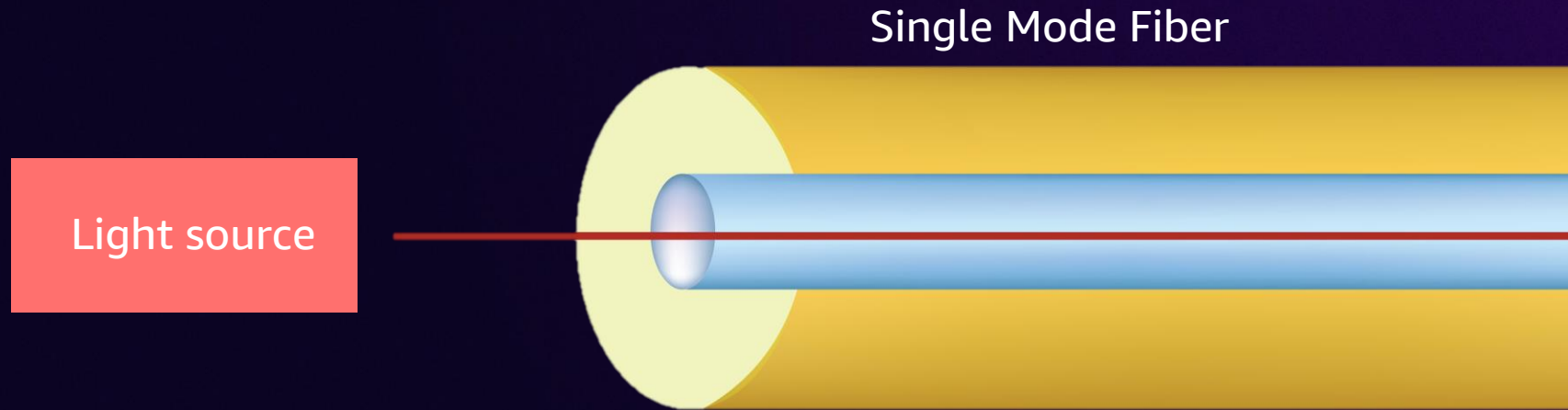
Space and time

300,000 km per second

1 light year
= 9 quadrillion km



Latency



Index of refraction: 1.44

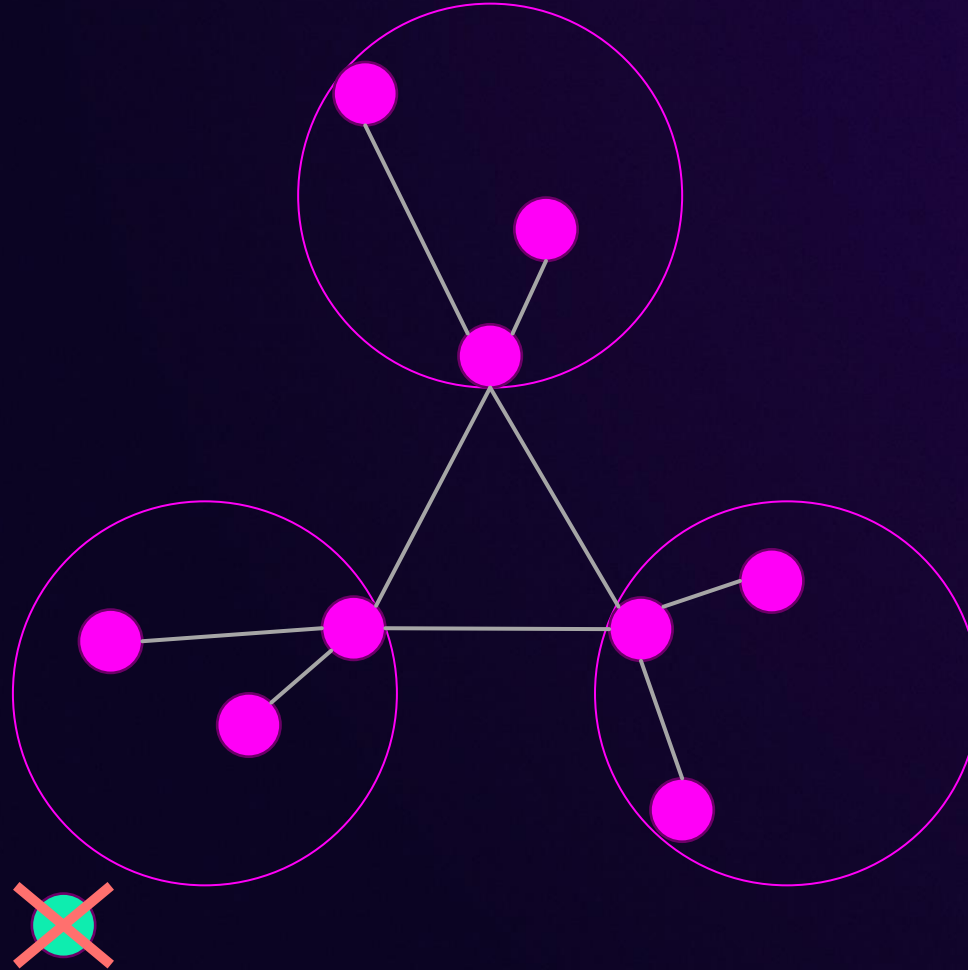
Speed of light in fiber = $3 \times 10^8 / 1.44 = 2.08 \times 10^8$

1m = 5ns

1km = 5 μ s

Region growth

— IntraAZ latency limit



Hollow core fiber

Replace silica core with air

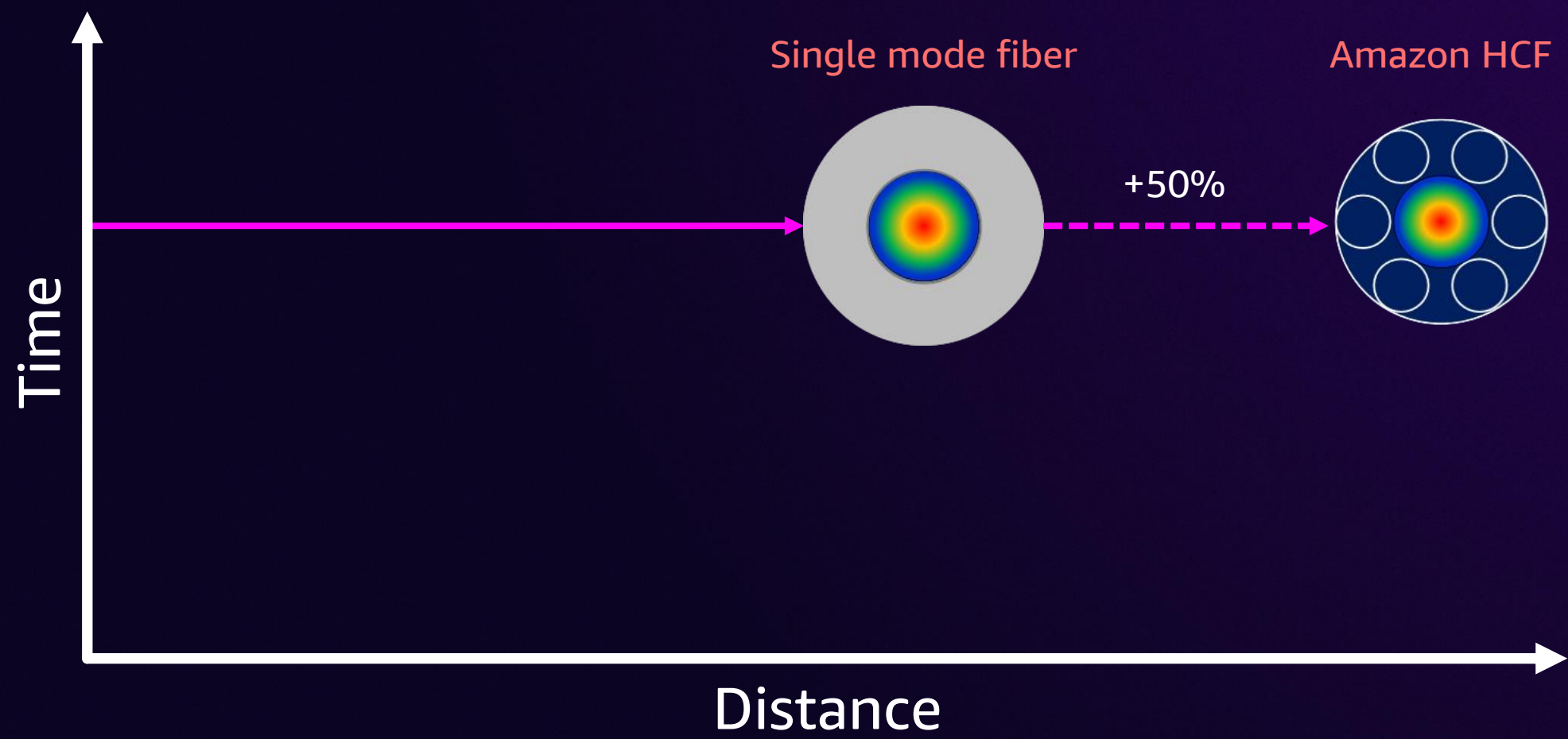
25+ years

DARPA



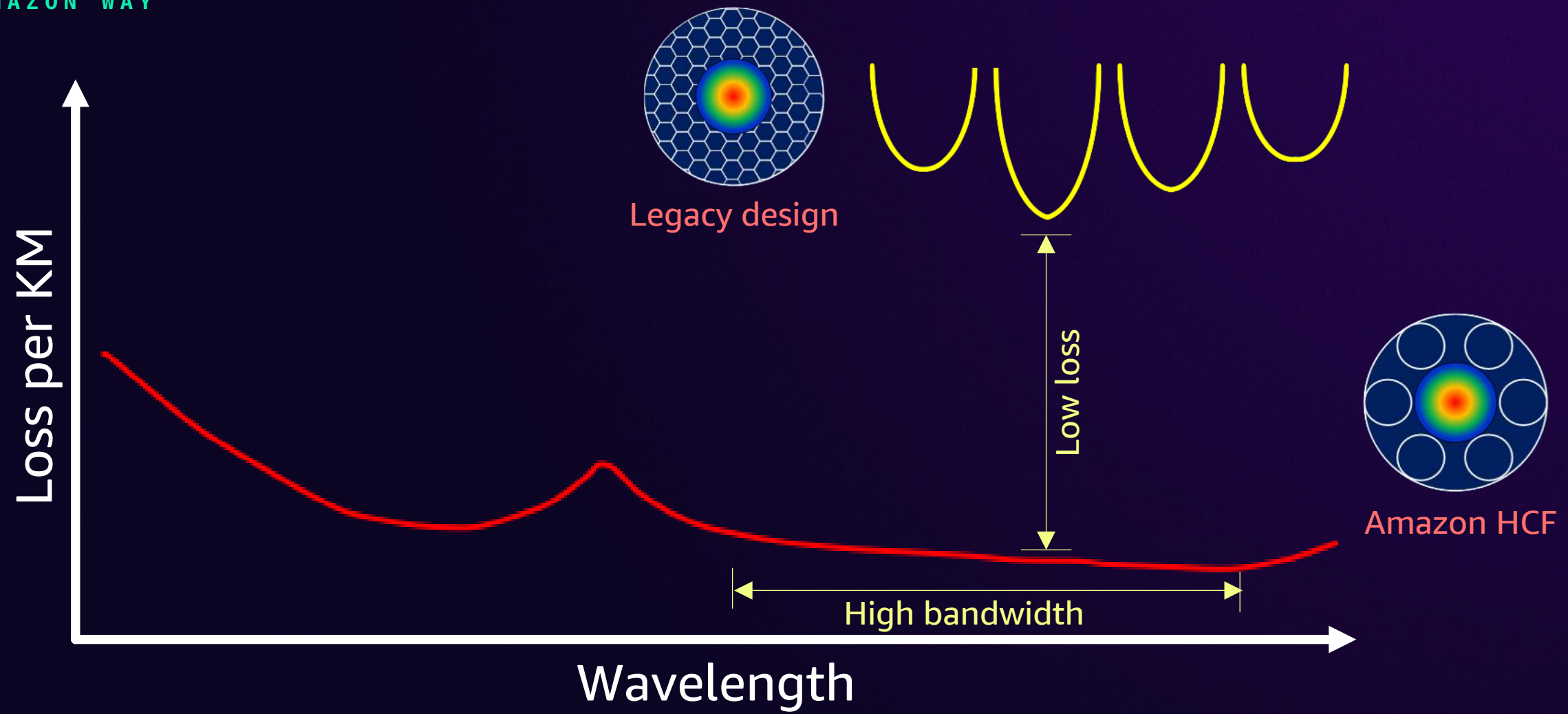
Hollow core fiber

BENEFITS

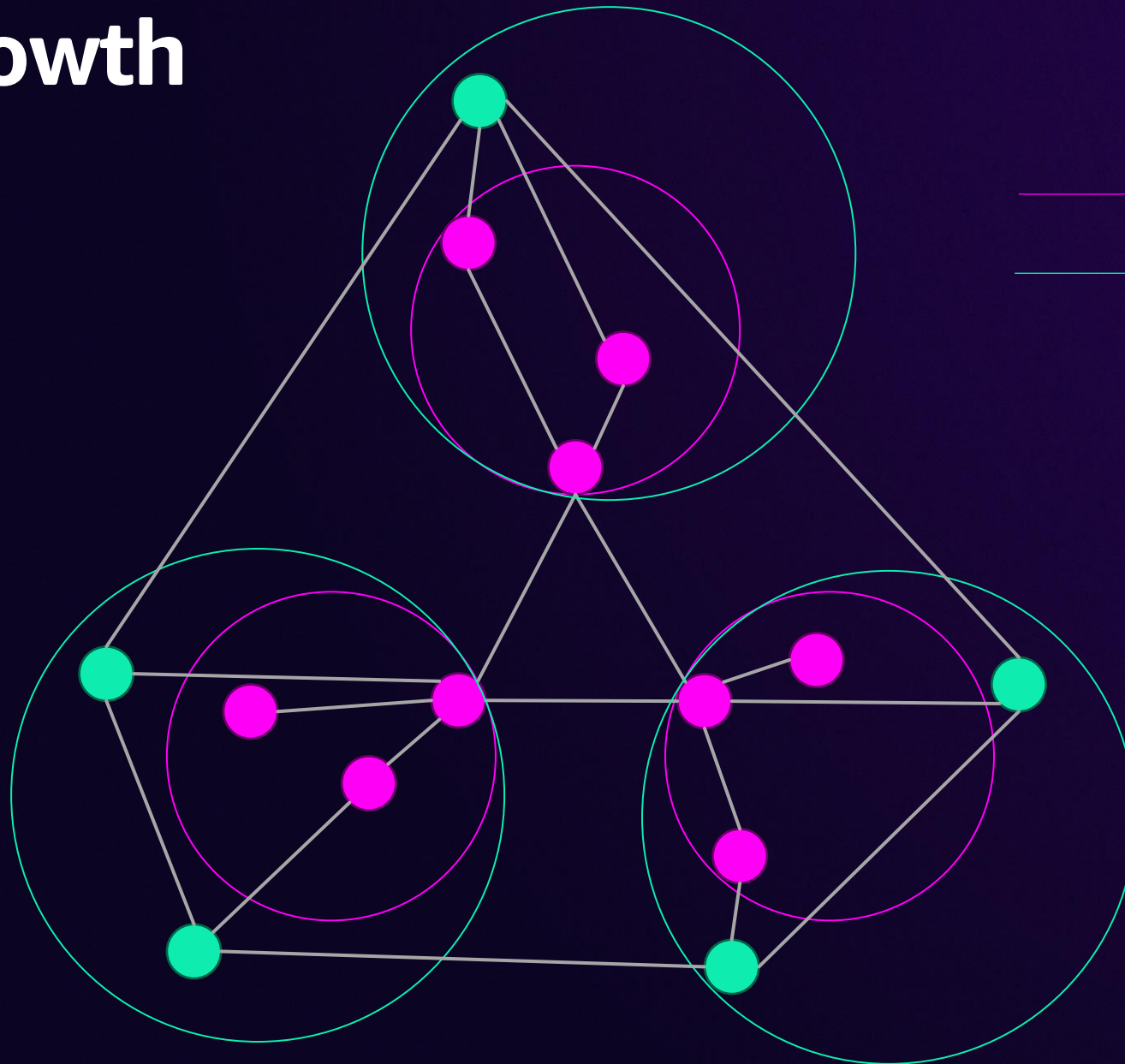


Hollow core fiber

THE AMAZON WAY



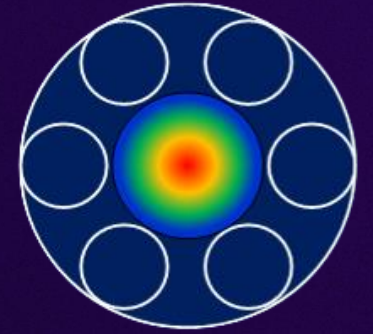
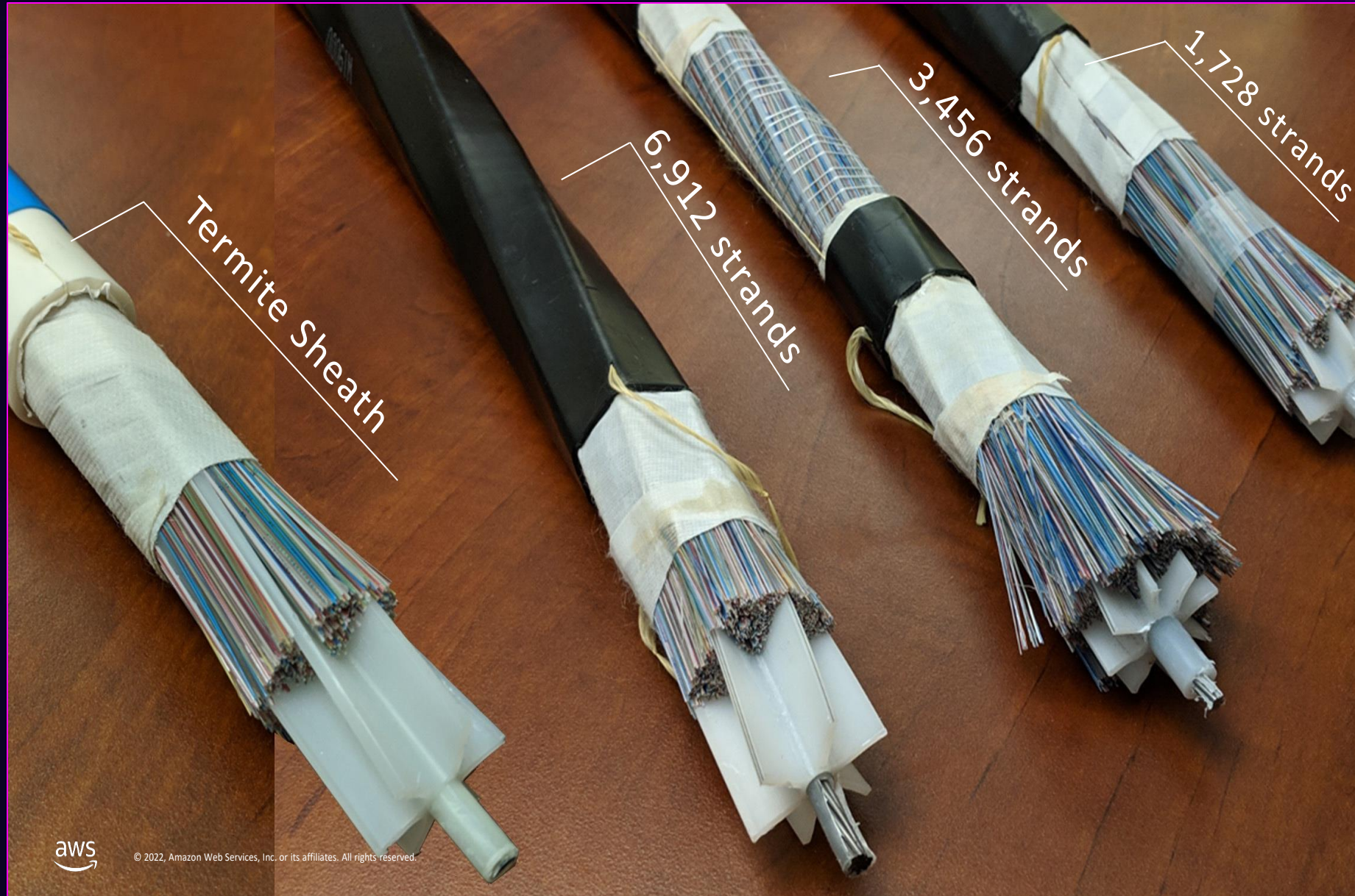
Region growth



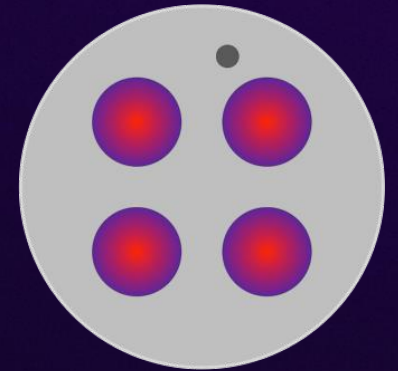
— IntraAZ latency limit
— IntraAZ latency HCF

1.5x radius
= 2.25x area

Fiber innovations



Hollow core



Multi core

Wrap up



Wrap up

Design

Ownership

Constant Improvements

Tiny plastic connectors

Future challenges

Survey

We Need



Thank you!



Please complete the session survey in the mobile app

Stephen Callaghan

Senior Principal Technologist
Amazon Infrastructure

Jorge Vasquez

Senior Principal Technologist
Amazon Infrastructure

