

# DELIVERING 100TBPS OF PEAK TRAFFIC

# PRIME VIDEO & LIVE SPORTS JOURNEY

2018: Thursday Night Football (non-exclusive)

2019: English Premiere League (exclusive)

2020 onwards Exclusively streaming UEFA Champions League (Italy, Germany); French Open (France); Copa Brazil, NBA Brazil, NZ Cricket (India); World Baseball Championship (Japan)



AMAZON

# LIVE SPORTS DELIVERY CHALLENGE

- Deliver premium video at scale to millions of customers in different countries across thousands of different devices
- Millions of RPS and terabits per second of data over highly variable networks
- Achieve 100% up-time using highly available, resilient service infrastructure
- Measure the quality of experience of every stream in real-time to deliver a flawless streaming experience
- Detect and mitigate customer issues in minutes

# LIVE SPORTS CAPACITY CHALLENGE

- We recognize that top live events require 3-4x usual capacity.
- We use multiple cdns to maximize already installed capacity
  - When needed we work with AWS and global partner cdns to add capacity
  - Performance based dynamic selection
- Work closely with isps to ensure we have right level of capacity in the right places.
- We have additional levers like lowering bit-rates when we exceed our forecast.
  - It's not preferred as the customer experience matters.

# PRIME VIDEO PERFORMANCE METRICS

- Performance is A 'point in time' metric.
- We measure the 'user experience' and use that to make cdn selection decision.
- Our customer/user centric metrics are related to buffering (zbr, ptsb), errors (zer, fer), resolution (pmr, phd).
- We also have network characteristics measurements - average bit rates, average bandwidth, ipv4/ipv6 split, network type etc.
- We plan to share some of the data with isps. What is the best way that is secure?

*We continuously measure buffering and errors and use that to determine the BEST performing CDN-ASN combination*

# BEHIND THE SCENE TECH

There is a lot of non-Network tech in play for a top tier live event

- Signals Acquisitions & encoding :
  - Video Feed from stadiums with 2-3 paths are transported as raw video not as IP
  - Production studios, advertisements.
- Encoding Efficiencies :
  - Variable bit-rate ladder that works on a combination of devices, available bandwidth
- Performance based load balancing for each ISP-CDN combination
  - Latency is measured as 'glass to glass' in 'seconds', so sometimes serving a few ms away from an uncongested path may yield better performance.

*We continuously measure buffering and errors and use that to determine the BEST performing CDN-ASN combination*

# TNF SCALE & OPERATIONS



# HOW DID AMAZON DELIVER THE LARGEST STREAMING AUDIENCE EVER?



**Scale**



**Availability**



**Best-in-class quality**







# Availability: near ubiquitous device coverage

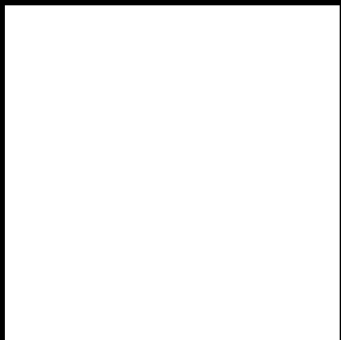
DISTRIBUTION ON 1B+ DEVICES WORLDWIDE



SONY

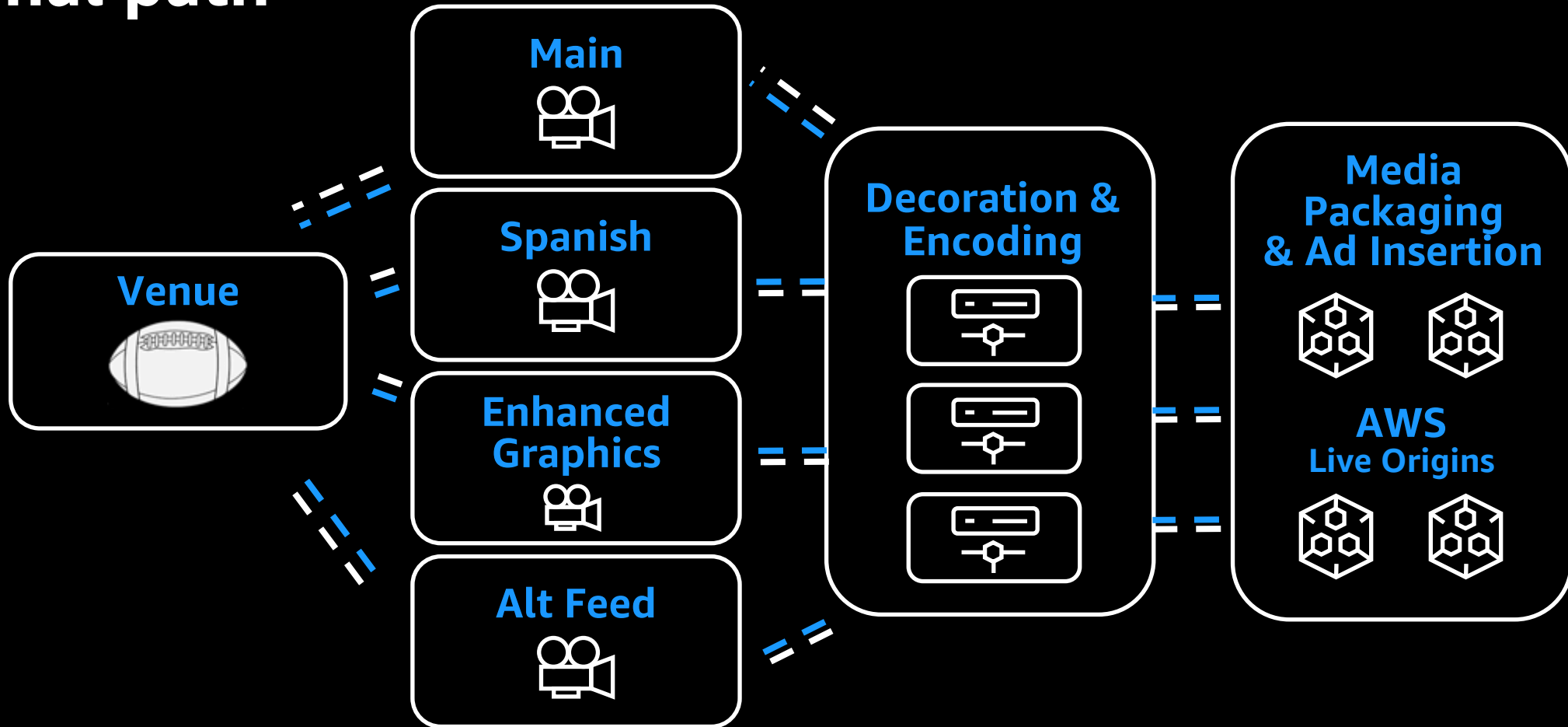


androidtv

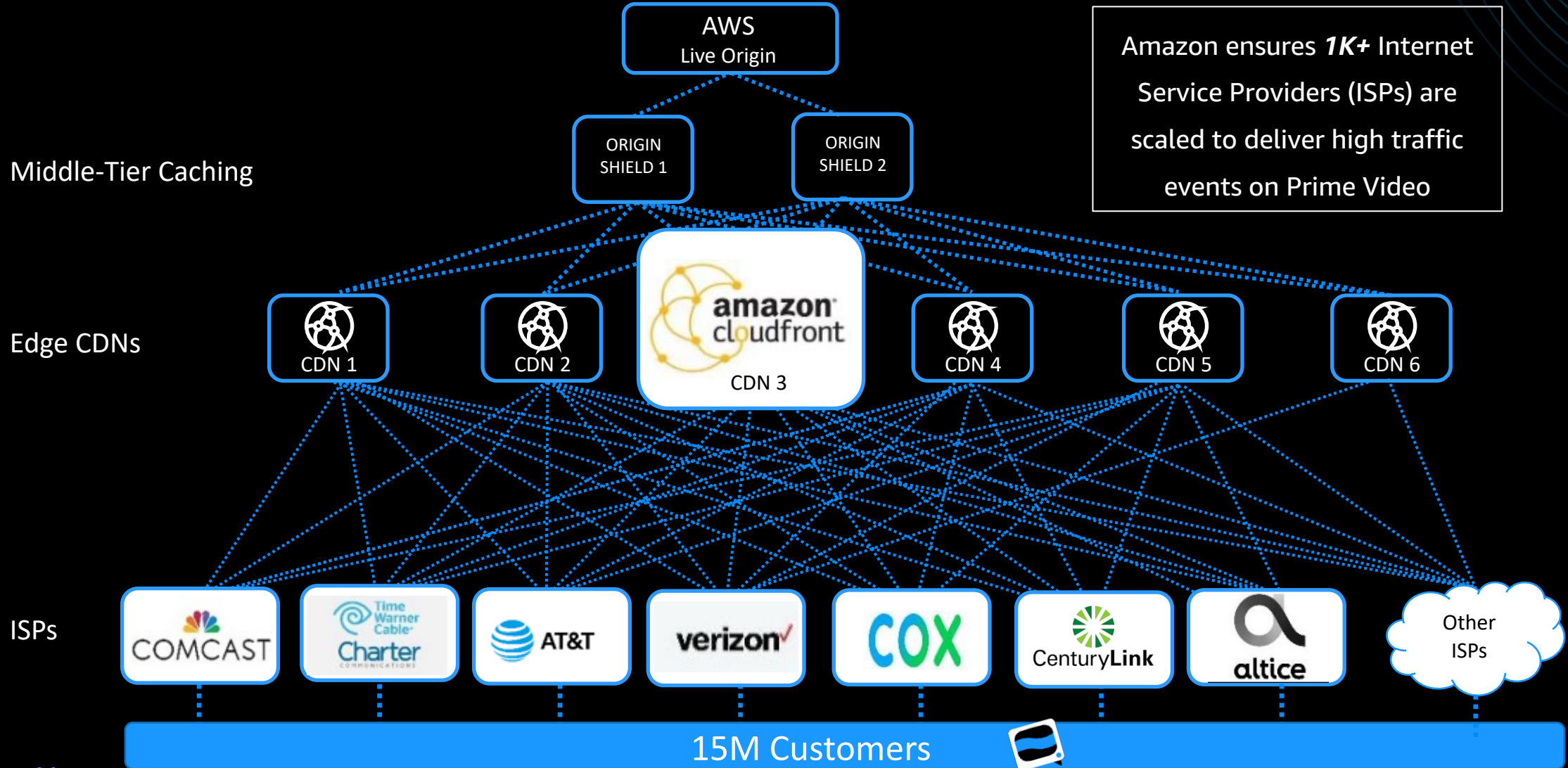
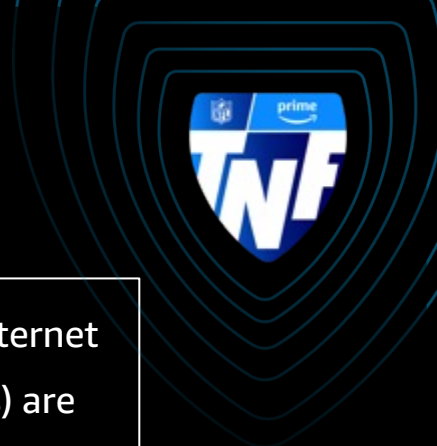




# Availability: resilience & redundancy across entire signal path



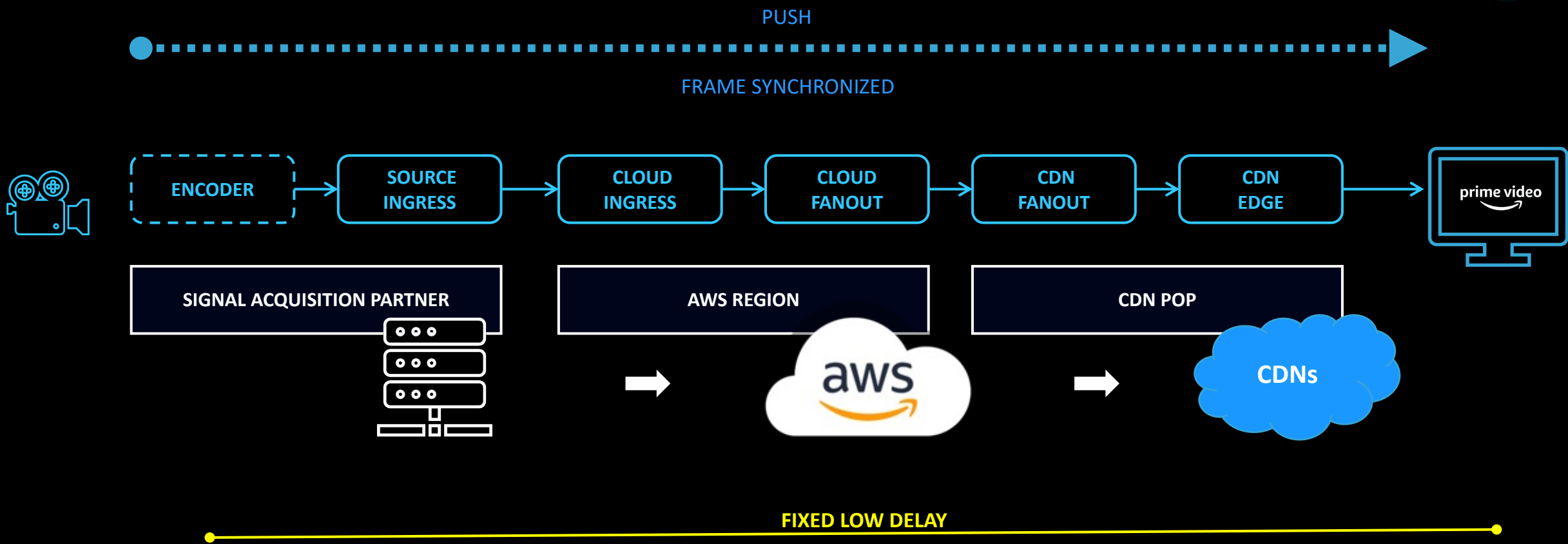
# Availability: complex video delivery

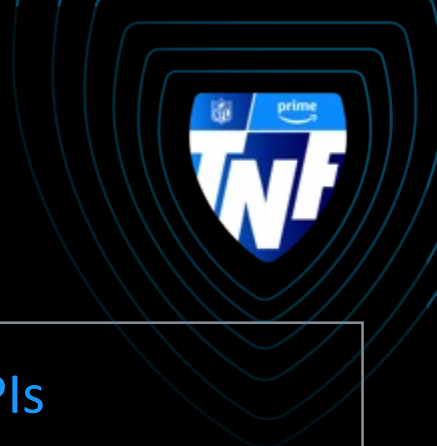




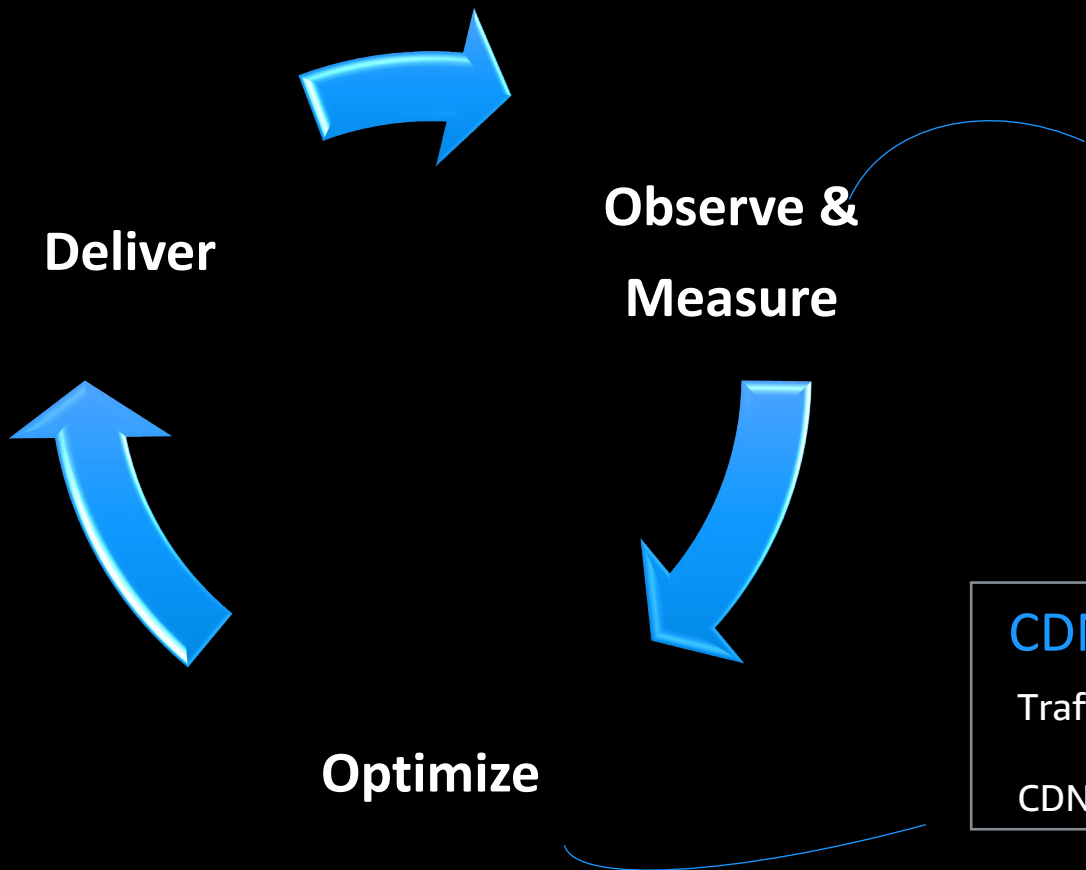
# Quality: best-in-class latency

Same low latency tech delivers latency ~8 seconds while delivering high-quality *faster* than cable/satellite TV





# Optimized for quality & reliability



INPUTS	QOE KPIs
Playback Start/Stop	Picture Quality
User Actions	Zero Rebuffer Rate
Network Bytes	Zero Error Rate
Status Codes	HD Delivered
Delivery Time	Time to First Frame
	Latency

CDNs/ISPs	Players
Traffic Management	Quality Adjustments
CDN Balancing	On-Screen Advice

**BIG DATA + COMPUTER VISION + MACHINE LEARNING**



# Quality: Extensive device-level monitoring



# PRIME VIDEO IN AUSTRALIA

# PRIME VIDEO IN AUSTRALIA

- We have done smaller scale events in Australia –
- Due to the small Scale – the regular CDNs we use for Video on Demand have sufficed.
- If we acquire rights for Live sports that are



**prime**

The Amazon smile arrow, a black curved line with an arrowhead pointing to the right, positioned below the word "prime".