The bridge to possible

Architecting Modern Broadband Networks

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What's Driving the Need for Broadband Network Transformation?

18 mbps

Rural telehealth

50 mbps

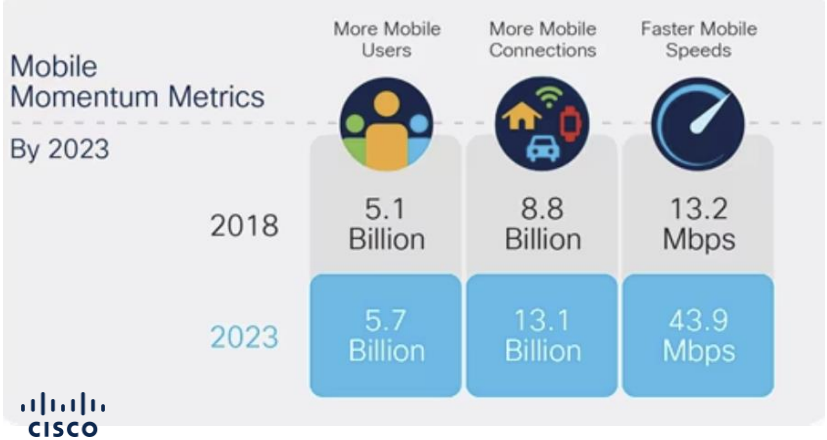
PHC / CHC / SC

20 mbps

Digital Agriculture

30 mbps

Gaming



8K and 12K Video

Immersive experience requires pushing streaming content distribution closer to the subscriber

Augmented / Virtual Reality

Business to consumer applications and advertising evolve to create a more realistic experience. Examples: Retail, real estate, social media

Enhanced Gaming Experience

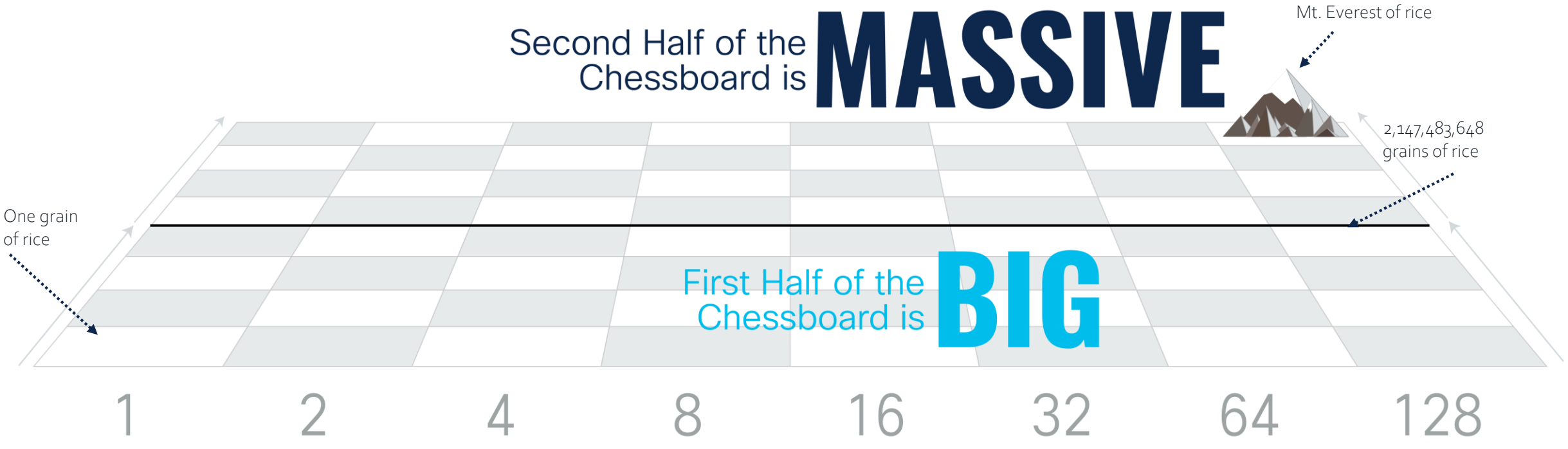
Low latency, high bandwidth, application-layer coordination with Service Provider networks

Enhanced Business Services

Business quality access to collaboration tools and applications, SD-WAN SLAs

The Exponential Growth of the Internet & Broadband Services

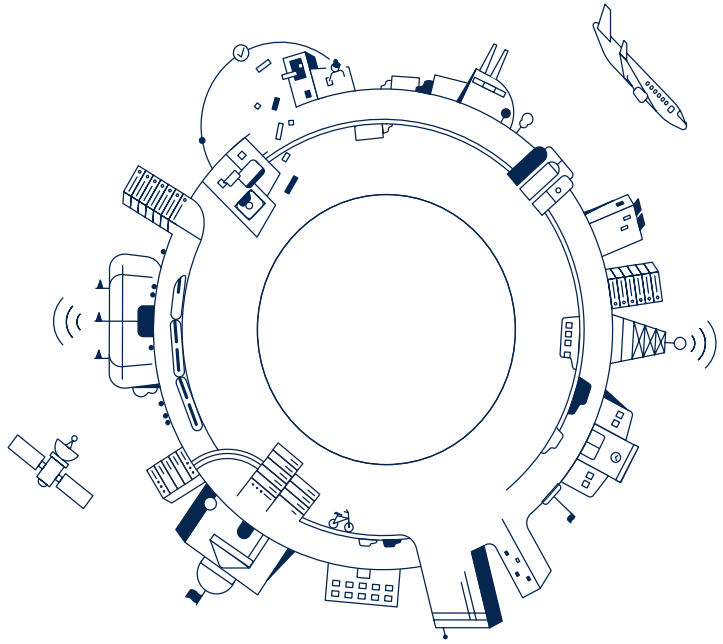
The Story of the Emperor, Inventor, and the Game of Chess



The Second Half of the Chess Board – The need for broadband network transformation

20X increase in data demand by 2032, driven by metaverse and streaming video[1]

75% of people think hybrid work requires broadband services to improve dramatically[4]



75% of enterprise-generated data will be created and processed at the edge by 2025[2]

29.3B networked devices in 2023 – up from 18.4B in 2018[5]

50% average percentage of CSP's total OpEx will be network-related[3]

10% growth in power consumption by network operators in 2021[6]

This is a demand-side view. Is it how the broadband market really works though…?

Sources: 1: A Guide to the Next-Gen Internet, Credit Suisse, 2022 | 2: Gartner analysis | 3: Telco Opex Analyzer, 2016-21, MTN Consulting | 4: Cisco Global Broadband Index 2022 | 5: Cisco Annual Internet Report, 2018-2023 | 6: MTN Consulting analysis

Innovation in Network Architectures

Innovations in ASIC Design
Optimized forwarding performance and cost

- Bifurcation of routing and switching silicon
- Massive reduction in power consumption
- Shared memory architecture for higher scale

Network Programmability
Intent-based underlay network to build services

- Segment Routing and network slicing
- Centralized view of network topology (controller)
- Simplified configuration and resiliency

Automation and Software
Untangling the complexity of integration

- Disaggregation of hardware and software
- Well defined APIs between systems
- Native platform data models, open/industry models

Optical and Optic Innovation
Converging optical and IP networks

- Shift in economics – cost moving to the transceiver
- Coherent optics extending reach and bandwidth
- Traffic demands almost entirely packet

Broadband networks have not kept pace with the innovation

Lack of innovation has led to… and what a new, better way looks like

Traditional access network architecture

Difficult to fully monetize

- Segmented Multi service delivery framework in proprietary
- Challenges in achieving fill rate and return on infrastructure investment
- Resource management complexity
- Disparate network underlays with limited SLA differentiation
- Separate hardware-based architecture for DWDM, GPON, IP MPLS

Software-defined access network architecture

Enables new, innovative business models

- Open interfaces with well-documented APIs, and open ONT/CPE choice
- 'Pay as you grow', and ease of capacity management and planning
- Automation of infrastructure and service provisioning
- Network underlay with policy intent to differentiate services based on subscriber experience
- Combined optics with ability to converge DWDM, PON & Susbcriber management in a single router

Introducing Cisco Silicon One

A New Silicon Architecture

Innovations in ASIC Design
Optimized forwarding performance and cost

ONE Unified Silicon Architecture

- Comprehensive routing with switching efficiency
- Multiple segments: web and service provider
- Multiple functions: system-on-a-chip, line card, and fabric
- Multiple form-factors: fixed or modular

Delivers Performance Without Compromise

- First routing silicon to break 10Tbps barrier
- Leading performance over current industry routing silicon
- 2x more power efficient
- Global route scale, deep buffering, P4 programmable

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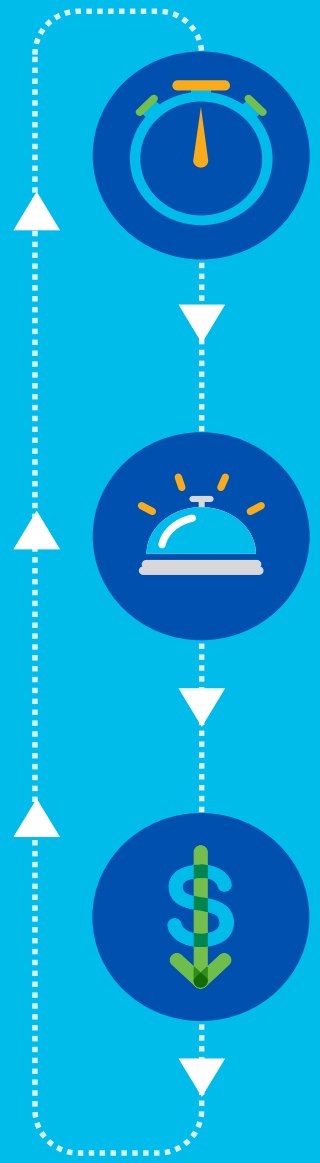
Network Programmability
Intent-based underlay network to build services

Simplicity Always Prevails

SR
Segment Routing

Segment Routing provides complete control over the forwarding paths by combining simple network instructions. It does not require any additional protocol. Indeed, in some cases it removes unnecessary protocols simplifying your network



Reduced Time to Deploy

Simplicity reduces time to deploy

- 60% reduction in internal testing (qualification) vs previous network design
- 4x improvement for software upgrade with fabric-style SP architectures

Better Productivity

Simplicity increases productivity

- 48% reduction in troubleshooting efforts vs previous network design

Reduced Capex

Low-End platforms also support SR

- 66% reduction in CapEx by optimizing the usage of feature-rich / higher-cost platforms only where it is needed, and using lighter platforms for simpler access / pre-aggregation / backhaul

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Redefining software for better operations

Simple

- Optimized to reduce memory, downloads, and boot times
- Streamlined protocols with SR/EVPN
- Secure zero-touch rollout

Modern

- Open APIs
- Customizable software images
- Cloud-enhanced

Trustworthy

- Assess hardware and software authenticity at boot and runtime
- Immutable record of all software and hardware changes
- Real-time visibility of trust posture

50% Less Memory Footprint

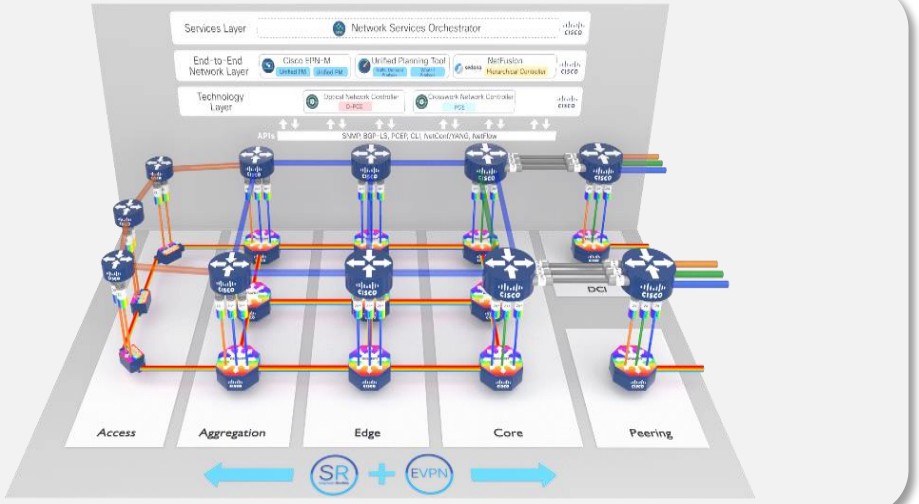
50% Faster Boot Times

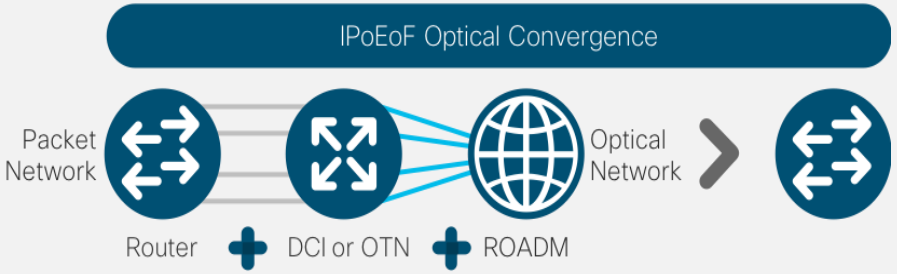
40% Smaller Image Sizes

40% Faster Download

RON Architecture Transition

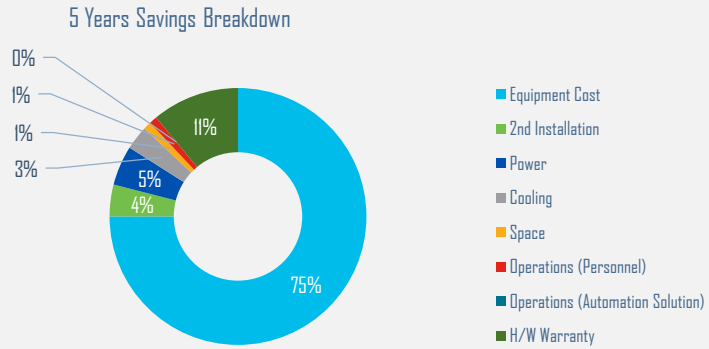
Optical and Optic Innovation
Converging optical and IP networks





- Converges all services onto a single network layer Eliminates siloed IP & Optical operational layers
- Integrates transponders & eliminates “grey” optics
- Integrates OTN Services & ROADMs
- Space, power & operational savings
- Shorter Time-to-Market for services

~45% TCO Savings



Summary

Innovations in ASIC Design
Optimized forwarding performance and cost

- TCO Impact for transport and subscriber edge
- Lower power consumption

Network Programmability
Intent-based underlay network to build services

- Optimal forwarding
- Differentiated Services
- Better use of fiber assets

Automation and Software
Untangling the complexity of integration

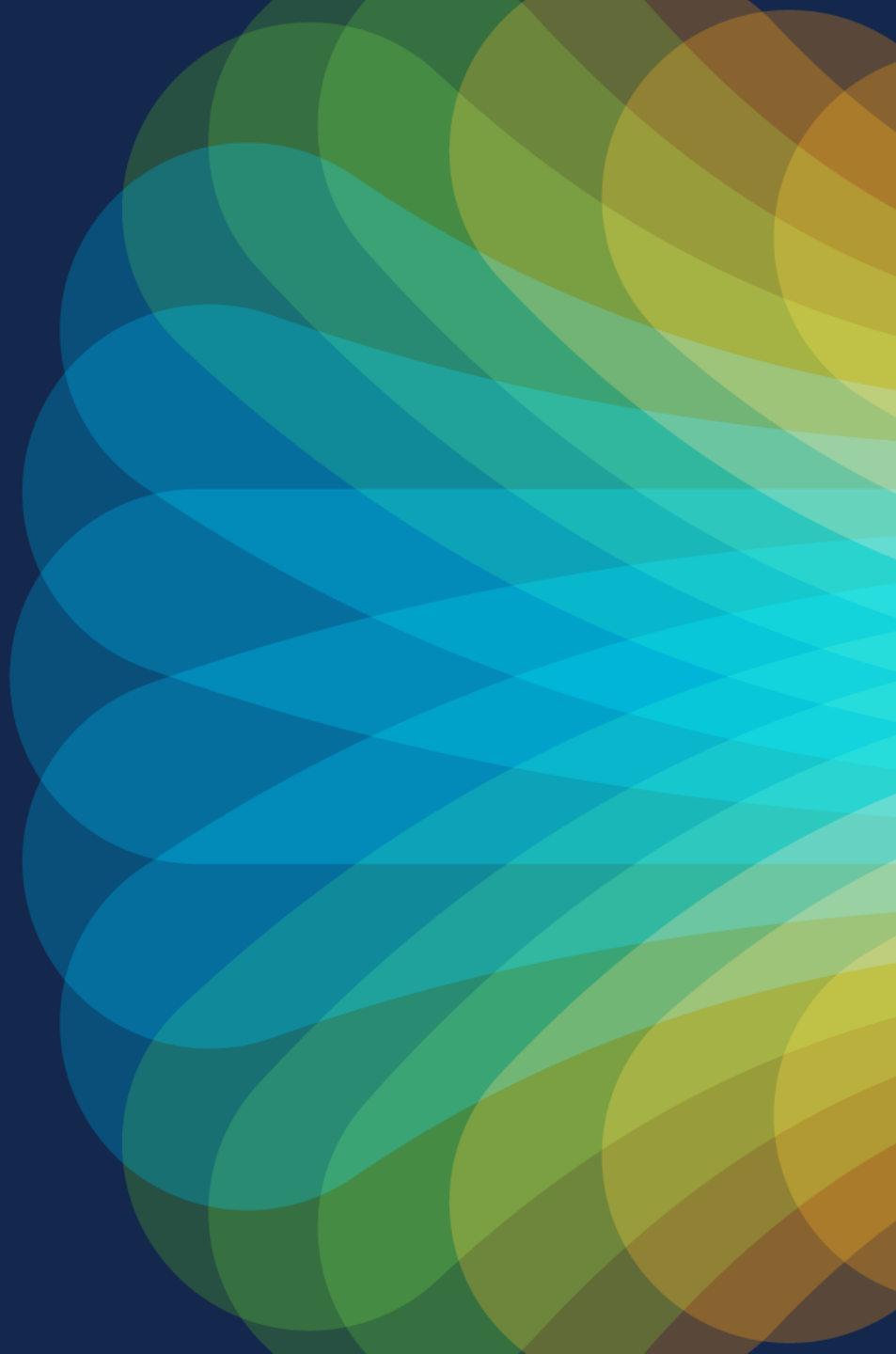
- Configuration management and consistency
- Operational advantages

Optical and Optic Innovation
Converging optical and IP networks

- Longer reach with Coherent
- Simplification with a single plane to manage

The bridge to possible

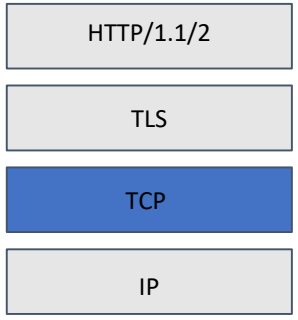
Thank you



Evolving application and subscriber behavior

Challenging the legacy assumptions of queuing

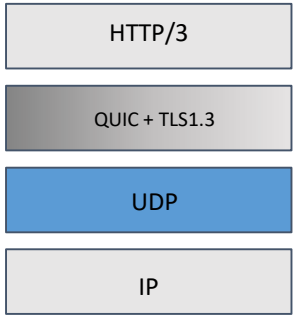
Old App Stack



Relies on the network
TCP Congestion Control
Per flow
Queuing required

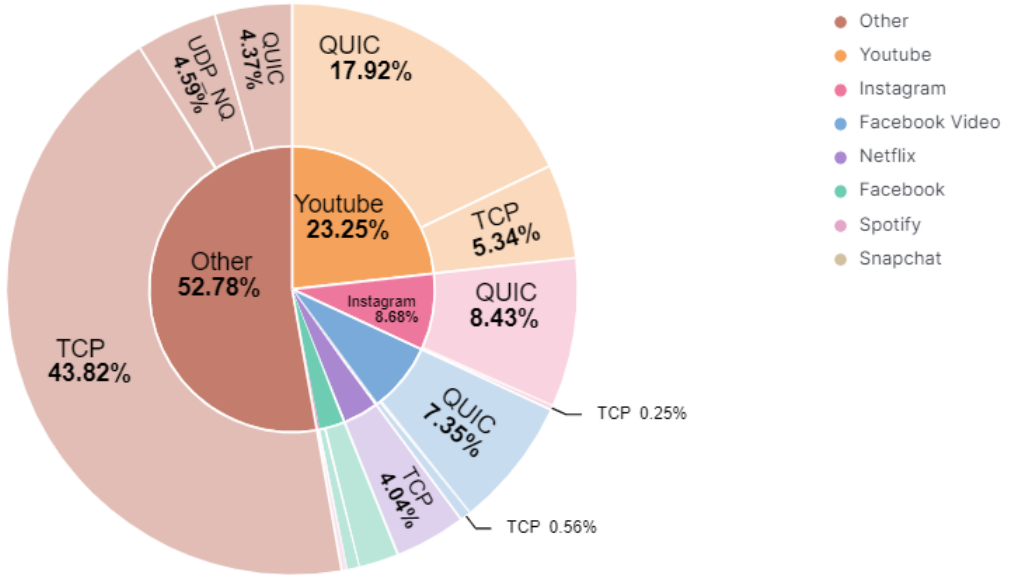
New App Stack

QUIC – RFC 9000
HTTP/3 – RFC9114



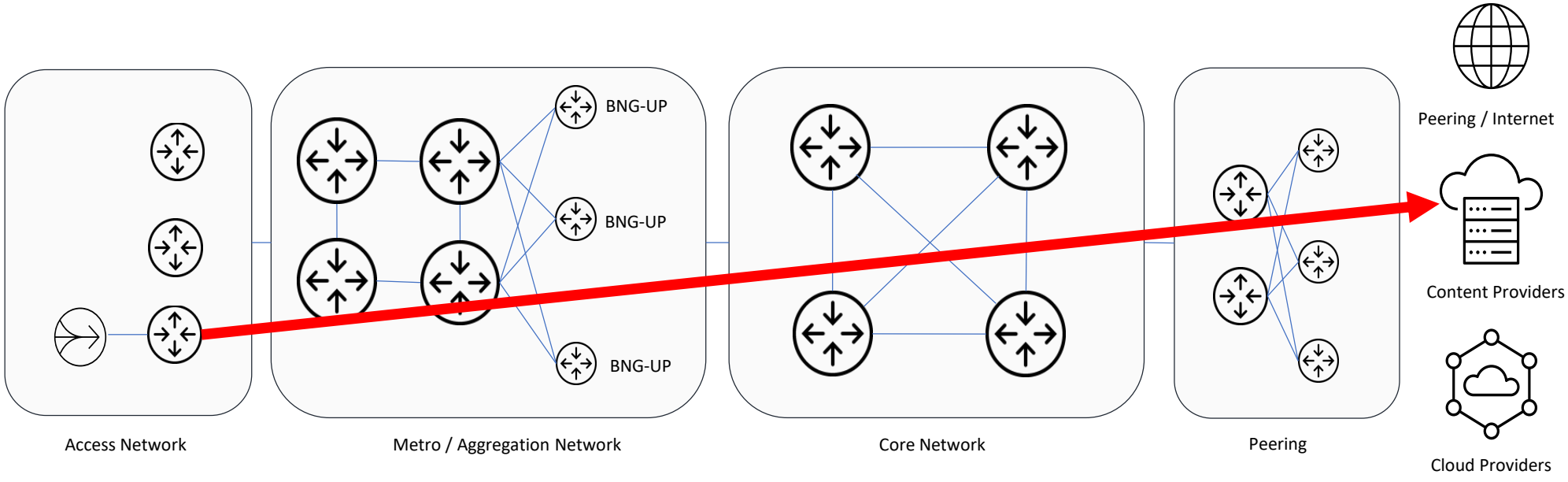
UDP = No congestion control
QUIC = flow scheduling / pacing
Application controls the flow
Queuing unnecessary

Traffic Volume (as of Nov '22)



Current CSP options don’t scale and limit business growth

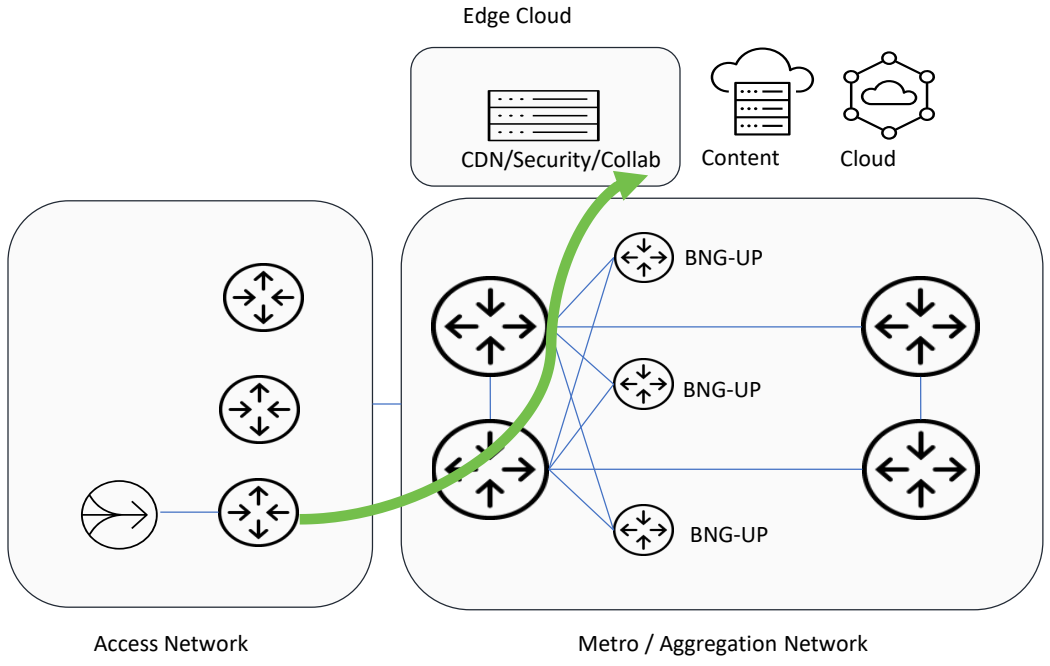
- Core bottlenecks and congestion
- No traffic visibility and control
- Complex deployment and operations
- Blind capacity upgrades
- No value creation



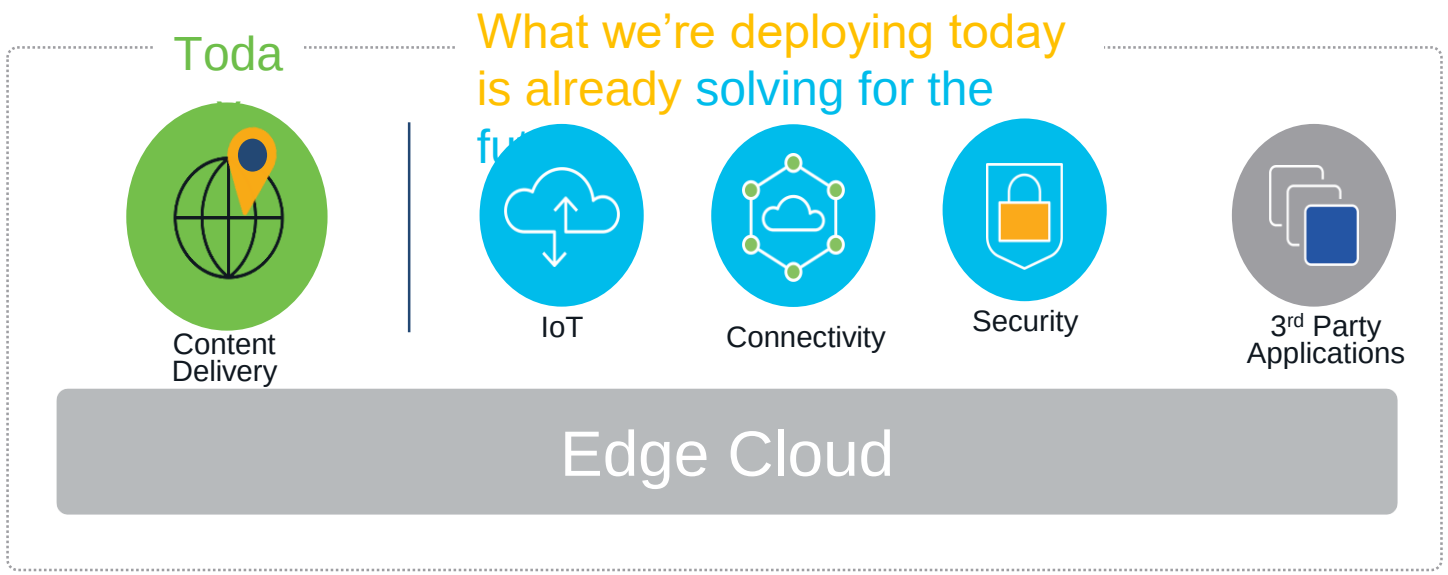
Systems are deployed at the edge for low latency, fast processing, and storage of data created by edge applications

Edge Compute Benefits

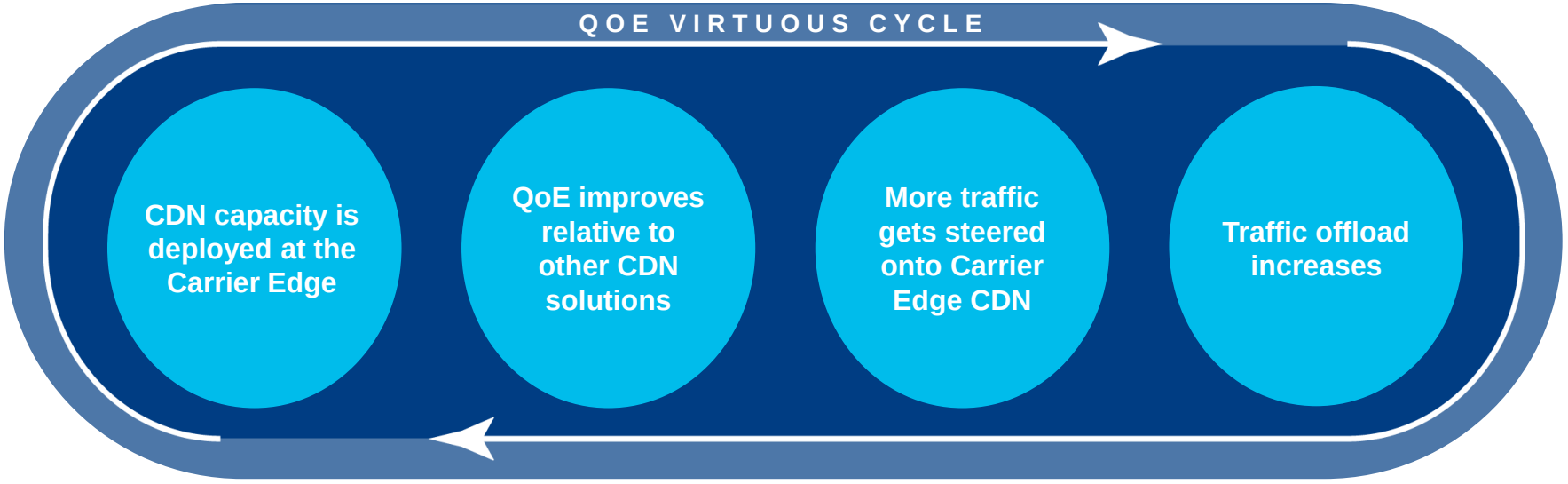
- Perform data analytics ad computation at the edge, so network connectivity and bandwidth issue are reduced
- Reduce latency in accessing compute facilitating NG applications
- Access big data analytics for Artificial Intelligence (AI), machine learning



Extending Enterprise Applications to the Edge



Best in Class Quality of Experience (QoE)



Metrics* Defining the Experience

9.4%	31%	55%	13%
Decrease in Error Rate	**Faster** Time to First Frame (TTFF)	**Quicker** Buffering Time	**Improvement** in Average Bit Rate (ABR)

Selected Metrics Comparing deep caching to average of Commercial CDNs; Client-Side Video Analytics during live events; Major Global Streaming Platform

Home broadband usage patterns anticipated over the next 12 months