The bridge to possible

The New Encrypted Protocol Stack

and how to deal with it

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May 2024

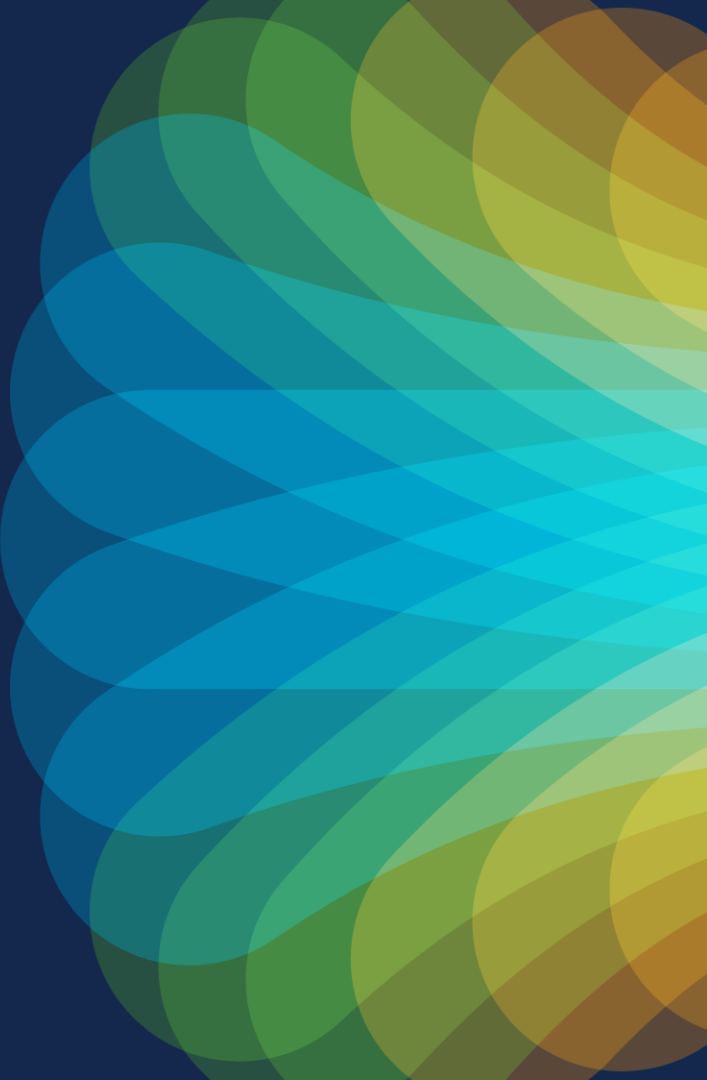
Agenda

- The New Internet
- The New IP Stack and New Traffic Behaviour
- What is left?

In memory of and based on the brilliant work of Mark Gallagher

14/09/1966-17/09/2021

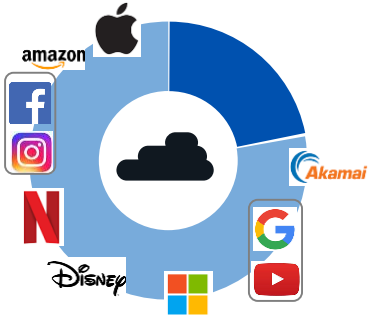
The New Internet



The Internet Reality – circa 2020 – Major US Carrier

>90% of
Volume: encrypted

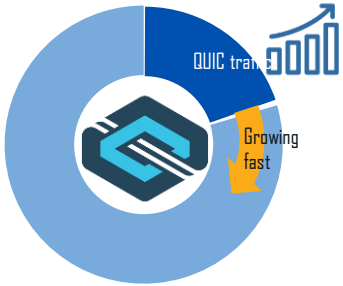
>70% of
Volume: to Cloud



10 Cloud sites
"Elephant destinations"
not "Elephant flows"

~50% of Flows: DNS

>20% of Traffic: QUIC



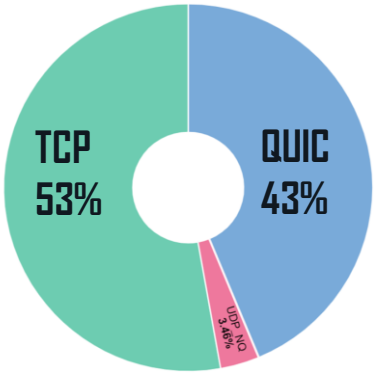
Many small flows
Micro-sessions

- Destination: all-encrypted world
- Cloud: concentrating the Internet

- Content: DNS is the load-balancer
- QUIC: Future Protocol of choice

Fast forward 18 months - Tier-1 EU Mobile Carrier

Overall Volume

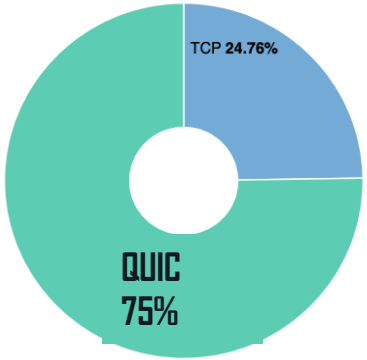


QUIC has doubled in 18 months

QUIC is 43% of total and rising

YouTube

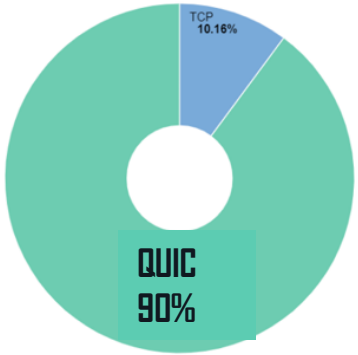
Volume



QUIC is "default"

Meta

Volume



Meta has gone full QUIC

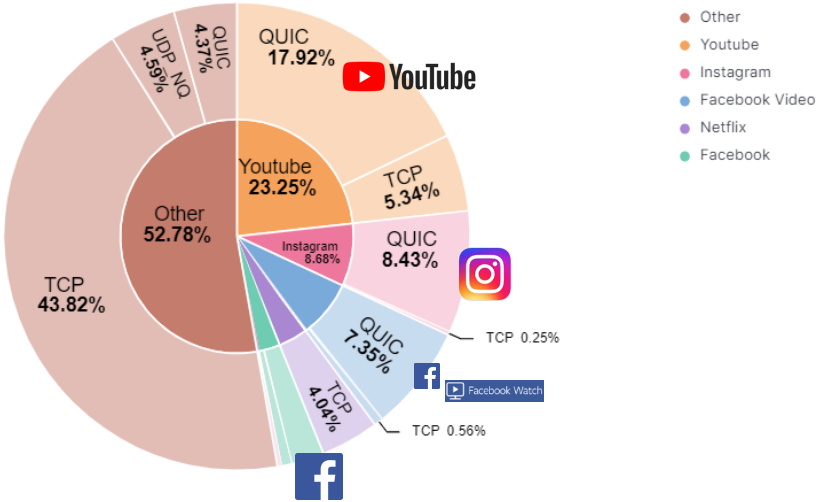
(snapshot 11/2/2022)

Network Traffic by Volume and Flows

The big flows that matter are predominantly QUIC

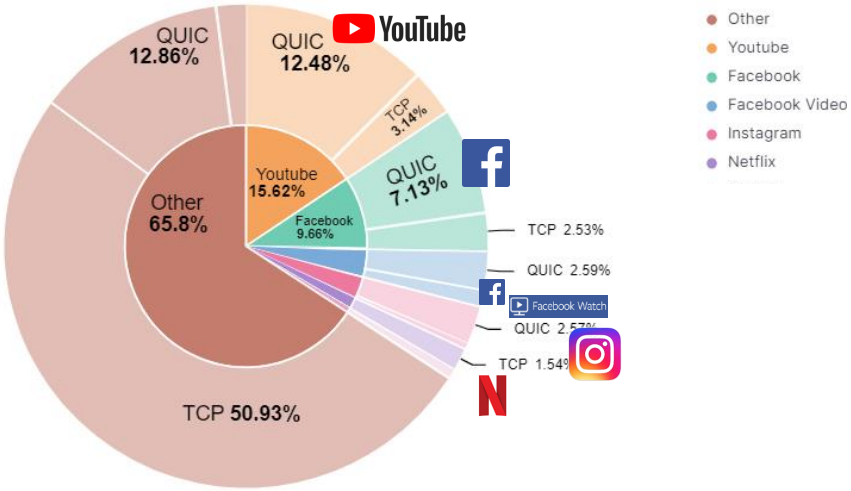
Overall Volume by Apps

Big 5 is 48% of traffic
QUIC is 40% of traffic
"other traffic" still largely TCP, QUIC now visible (4.3%).



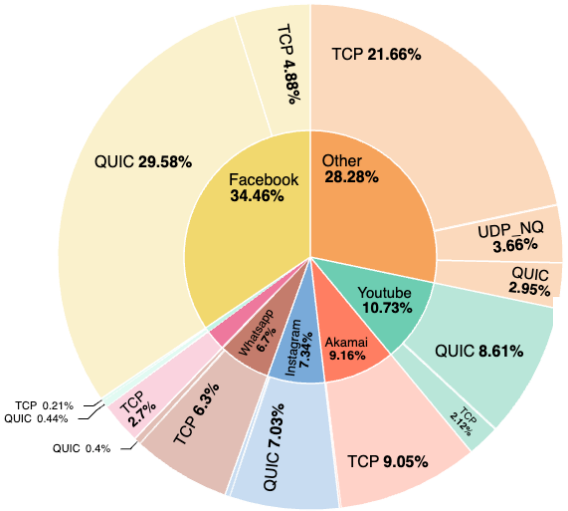
Total Flows by Apps

Lots of TCP sessions (likely IOT related, transactional related)
Big 5 APPs QUIC sessions are very targeted and high efficiency (video related behaviour); fewer but higher in volume



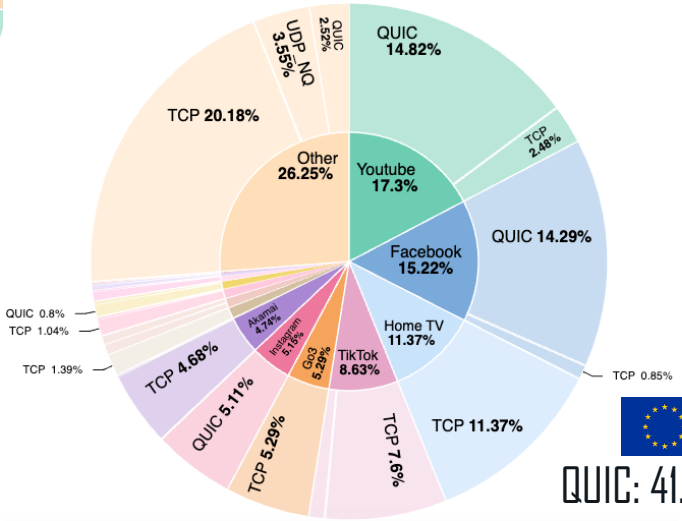
(snapshot 11/2/2022)

Early 2024 Data: QUIC still going strong

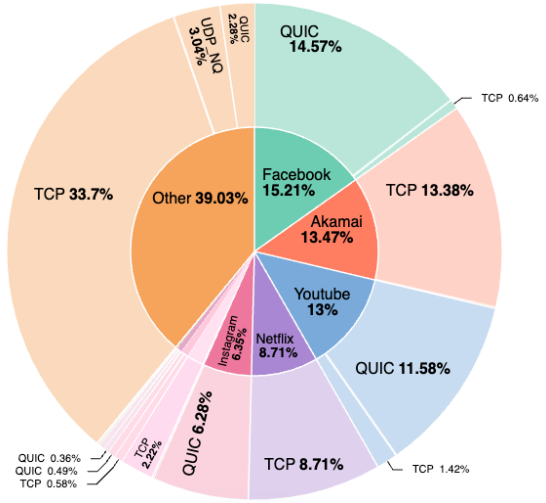


LATAM

QUIC: 47.31%



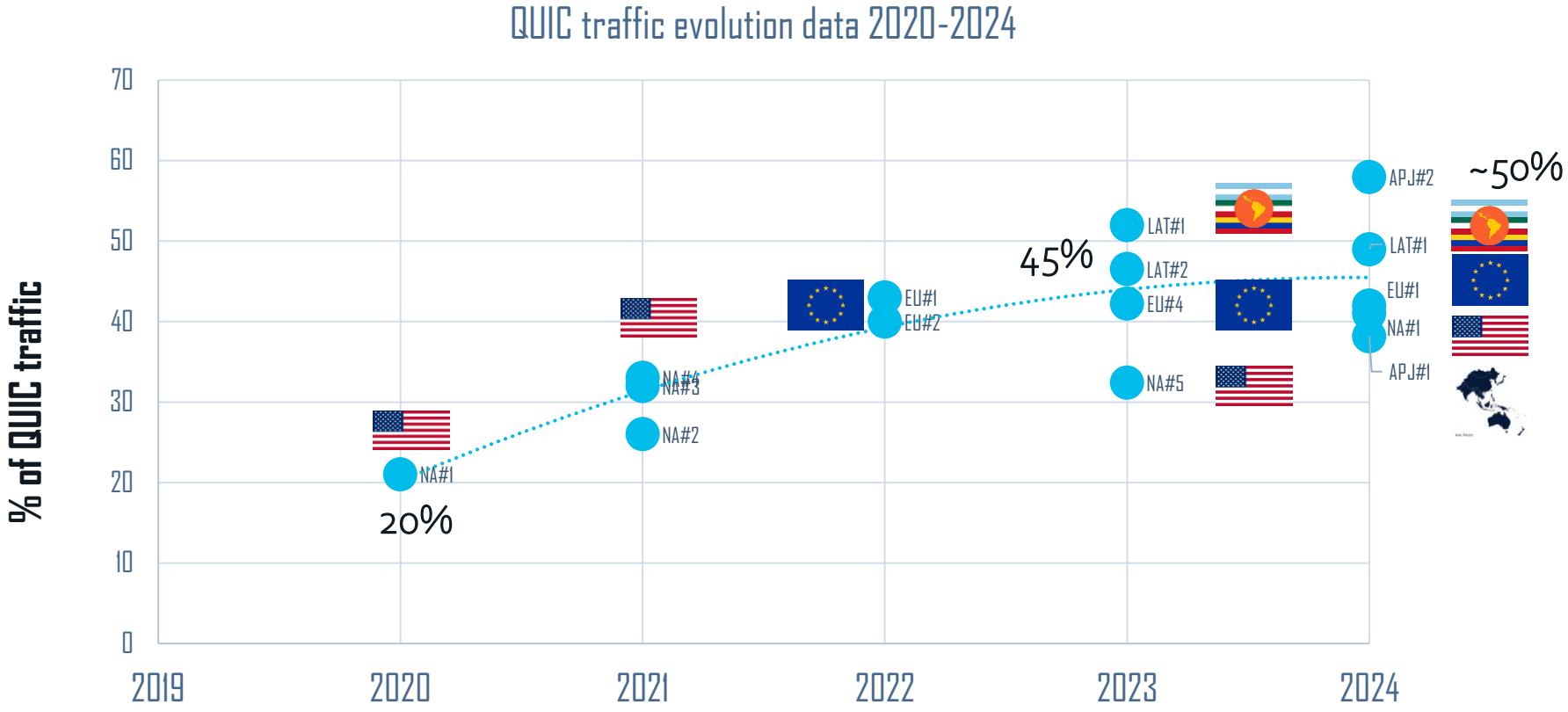
QUIC: 41.98%



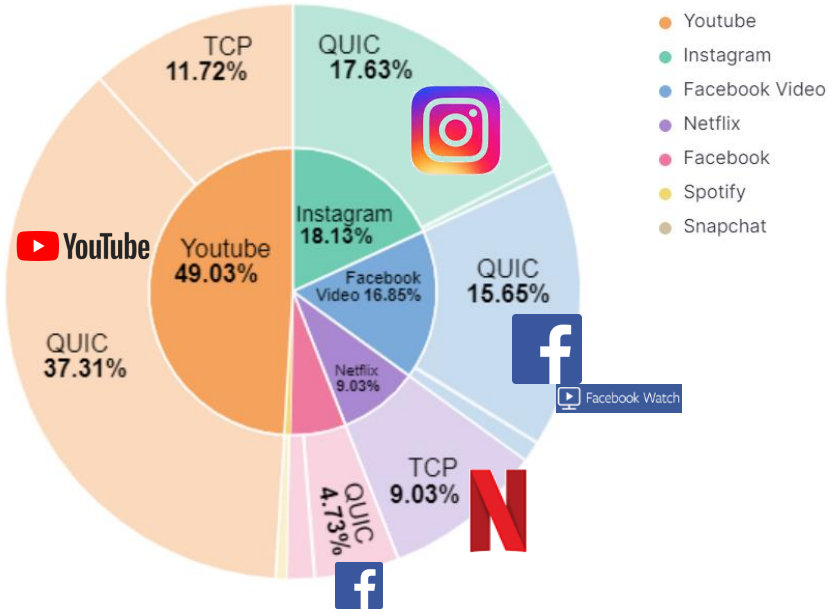
QUIC: 41.5%

QUIC is growing across the world

Various snapshots – Approaching 50% WW

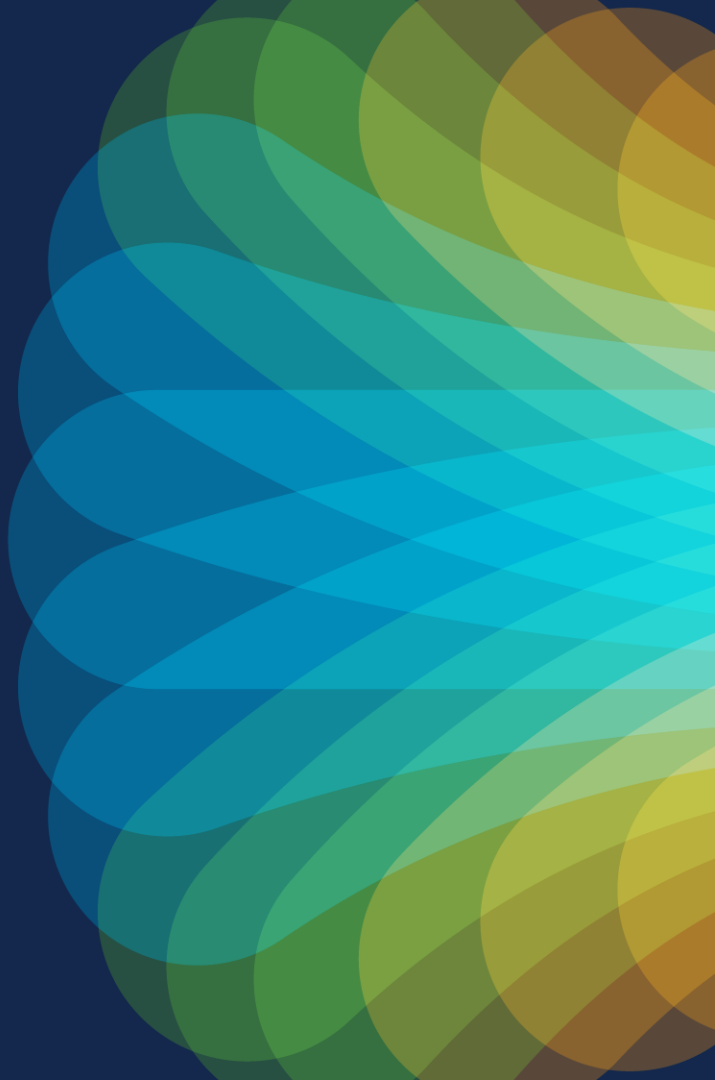


Top 5 Apps – QUIC is dominant
80/20 rule now



April 10 2022

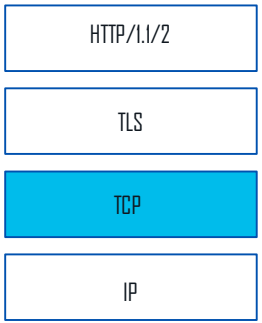
The New IP Stack and New Traffic Behaviour



An application driven global transition

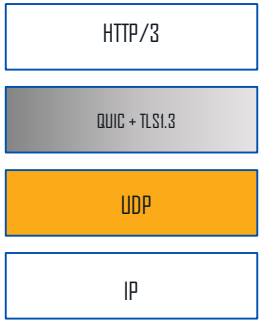
HTTP/3 Stack = UDP+QUIC+TLS

Old App Stack



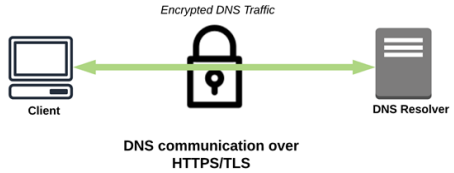
New App Stack

QUIC – RFC 9000
HTTP/3 – RFC9114



DoH

DoT – RFC7858
DoH – RFC8484



eSNI / ECH

RFC8744

Large Scale Adoption

DoT: DNS over Transport Layer Security
DoH: DNS over HTTPS
eSNI: Encrypted Server Name Identification
ECH: Encrypted Client Hello

DPI is gone

HTTP/3 Stack = UDP+QUIC+TLS+H3+DoH+eSNI/ECH

Old App Stack

- HTTP/1.1/2
- TLS
- TCP
- IP

New App Stack

QUIC – RFC 9000
HTTP/3 – RFC9114

- HTTP/3
- QUIC + TLS1.3
- UDP
- IP

- ***Improved Security***
- ***Multi-session***
- ***Improved QoE***
- ***APP friendly design***

DoH

DoT – RFC7858
DoH – RFC8484

Application Controlled DNS
DNS Traffic not observable

Google & CloudFlare serve 50% of global DNS requests
Both support DoH
All major OSs & Browsers support DoH (Firefox Defaults for US to CloudFlare)

eSNI / ECH

RFC8744

Target Domain is opaque / unobservable

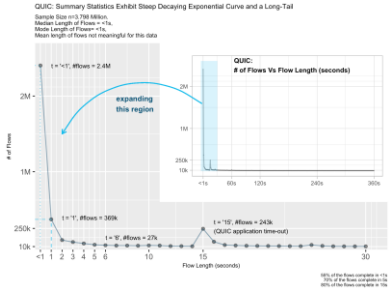
Large Scale Adoption

DPI Ineffective

including alternative hints e.g. DNS or SNI analysis

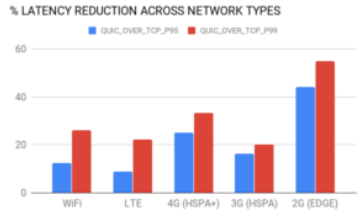
QUIC Moves Control of the User Experience to the App

Apps do not play nice – they will deliver over everyone else

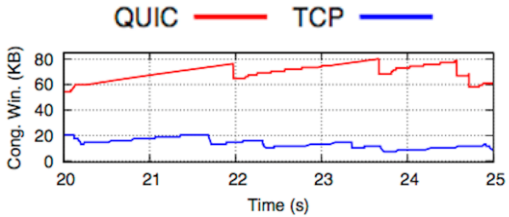


70% of interactions complete in <5s**

Scenario	Flow	Avg. throughput (std. dev.)
QUIC vs. TCP	QUIC	2.71 (0.46)
	TCP	1.62 (1.27)
QUIC vs. TCPx2	QUIC	2.8 (1.16)
	TCP 1	0.7 (0.21)
	TCP 2	0.96 (0.3)
QUIC vs. TCPx4	QUIC	2.75 (1.2)
	TCP 1	0.45 (0.14)
	TCP 2	0.36 (0.09)
	TCP 3	0.41 (0.11)
	TCP 4	0.45 (0.13)



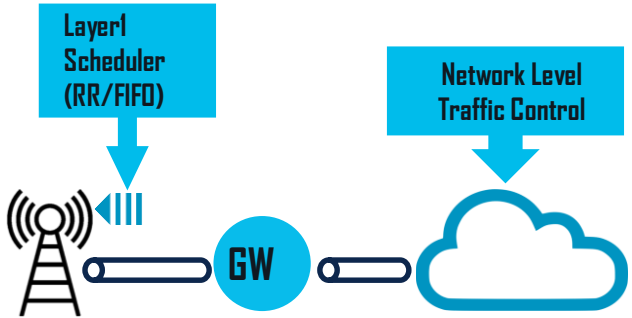
The poorer the network, the better the improvement*



QUIC is "Unfair"***

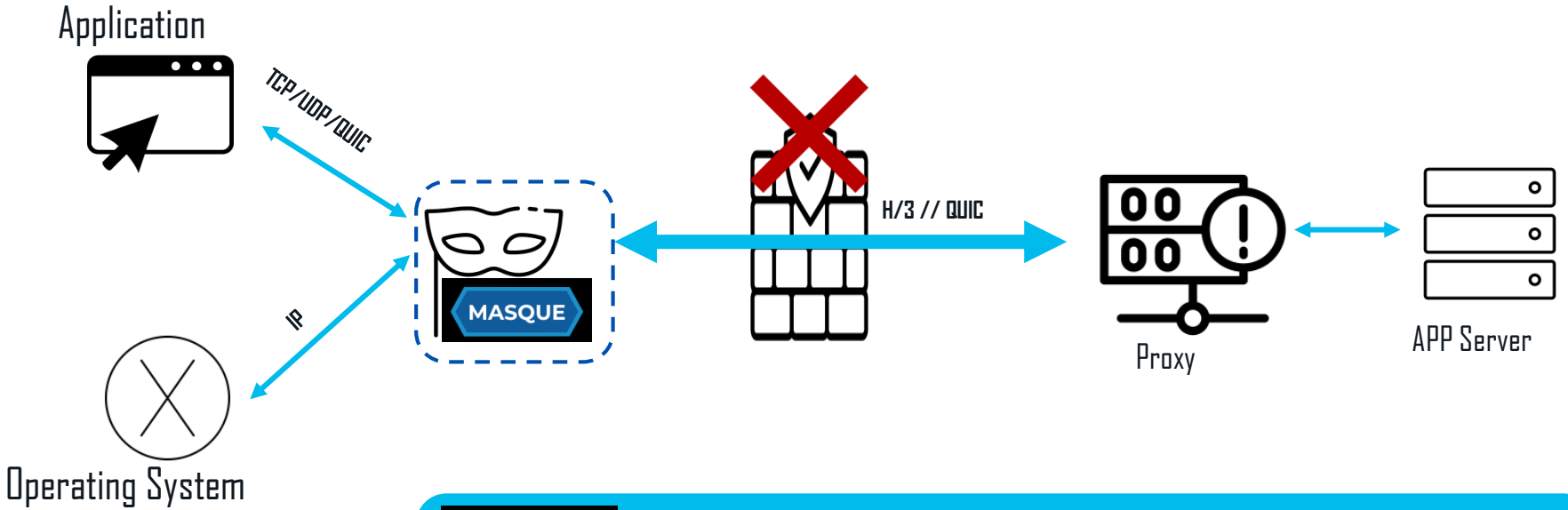
Impacted Areas

(e.g. wireless access)



*uber engineering;**Cisco Analysis, cust.data;***APNIC study

Tunneling is a new threat vector

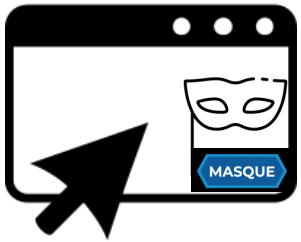


MASQUE

Multiplexed Application Substrate over QUIC Encryption

Goal is to develop mechanism(s) that allow configuring and concurrently running multiple proxied stream- and datagram-based flows inside an HTTP connection.

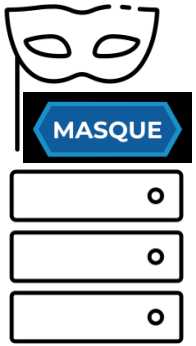
Options for Masque



Inside the App

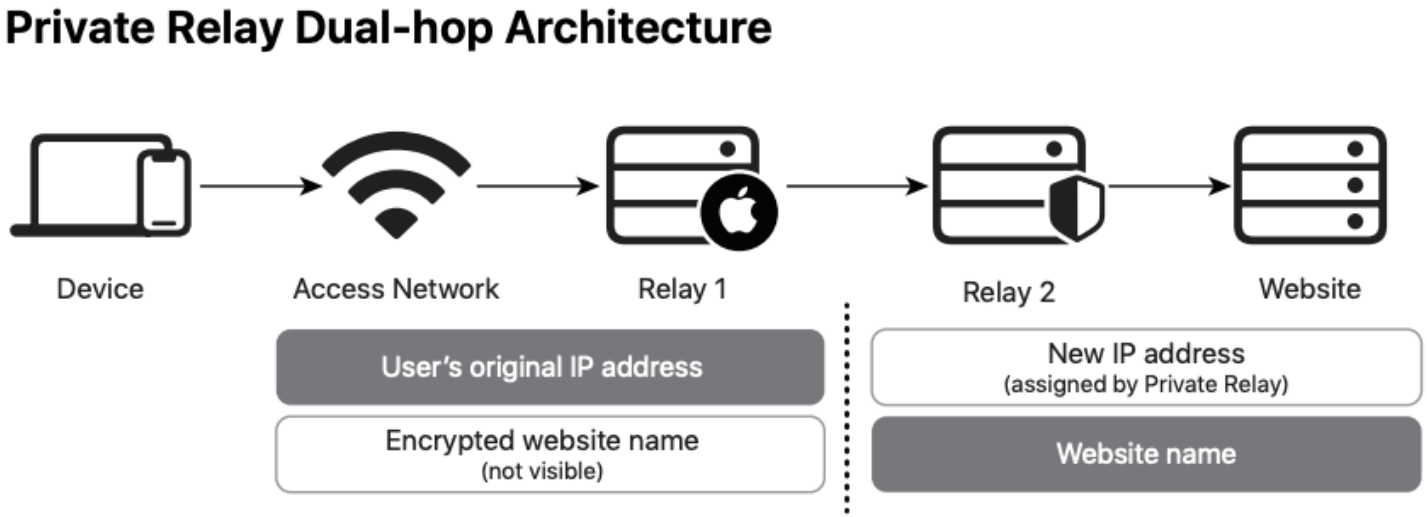
Inside the O/S

Client to O/S



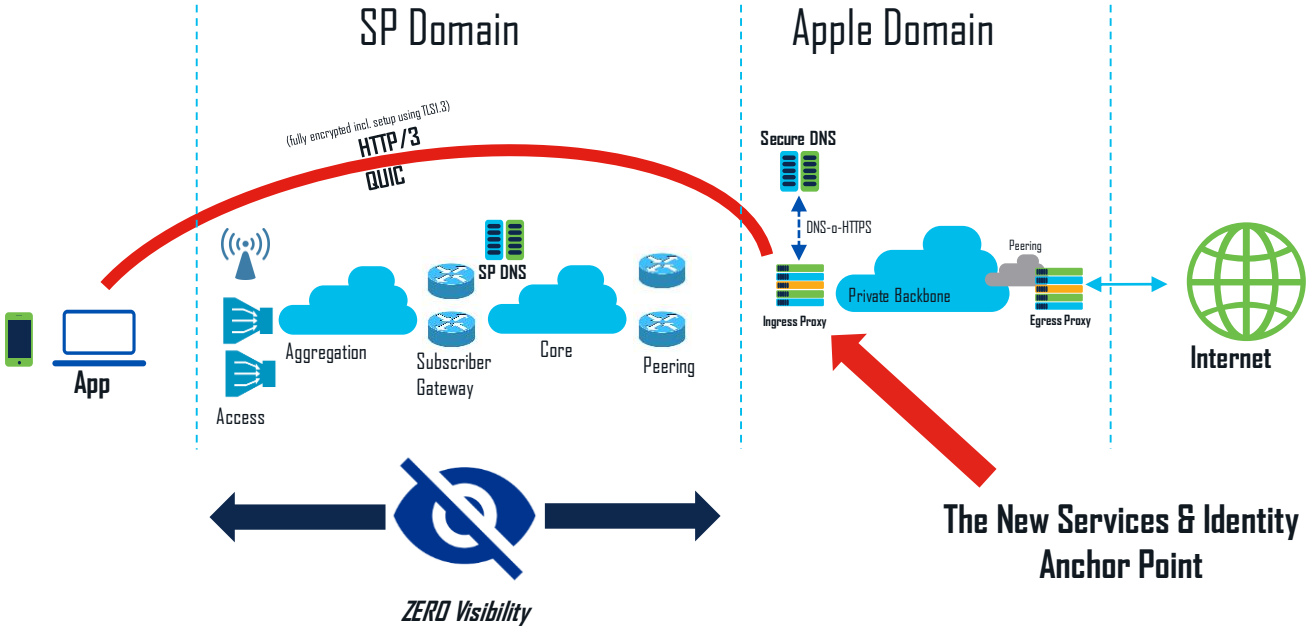
Network Appliance
(tunnel IP)

Apple Private Relay: Dual Hop Masque



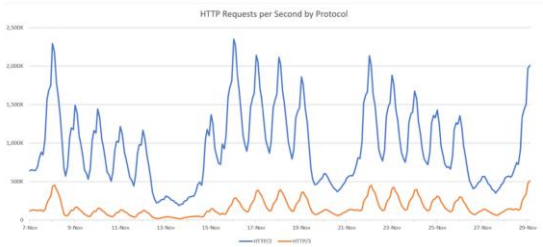
Decoupling users from content

SP Domain has less insights on traffic

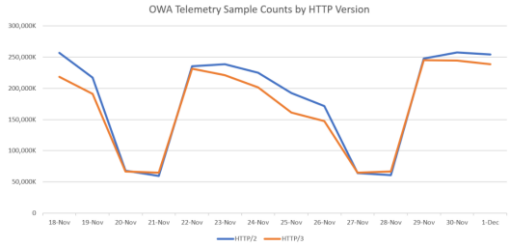


QUIC at MSFT*

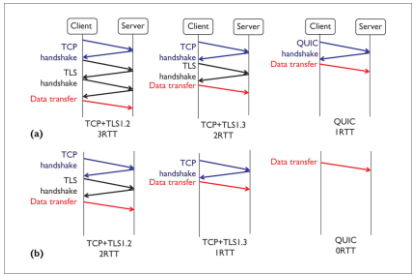
- 70% of worldwide front-end servers deployed latest Windows Server with HTTP/3 support
- Chart below shows **all** EXO H2/H3 usage; including browser, mobile and desktop clients



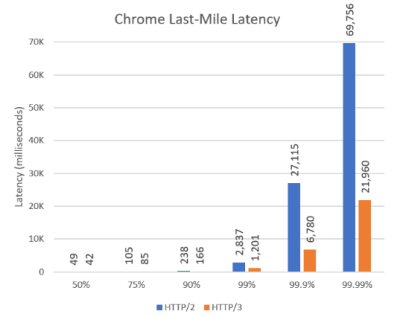
Easy to adopt

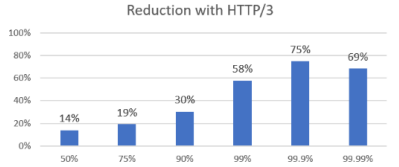


Outlook runs on Quic/H3



SMBoQUIC – No VPN





Outlook web access *actually* runs better using H/3

Pervasive across Products

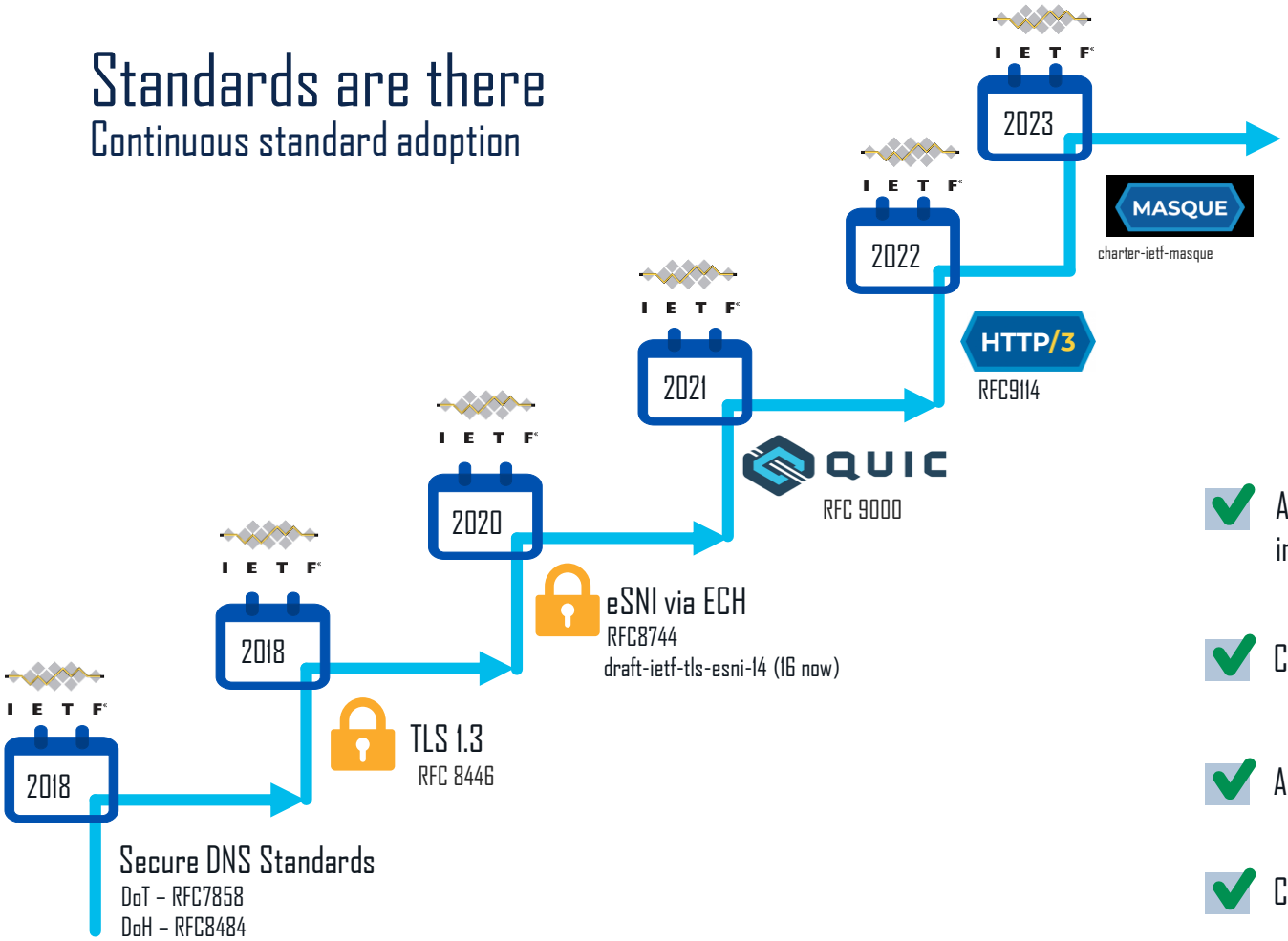
* Source: EPIQ 20212, Nick banks, MSFT

QUIC/H3/DoH stack is in business

Content Delivery | Security | Privacy | Loadbalancing | App Infrastructure | App Experience

Standards are there

Continuous standard adoption

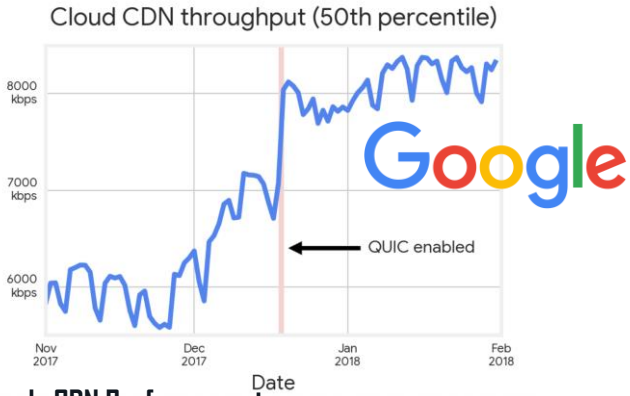


- ✓ At scale, in production
- ✓ Client — android, chromium, Microsoft Edge, Mozilla
- ✓ Application
- ✓ Cloud

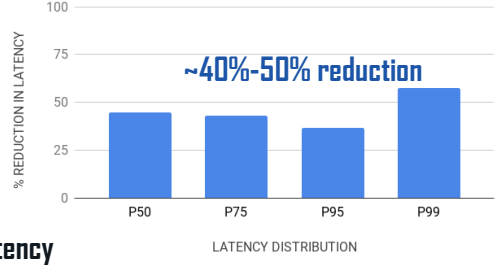
The consumers are observing benefits

QoE Drives QUIC Adoption

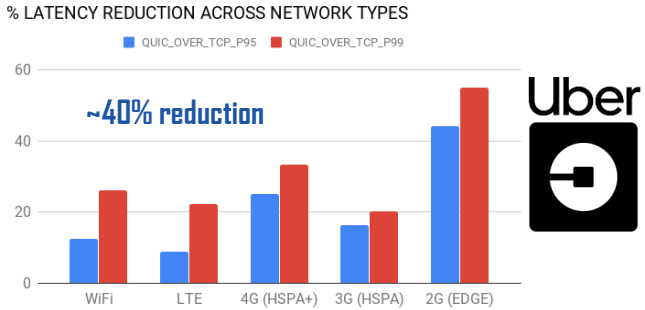
1.8B Daily Active Users – 3B Monthly
QUIC and H/3 are protocols of choice*



Google CDN Performance increase



Latency
reduced significantly**



The more fragile the network, the more QUIC excels**

*source Facebook engineering

** source Uber engineering

SP Services Portfolio needs assessment
(non-exhaustive list)

Differentiated Billing

- *Zero rated Apps*
- *App aware service*

Regulated Services

- *Site blocking*
- *Traffic intercept*

Traffic Management

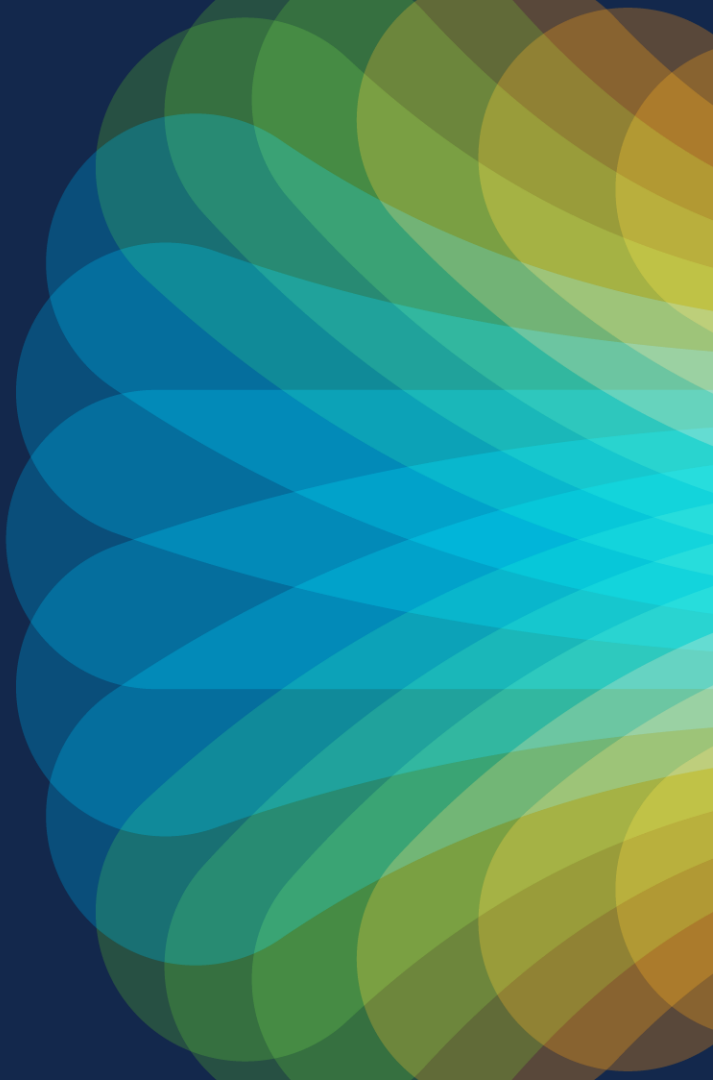
- *Peering*
- *Optimal interconnect*

Business Services

- *VPN*
- *Security*

non-exhaustive list

What is left?



Customers are looking for solutions

Example Use Cases Asked

Manage video downloads vs video streaming, downloads being the priority

DPI won't work anymore in QUIC

Recognise type of flow and act accordingly

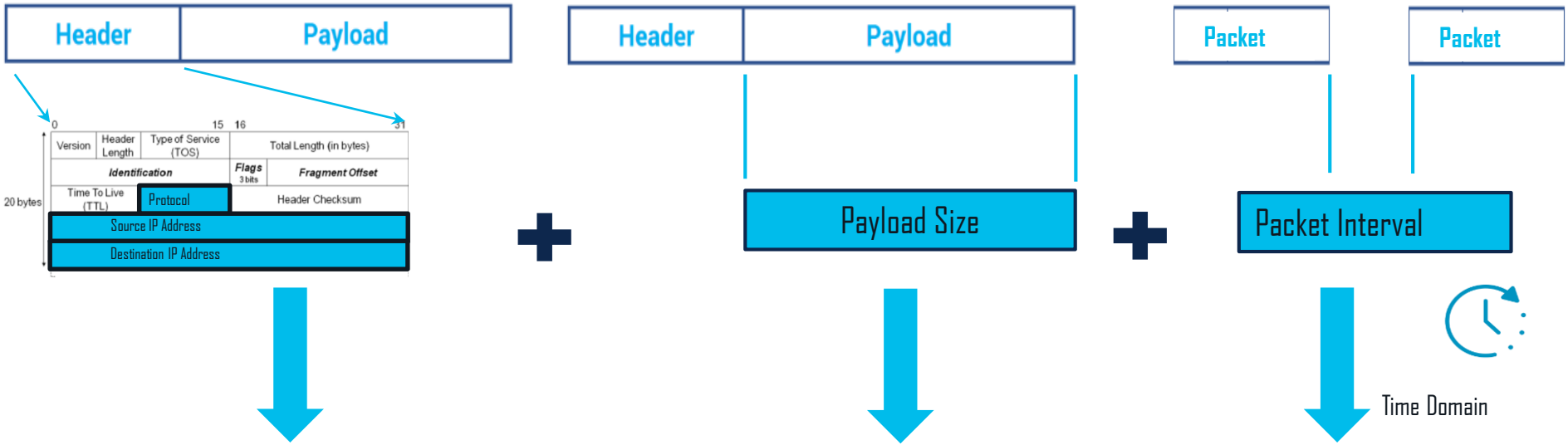
Manage Snap video vs Snap apps

Same problem

Account for encrypted traffic in terms of source/destination

More generically: Identify and manage QUIC flows; mitigate impact on Radio; optimise against industry metrics; future-proof network smarts

There is some information that will not go away

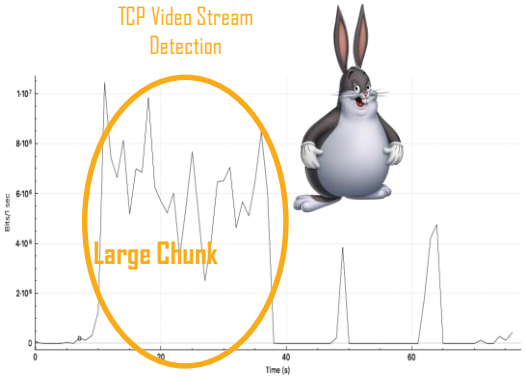


CDN Information

Traffic Volume in Time Information

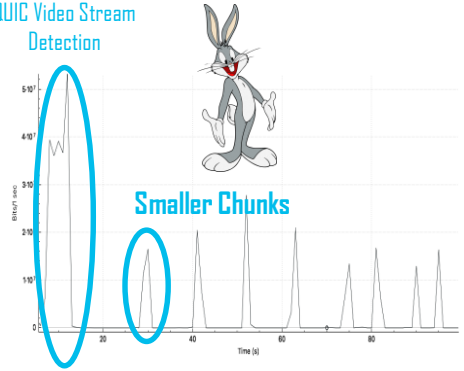
App (e.g. Video) Behavior varies by protocol and use case

TCP Video Stream Detection



TCP based ABR video players prefer larger, sustained downloads due to high cost of establishing the TCP session and reducing time spent in TCP slow start.
Often use HTTP/2 connection. (DASH/HLS) to fix HOL.

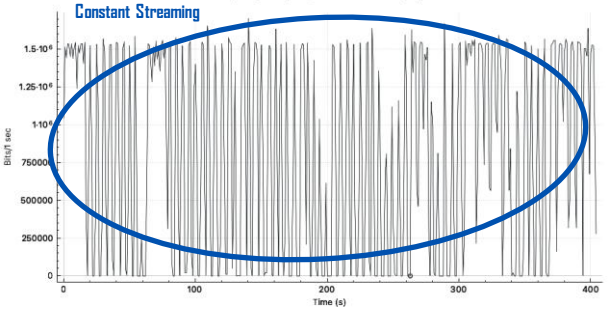
QUIC Video Stream Detection



QUIC based ABR video players prefer requesting video in smaller chunks.

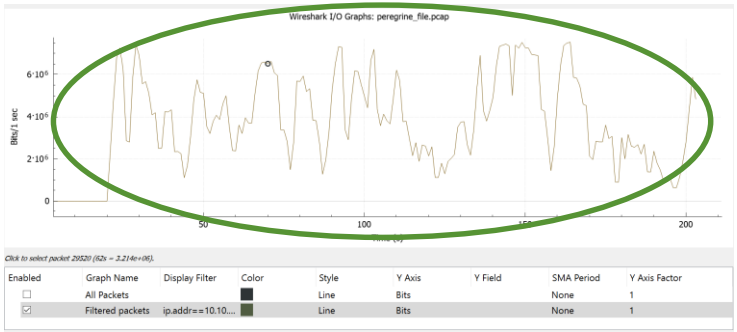
Multiple QUIC Streams in many cases to (different) servers

UDP Video Live Stream Detection



UDP based video players are extremely reliant on consistent network performance
Small buffer, sustained T'put
Applications: YouTube Live, WebEx, Microsoft Teams, Zoom

YouTube TV webex by CISCO zoom



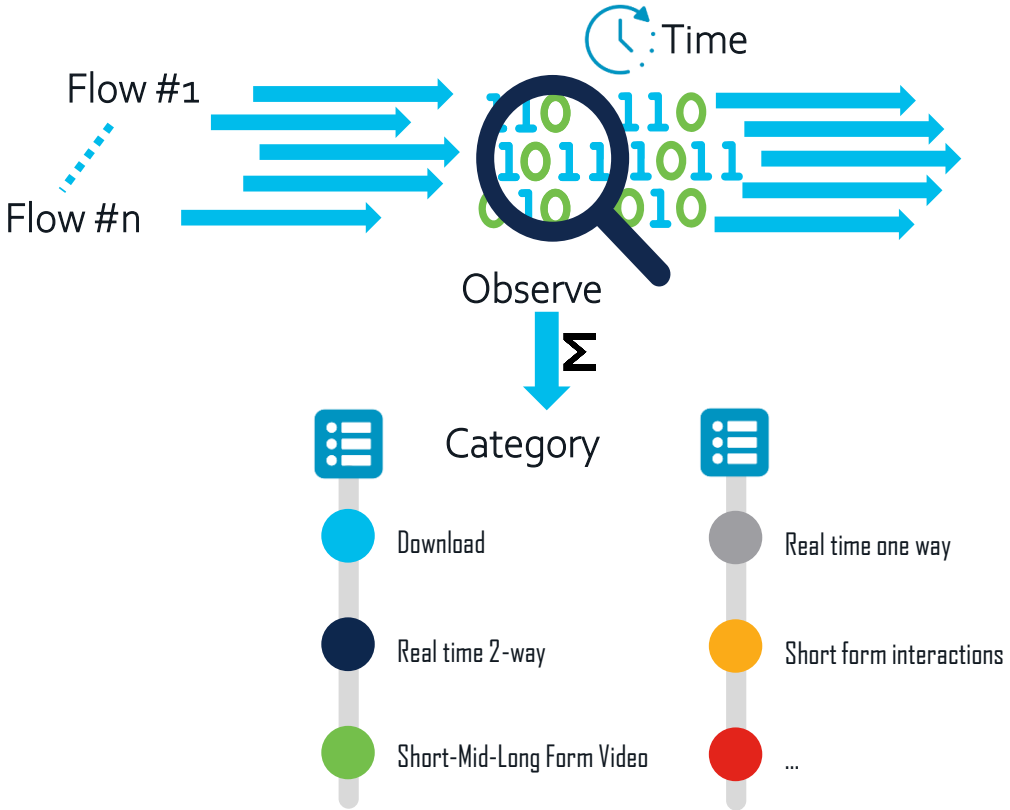
Download Stream Detection

Premium

NETFLIX

Time Domain Flow recognition

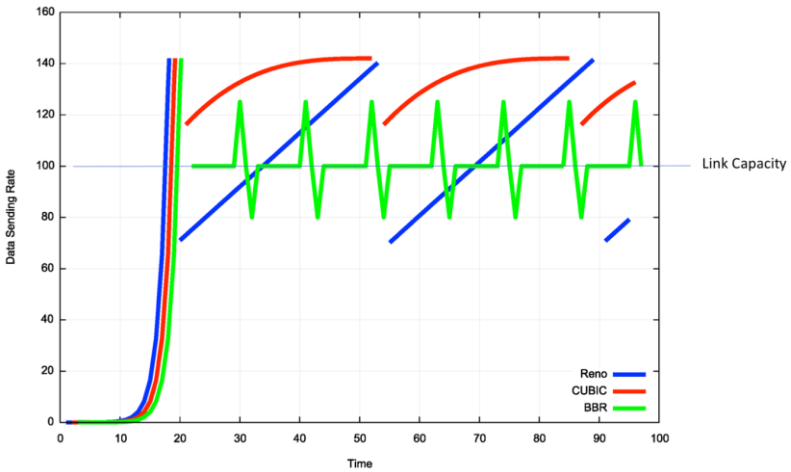
- Observe all flows
- Profile per flow (Time domain matched)
- The resulting profile will allow to distinguish the nature of the flow
  - Content Download
  - (x-Form) Streaming content
  - Real time 2 way communication
  - Video/non-video
  - Short lived flows



Inferring congestion

- Different congestion algo's have different behaviour
- Time-domain observation + anomaly detection -> congestion inference

Reno vs CUBIC vs BBR behaviour*

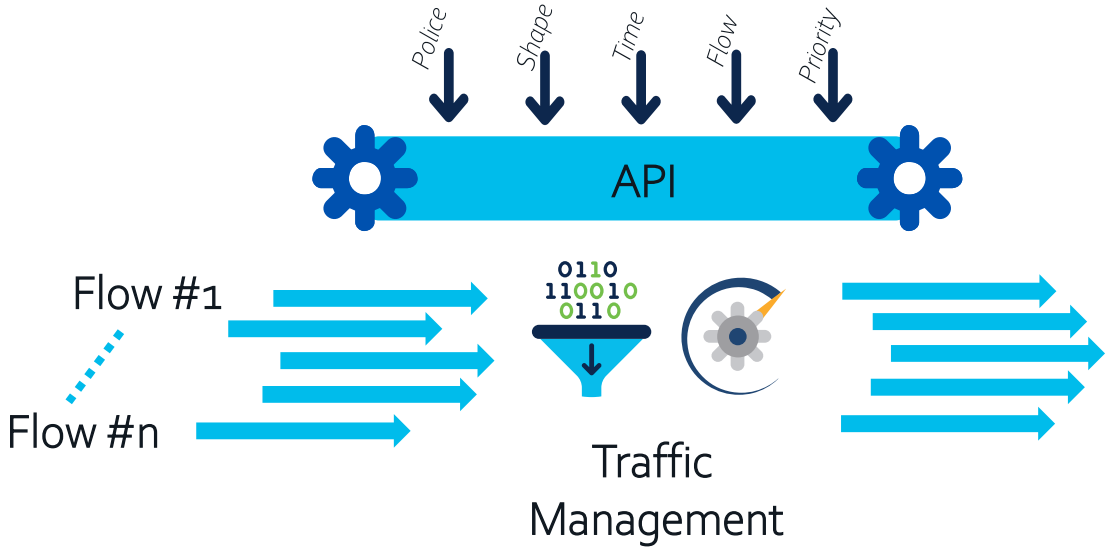


- Assessment of various flows in parallel
- Understand Protocol behaviour: congested or not
- This serves as input for Policy Application

* https://blog.apnic.net/2017/05/09/bbr-new-kid-tcp-block/

Programmable Traffic Management

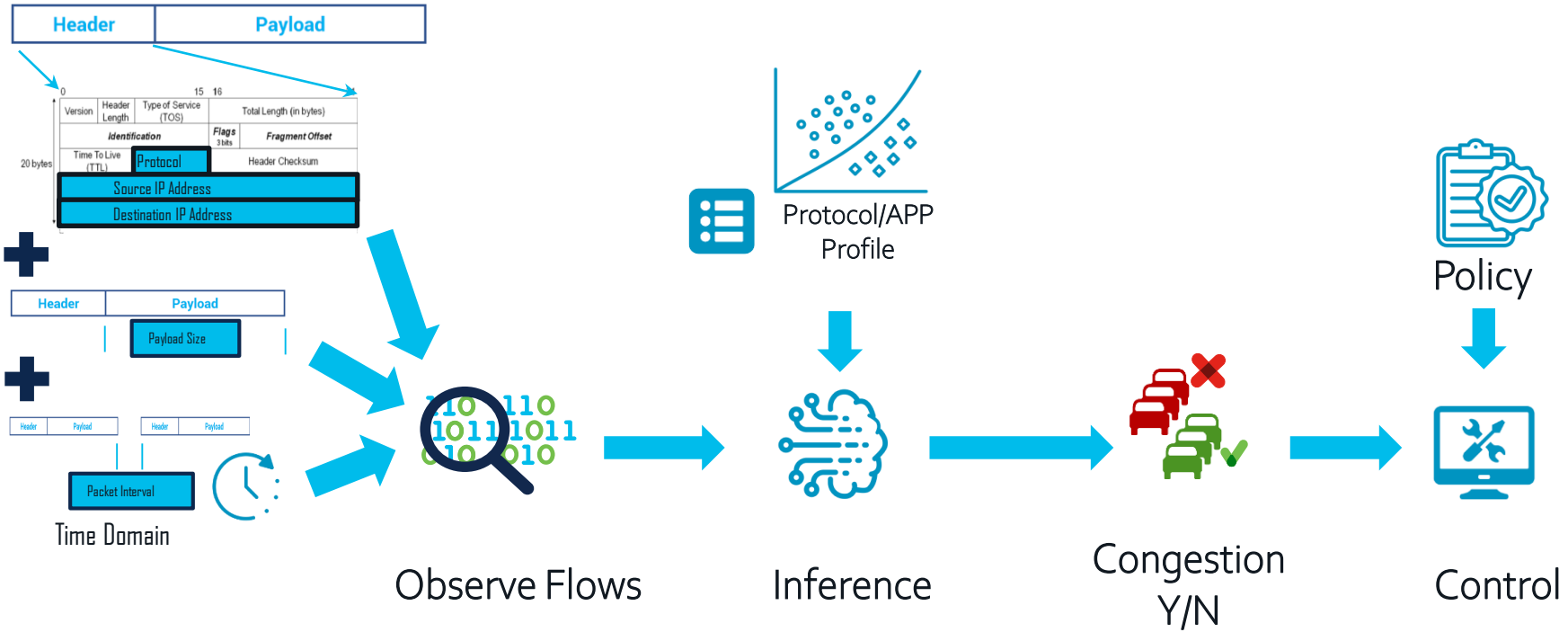
- Traffic can be controlled in various ways.
  - Buffer
  - Discard
  - Flow control
  - …
- e.g. CUTO(*) is a pre-compiled example where the parameters are implicitly configured



* CUTO: Cisco Ultra Traffic Optimization

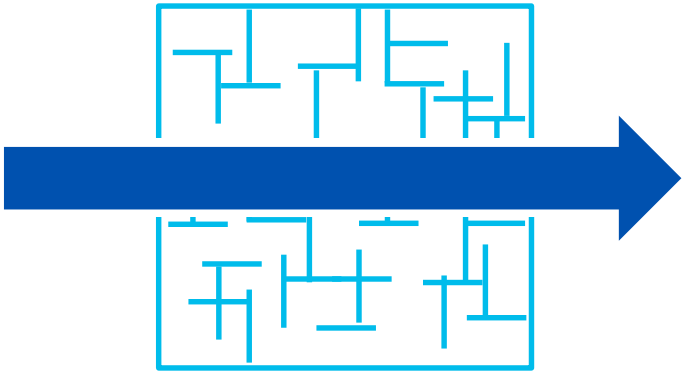
Overall System Logic

Basis for building use cases



Why does this scale?

Simple



- I only use state on the important/interesting stuff
  - 20% of the flows generate 80% of the volume

Smart

- I only use state if I need it
  - when there is a reason e.g. congestion

Summary

- Traffic is encrypted, application controlled, and obfuscated
- Traditional DPI approaches (w)(d)on't work
- This evolution will affect Service Provider consumer offering policy
- An IP centric approach is feasible and addresses several use cases

cisco The bridge to possible

Thank you