

A photograph of a living room with a brick wall. A large Samsung TV is mounted on the wall, displaying a presentation slide. In the foreground, the backs of two people's heads are visible as they watch the TV. The room is dimly lit, with a warm glow from the TV and a small lamp on the left. A wooden shelf below the TV holds various electronic devices, including a black subwoofer and a red speaker. A small framed picture hangs on the wall to the left of the TV.

Streaming With Open Caching on the ISP Edge

NANOG 89
Jeff Budney
October 2023

Agenda

- Introduction
- Streaming Media Trends
- Verizon Interconnect Background
- Streaming Video Technology Alliance
- How Does Open Caching Work?
- Open Caching at Verizon
- Performance Comparison

Legal Disclaimer/Safe Harbor

NOTE: In this presentation we have made forward-looking statements. These statements are based on our estimates and assumptions and are subject to risks and uncertainties. Forward-looking statements include the information concerning our possible or assumed future results of operations. Forward looking statements also include those preceded or followed by the words “anticipates,” “believes,” “estimates,” “expects,” “forecasts,” “hopes,” “plans” or similar expressions. For those statements, we claim the protection of the safe harbor for forward-looking statements contained in the Private Securities Litigation Reform Act of 1995. We undertake no obligation to revise or publicly release the results of any revision to these forward-looking statements, except as required by law. Given these risks and uncertainties, readers are cautioned not to place undue reliance on such forward-looking statements. Furthermore, the this presentation shall not represent any guarantee or commitment of level of service for any Verizon product or service.

Introduction



Jeff Budney

- Senior Manager, Network Planning
- Peering Manager:
AS 701, 702, 703, 2828, 14551
- Board Member:
Streaming Video Technology Alliance
- NANOG Scholarship Committee
- First NANOG presentation

Introduction

verizonThe Verizon logo consists of the word "verizon" in a bold, black, sans-serif font. A red checkmark is positioned to the right of the letter "n", partially overlapping it.

- 8.5M broadband connections (wireline and wireless)
- 143.2M Wireless retail connections
- 1M+ miles of global fiber
- Countries served 150+
- Fortune 500 customers served: 99 percent
- Three major U.S. Government contracts in past year

Streaming Media Trends

The Consumer - “Cutting the Cord”

- Nielsen Insights [“The Gauge”](#)
 - Streaming surpassed Cable for preferred format in 2022
 - Streaming 38.7%, Cable 29.6%, Broadcast 20%, Other 11.6%
- Omdia’s [Media & Technology Digest](#)
 - OTT subscriptions grew 67m in 2022 to 437 million (7x pay TV)
 - 615M streaming subscriptions by end of 2028 (10x pay TV)

Trend is towards “Streaming first” content sources

Streaming Media Trends

The Content Providers -Tech and Business Innovation

- Encryption
 - Since 2018 over half of Internet encrypted ([Sandvine](#))
 - IETF QUIC published May 2021 and adopted beyond Google ([Sandvine](#))
- “Multi-CDN” strategies ([StreamTV](#))
 - Price / Performance
- Sports league exclusive broadcast rights to streamers

Streaming traffic is a moving target

https://www.sandvine.com/hubfs/Sandvine_Redesign_2019/Downloads/2018-phenomena-report.pdf

https://www.sandvine.com/hubfs/Sandvine_Redesign_2019/Downloads/2023/reports/Sandvine%20GIPR%202023.pdf

<https://www.streamtvinsider.com/tech/industry-voices-rayburn-pros-and-cons-deploying-a-diy-or-outsourced-multi-cdn-solution>

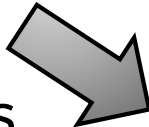
Verizon Interconnect Background

- AS701 North America
 - FiOS, DSL, Enterprise
 - <https://www.peeringdb.com/net/140>
- Verizon Wireless
 - Behind AS 701
 - AS 6167, 22394
- Direct Interconnect to ~15 “Major content networks”
 - Vast majority of capacity
 - 14+ Metro areas

Verizon Interconnect Background

- Video dominates Internet traffic
- Four of [Sandvine's](#) top 10 applications surpass 77% downstream bandwidth
 - Largely repeated content by volume
- Constantly reacting to content shifts
 - [Kentik](#) reported TNF on five different CDNs plus embedded caches
 - Sports leagues rotate media partners annually for big games

POV: You play
whac-a-mole
at work



Application (Rank)	
Video (1)	65.93%
Gaming (3)	5.58%
Social Networking (4)	5.26%
Audio (10)	0.95%

Streaming Video Tech. Alliance

A global technical association focused on solving key challenges in delivering high-quality video at scale

- Neutral forum
- Education
- Collaboration
- Technical documents
- Software code



Visit svta.org for more

Streaming Video Tech. Alliance



Streaming Video Tech. Alliance

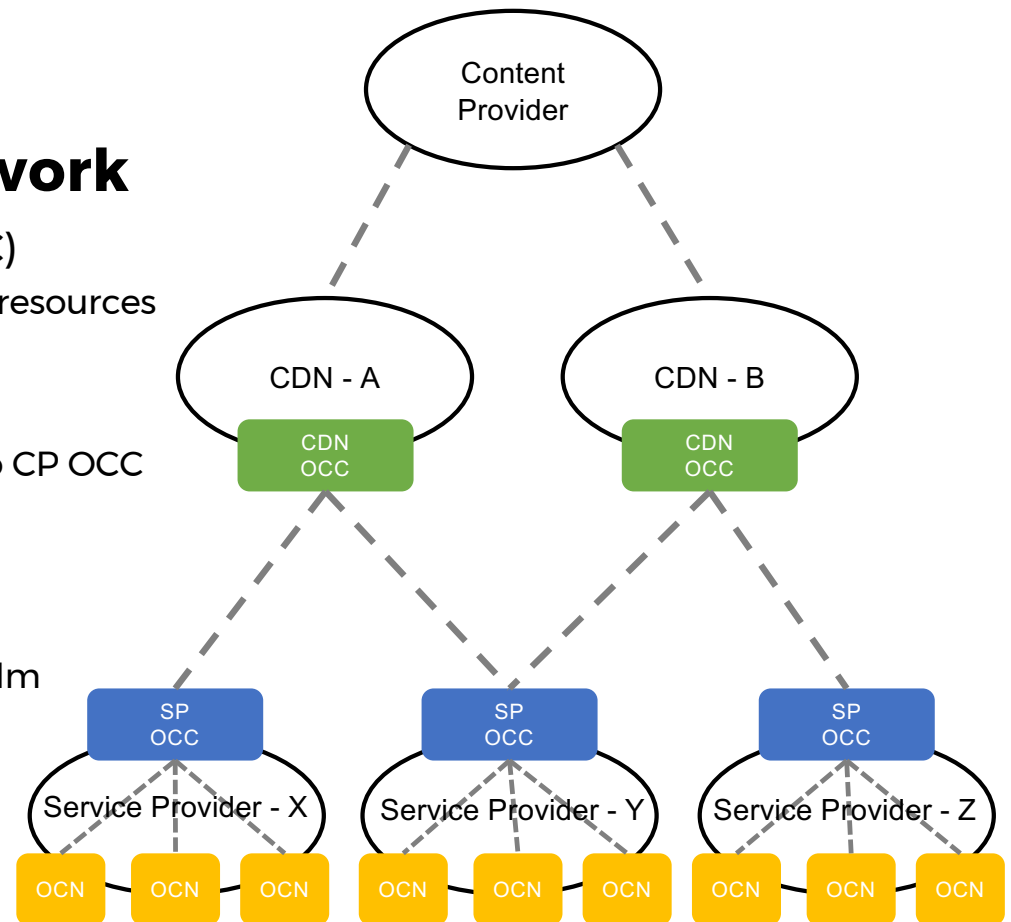
What is Open Caching?

- Working Group formed to address the efficiency of large scale video streaming
- Cache content inside the ISP on a shared server
- Cooperation of Content Provider (CP), Content Delivery Network (CDN) and Service Provider (SP)
- Ten functional requirement and specification published at opencaching.svta.org

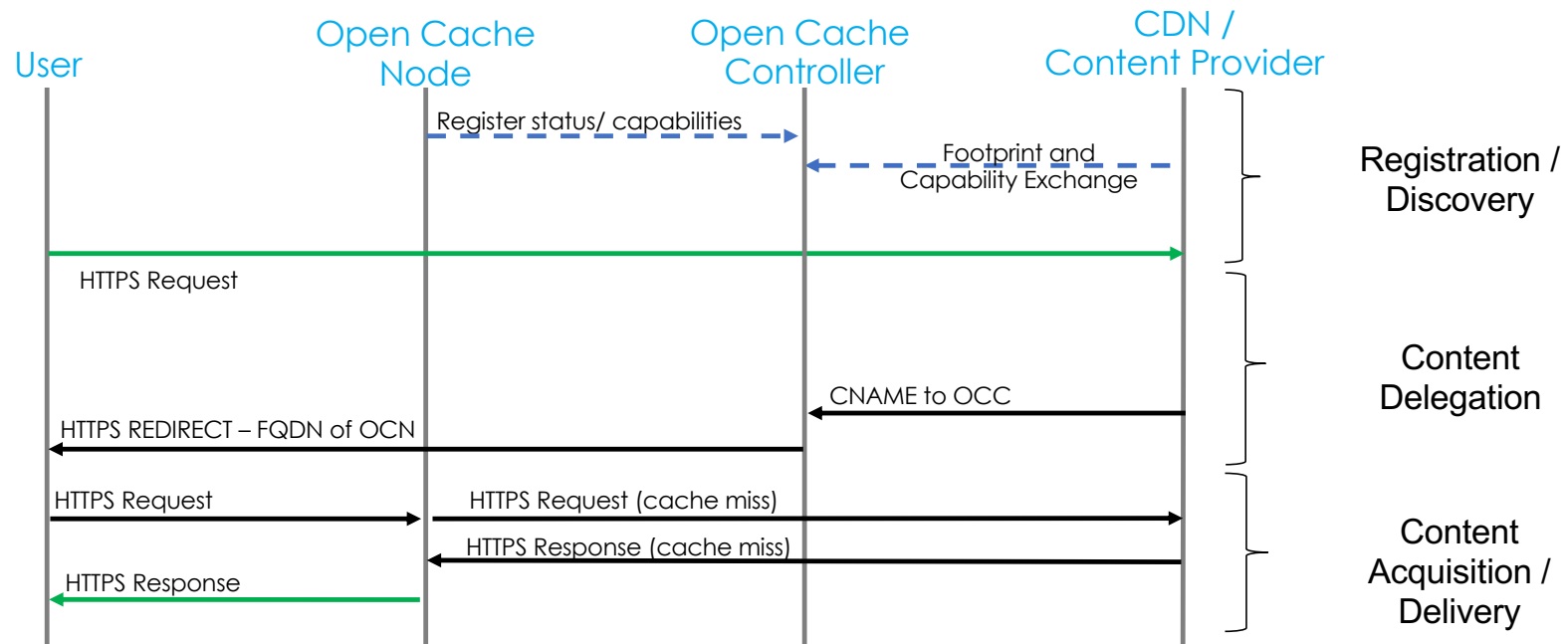
Open Caching

SVTA Open Caching Framework

- CP/CDN Open Cache Controller (OCC)
 - Used to delegate delivery to Open Cache resources
 - Communicate with multiple SP OCC
- SP Open Cache Controller (SP OCC)
 - Footprint and capability advertisement to CP OCC
 - Subscriber mapping to OCNs
- Open Caching Node (OCN)
 - A universal multi-tenant cache device
 - Deliver content to users within the SP realm



Open Caching



Open Caching

Why Open Caching?

- Large Service Provider (SP)
 - Efficiency / Reduce backbone traffic
 - Avoid space/power constraints of multiple proprietary caches
 - New revenue source
- Small / Medium Service Provider
 - Efficiency / Reduce Internet transit costs
 - New revenue source
- Content Provider (CP) / Content Delivery Network (CDN)
 - Extended delivery reach and management
 - Improved QOE

Open Caching

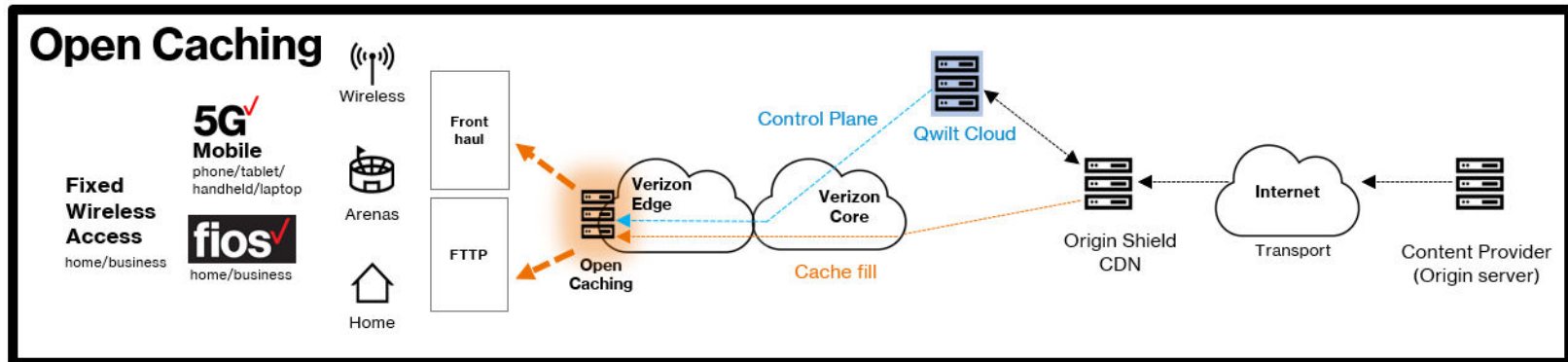
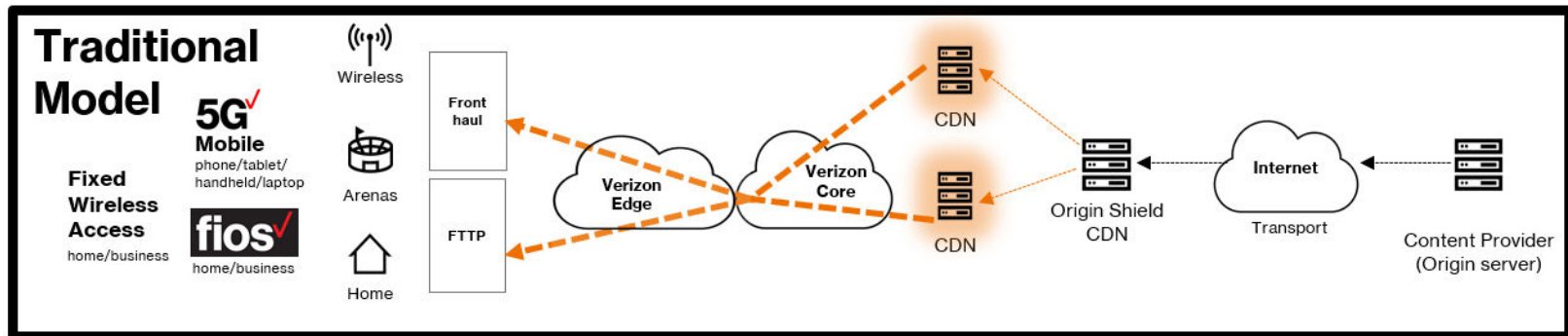
Relevant Specifications

- SVTA Open Caching Working Group
 - **SVTA2000** [Solution Functional Requirements](#)
 - **SVTA2007** [Request Routing Functional Specification](#)
 - **SVTA2008** [Content Management Operations Specification](#)
- IETF / CDNi
 - **RFC 8804** [CDNI Request Routing Extensions](#)
 - **RFC 9388** [CDNI Footprint Types](#)

Open Caching at Verizon

- Nodes located within Wireless and Wired Networks
 - Broadband Network Gateway locations
 - Wireless aggregation points
 - Virtualized compute platforms
 - Edge locations
- Usage
 - Video on demand
 - Live events
 - Large downloads

Open Caching at Verizon



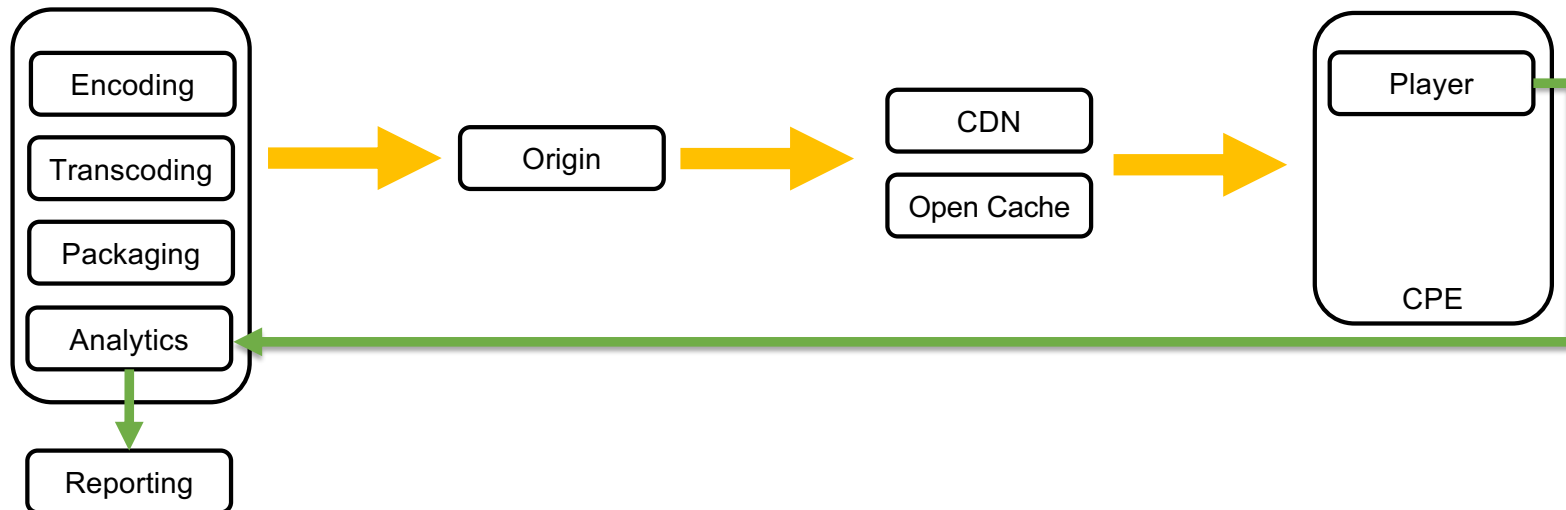
Performance Comparison

Internal Use Case for Open Caching

- In-House video service with live and on-demand
- Real customers
- Live network
- Allows end-to-end visibility for performance

**Content Provider has
the best perf visibility**

Performance Comparison



- Video workflow with CDN or Open Cache delivery
- Video statistics are fed from player in feedback loop

Performance Comparison



- **Buffering Ratio** - Percentage of time a viewer must wait for the video to resume playing (Seconds spent with spinning wheel / total play time)
- **Video Start Failures** - Percentage of client requests that are unsuccessful versus total playback requests
- **Play Failures After Video Start** - Measurement of video plays terminated due to a playback error after starting other than client hitting the stop button or an "end of stream" which comes at the end of a video on demand
- **Exit Before Video start** - Measures the requests for content terminated by the user before the video started by requesting for a second content before the first one played
- **HD Performance** - Percentage of playback using either of the two highest video resolutions

Performance Comparison

Performance Metric	CDN (%)	Open Caching (%)	Improvement (%)
Buffering	0.21	0.10	54%
Video start failures	0.70	0.26	63%
Play failures after video start	0.27	0.14	48%
Exit before video start	0.68	0.04	94%
HD performance (average)	93.13	99.32	7%

Verizon video application client-side metrics with and without Open Caching

Conclusion

- OTT video growth demands new network architecture
- Open Caching benefits ISP, CP, CDN and user
- Real world, demonstrated performance
- How to learn more
 - Open specifications and RFCs
 - Participate in SVTA

**Additional Case Study:
SMPTE Motion Imaging Journal**

**Open Caching: An Innovative Way for
Content Providers to Serve Customers**
<https://ieeexplore.ieee.org/document/10058720>