



OpenCache

A Platform for Efficient Video
Delivery

Matthew Broadbent

1st Year PhD Student

School of **Computing**
and **Communications**

Motivation

- Consumption of video content on the Internet is constantly expanding
- Video-on-demand is an ever greater proportion of this traffic
- In the main, video-on-demand is distributed through use of unicast flows
- Currently:
 - A client requests a video
 - This content is delivered through the operator's network
 - After a period of time, a second user requests the same content
 - This (identical) content is again delivered through the operator's network
- We can avoid this inefficiency by caching the content inside the operators network
- OFELIA: 2nd Call

- A SDN technology which separates the control plane from the data plane in switching hardware
- Places this control with a software *controller*
- Using a *controller*, an experimenter can define network behaviour
- In the case of OpenCache, we use this to transparently redirect requests for content to a local cache
- We also exploit other features in OpenFlow to further enhance the OpenCache platform (see later)

mpeg-DASH

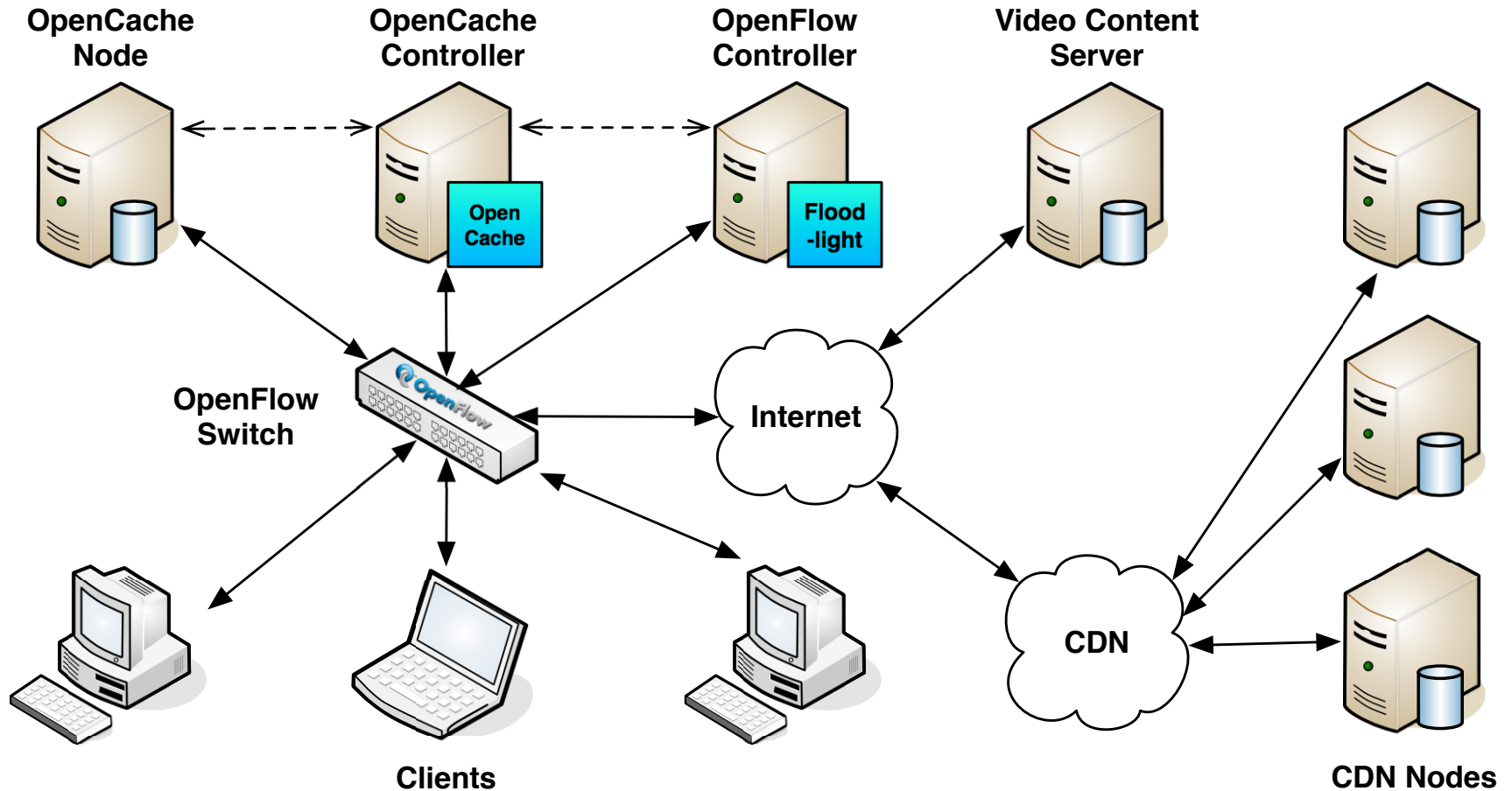
Five small blue squares arranged horizontally below the "mpeg-DASH" text.

- OpenCache is centered around the delivery of Video-on-Demand video
- We have chosen MPEG-DASH *initially*: a relatively new standard for chunked based media delivery over HTTP
- Allows the switching of bit-rates during playback
- Videos are stored in different quality levels
- Content is chunked into fixed length segments
- Changing quality is as simple as requesting a different bitrate chunk
- A number of other commercial alternatives exist: we plan to work with these too

OpenCache

- OpenCache is a caching platform design from the ground up to accommodate local delivery of Video-on-Demand content
- It's primary aim is to reduce external link load and minimise latency for the delivery of content
- OpenCache is open technology designed primarily for large campus networks, smaller ISPs and networks in developing countries where bandwidth is limited or prohibitively priced – networks that CDNs would otherwise not deploy into
- It works alongside existing infrastructure
- Transparent to a client session, requiring no additional software for a user to install
- Highly configurable and controllable through a centralised mechanism, or *controller*

Design



Prototype

- Define cacheable content within *OpenCache controller*
- When requested, *OpenCache node* fetches and delivers content from the origin server in the first instance
- For subsequent requests, delivers content from the cache
- Utilises a small scale development testbed established at Lancaster:
 - 2 identical clients with DASH playback abilities: GPAC MP4Player
 - An OpenFlow switch
 - An OpenFlow controller
 - An OpenCache node
 - An OpenCache controller
 - External connectivity to clients



Evaluation

- We did a simple evaluation to prove it was technically feasible to achieve caching functionality with OpenFlow and OpenCache
- Monitored external link usage as well as client behaviour
- We used a number of existing resources in the D-DASH dataset: geographically distributed DASH content in Europe
- Not only did this allow us to demonstrate the potential benefits when compared to OpenCache, it highlights the variability in server response times out of our control

Results*

	D-DASH Distributed Dataset			OpenCache
	1	2	3	
Load Time	5.4s	5.9s	6.0s	4.2s
Packets	800.5p/s	414.5p/s	847p/s	0.2p/s
Bytes	954.7kb/s	463.8kb/s	864.4kb/s	0.2kb/s

#	Location	URL
1	Telecom ParisTech, France	http://download.tsi.telecom-paristech.fr/gpac/dataset/dash/mmsys13/
2	Czech Technical University, Czech Republic	http://dbq.multimediatech.cz/mmsys13/
3	TNO Netherlands, Netherlands	http://ddash.tnomedialab.nl/dash/datasets/mmsys13/

*averaged over 10 experimental runs per dataset

Future Features

- We have shown it is *technically* possible
- But this is not the most interesting bit!
- By using OpenFlow and concentrating on MPEG-DASH, we have identified a number of additional features that fully utilise the underlying technologies

These are outlined in the next few slides

Network Awareness

- The OpenFlow specification mandates that OpenFlow-enabled switches store a number of *counters*
- These include flow and port specific metrics
- We can periodically retrieve these to get a picture of network-wide health and conditions
- We can feed these back into caching strategies, node locations and cache selection policies
- OpenCache can make informed decisions as to when particular actions should take place

Inter-cache Communication

- We want to move away from the traditional ICP protocol used by traditional proxies, such as Squid
- We propose a hierarchical cache control mechanism, ultimately controlled by an *OpenCache controller*
- This architecture is inspired by the design of OpenFlow
- Through a centralised control location, we can tightly control the behaviour of cache instances
- This includes:
 - The specific content stored on caches
 - Intelligently sharing content between caches

Load Balancing

- Such a control platform enables us to combine network health and cache load to effectively balance traffic between caches
- We have fine grained control as to where a flow is directed to and serviced from – a client does not have to be served from their nearest cache
- This caters for a number of circumstances, including:
 - General congestion within a network
 - Unexpected demand for a particular piece of content

Quality Awareness

- As mentioned previously, OpenCache is designed around HTTP Adaptive Streaming technologies
- This presents us with a number of interesting possibilities!
- One of the elements of these technologies is their reliance on a manifest file that describes the chunks that constitute an entire video
- Using this information, we can dynamically shift the playback quality of a user to meet the internal network conditions
- This is particularly relevant as we can deliver a video that is of *higher quality* than what they would otherwise receive if they were limited by an external link

External Interface

- OpenCache does not attempt to *replace* CDNs, but work alongside them
- We propose a new paradigm:
 - Collaboration between CDNs , content creators and network operators
 - An interface to influence cache content and behaviour, without having to fully understand the underlying network topology
 - Content creators have a unique insight into the their own catalogues and have a better understanding of what will be popular ahead of time
 - Monetisation opportunities for network operators

Pre-caching

- With the knowledge gathered from a number of third-parties, we could seed caches with content that is not yet publically available
- In anticipation of it's release to the general public
- Particularly pertinent if a one of the parties knows that content is likely to be highly requested: think Olympics!

Evaluation

- Lancaster has recently deployed ~42 OpenFlow Switches in the School of Computing and Communications*
- Existing IPTV delivery platform available to ~6000 students
- Experimental MPEG-DASH player available soon to students
 - based on DASH-JS



*<http://www.scc.lancs.ac.uk/research/sdn/loft.html>

Thanks for listening!

Questions?

m.broadbent@lancaster.ac.uk