

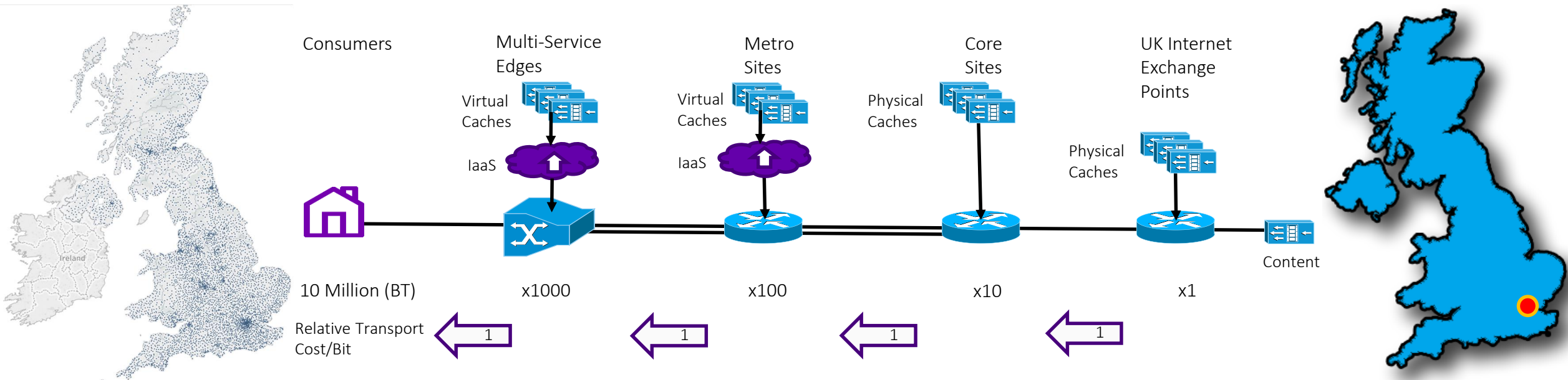
Virtual CDN Implementation

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What is BT's Virtual CDN Concept

1. A Content Delivery Network (CDN) is a set of servers specifically designed for optimizing the storage and delivery of content (e.g., web, audio-visual live or on-demand content, large files, etc.). CDNs can be deployed over a single or multiple networks.*
2. BT has network cache appliances from a range of CDN and OTT Video providers.
3. BT's vCDN provides Infrastructure as a Service at the edge of BT's UK network for CDN Operators.
4. The vCDN IaaS hardware may be standard commodity servers but the commercial and operational models will be optimised for CDN Operators.
5. vCDN is NOT transparent caching run by a network operator nor will it compete with any existing CDN operators.



Lab Testing

- **KVM Hypervisor running three independent virtual caches**
- **Virtual networks presented to the vCaches using SR-IOV**
- **Spirent Avalanche tester used to simulate client requests to the vCaches**

System: CentOS Linux release 7.2.1511 (Core)

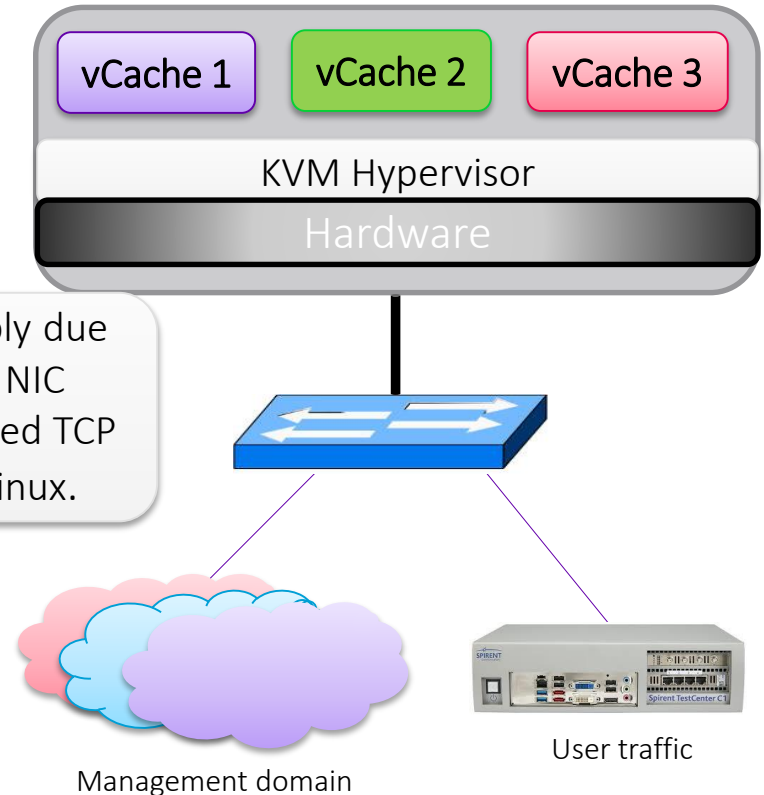
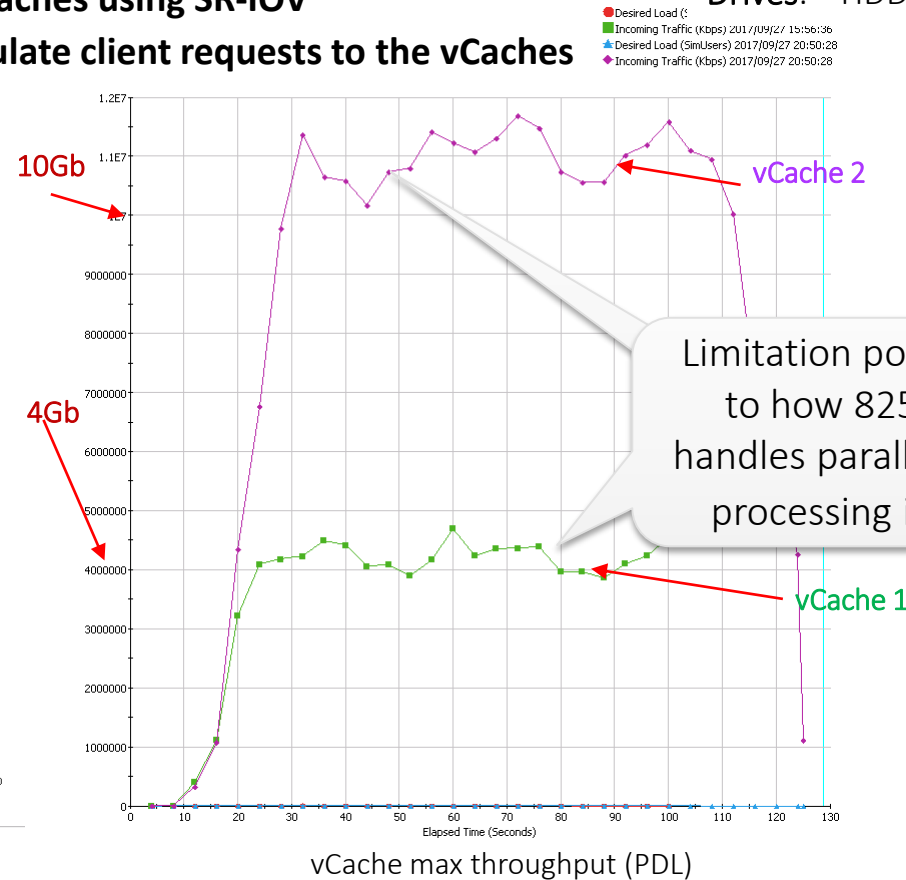
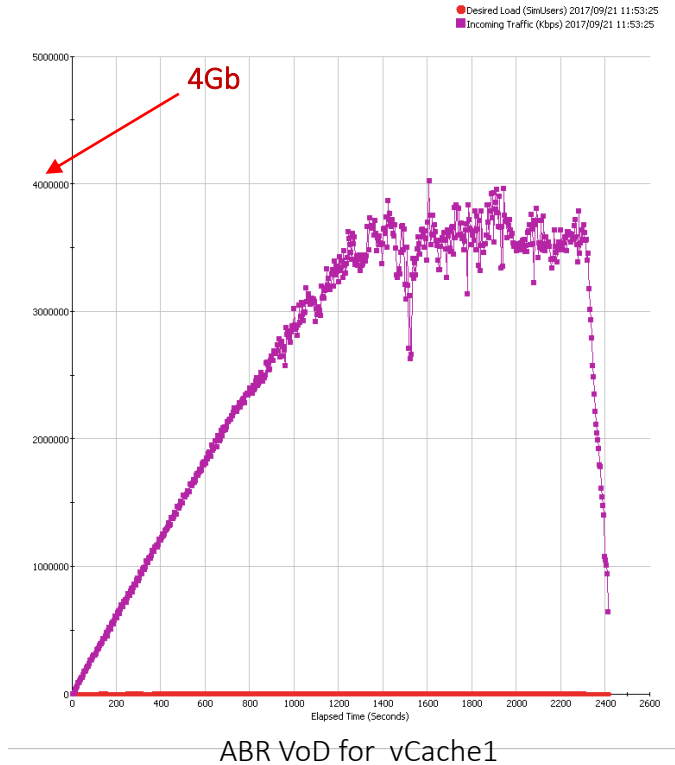
Machine: ProLiant DL360 Gen9

CPU: Octa core Intel Xeon E5-2630 v3 cache: 20480 KB @ 2.40GHz

Memory: 64GB RAM

Network Cards: X Intel 82599ES 10-Gigabit SFI/SFP+ Network Connection

Drives: HDD Total Size: 1600.3GB



- ~3.5 and 10 G steady-state network throughput from vCache 1 and 2 respectively. Gradual ramp-up simultaneous users making HTTP GET requests
- PDL files size “large” MP4 of ~1.8G. Only required relatively low number of simultaneous users to max the bandwidth. Recorded at elapsed time = 130secs

Challenges

1. Performance & Efficiency – Sufficient to make the business case work.

- a) Need not be as efficient as a specific CDN operator's current implementation due to the benefits of aggregation.
- b) High level of distribution reduces need for very high performance e.g. 100Gbps per node, 10 Gbps per server or node might be sufficient.

2. Business case – see next slide.

3. CDN operators' Load balancing/distribution mechanisms may need modification.

4. Orchestration

- a. Multi-tenancy
- b. Integration with CDN operators orchestrators (vCDN IaaS)
- c. And BT providing an orchestrator (vCDN PaaS) to those CDN operators without their own
- d. Scale (~1000 distributed nodes for UK)

5. Security

6. Commercial motivation – CDN operators may prefer their own hardware platforms and not perceive a benefit in using a third party's.

- a) Can we find a win/win/win/win scenario for Consumers, CDN operators, Content owners and network operators?

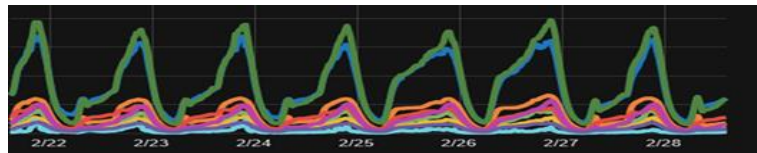
Required Performance of Business Case

The decision to deploy vCDN infrastructure can be made on a site by site basis and reviewed as traffic grows.

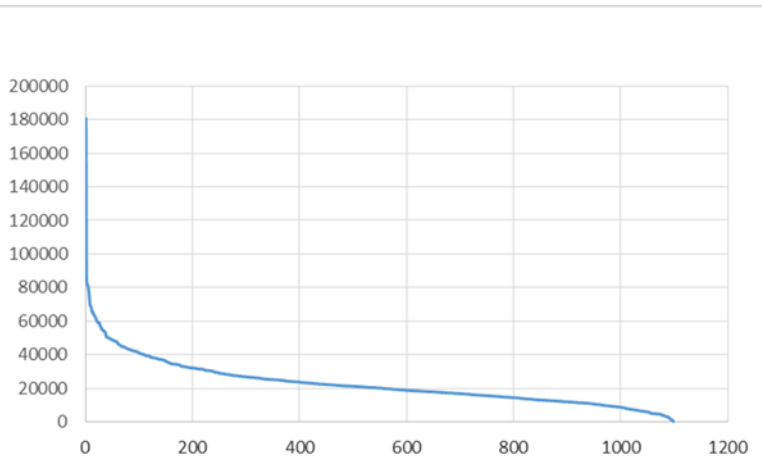
Given aggregate internet traffic is growing by ~50% PA then the business case for vCDN is positive when it costs less to deploy a vCDN at a site than upgrade its bandwidth (Return on Investment in < 1 year).

Need to take in to account 2 significant complexities:

1. All sites serve a different number of aggregate customers.
2. The fewer the customers a site serves the lower is the cache efficiency or hit ratio.



Traffic Volumes & Growth

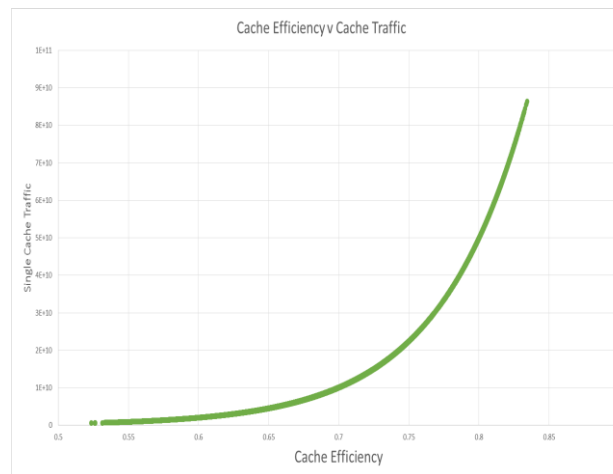


Number of customers per Multi-Service Edge

Transport Costs

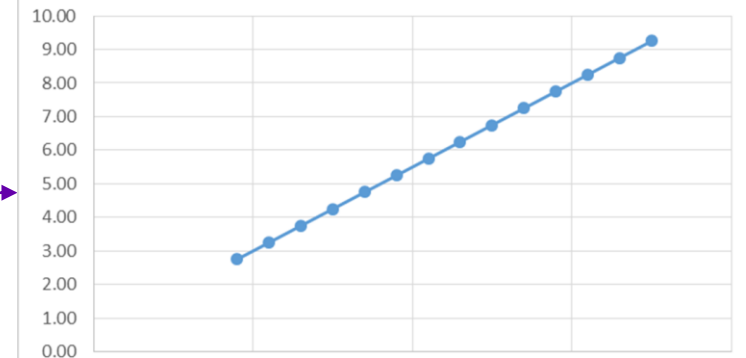
Compute Costs

Business Case



Worst Case Cache Efficiency Model

Gbps/server required v Cost of CDN Install



Initial results show cost & performance is sufficient for a positive business case if enough CDN operators use the vCDN edge infrastructure.

Orchestration Developments – sonata

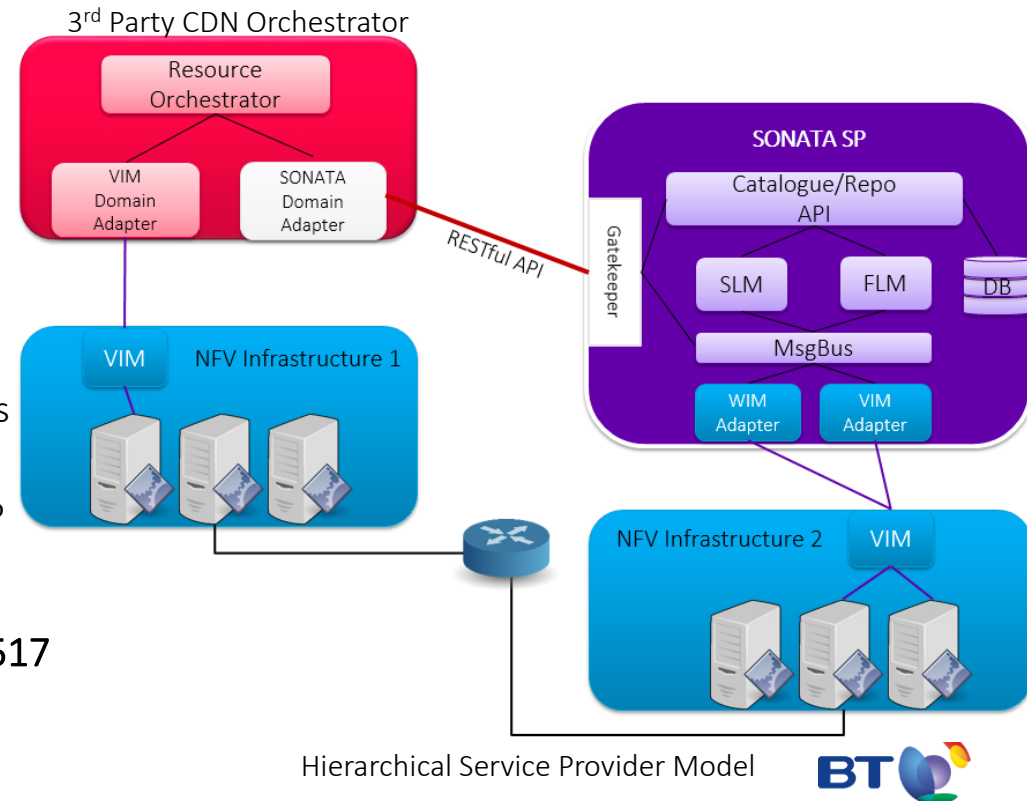
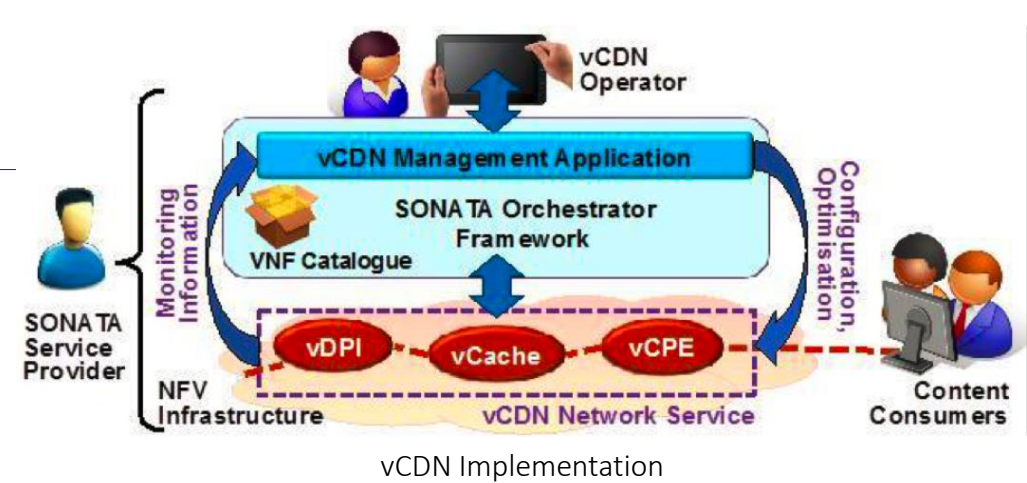
A Horizon 2020 ICT Collaborative Project which is focused on the development of:

1. SDK of tools to accelerate the development, testing and deployment of NFV-based services
2. An open source orchestrator platform that provides a flexible and extensible orchestration framework based on a plugin architecture.

For the vCDN use case SONATA is developing the use of:

1. **Function Specific Modules (FSMs) and Service Specific Modules (SSMs) for the configuration, service chaining, instantiation, monitoring and smart scaling of vCDNs.**
 - Can instantiate vCaches based on configurable parameters like load, latency, bandwidth demands, etc.
2. **Hierarchical (2 Service Provider) model for vCDN operator with own orchestrator.**
 - A hierarchical service provider framework that allows two (or more) Service Platforms to cooperate for rapid and dynamic service provisioning in a NFV environment.
 - Higher level orchestrators on different management domains can leverage Sonata HSP model to orchestrate vCaches on the “far” segment of the NFVi

Sonata Project ■ H2020 ■ Grant Agreement #671517
Call: H2020-ICT-2014/H2020-ICT-2014-2
■ Topic: ICT-14-2014



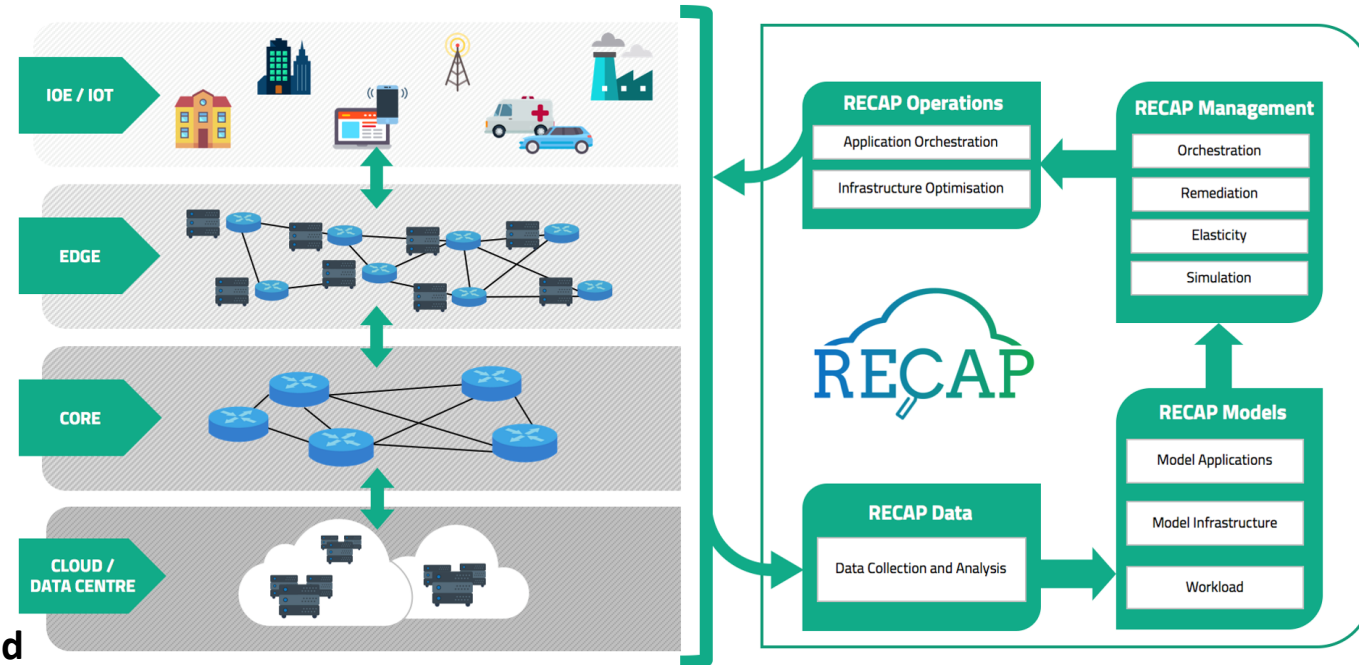
Application of Machine Learning – *Reliable Capacity Provisioning for Distributed Cloud Applications*

A Horizon 2020 ICT Collaborative Project using the:

1. Application of machine learning to the provisioning and remediation of distributed cloud/edge/fog/NFV computing.
2. Driven by simulation models created from network and application telemetry allowing prediction of application and network behavior in advance.

For the vCDN use case RECAP is developing the use of:

1. Auto-regressive workload analysis and classification techniques for characterization and prediction of workload behaviour.
2. Combinatorial and dynamic programming techniques for rapid optimization of the deployment and configuration of distributed edge cloud applications.
3. Dynamic cache placement and eviction strategies for adaptation to workload changes in virtualized CDNs.
4. Scheduling techniques for proactive autoscaling and adaptation of resource schedules to meet desired application quality of service.



RECAP Project ■ H2020 ■ Grant Agreement #732667
Call: H2020-ICT-2016-2017 ■ Topic: ICT-06-2016

Next Steps

- 1. Further testing to identify bottlenecks and fix e.g. replace 82599 NIC with 710.**
- 2. Refine the cache efficiency/hit model.**
- 3. Engage more CDN operators in the discussion.**
- 4. Need Industry collaboration to develop multi-tenant & hierarchical orchestration solutions.**
- 5. vCDN may be the business case that builds the infrastructure for Multi-access Edge Computing (MEC).**

Acknowledgements

1. BBC Research and Development
2. Lancaster University
3. Akamai
4. Sonata Project ■ H2020 ■ Grant Agreement #671517 Call: H2020-ICT-2014/H2020-ICT-2014-2 ■ Topic: ICT-14-2014
5. RECAP Project ■ H2020 ■ Grant Agreement #732667 Call: H2020-ICT-2016-2017 ■ Topic: ICT-06-2016



Further Reading

- ***Recent Advances and Perspectives on Content Delivery Networks:** <https://www.igi-global.com/chapter/recent-advances-and-perspectives-on-content-delivery-networks/131380>
- **SONATA NFV: Agile Service Development and Orchestration in 5G Virtualized Networks:** <http://sonata-nfv.eu/>
- **Reliable capacity provisioning and enhanced remediation for distributed cloud applications (RECAP):** <https://recap-project.eu/>



Thank you

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