

Networks for Cloud Computing



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Data Centre Networks for Cloud Computing

Multi-tenancy and Security

- Host multiple customers on single shared infrastructure
- Allow each customer to configure their own network topology to suit application needs
- Data and performance isolation between customers
- Allow controlled and efficient inter-communication between customers if required and permitted

Large scale

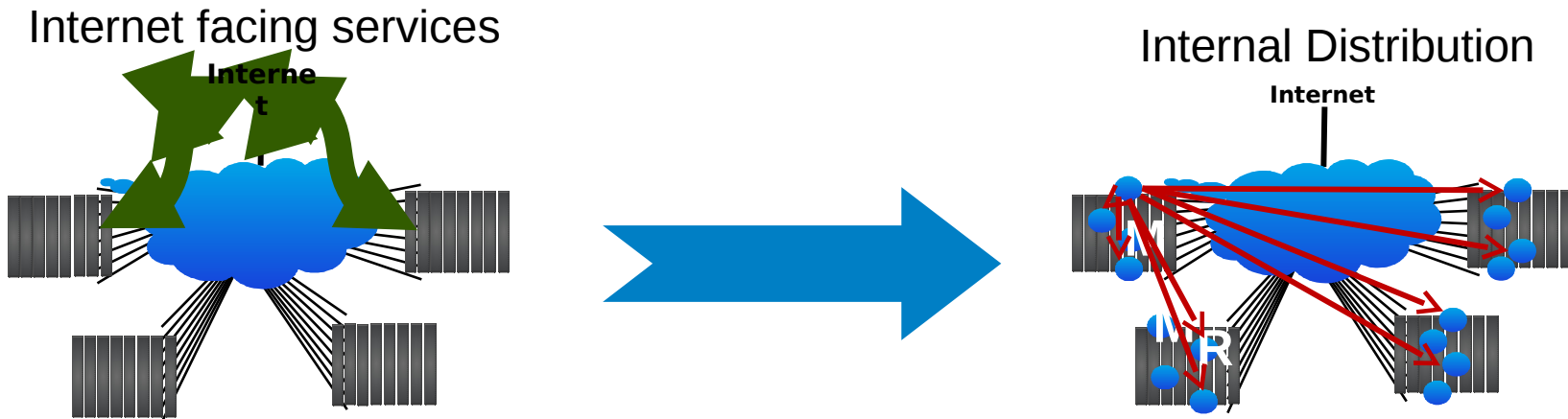
Automation

Flexibility

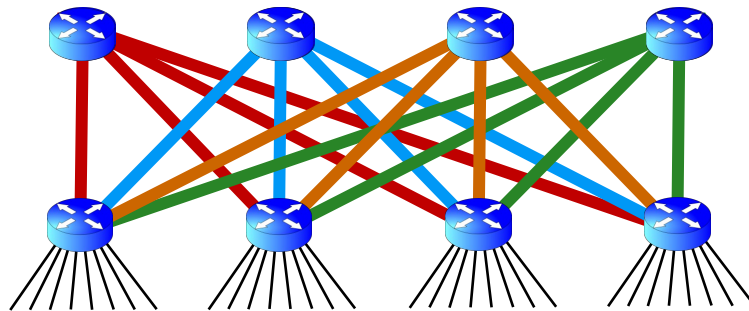
Performance



SPAIN: VLAN-based load management



High bisection BW
Flat network
Low-cost



Mudigonda et al, NSDI 2010



OpenFlow-based management

Support for cloud computing

Implemented OpenFlow for HP ProCurve

- Switch firmware patch
- ONE module controller

Load balancing traffic control protocols

Virtual network implementation based on OpenFlow



Diverter

Isolate customer resources into **Cells**

- Cell is a collection of virtual resources
- Cell has a single owner

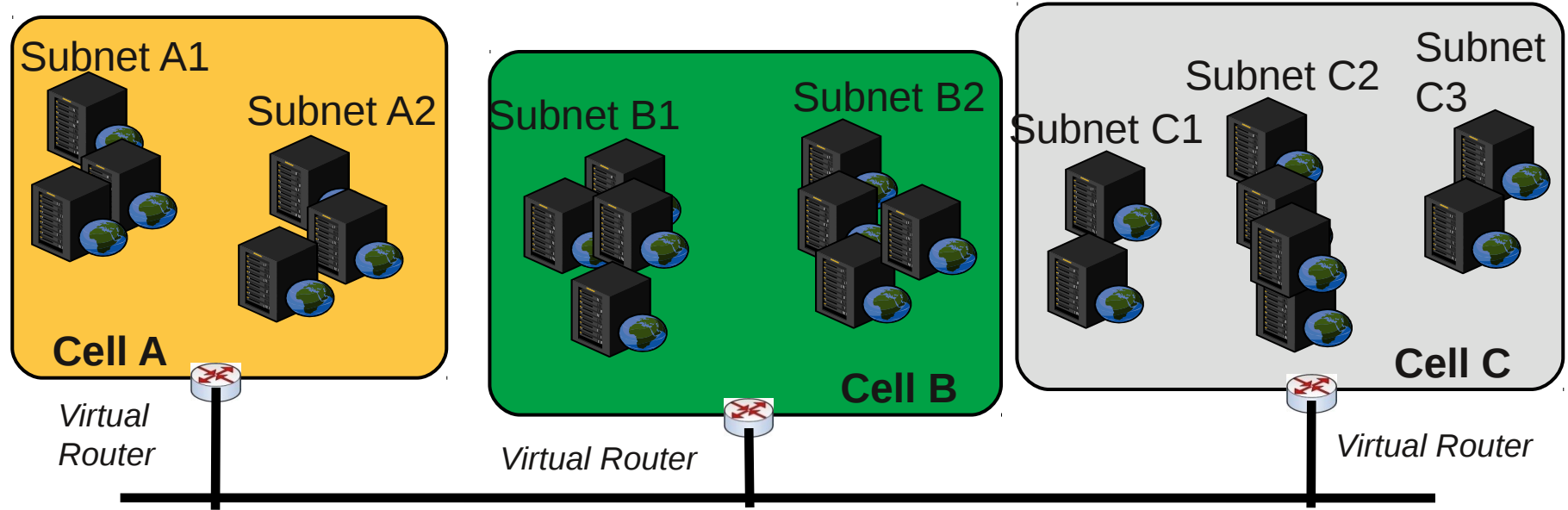
Each Cell can have its own virtual network topology

- Cells consist of several **Subnets**
- Cell owner can define network policies
- Security: define who can communicate with VMs
- QoS: define bandwidth limits for VMs

Edwards et al, WREN 2009



Diverter Virtual Network Topology



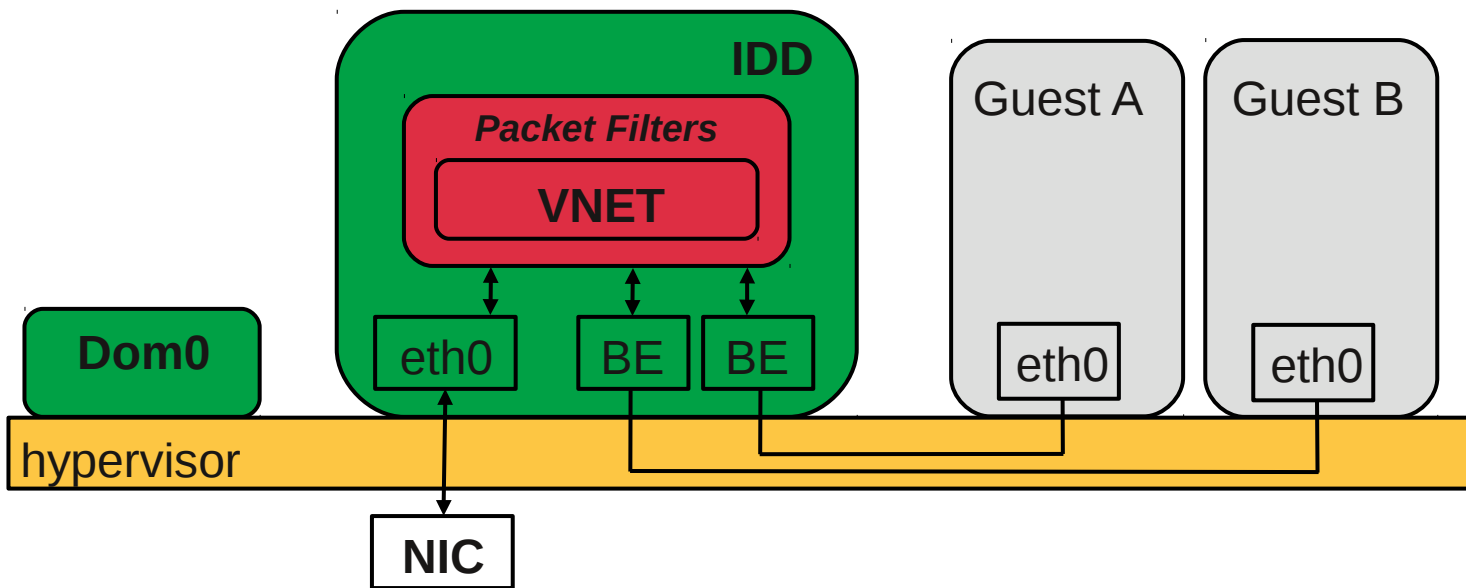
Globally managed virtual IP address space representing virtual network topologies



Diverter Virtualized Endpoint Architecture

Isolated Driver Domain

- Owns and controls physical hardware
- Intercepts packets from/to guests
- Enforces network policies (packet filtering + rate controlling)



Wide Area Networking for Cloud Computing

Transition to cloud model for infrastructure provisioning

- Multi-tenancy
- Automation
- Flexibility
- Performance
- Cost models

Take advantage of distribution



Current Situation from Network Perspective

Internet: a best effort bit pipe

Network-based VPNs are widespread technology in enterprise networks

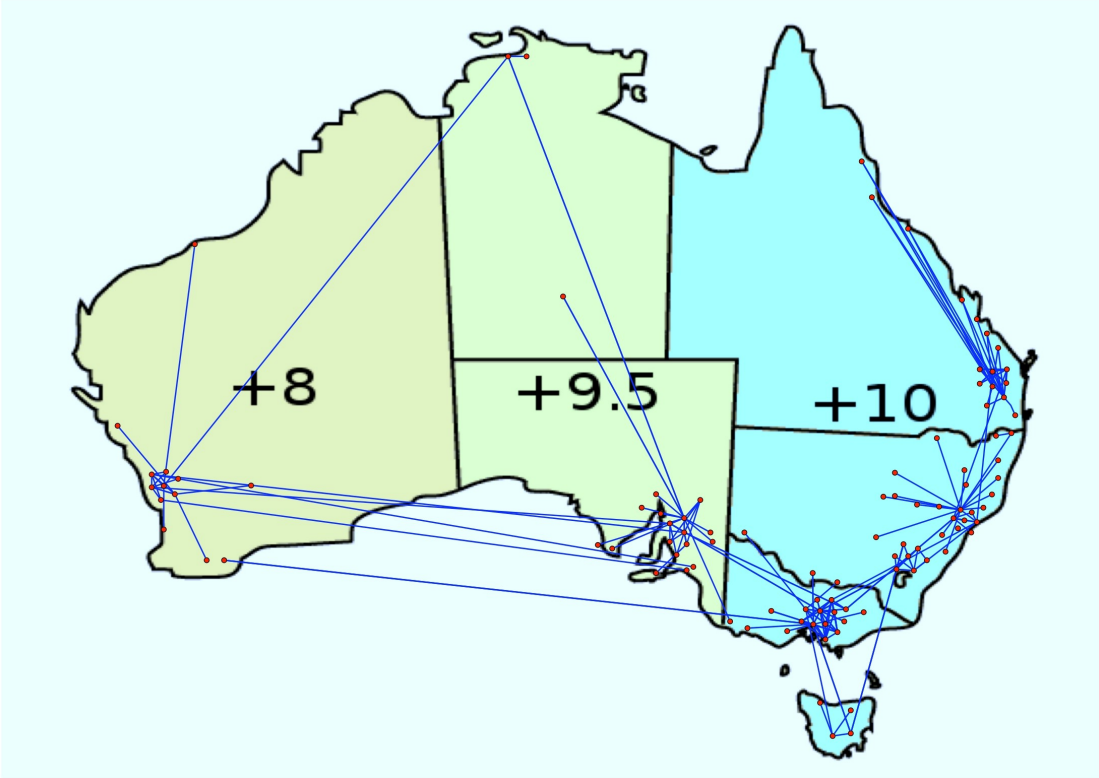
- Connectivity between geographically dispersed sites
- Outsource complexity of running the network to a service provider
- Offers operators the possibility to become more than just bit pipe providers
- VPNs will likely continue to be dominant in the foreseeable future

VPNs were not conceived to deal with dynamic properties of clouds

- Elasticity
- Reconfiguration
- Resource mobility
- On-demand allocation of resources



Telstra Australia Network

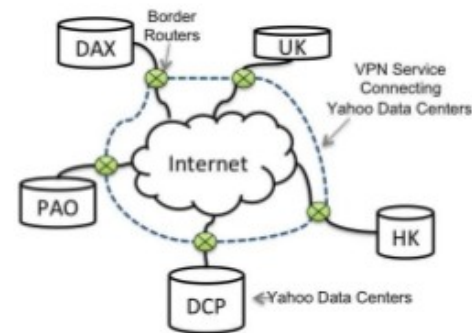
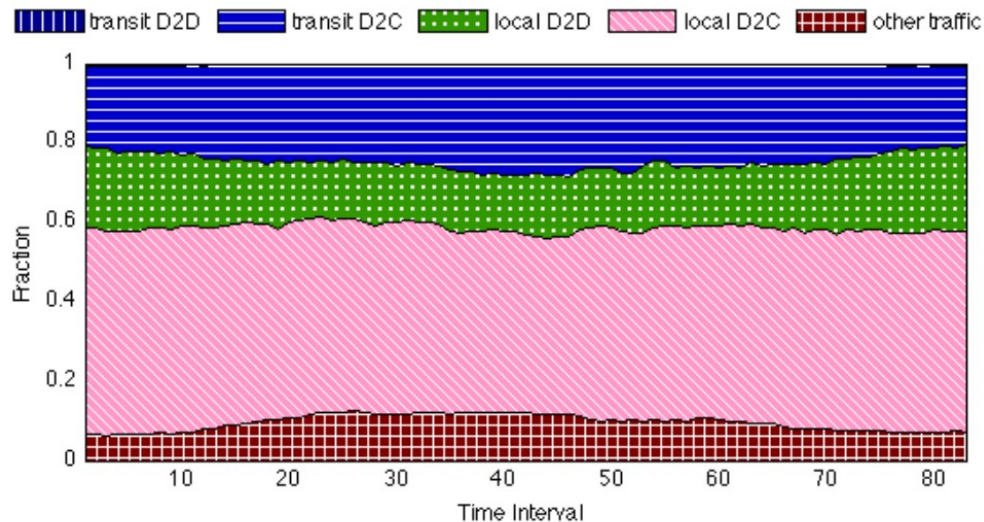


Anonymised NetFlow data in Yahoo!'s DCs

Connected via VPNs

Hierarchy of DCs (PAO, DAX, DCP are core DCs; UK, HK are satellite)

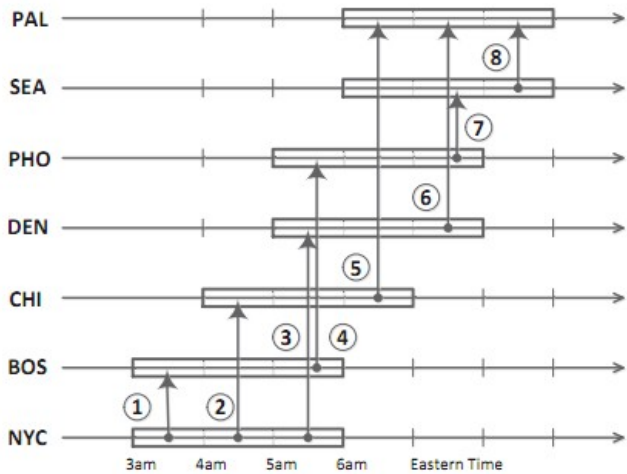
45% of the traffic spans a single DC



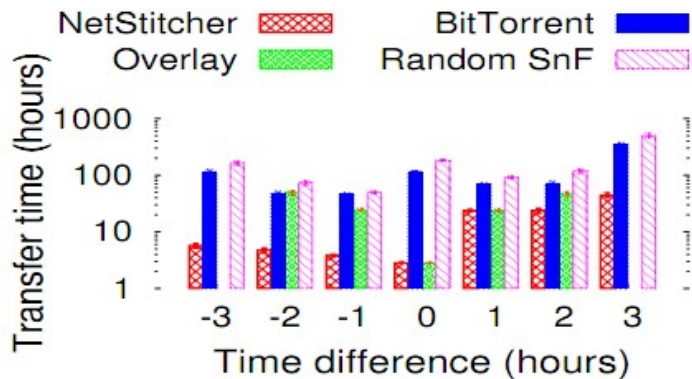
Large Data Movement

Maximize the backup volume from NY to Palo Alto, 3 hour window early in the morning (e.g. 3-6 am):

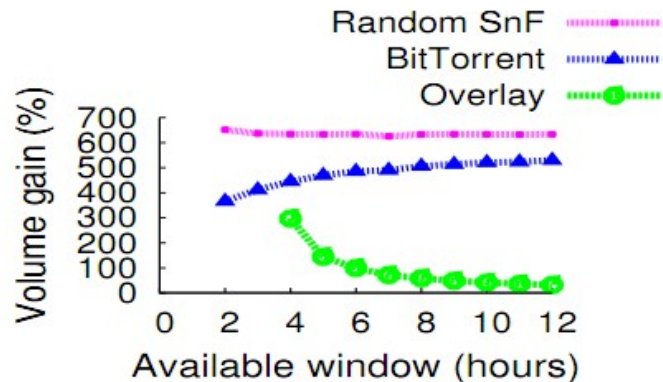
- *Stitching unutilized bandwidth across different datacenters*
- *Bypassing the problem of misaligned bandwidth*



Images from Laoutaris et al. SIGCOMM 2011



(a)



(b)



SAIL – Scalable Adaptive Internet Solutions

EU Call FP7-ICT-2009-5 Large-scale IP

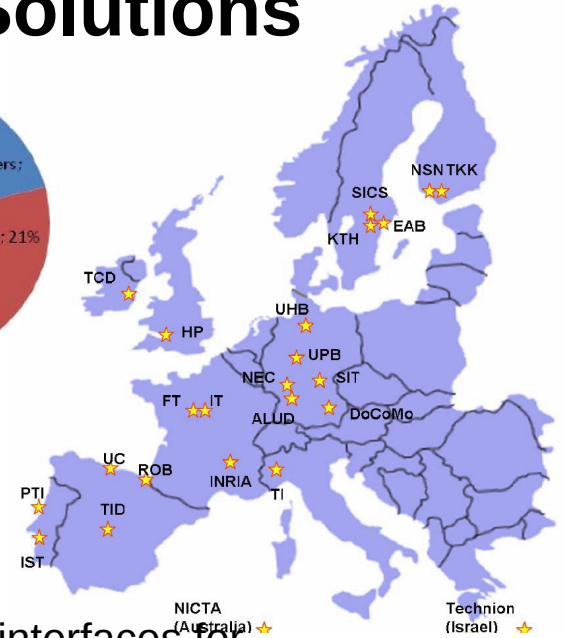
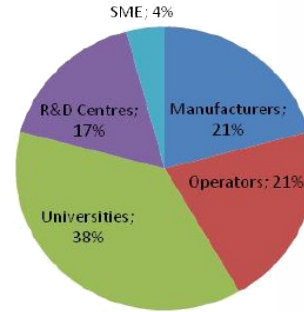
- Industry-led consortium of 24 partners
- Operators, vendors, and research institutes

SAIL's main objective

- Future network concepts and technologies

Technical objectives

- **Network of Information (NetInf)**: application support via an information-centric paradigm
- **Open Connectivity Services (OConS)**: signalling and control interfaces for heterogeneous media technologies
- **Cloud Networking (CloNe)**: integration of networking with cloud computing via NW virtualization and self-management



CloNe: Cloud Networking

Distribute computing and storage resources through the network

- Sometimes the data centers are too far away
- Maximize end-user experience
- Reduce the stress over the network

Provide *dynamic* connectivity services

- Dynamic provisioning of network services for specific tasks
- On-demand, pay-as-you-go
- Customer-cloud and datacenter-datacenter connectivity



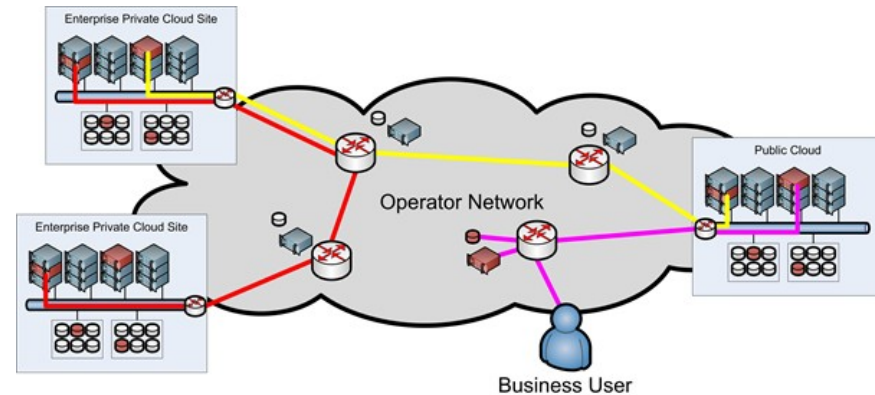
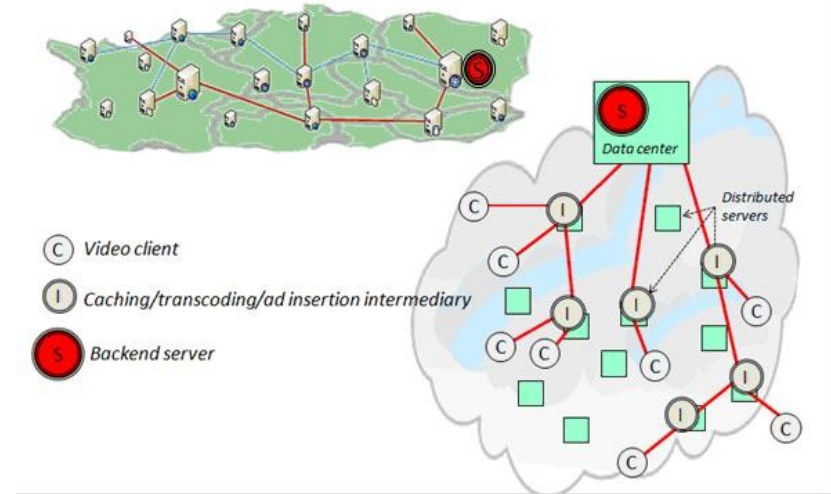
ClONE Use Cases

Elastic Video Distribution

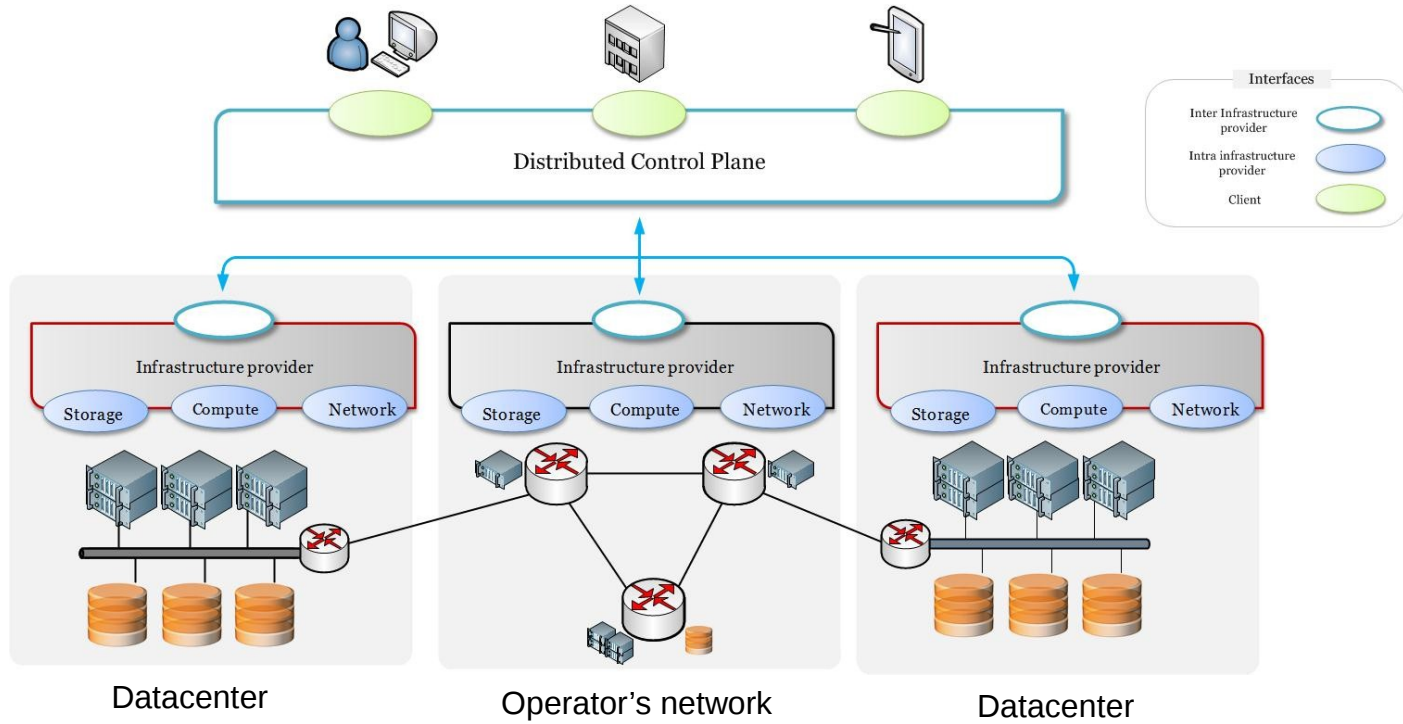
- Elastic live video distribution
- Elastic video on-demand distribution
- Distributed gaming
- Video conferencing

Dynamic Enterprise

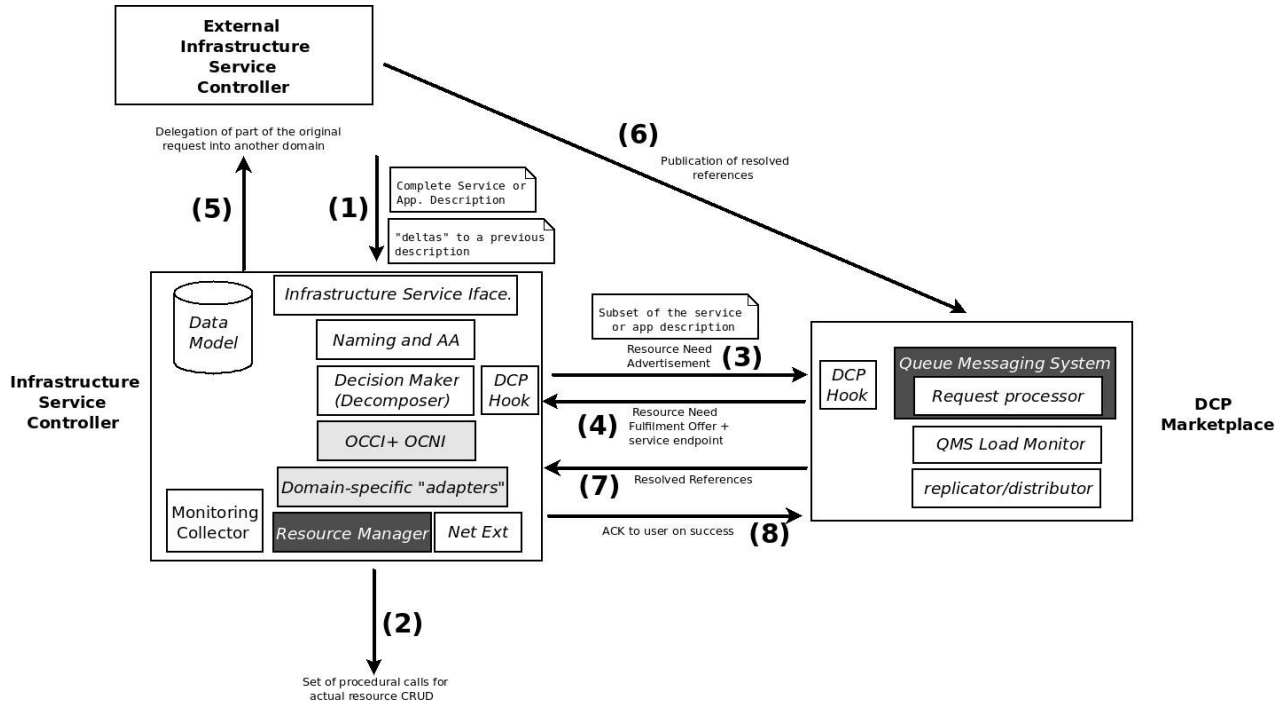
- Media production
- Remote auditing
- Business goal management
- Virtual desktop



CloNe High Level Architecture



Currently under development



NOTE: Steps 5-7 are optional and only apply when the local domain lacks enough resources. Darker colour indicate some commercial or research products already exist that could be used.



Thank you

