Combining Optics and SDN In next Generation data centre Networks:

The COSIGN Project

The research in future data centre technology is by no means only a matter of increased capacity. Future datacentres will play a more dominant role in next generation ICT infrastructure - supporting a much wider range of services and new types of service providers.

COSIGN is supporting this path within the area of datacentre networks (DCN) by providing flexible DCN solutions that enable much better scaling and utilization of resources.

COSIGN demonstrates new data plane technology that both scales to capacities far beyond state of the art and reduces the latency to a minimum - fully integrated with control plane solutions and orchestrations that make it possible to integrate the DCN resources with the computational, memory and storage resources for integrated administration and optimization.

COSIGN is a three-year research project with a budget of 10 million Euro, partly funded by the EU FP7 programme.

COSIGN has just passed the halfway mark, and the overall architecture is in place with scenarios for short-term, medium-term and long-term solutions.

Developing solutions that integrate disruptive hardware solutions for the DCN with software realization matching generic trends for control plane strategies and broader integration of different kinds of resources has been a major task – and the project is now ready to enter the phase of demonstrating the new ideas and solutions.

The project is challenging classical architectures and technologies by introducing advanced technologies for transmission and optical and electronic switching. Furthermore, control and orchestration mechanisms will be developed that will also work efficiently with existing data centre resources, including legacy installations.

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Partners

Danmarks Tekniske Universitet (DK)
Nextworks (IT)
Fundacio Privada i2CAT (ES)
Polatis Ltd (UK)
University of Bristol (UK)
Venture Photonics Ltd (UK)
Universitat Politecnica de Catalunya (ES)
University of Southampton (UK)
Technische Universiteit Eindhoven (NL)
Photonx Networks BV (NL)
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COSIGN Architecture

COSIGN aims to bring innovation to Data Centre Networks (DCNs) by designing a novel architecture, with the vision of moving away from present dayhighly hierarchical, vendor specific, manually controlled DC solutions towards flat, scalable, automatic and optimized DC infrastructures, thus overcoming their performance and scalability limitations.

Three **key industrial** use cases have been proposed:

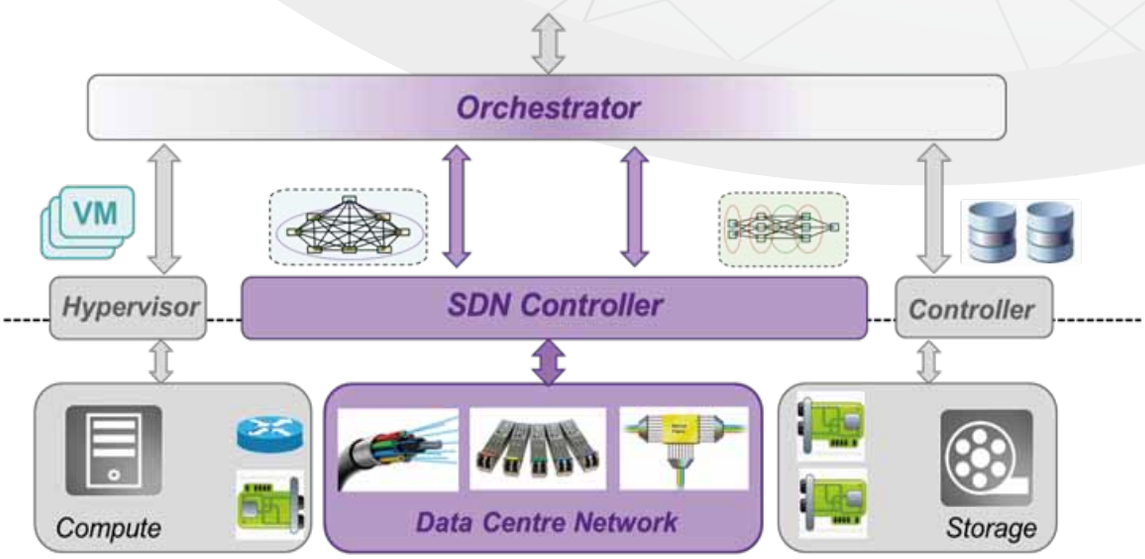
- Multi-Tenant Software Cloud.
- Virtual Data Centre (VDC) as advanced IaaS provisioning.
- Advanced Data Centre Infrastructure Orchestration and Management.

Two of these use cases will be outlined below.

From these use cases and an analysis of state-of-the-art **DCN architectures**, an extensive compilation of well-defined requirements for future DCNs has been established. As shown in the figure below, this has resulted in the design of a three-layered DCN architecture:

- The Data Plane layer, with novel features and optical technologies.
- The Control Plane layer, based on SDN technology and implementing network virtualization and resource optimization through multiple abstraction layers and a variety of cooperating functional control blocks.
- The Orchestration layer, designed to coordinate the underlying COSIGN layers with the application/server layer while computing data transfer paths and configuring data plane devices to enforce the computed paths.

This architecture design reshapes and enhances the building blocks, functionalities and interfaces of current DCN designs to overcome present barriers and challenges.



COSIGN Control Plane

The COSIGN Control Plane offers an open **SDN-based solution** for **multi-tenant** network virtualization and **dynamic** allocation of optical resources, with flexible and application-aware connections established ondemand over the multi-technology datacentre network.

The COSIGN control plane combines overlay-based **network virtualization** with a deep programmability of the optical network, integrating the required Quality of Service and connection recovery features at the underlying layers.

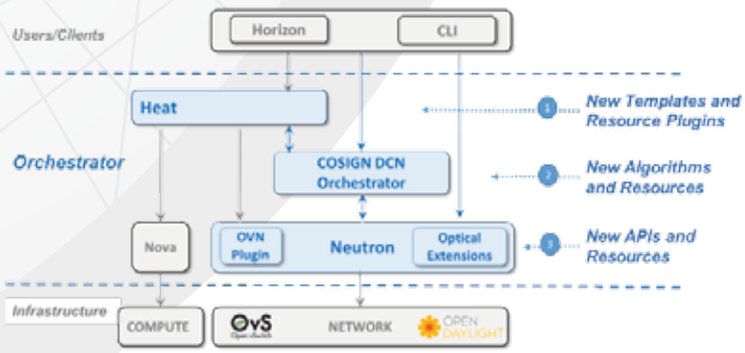
The datacentre data plane is controlled through standard and open protocols like OpenFlow, with enhanced abstraction mechanisms at the SDN controller to model and operate emerging **optical technologies**. Powerful REST APIs enable smart cooperation with the cloud orchestrator for converged virtualization of network and computing resources.

The COSIGN software solution builds upon consolidated open source projects. OpenDaylight Lithium is the platform for the COSIGN **infrastructure controller**, responsible for provisioning of DCN optical circuits through **configuration** and management of the datacentre network devices.

The overlay controller, which operates over the OpenvSwitch instances in the servers, is based on OVN and implements the overlay-based network virtualization.

COSIGN Orchestration and Management

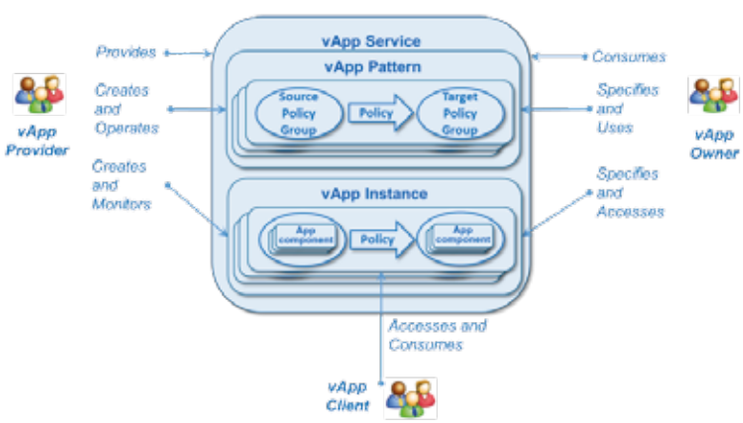
The COSIGN Orchestrator to be placed above the infrastructure, which includes data plane and control plane layers, and directly below the DCN clients layer. The Orchestrator will be built with three major components:



- OpenStack Heat, extended with new templates and resource plugins.
- OpenStack Neutron extended to allow access to the optical infrastructure controller in addition to providing logical network abstractions of the core Neutron API through edge based overlays.
- A new OpenStack component, shown in the figure as COSIGN DCN Orchestrator, will feature intelligent COSIGN resource allocation and management at a higher level of abstraction than is possible with Neutron.

Use Case Scenarios

Virtual Application Cloud (vApp)



Virtual Application Cloud (vApp)

The Virtual Application Cloud (vApp) is an infrastructural building block towards Platform as a Service (PaaS) solution, providing an advanced infrastructure-independent platform to multiple application developers, operators and clients over a single shared physical infrastructure. While each virtual cloud application consumes physical infrastructure resources, a set of resources provided to such application does not attempt to replicate the capabilities of a physical DC or to provide configuration-level access to the physical infrastructure. Instead, in this use case,the cloud provider allows the users to develop, deploy and operate complex dynamic applications without considering or even being aware of the intrinsic details of the underlying DC technologies.

The figure represents high level actors of the vApp Use Case and their relationships. A typical vApp Owner request is usually formulated in natural language using application level terminology. The request includes the type and the number of application components to be deployed, the connectivity pattern required to interconnect the components, and a set of business driven or compliance driven rules that govern the components and the connectivity. From the point of view of a vApp Provider, vApp provisioning involves joint orchestration of compute and network resources so as to ensure the fulfilment of the user request in a context of concrete technologies and capabilities existing in the DC. The vApp Client consumes the deployed application.

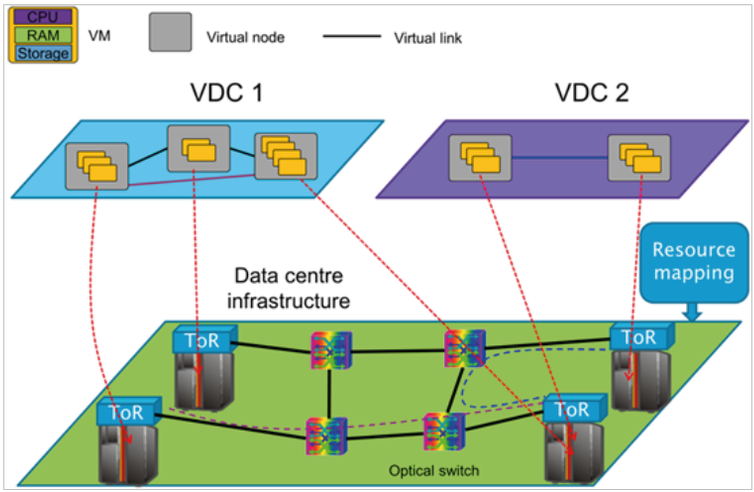
vApp is an example of the Multi-Tenant Software Cloud.

Virtual Data Centre (VDC)

The Virtual Data Centre (VDC) is a case of Infrastructure as a Service (IaaS) which provides advanced virtual infrastructure solutions to multiple VDC owners over a single shared physical infrastructure. Essentially, a VDC tries to replicate the capabilities of a physical DC, providing a fully manageable, secure and operable infrastructure that can grow or shrink according to the needs of the VDC owner and VDC clients, but without the associated maintenance costs.

Hence, a VDC is mainly designed to allow VDC owners to design, deploy and manage cloud services, intended to be offered to VDC clients, through a dedicated infrastructure composed of compute, storage, network, and security appliances that fulfil specific service requirements.

Key features of a VDC service are the joint orchestration of computing and network resources for efficient utilization of the underlying physical infrastructure, as well as the isolation of different VDC instances, to avoid interferences in terms of security and performance and to ensure a suitable level of quality and reliability of the services. The COSIGN VDC extends the traditional representation of a virtual network with VM pools, virtual links and virtual network apps, e.g., firewall and load balancers, adding the option to request virtual ToRs and optical switches as a service targeting researchers and experimenters who require higher control on the VDC resources.



Validation stages

The COSIGN solutions will be developed and validated in three stages:

- Stage 1: is a **Short-term** solution, based on high radix Ethernet switches and flattened network architecture.
- Stage 2: is a **Medium-term** solution, based on flexible capacity allocation through optical switching.
- Stage 3: is a **Long-term** solution, with multiple optical switching and fibre technologies in a fully optical DC network.

Meet COSIGN

EuCNC (Paris, July 2015)

Polatis and DTU presented two papers on the COSIGN architecture and technology for datacentre networks in the EuCNC GreenTouch workshop #7:

- Providing and orchestrating flexible DataCentre Networks (DCNs), Lars Dittmann (Technical University of Denmark, Denmark)
- SDN-enabled optical circuit switching for efficient and scalable datacentre networks, Nick Parsons (Polatis Ltd, UK)

The presentations are available to download along with others from the workshop from the EuCNC website.

Photonics in Switching 2015 (Firenze, 22-25 September)

Two invited papers will be presented at Photonics in Switching 2015:

"High performance optical circuit switching for software-defined datacentre networks", Nick Parsons, Polatis, UK

Abstract: "DirectLight is a well-established dark fibre optical circuit switch platform offering currently up to 192x192 fibre ports with typical loss and switching speed of 1dB and 20ms, respectively. This talk reviews the performance and scalability of DirectLight for dynamic reconfiguration of the fibre layer in energy-efficient software-defined data centre networks".

"Monolithic InP-based fast optical switch module for optical networks of the future" Xi Chen [1], James Regan [2], Tim Durrant [2], Yi Shu [3], George Saridis [3], Georgios Zervas [3], Dimitra Simeonidou [3], Valerija Kamchevska [4], Anna M. Fagertun [4], Siyuan Yu [1,2], Photonics Group - University of Bristol [1], Venture Photonics [2], HPN Group - University of Bristol [3], Tech. Univ. Denmark [4]

Abstract: "The paper summarizes the development of Venture Photonics' sub-10 ns fast optical switch which demonstrates low insertion loss, excellent crosstalk level and polarization independent switching performance".