Network Function Virtualization in Software Defined Optical Transport Networks

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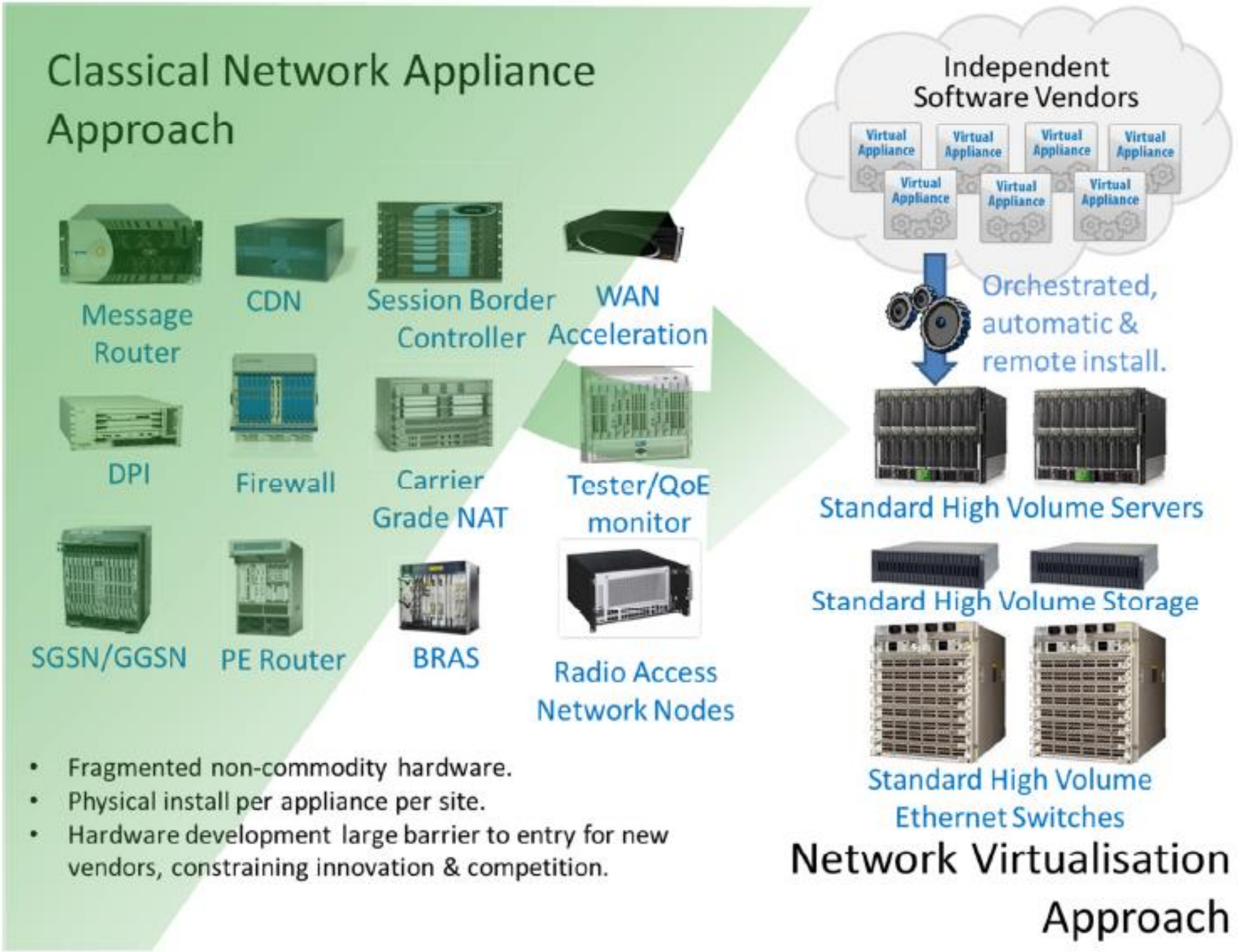
Group Meeting, June 17, 2016

Outline

- NFV enabled software defined multi-domain optical networks
- Procedure of vNF call and return
- NFV enabled optical transport node architecture
- Parallel processing method for NFV enabled OTN nodes
- Conclusion

What is Network Functions Virtualization (NFV)?

Network Functions Virtualization aims to transform the way that network operators architect networks by evolving standard IT virtualization technology to consolidate many network equipment types onto industry standard high volume servers, switches and storage, which could be located in Datacenters, Network Nodes and in the end user premises.



Network Functions Virtualization – Introductory White Paper

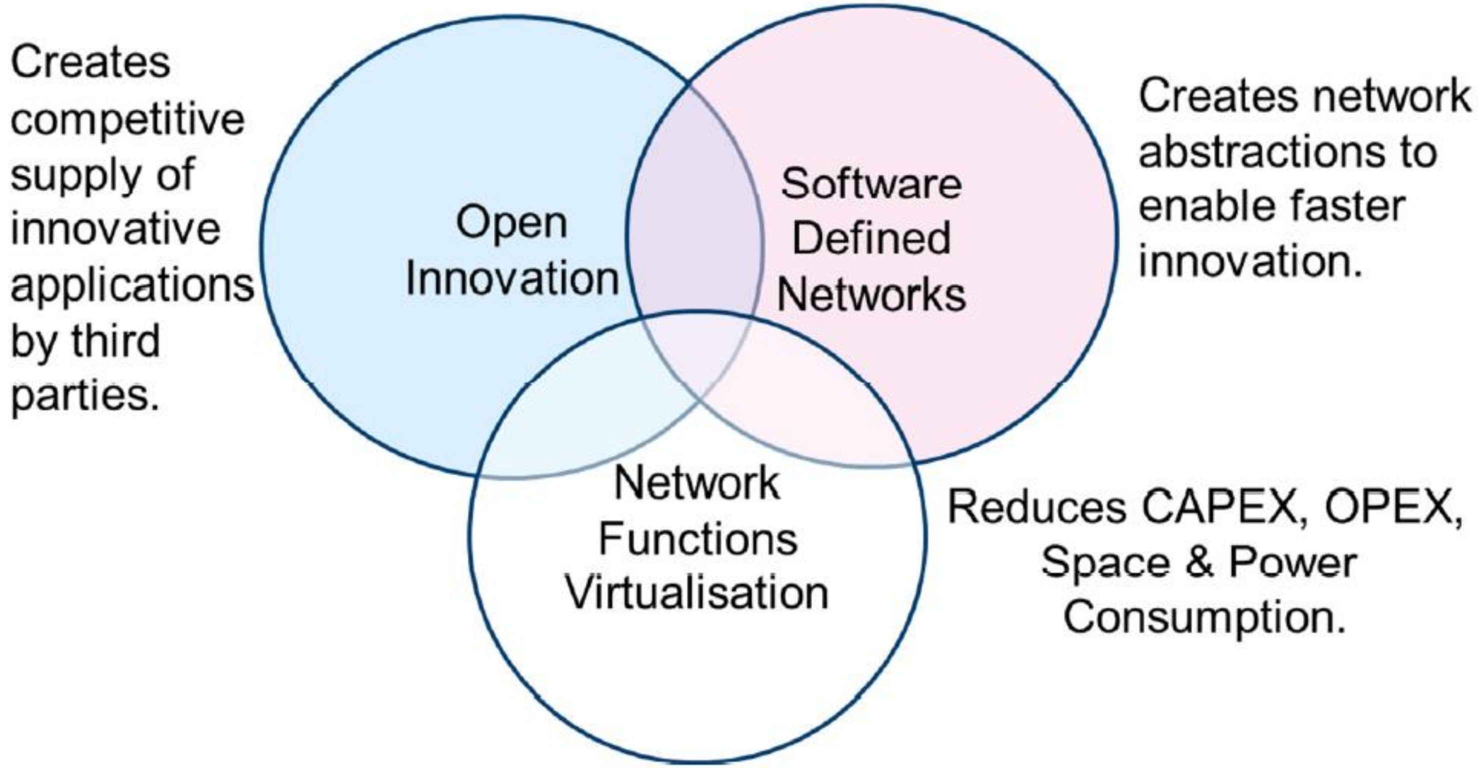
Benefits of Network Functions Virtualization

- Reduced equipment costs and reduced power consumption through consolidating equipment and exploiting the economies of scale of the IT industry.
- Increased velocity of Time to Market by minimizing the typical network operator cycle of innovation.
- Targeted service introduction based on geography or customer sets is possible. Services can be rapidly scaled up/down as required.
- Enabling a wide variety of eco-systems and encouraging openness.
- Optimizing network configuration and/or topology in near real time based on the actual traffic/mobility patterns and service demand.
- ………………….

Network Functions Virtualization – Introductory White Paper

Relationship with Software Defined Networks (SDN)

Network Functions Virtualization is highly complementary to Software Defined Networks (SDN), but not dependent on it . Network Functions Virtualization can be implemented without a SDN being required, although the two concepts and solutions can be combined and potentially greater value accrued.



- NFV can be achieved using non-SDN mechanisms. But approaches relying on the separation of the control and data forwarding planes as proposed by SDN can enhance the performance.
- NFV is able to support SDN by providing the infrastructure upon which the SDN software can be run. Furthermore, NFV aligns closely with the SDN objectives to use commodity servers and switches

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Fields of Application and Use Cases

• Switching elements: BNG, CG-NAT, routers.
• Mobile network nodes: HLR/HSS, MME, SGSN, GGSN/PDN-GW, RNC, Node B, eNode B.
• Functions contained in home routers and set top boxes to create virtualized home environments.
• Tunneling gateway elements: IPSec/SSL VPN gateways.
• Traffic analysis: DPI, QoE measurement.
• Service Assurance, SLA monitoring, Test and Diagnostics.
• NGN signaling: SBCs, IMS.
• Converged and network-wide functions: AAA servers, policy control and charging platforms.
• Application-level optimization: CDNs, Cache Servers, Load Balancers, Application Accelerators.
• Security functions: Firewalls, virus scanners, intrusion detection systems, spam protection.

How about optical transport networks?

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Optical Service Chaining for Network Function Virtualization

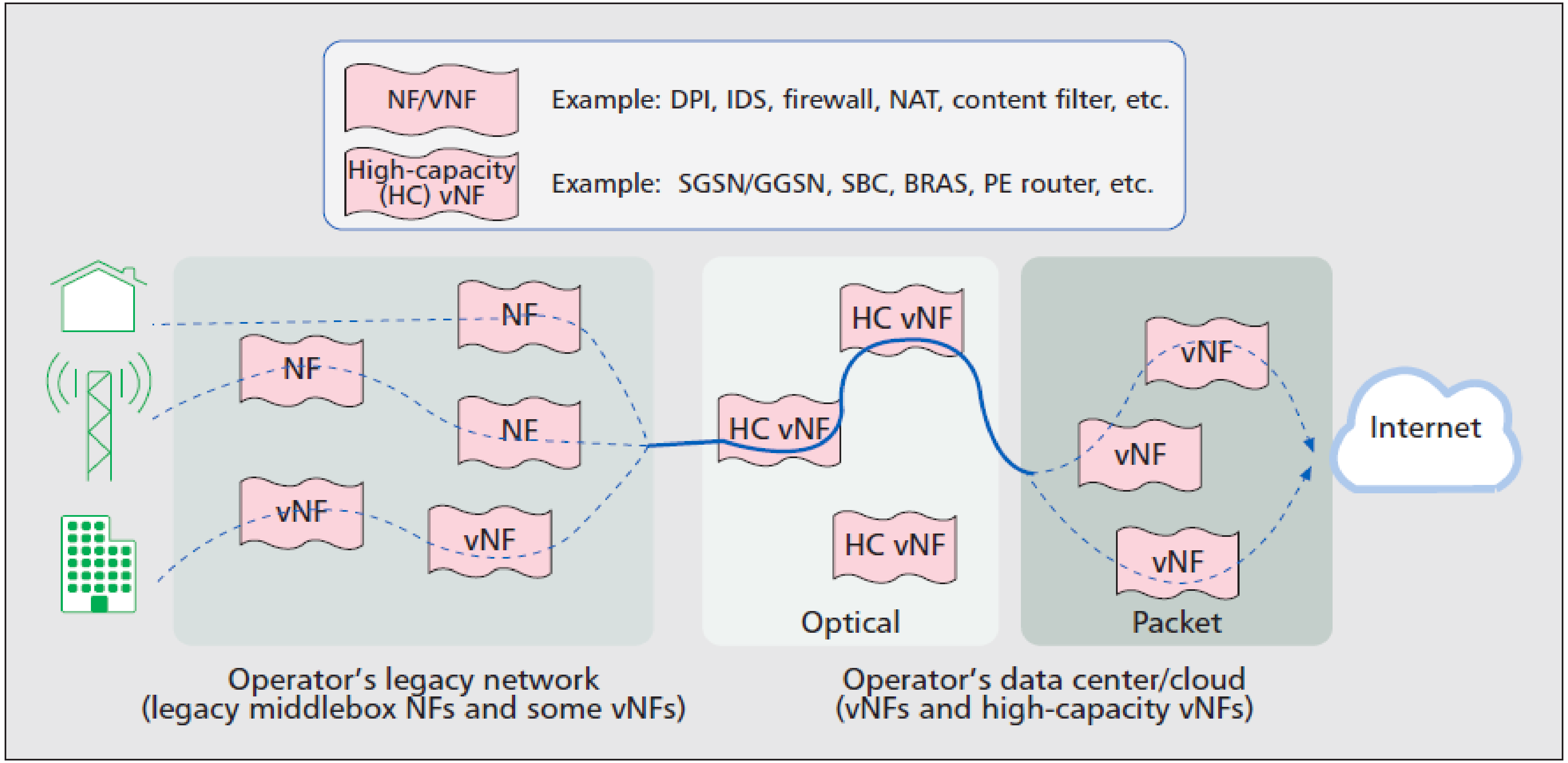


Figure 1. Illustration of service chaining. In the operator's DC/cloud, an aggregated flow first goes through the high-capacity core vNFs in the optical steering domain, and then continues to the fine-grained processing.

NFV traffic patterns are expected to fluctuate substantially compared to the legacy network services, because vNFs can be dynamically created and destroyed as needed. The configuration of matching rules can be complicated and error-prone as flow number goes large, and may lead to high operational complexity and cost.

Ming Xia, et al., "Optical Service Chaining for Network Function Virtualization Network," IEEE Communications Magazine, April 2015.

Optical Service Chaining for Network Function Virtualization

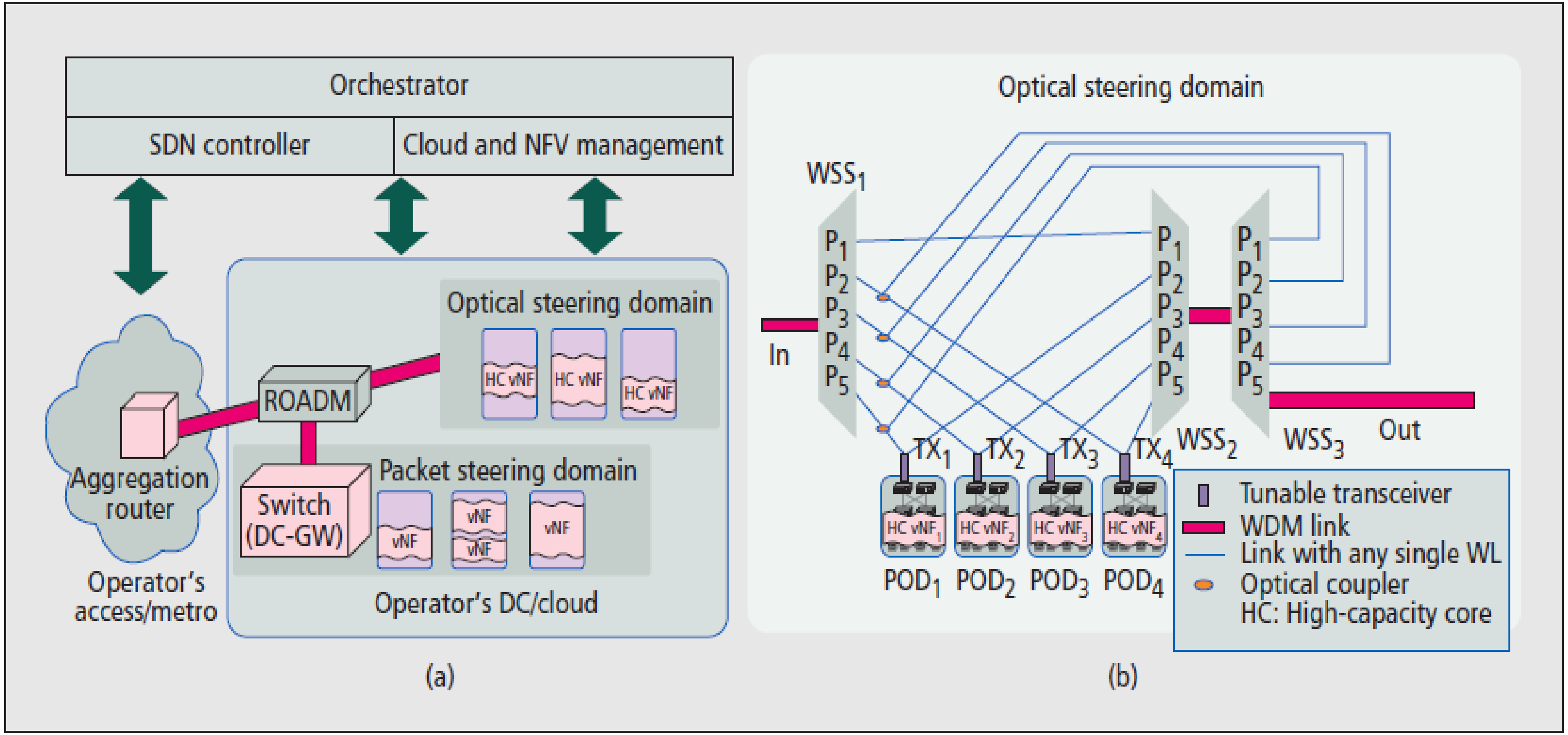
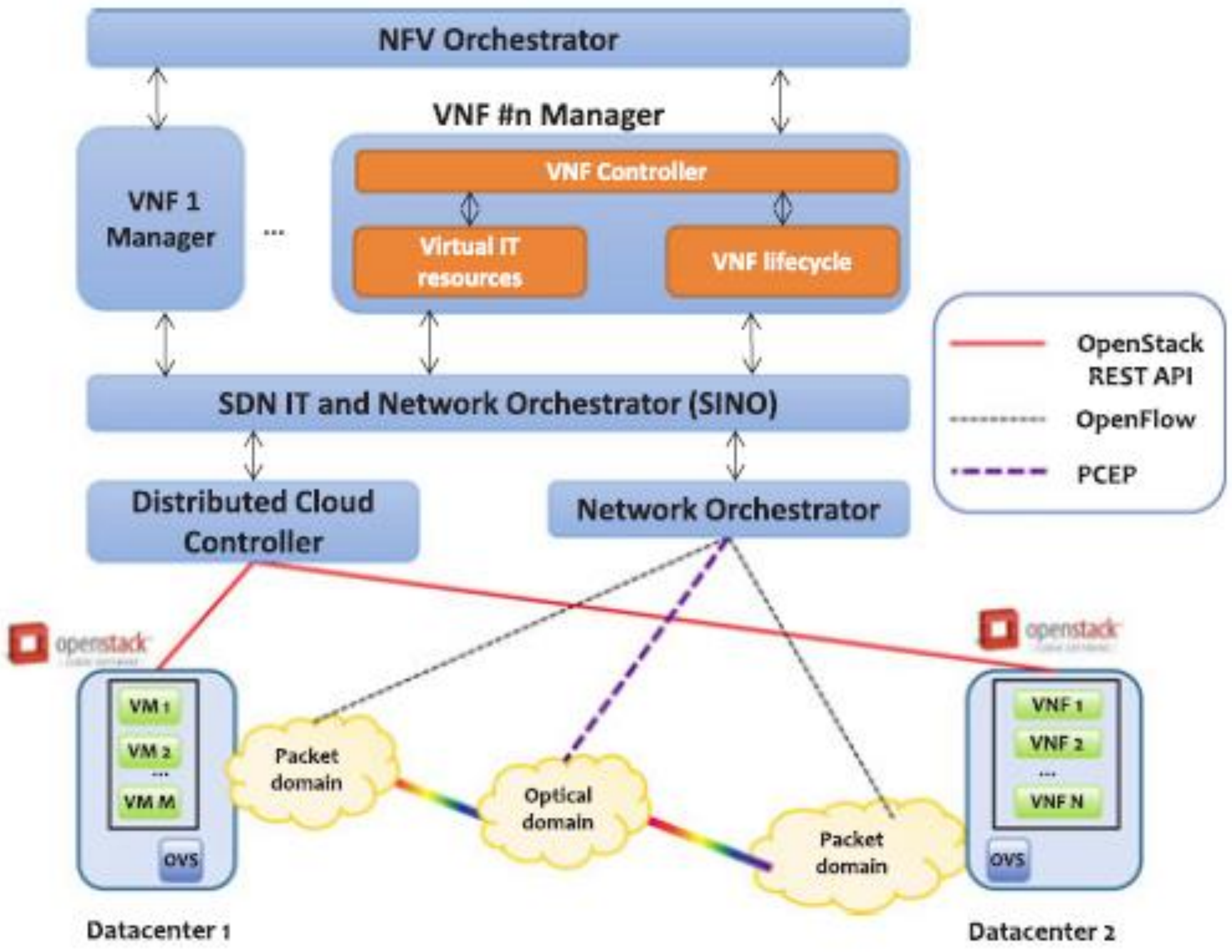


Figure 3. Proposed architecture for optical service chaining: a) overall architecture; b) optical steering domain.

It introduces an optical steering domain into the operator's data centers for NFV service chaining at a coarse-grained traffic level using wavelength switching. In the proposed architecture, a service chain may partly reside in the optical domain and partly reside in the packet domain.

Ming Xia, et al., "Optical Service Chaining for Network Function Virtualization Network," IEEE Communications Magazine, April 2015.

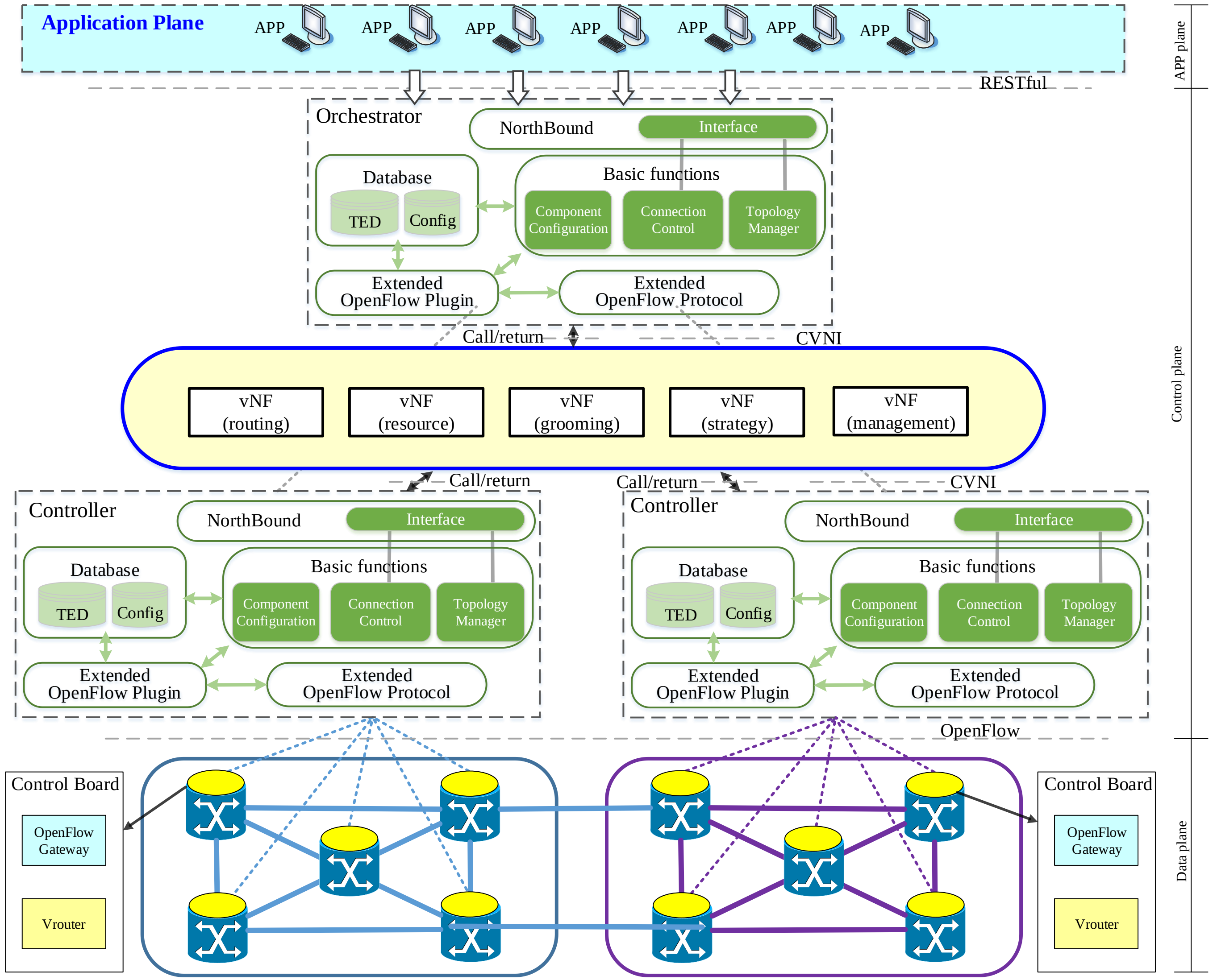
Transport NFV Architecture



NFV concepts do not only apply to data plane functions (i.e., packet processing or forwarding), but also to control plane functions, such as path computation. First, they focus on the IT and network resources that are virtualized to provide the required VNFs. Second, they provide an example of VNF on top of the virtualized infrastructure, by proposing a path computation element (PCE) architecture to deploy a PCE by means of NFV.

Ricard Vilalta, et al., "Transport Network Function Virtualization," Journal of Lightware Technology, vol.33, no.8, Apr.2015.

NFV enabled software defined multi-domain optical networks



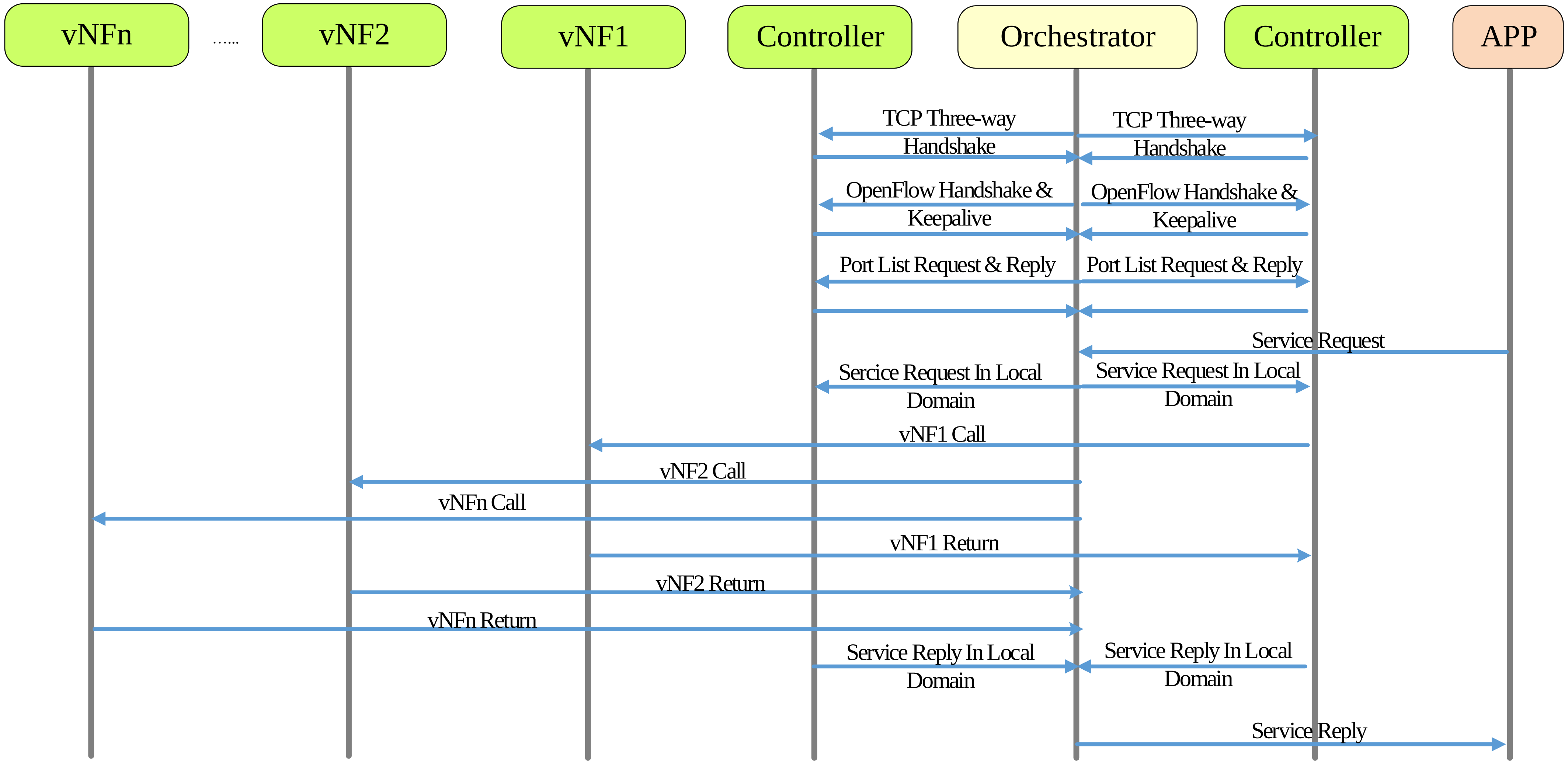
•<u>Application (APP) plane</u> contains various applications, such as bandwidth on demand (BoD), network on demand (NoD), and service scheduling expert (SSE). These service requests are initialed by this plane, and served by the network orchestrator through RESTful APIs interfaces.

•<u>Control plane</u> is composed of two kinds of controllers. Each domain owns one local controller, and the local domain controllers are managed by one super controller, which is named as network orchestrator. Developed based on Open Daylight controller, the orchestrator is responsible for communicating with controllers of different domains via control virtual network interface (CVNI), which is implemented based on the extended Openflow protocol. Based on the implementation mechanism of different function modules with software engineering, NFV is considered to be embedded into the control plane. Some function modules can be abstracted from the controller as vNF, such as path computation, resource allocation, grooming algorithm, security strategy, and user management. Both orchestrator and local controllers can call the necessary functions from different vNFs, and then the related vNF returns the result.

•<u>Data plane</u> consists of all the transport equipment controlled by SDON controllers. In each domain, the transport nodes are equipped with specialized control boards to communicate with their domain controller via the domain-specified protocol, i.e, OpenFlow protocol.

Yongli Zhao, et al., “Network Function Virtualization in Software Defined Optical Transport Networks,” OFC2016, Anaheim, CA, USA, Mar.2016.

Procedure of vNF call and return



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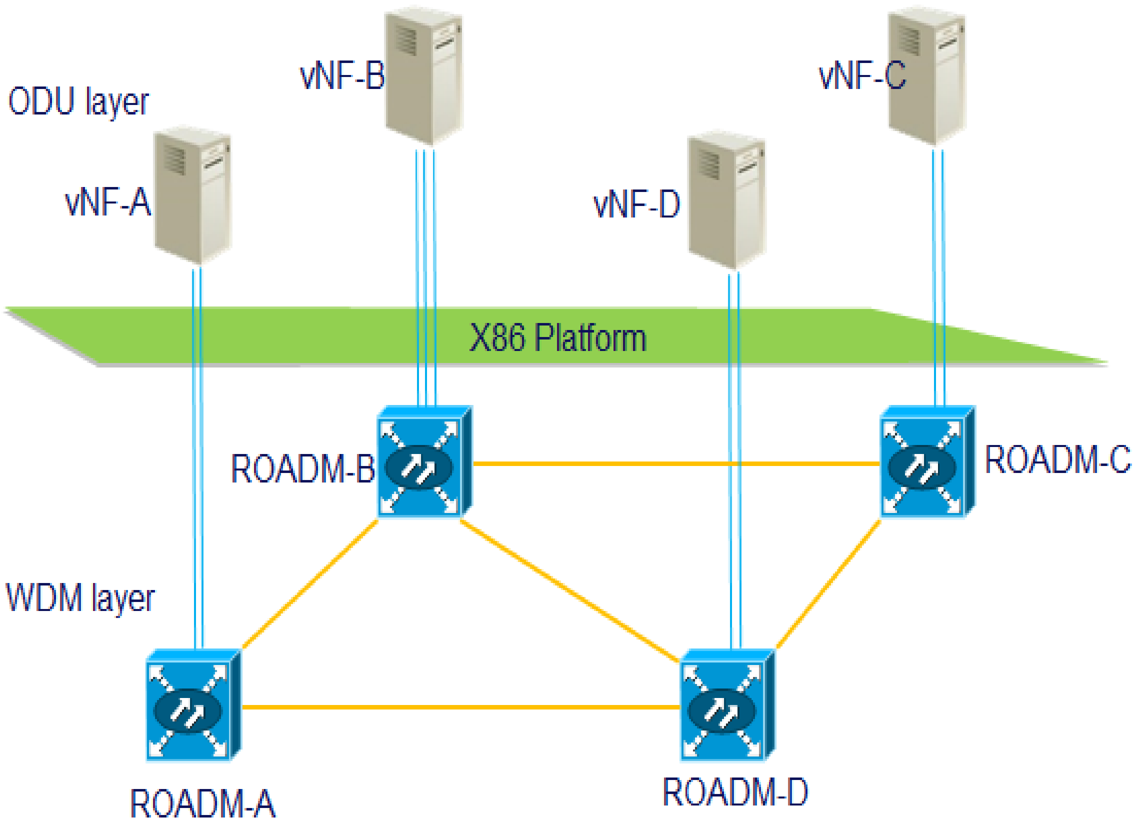
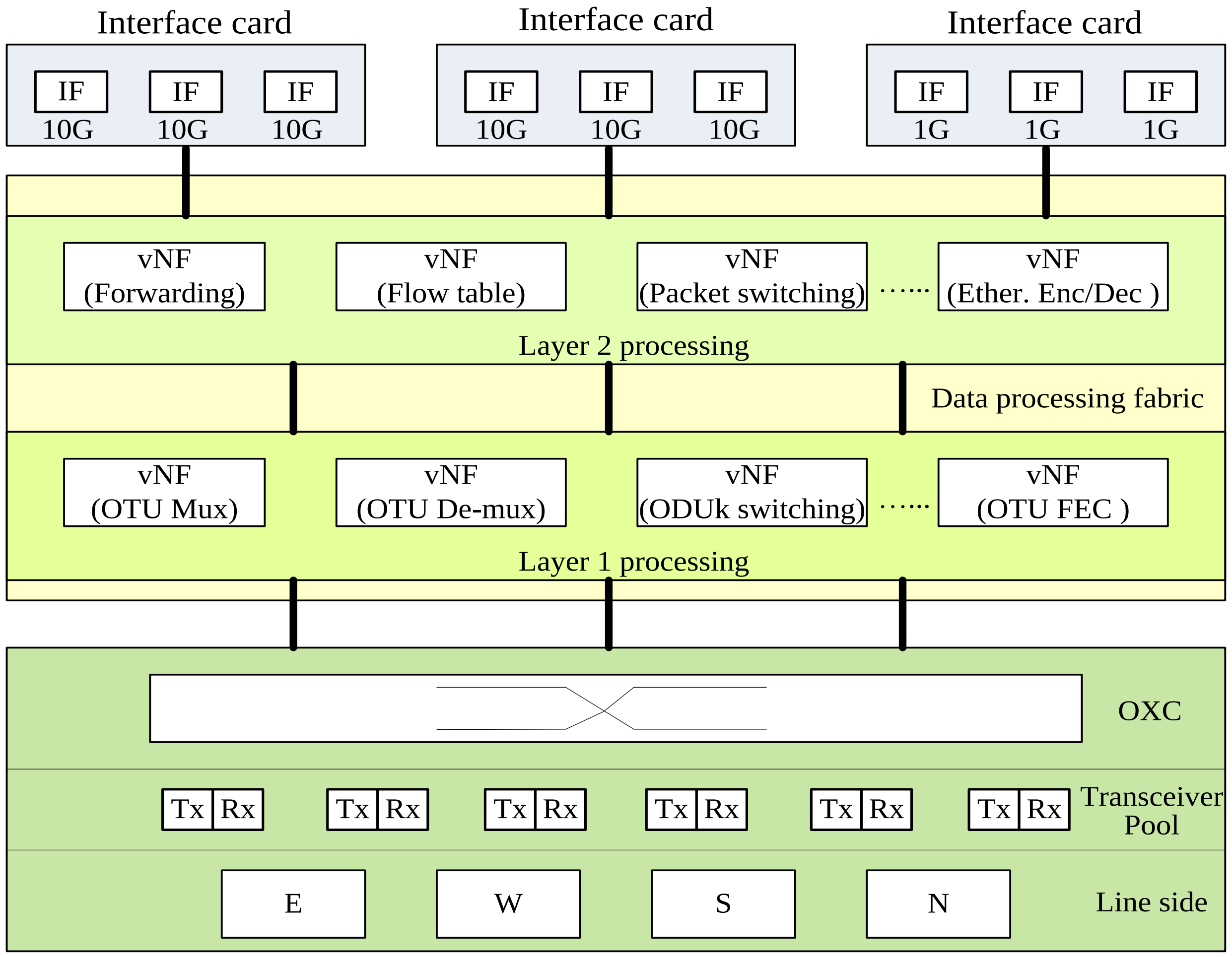
NFV enabled optical transport node architecture





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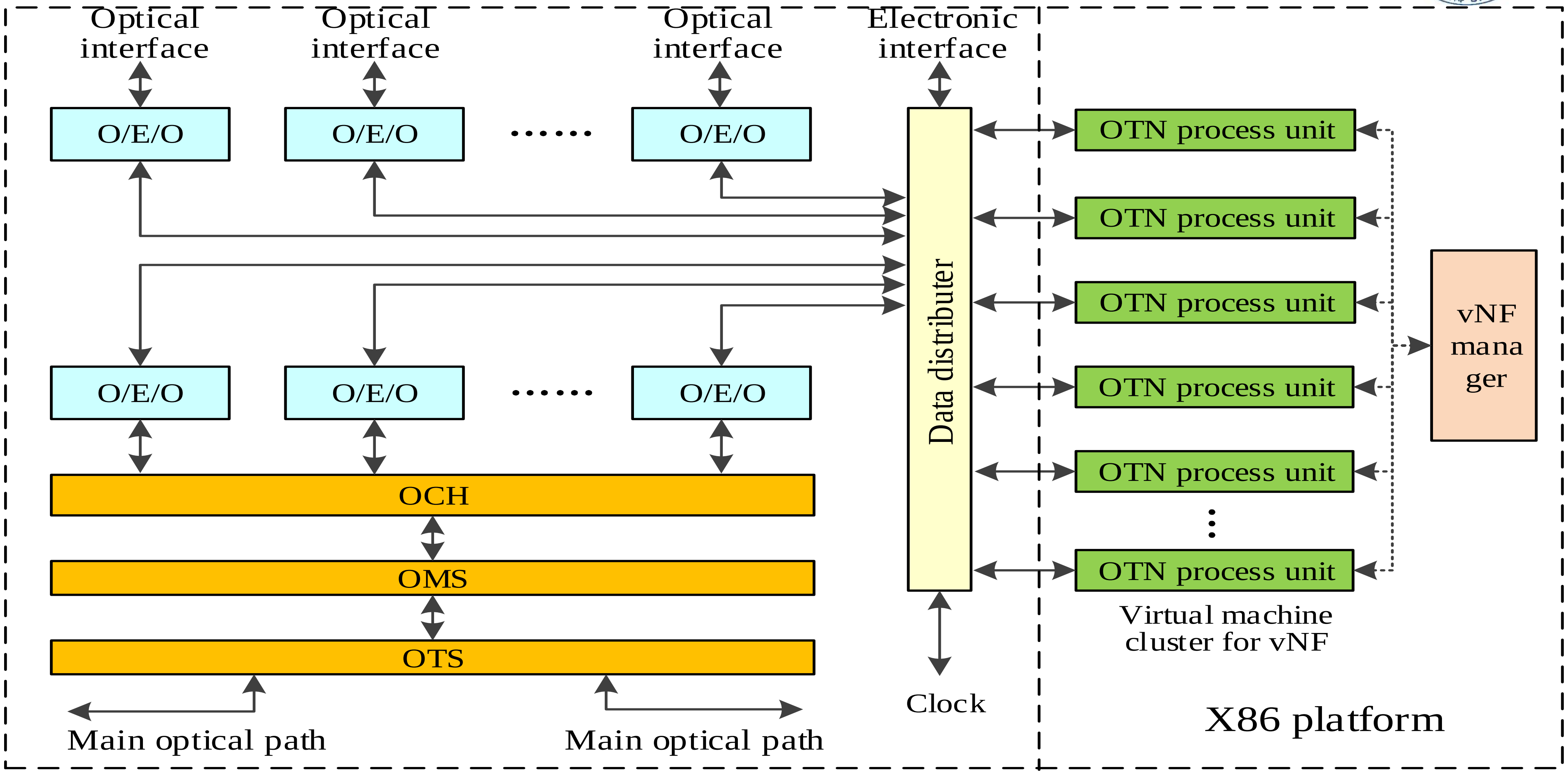
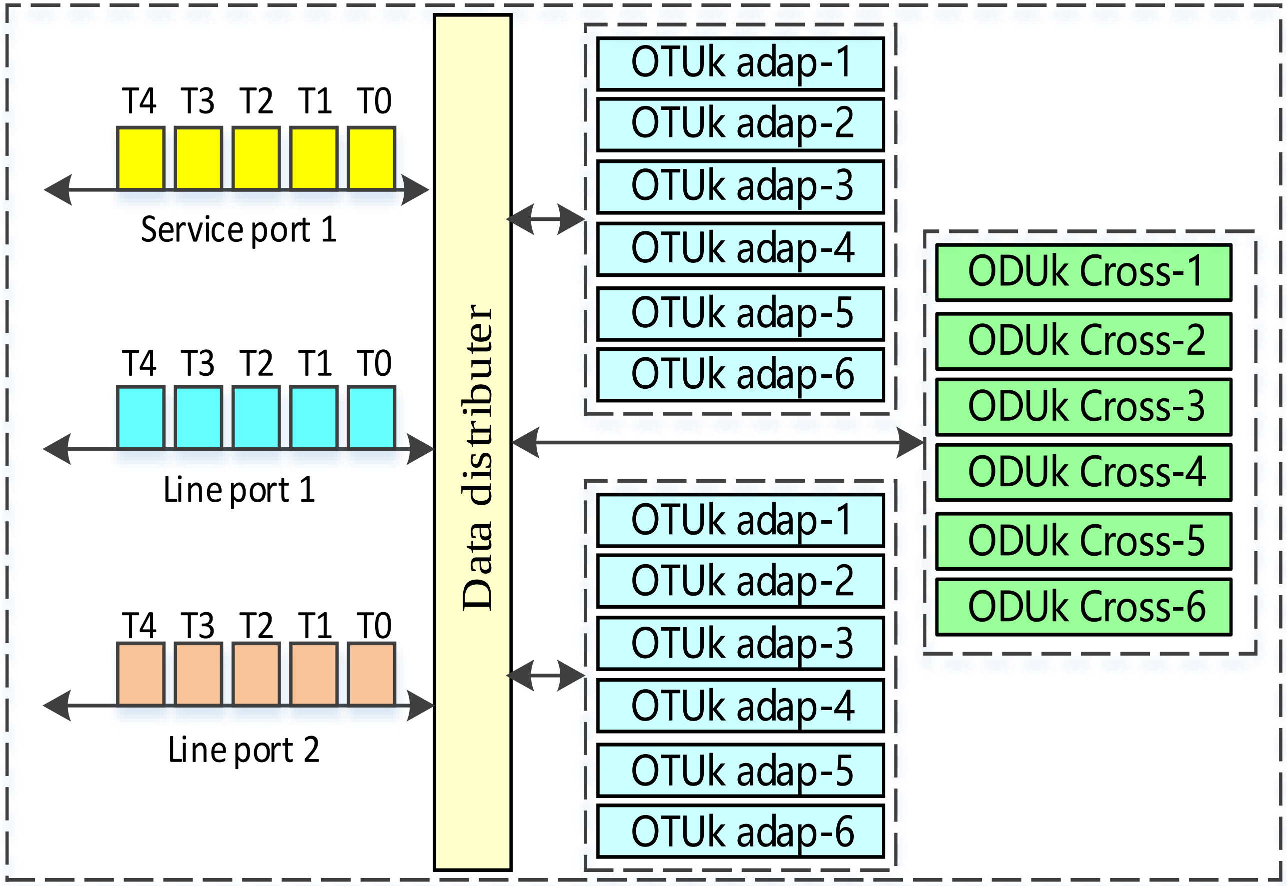
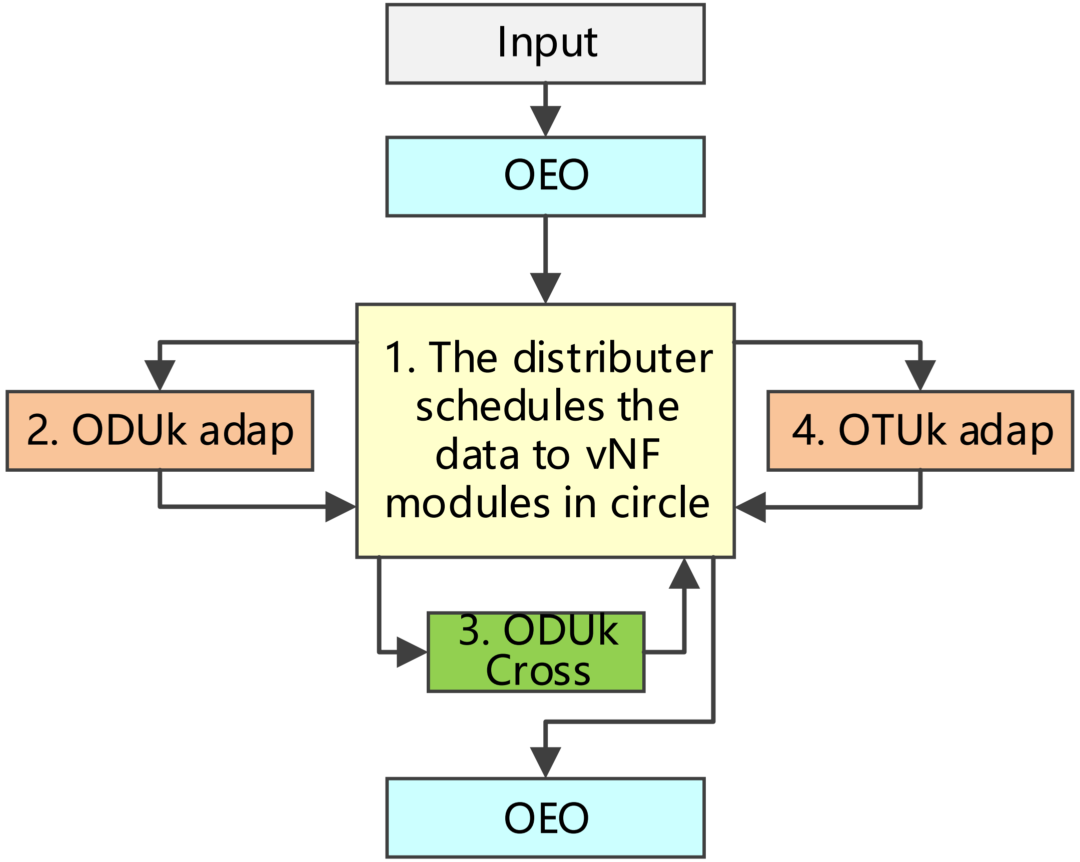
NFV enabled optical transport node architecture

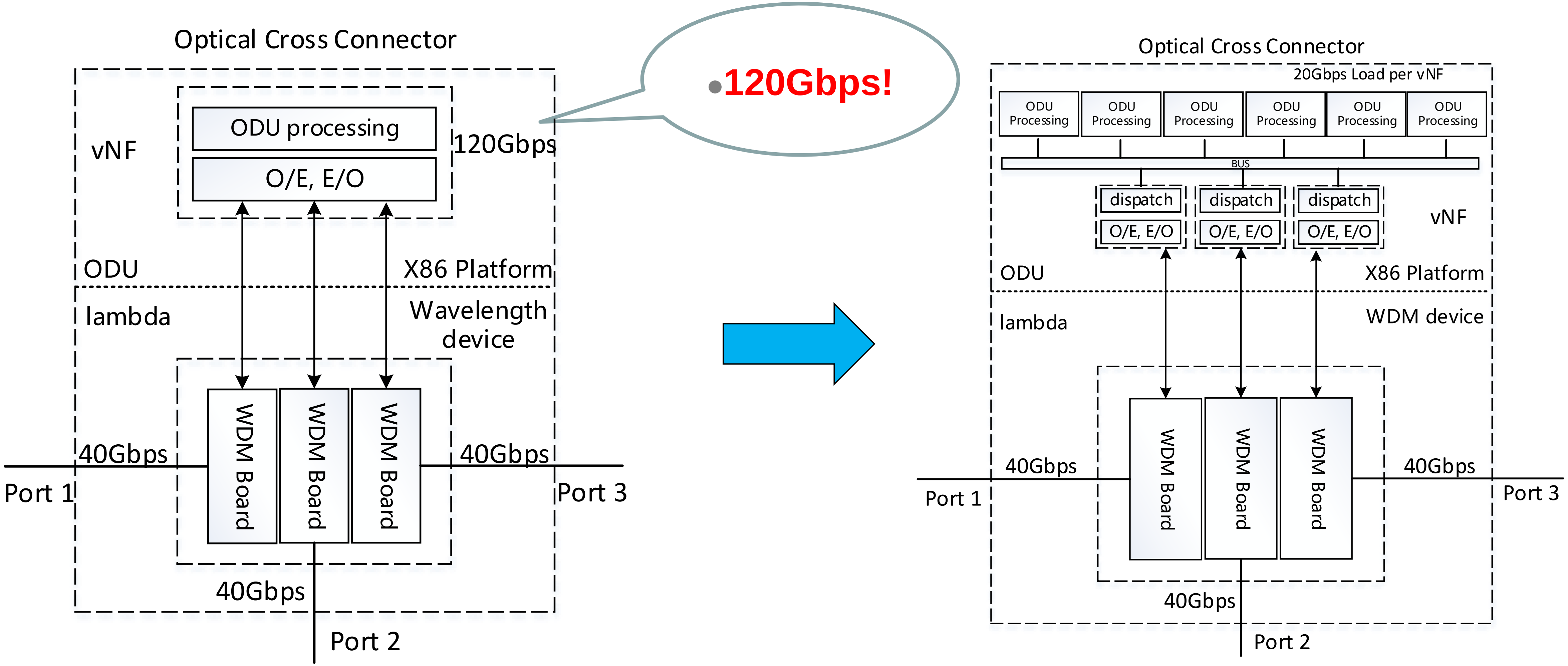


Parallel processing method for NFV enabled OTN nodes



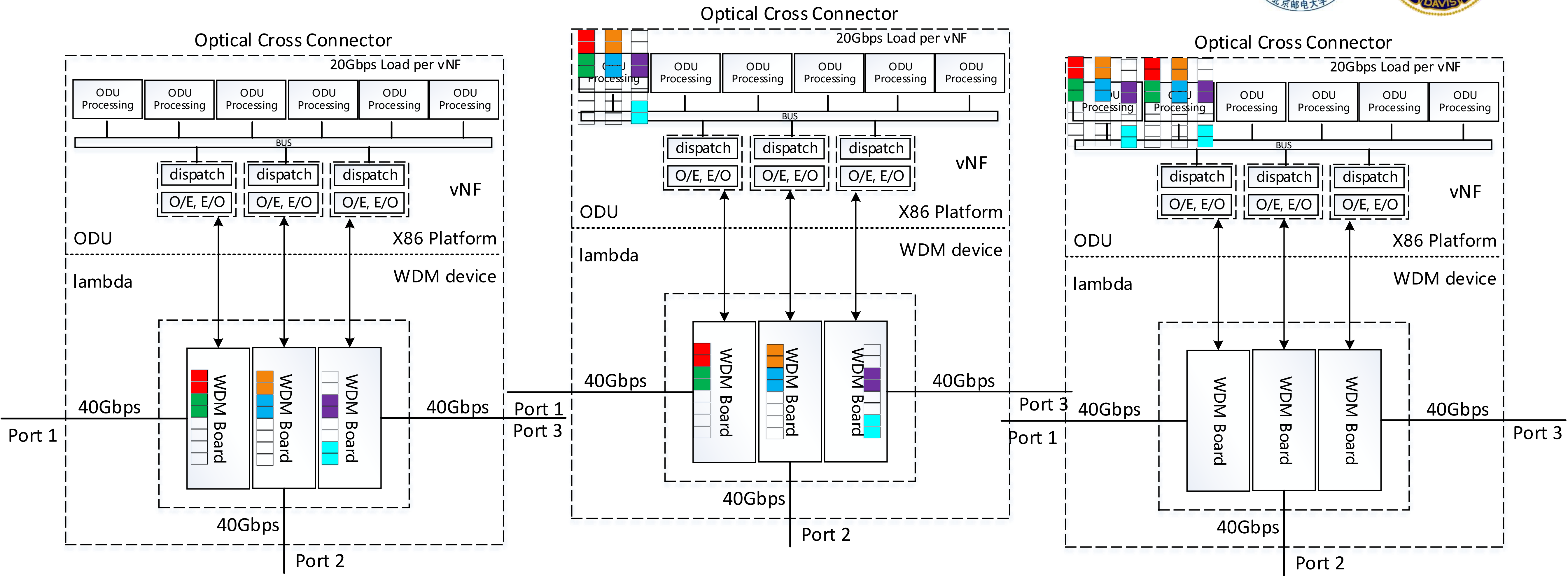


Use case



Optical Cross Connector
vNF
ODU processing
O/E, E/O
120Gbps
ODU
X86 Platform
lambda
Wavelength device
WDM Board
WDM Board
WDM Board
40Gbps
40Gbps
Port 1
Port 3
40Gbps
Port 2
120Gbps!
Optical Cross Connector
20Gbps Load per vNF
ODU Processing
ODU Processing
ODU Processing
ODU Processing
ODU Processing
ODU Processing
BUS
dispatch
dispatch
dispatch
O/E, E/O
O/E, E/O
O/E, E/O
vNF
ODU
X86 Platform
lambda
WDM device
WDM Board
WDM Board
WDM Board
40Gbps
40Gbps
Port 1
Port 3
40Gbps
Port 2

Use case



Step 1

Step 2

Step 3

Conclusion

- This paper introduce NFV into software defined optical transport networks (SDON).
- NFV enabled software defined multi-domain optical networks is designed with procedure demonstration of vNF call and return.
- NFV based control plane and transport nodes are designed to support NFV enabled SDON.
- Parallel processing method is proposed for NFV enabled OTN nodes.

Thank You!

Beijing University of Posts and Telecommunications