

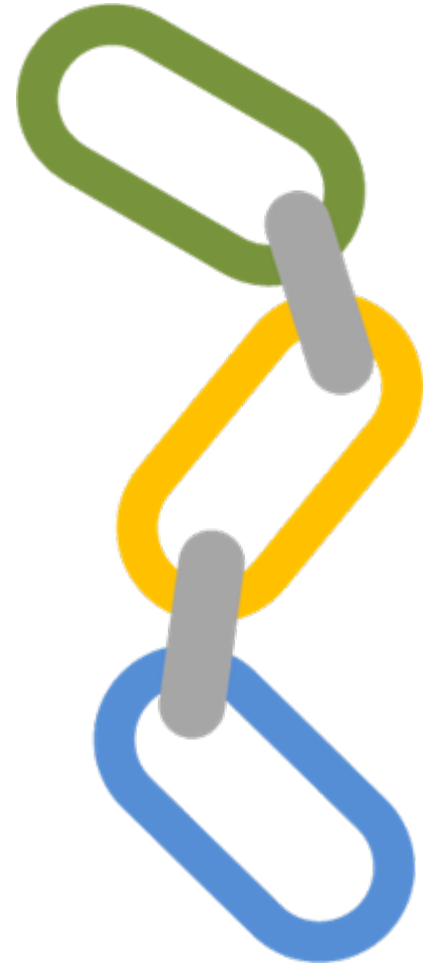
Optical Service Chaining by Combining Optics, SDN, and NFV

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*Workshop on software defined
optical networking*

Geni conference 2014, davis, ca

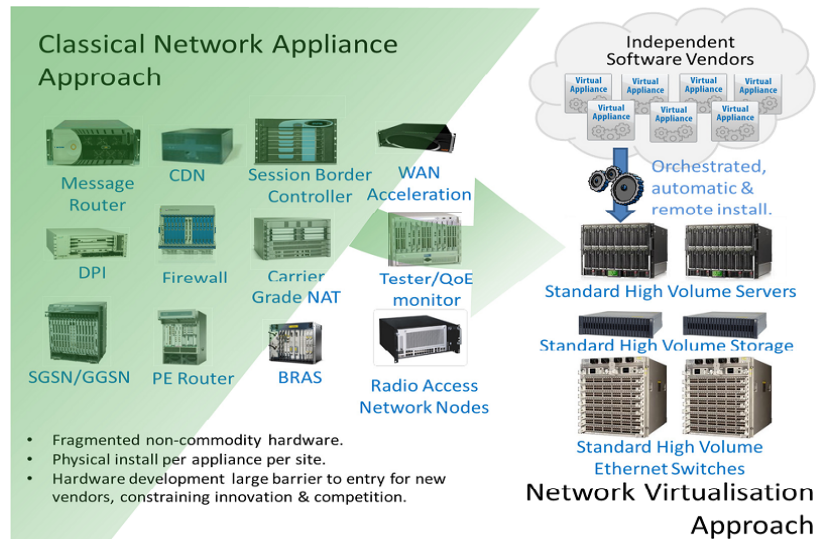




Network Function Virtualization

› Network Function Virtualization

- Middlebox services or network functions are realized in *software* running on generic hardware and in virtualized environments.
- Motivated by CAPEX savings and faster time to market of new offerings and solutions.



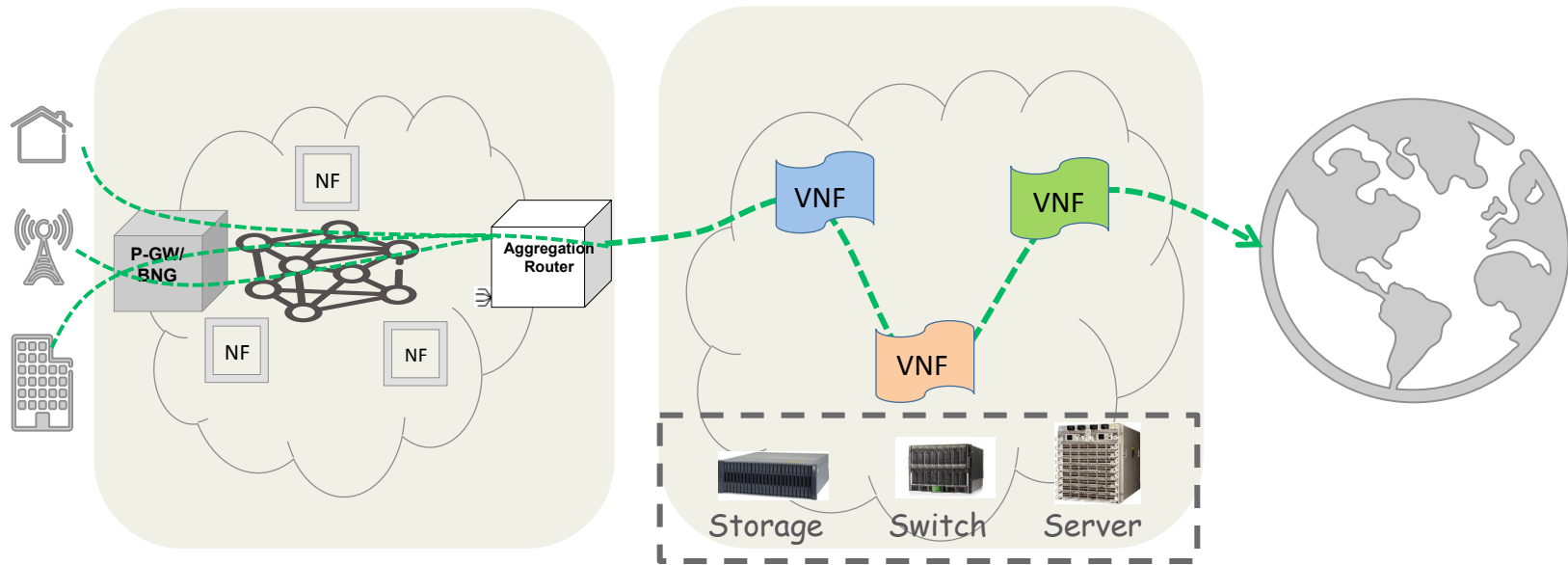
Source: ETSI NFV Whitepaper 2012

Benefit

- CapEx/OpEx saving
- Shorter development cycles for new services
- Automation of NF configuration and management
- Support multi-tenancy of NF



End-To-End Path of Traffic Flow



Operator's Access Network with Legacy NFs (e.g. middleboxes)

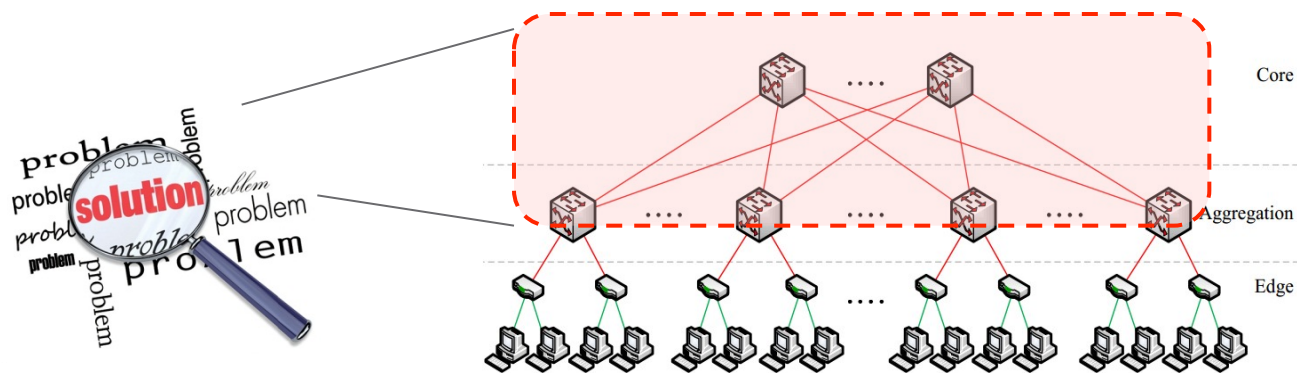
Operator's DC/Cloud with virtualized network functions

Internet



Challenge in Data Center Networks

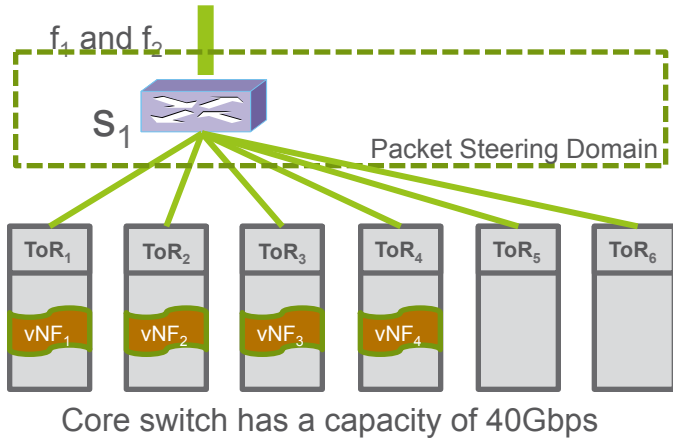
- Steering traffic across core network functions in data centers requires high efficiency and scalability
 - How to efficiently handle ~10s of Gbps traffic steering?
 - How to dynamically shape network infrastructure to support bulky traffic transmission?
- Data center network infrastructure and cloud manager needs to be interacted to optimizing networking and server resources



Source: A Scalable, Commodity Data Center Network Architecture



Scalability Issue – An Example



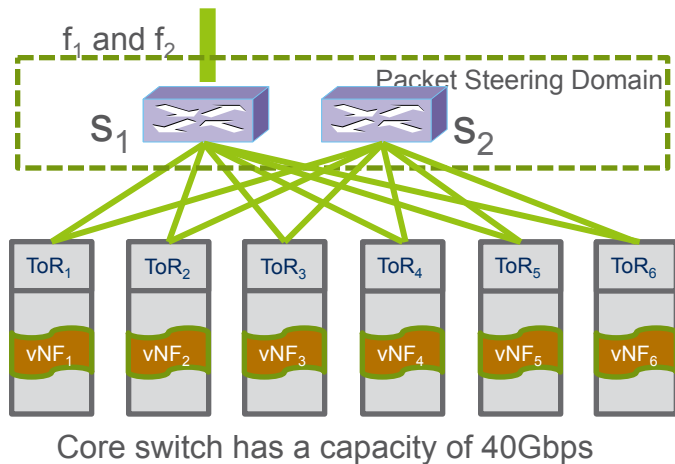
f_1 and f_2 are 5 Gbps flows

f_1 needs to go through vNF_1 and vNF_2

f_2 needs to go through vNF_3 and vNF_4

f_1 : S_1 - ToR_1 - vNF_1 - ToR_1 - S_1 - ToR_2 - vNF_2 - ToR_2 - S_1

f_2 : S_1 - ToR_3 - vNF_3 - ToR_3 - S_1 - ToR_4 - vNF_4 - ToR_4 - S_1



f_1 and f_2 are 10 Gbps flows

f_1 needs to go through vNF_1 , vNF_2 , and vNF_3

f_2 needs to go through vNF_4 , vNF_5 , and vNF_6

f_1 : S_1 - ToR_1 - vNF_1 - ToR_1 - S_2 - ToR_2 - vNF_2 - ToR_2 - S_2 - ToR_3 - vNF_3 - ToR_3 - S_1

f_2 : S_1 - ToR_4 - vNF_4 - ToR_4 - S_2 - ToR_5 - vNF_5 - ToR_5 - S_2 - ToR_6 - vNF_6 - ToR_6 - S_1



Motivation of Using Optics

- › The throughput of the packet steering domain increases as traffic volume grows.
- › Power consumption goes up correspondingly as throughput.

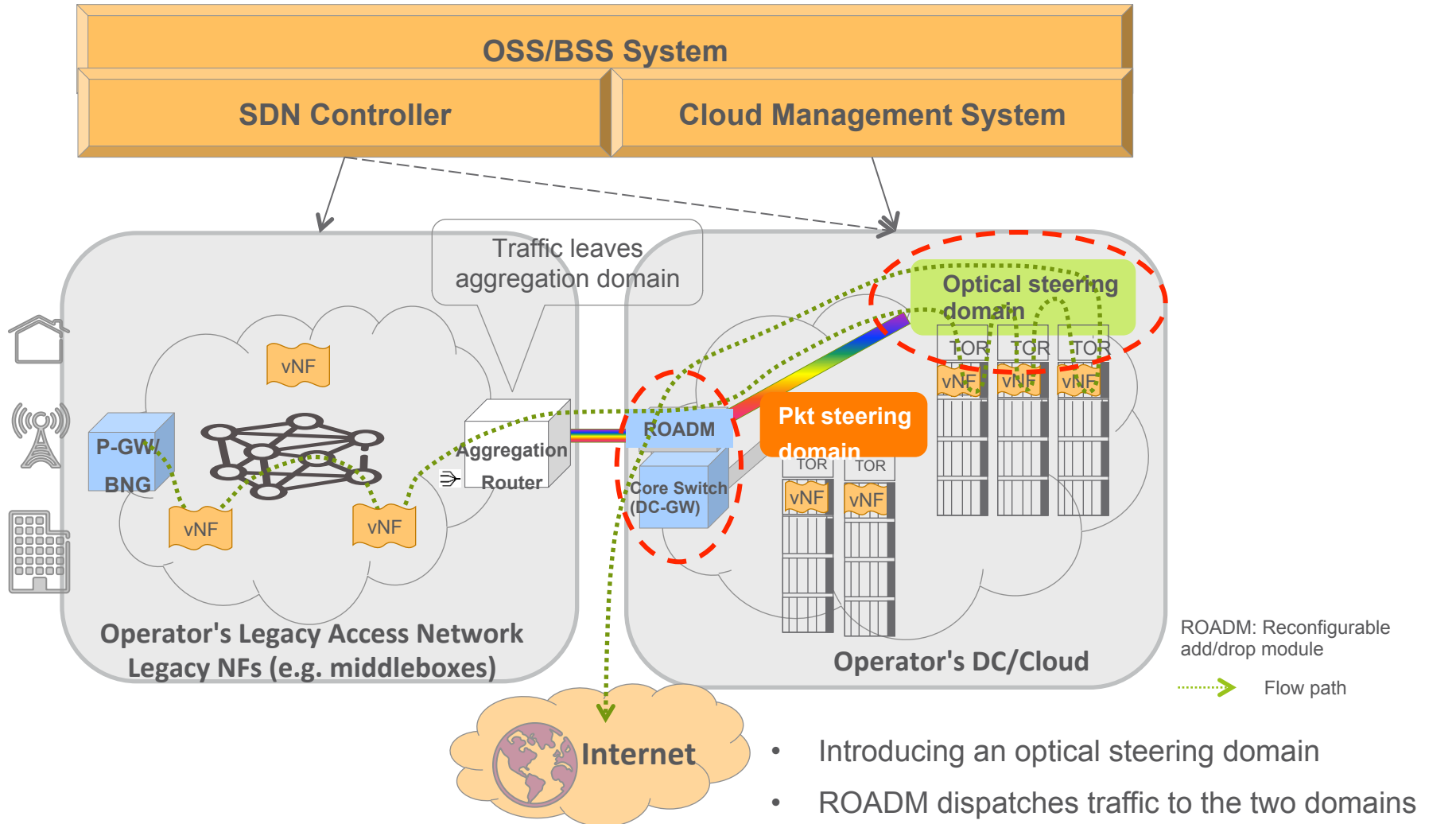
A new scheme is needed:

- Insensitivity to traffic growth and number of virtual network functions
- High power efficiency





Overall Architecture

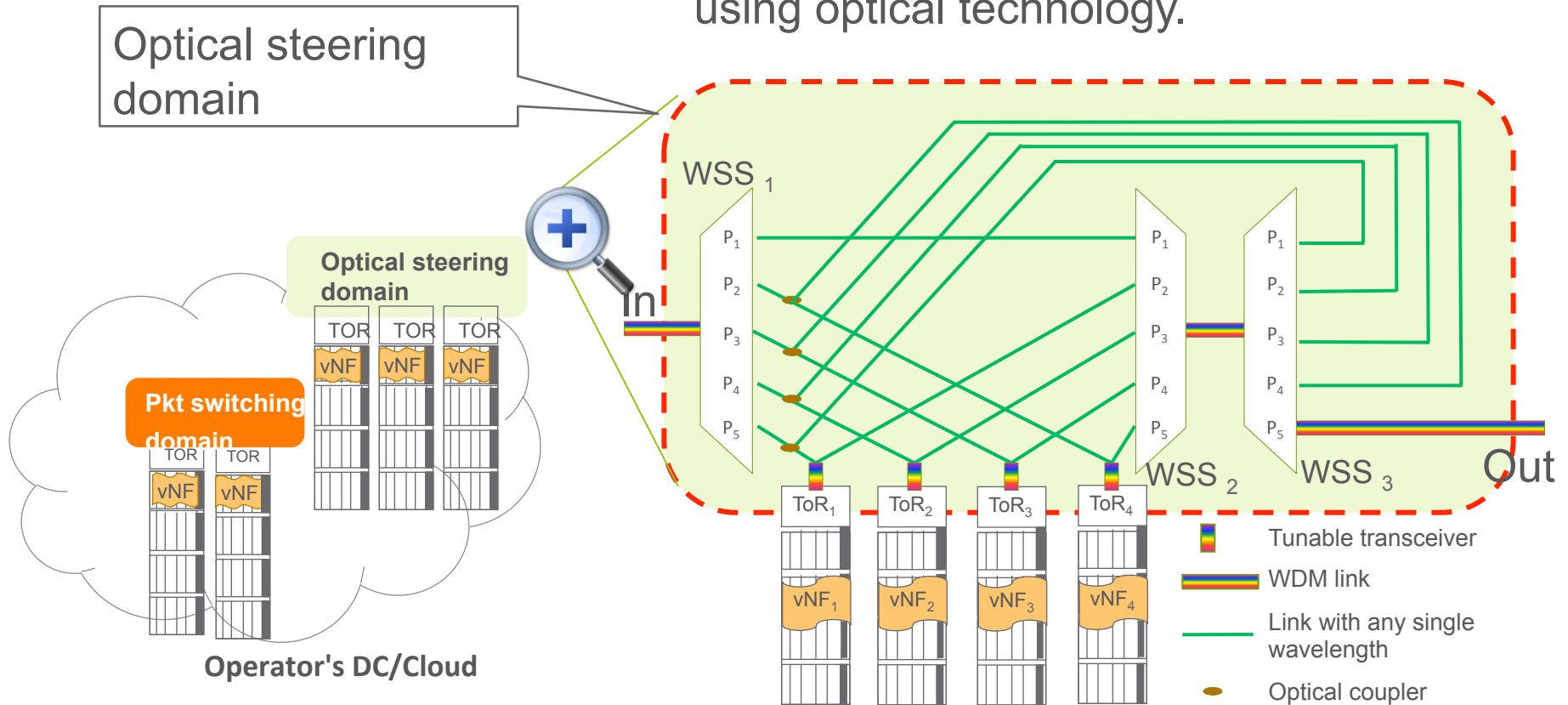


- Introducing an optical steering domain
- ROADM dispatches traffic to the two domains
- Optical domain is complement to packet domain



Optical Steering Domain

Architecture for traffic steering for NFV using optical technology.





Performance Analysis-Setting

Table 1 Scenarios for scalability analysis (2 flows).

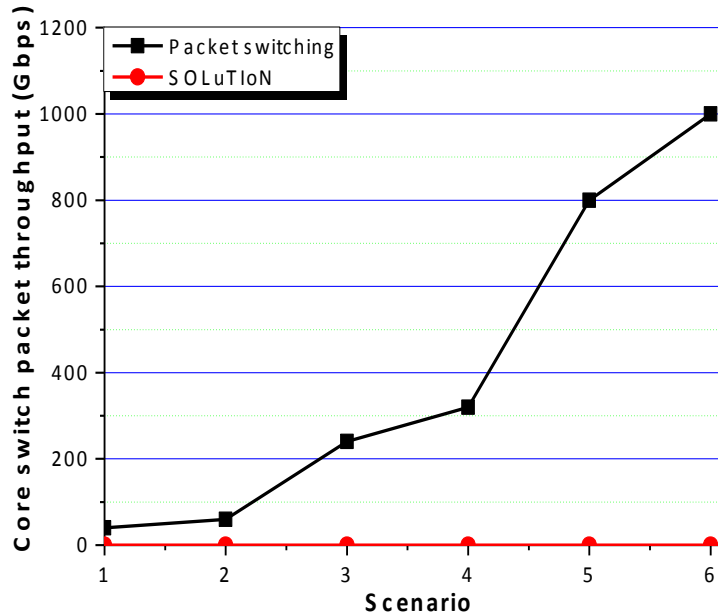
| Scenario | Flow rate (Gbps) | # of needed vNFs per flow |
|----------|------------------|---------------------------|
| 1 | 10 | 1 |
| 2 | 10 | 2 |
| 3 | 40 | 2 |
| 4 | 40 | 3 |
| 5 | 100 | 3 |
| 6 | 100 | 4 |

Table 2 Power consumption at different flow rates (W)*.

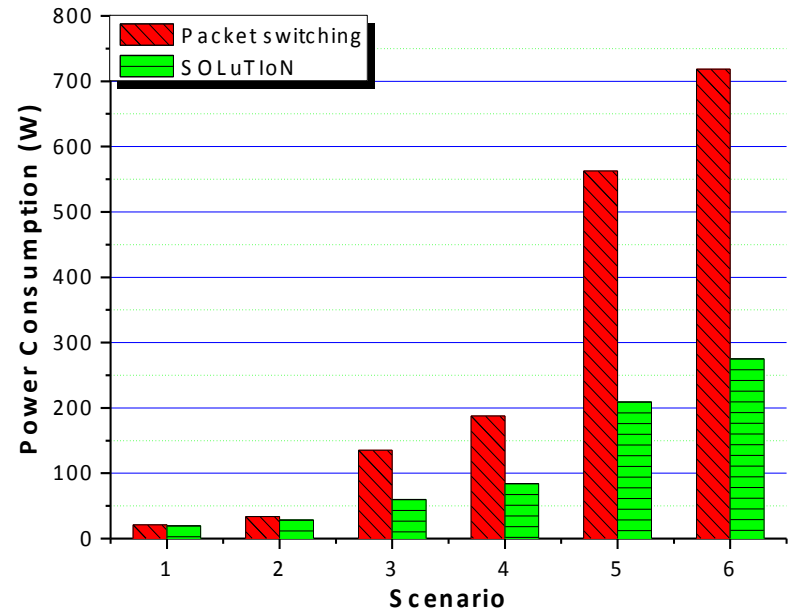
| | Core switch | ToR switch | Optics |
|--------------|-------------|------------|--------|
| 10GbE | 3.91 | 1.3 | / |
| 40GbE | 15.625 | 5.21 | / |
| 100GbE | 46.875 | 15.63 | / |
| WSS per port | / | / | 2.0 |



Performance Analysis-Result



Total packet throughput by core switches.



Power consumption for the six scenarios.



Summary

We propose a circuit based (optical-layer) solution for efficient traffic steering to support network function virtualization (NFV).

- Based on software-defined networking (SDN) principles
- High scalability and power efficiency for bulky traffic steering
- Complement to existing packet-based solutions



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