What is SDN, Current SDN projects and future of SDN
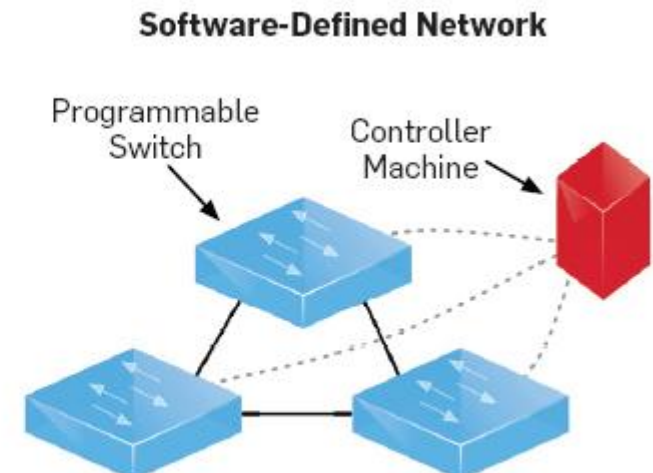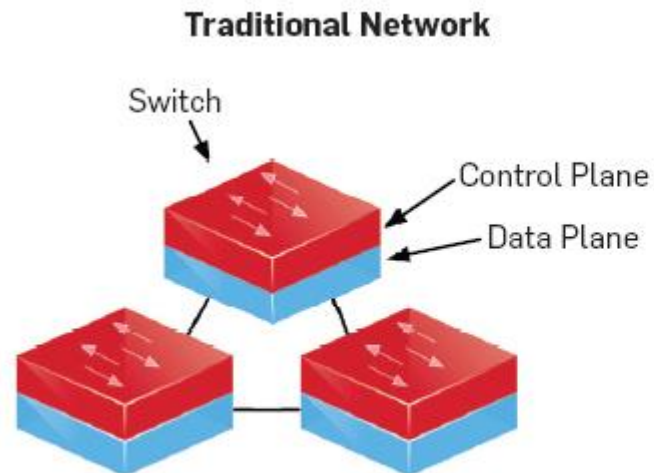
VAHID NAZAKTABAR

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- What is SDN?

- How does it work?

- Advantages and Disadvantages

- SDN's Application Example 1, Internet Service Providers

- SDN's Application Example 2, Google

- Conclusion and Future Works

What is SDN?

- Single/Central Controller vs Many/Distributed Controller

- Simple Forwarder vs Complicated Forwarder

- Standard API vs Vendor Variety

Traditional Network

Switch

Control Plane

Data Plane

Software-Defined Network

Programmable Switch

Controller Machine

What is SDN?

Application Layer: User application (Security, Routing, Optimization, …)

Control Layer: Operating System (Logic Layer)
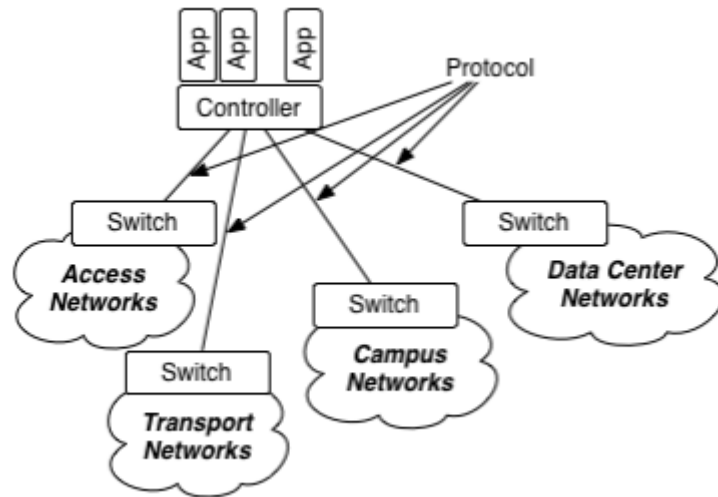
Data Layer: Physical Equipment (Switch & Router)
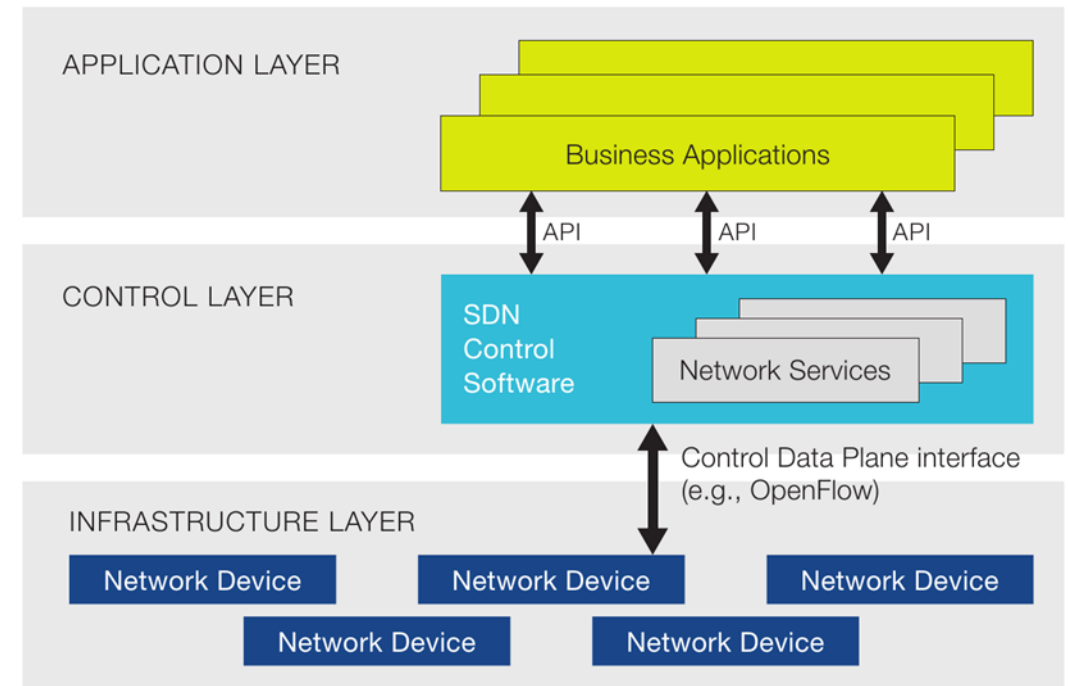
OpenFlow

Standard in Southern API (only one of many)

University of Stanford, 2008

Current Version "1.5"

Type\Version	OFP 1.0 1	OFP 1.1 2	OFP 1.2 3	OFP 1.3 4	OFP 1.4 5
0	Hello	Hello	Hello	Hello	Hello
1	Error	Error	Error	Error	Error
2	EchoReq	EchoReq	EchoReq	EchoReq	EchoReq
3	EchoRes	EchoRes	EchoRes	EchoRes	EchoRes
4	Vendor	Experimenter	Experimenter	Experimenter	Experimenter
5	FeatureReq	FeatureReq	FeatureReq	FeatureReq	FeatureReq
6	FeatureRes	FeatureRes	FeatureRes	FeatureRes	FeatureRes
7	GetConfigReq	GetConfigReq	GetConfigReq	GetConfigReq	GetConfigReq
8	GetConfigRes	GetConfigRes	GetConfigRes	GetConfigRes	GetConfigRes
9	SetConfig	SetConfig	SetConfig	SetConfig	SetConfig
10	PacketIn	PacketIn	PacketIn	PacketIn	PacketIn
11	FlowRemoved	FlowRemoved	FlowRemoved	FlowRemoved	FlowRemoved
12	PortStatus	PortStatus	PortStatus	PortStatus	PortStatus
13	PacketOut	PacketOut	PacketOut	PacketOut	PacketOut
14	FlowMod	FlowMod	FlowMod	FlowMod	FlowMod
15	PortMod	GroupMod	GroupMod	GroupMod	GroupMod
16	StatsReq	PortMod	PortMod	PortMod	PortMod
17	StatsRes	TableMod	TableMod	TableMod	TableMod
18	BarrierReq	StatsReq	StatsReq	MultipartReq	MultipartReq
19	BarrierRes	StatsRes	StatsRes	MultipartRes	MultipartRes
20	QueueGetConfigReq	BarrierReq	BarrierReq	BarrierReq	BarrierReq
21	QueueGetConfigRes	BarrierRes	BarrierRes	BarrierRes	BarrierRes
22	-	QueueGetConfigReq	QueueGetConfigReq	QueueGetConfigReq	-
23	-	QueueGetConfigRes	QueueGetConfigRes	QueueGetConfigRes	-
24	-	-	RoleReq	RoleReq	RoleReq
25	-	-	RoleRes	RoleRes	RoleRes
26	-	-	-	GetAsyncReq	GetAsyncReq
27	-	-	-	GetAsyncRes	GetAsyncRes
28	-	-	-	SetAsync	SetSync
29	-	-	-	MeterMod	MeterMod
30	-	-	-	-	RoleStatus
31	-	-	-	-	TableStatus
32	-	-	-	-	RequestForward
33	-	-	-	-	BundleControl
34	-	-	-	-	BundleAddMessage

Advantages and Disadvantages

+ Programmability: Enable innovation/differentiation - Accelerate new features and services introduction

+ Centralized Intelligence: Simplify provisioning - Optimize performance - Granular policy management

+ Abstraction: Decouple Hardware & Software - Control plane & forwarding - Physical & logical

+ Flexibility

+ Global View

- Scalability

SDN Forwarding Mode

➤ **Proactive Mode**

➤ **Reactive Mode**

➤ **Predictive Mode**
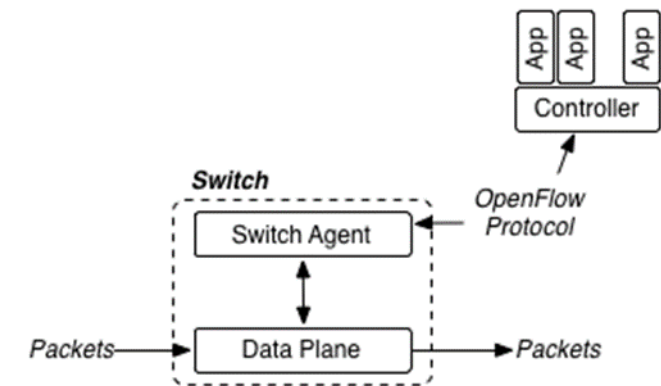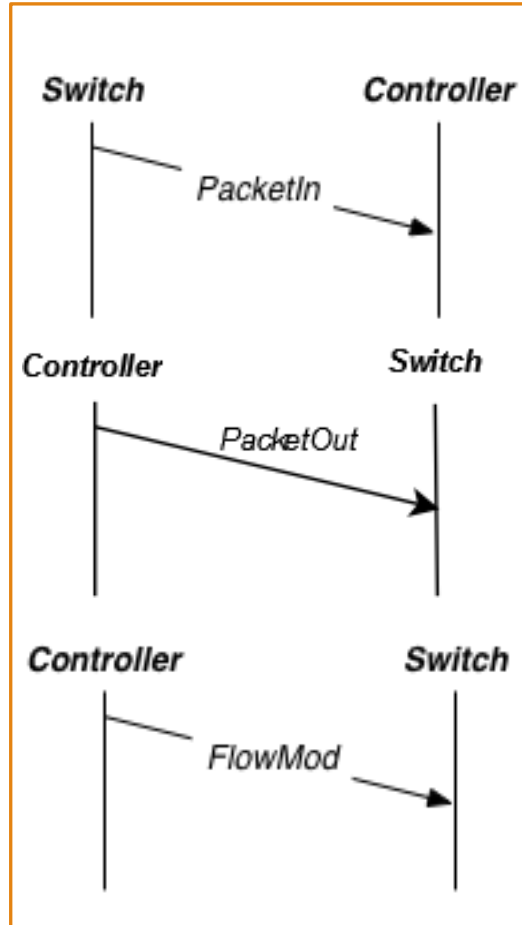
Reactive Mode, Unknown-Unknown

$$1 * M_{packet\_in} + S * M_{flow\_mod} + H * M_{packet\_out} + 1 * M_{packet\_in} + S * M_{flow\_mod} + 1 * M_{packet\_out} + 1 * M_{packet\_in} + 1 * M_{packet\_out}$$

Reactive Mode, Known-Unknown

$$+ H * M_{packet\_out} + 1 * M_{packet\_in} + S * M_{flow\_mod} + 1 * M_{packet\_out} + 1 * M_{packet\_in} + 1 * M_{packet\_out}$$

Reactive Mode, Unknown-Known

$$2 * M_{packet\_out} + 2 * M_{packet\_in} + S * M_{flow\_mod}$$

Reactive Mode, Known-Known

$$2 * M_{packet_{in}} + 2 * M_{packet_{out}}$$

SDN and its scalability

$$M = O(H) \ \& \ M = O(S)$$

Example of SDN's application

Problem:

Using internet in different aspects of daily life like economy, research, education and entertainment is very important. New services like interactive multimedia system cause diversity in application's type. This diversity causes a variety in the requirement to be satisfied by the quality of services demand. Thus, internet service providers (ISP) are facing challenges to satisfying their customers. From this point of view, satisfying these needs, require momentary changes in the settings of their internal network structure, due to the number of customers, this is a complex and expensive task.

Solution: SDN!

Is SDN a match?

Now, We want to see, How SDN can help us Solve this problem…

Is SDN a match?

Now, We want to see, How SDN can help us Solve this problem...

Dynamic Changes in Users Demands

✓ (Flexibility)

Is SDN a match?

Now, We want to see, How SDN can help us Solve this problem…

Variety in different service requirements

✓ (Programmability)

Is SDN a match?

Now, We want to see, How SDN can help us Solve this problem…

Different Brands and Vendor

✓ (Standard OpenFlow API)

Is SDN a match?

Now, We want to see, How SDN can help us Solve this problem...

Expensive traditional solutions in ISPs
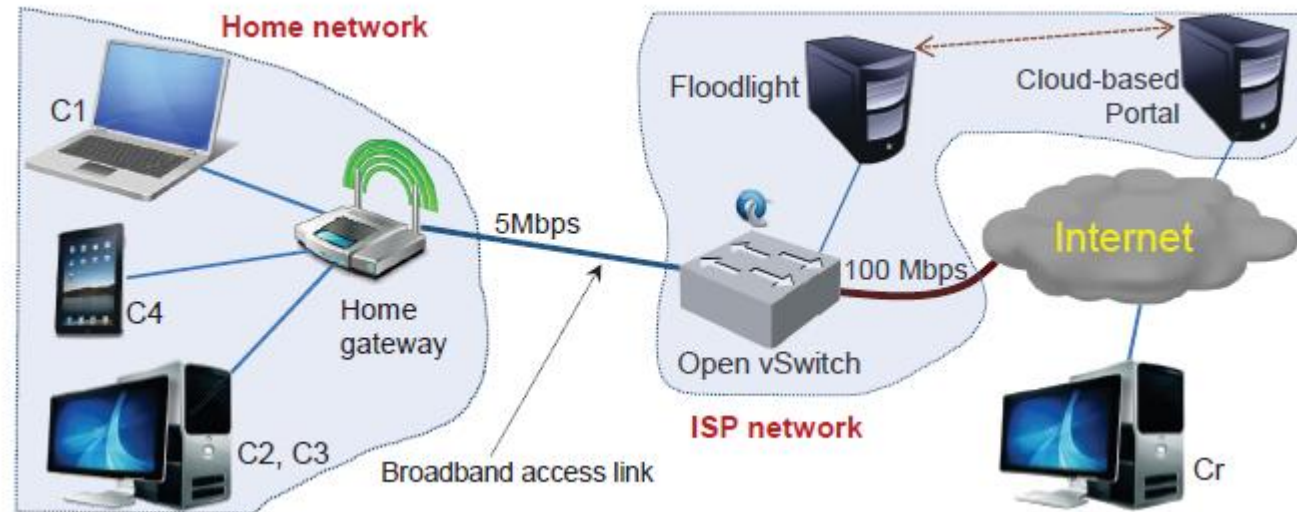
✓ (One time development in Control Plane)

Is SDN a match?

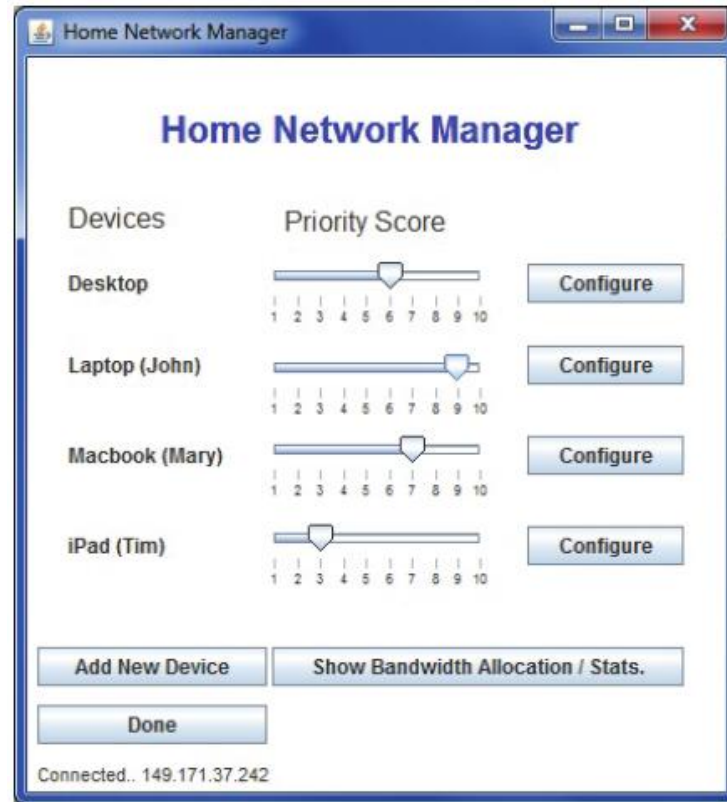Now, We want to see, How SDN can help us Solve this problem…

Economic overhead for home users

✓ (No Need to add new Infrastructure Devices)
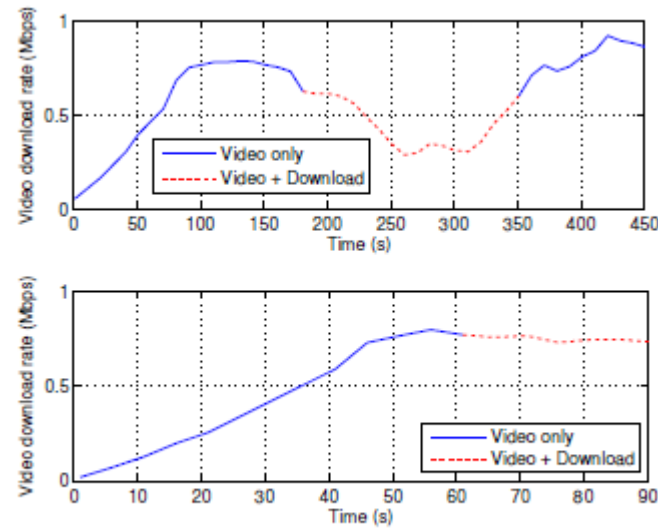
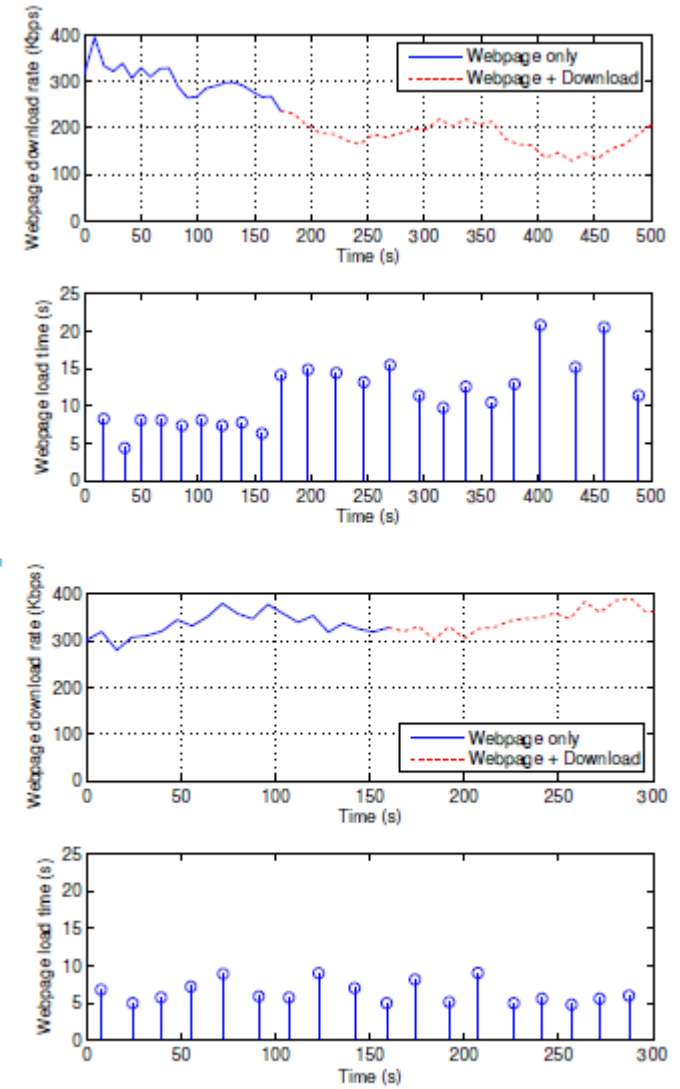# Framework based on SDN

Framework based on SDN

Results

Results

Video stream

Web browsing

SDN and its scalability

User flow(distinct set): F

ISP total flow: FU_{ISP}

$$M = U_{pop} * M_{uu} + U_{pop} * (F - 1) * M_{ku}$$
$$M = O(H) \ \& \ M = O(S)$$

Variable	Value
Number of users(U)	~1M
User per BRAS(n)	32768
DSLAM per access switch	32
Number of access switch	30

Number of Rules effect on performance

Dell 5406zl forwarding schema	Descriptor size	Possible entries	Lookup	Rules	Entries per active host
Ethernet L2 Switch	60 bits	~64000	Standard memory hash lookup	Per-destination	1
OpenFlow Switch	288 bits	~1500	TCAM wildcarding	Per-flow	~10

Number of Rules effect on performance

Number of rules effect on switch performance (Mpps)
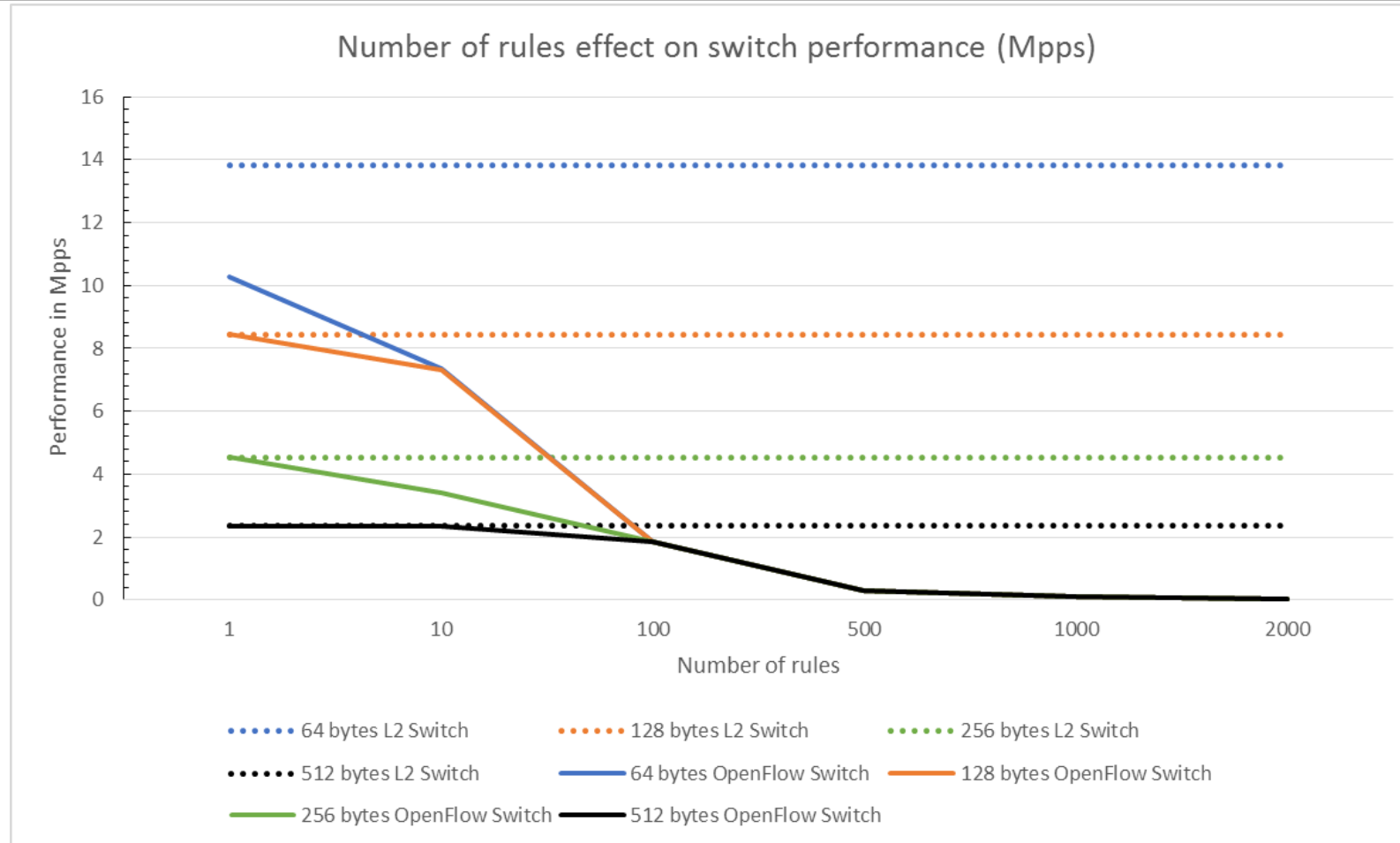
Some companies use SDN

Google: implement SDN with OpenFlow switches for intra Backbone network

Microsoft: Implementing overlay technology, communicating via enhanced OpenFlow, creating tens of thousands of virtual networks

eBay: Creating public cloud virtual networks base on SDN

Goldman Sachs: Using Floodlight-based application and OpenFlow-supporting commodity switches

Rackspace: Creating large multitenant public clouds with SDN

Google Network

Two type of google Networks
- ◦ User-Facing Network (internet traffic)
- ◦ B4 Network (Datacenter traffic)

unique characteristics of Google B4 Network
- ◦ 90% of all traffic generated in google network
- ◦ Massive bandwidth requirements deployed due to number of sites
- ◦ Dynamic traffic demand that seeks to maximize average bandwidth
- ◦ Full control over the edge servers and network

Traffic types across B4

- **user data copies** (e.g., email, documents, audio/video files) to remote data centers for availability

- **remote storage access** for computation over inherently distributed data sources

- **large-scale data** push synchronizing state across multiple data centers

Google's SDN on B4

Google's SDN architecture in 2 layers
- ◦ Switch hardware
- ◦ Site controllers

- ✓ Global View is The Key!

Some features of SDN Network
- ◦ SDN adjust transmission rates to avoid the need for deep buffer while avoiding expensive packet drops
- ◦ SDN specifies the bandwidth allocation to an application
- ◦ Optimization Algorithm to prioritize at bottleneck sites

Advantage of B4 base on SDN

- Convergence time decreased

- Better network link utilization →

- Allows more control on network bandwidth

- Great environment for testing new protocols

- Overall view from all datacenter traffic
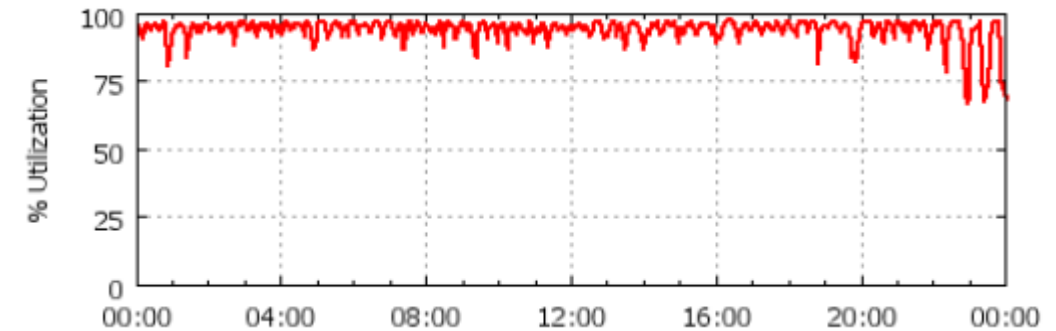
Conclusion

- What's SDN?

- Example 1: Good solution, not suitable for real world!

- Example 2: Good solution with a good development and good results!

- What is the future of SDN? What should we do?

Future…

- ✓ Create social network of SDN Experts

- ✓ Generate Content (Tutorials, Papers, Simulation and Development Reports, …)

- ✓ Weekly meetings

Specials thanks…

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Specials thanks…

Thank you!