

Software Defined Networking

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- 1 The Road to SDN
- 2 Die SDN Architektur
- 3 OpenFlow
 - Switches
 - Controller
- 4 SDN im Lab (und zuhause)



Inhalt

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Unser Netzwerk soll schöner* werden

*:

- Das alte Netzwerk ist uns nicht flexibel genug
- Wir können das besser/Wir sind voll alternativ und so!
- Dynamisch, programmierbar, cyber!!1!
- Dieses mal klappt das auch

RIP

- Active Networks
- ForCES
- NETCONF/YANG
- I2RS

OpenFlow ist der neue Hype

- < 2009 in Stanford entwickelt
- „from scratch“
- Konzept für ein Campus Network

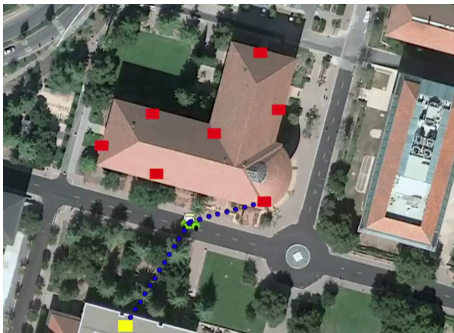


Abbildung: <https://www.youtube.com/watch?v=-Ypqwryn7As>



Open Networking Foundation

Accton

ADVA

Alibaba Group

Allied Telesis

Infinera

Infoblox

Intel

Intel

ARGELA

Aricent

ARM

AT&T

Inventec

ITRI

IXIA

Juniper

ATTO

Baidu

BAREFOOT NETWORKS

Bit

Kulcloud

Lenovo

Level(3)

LUMEN

BDS

BLUE COAT

Brain4Net

Broadcom

Mediatek

Microsoft

NAIM

NEC

BROCADE

bti

CAVIUM

CENGN

Nephos

NetScout

NETSCOUT

NETSCOUT

CENTEC

cenx

CERAGON

China Mobile

NOKIA

Northbound

NoviFlow

PCCW Global

中国移动

中国电信

China Telecom

China Telecom

NXP

xNet

ORACLE

PCCW Global

CISCO

CITRIX

Coriant

CORSA

PICA8

Prestige

RICOH

Sanctum Networks

CRITERION NETWORKS

D&H

DELL Force10

T-Mobile

SDN Essentials

SDNLAB

sedona systems

SDNLAB

ECI

ecode

ERICSSON

ETRI

sify

SK Telecom

smoptics

SPRINT

Extreme networks

FiberHome

FUJITSU

swisscom

TSMC

TATA

TELECOM

Gigamon

Globe Business

Golden Gate

Google

TTA

Telefonica

TELUS

Tencent

H3C

HCL

Hewlett Packard Enterprise

HUAWEI

TREQ

UBERFLOW

velocloud

verizon

TSC

Virtela

vodafone

WIPRO

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0815 Netzwerk

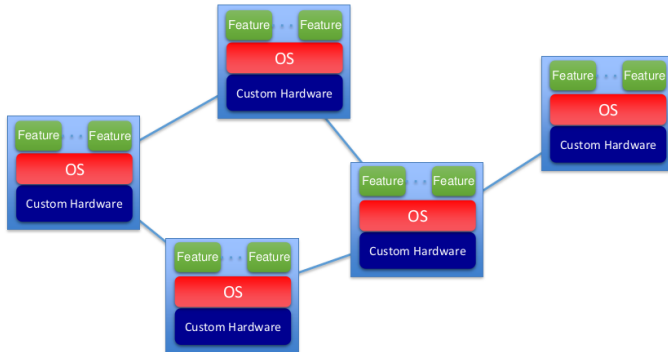


Abbildung: Nick McKeown, keynote speech for ITC 2011



SDN Netzwerk

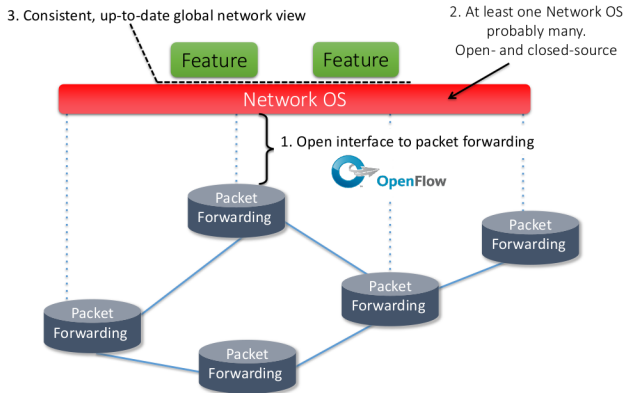


Abbildung: Nick McKeown, keynote speech for ITC 2011



SDN nach IETF (RFC7426)

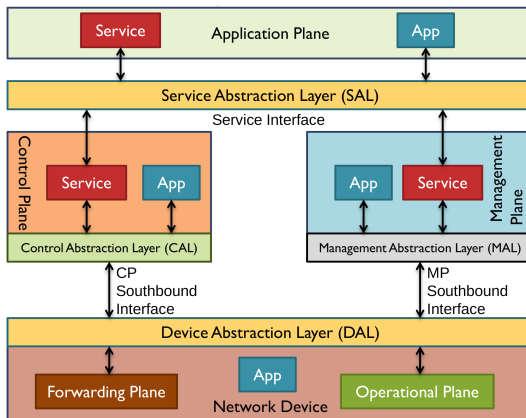


Abbildung: <https://datatracker.ietf.org/doc/rfc7426/>



Toll, aber Was hab ich davon?

Eine einheitliche Schnittstelle zu meinen Netzwerkgeräten!

- Einfaches hinzufügen/tauschen von Geräten
- Ich muss nicht immer vom gleichen Hersteller kaufen
- Dynamisch Traffic lenken
- Applikationen wie Firewall, Load-balancer
- ...

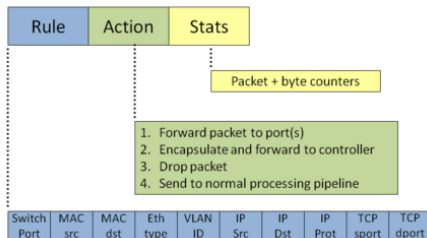
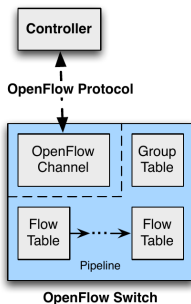


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OpenFlow - SDN in der Praxis



Stanford CS244 Wiki. <http://yuba.stanford.edu/cs244wiki/index.php/Overview>



OpenFlow v1.4 Match Fields

No.	Content	No.	Content
01	Switch input port	21	ARP opcode
02	Switch physical input port	22	ARP source IPv4 address
03	Metadata passed between tables	23	ARP target IPv4 address
04	Ethernet destination address	24	ARP source hardware address
05	Ethernet source address	25	ARP target hardware address
06	Ethernet frame type	26	IPv6 source address
07	VLAN id	27	IPv6 destination address
08	VLAN priority	28	IPv6 Flow Label
09	IP DSCP (6 bits in ToS field)	29	ICMPv6 type
10	IP ECN (2 bits in ToS field)	30	ICMPv6 code
11	IP protocol	31	Target address for ND
12	IPv4 source address	32	Source link-layer for ND
13	IPv4 destination address	33	Target link-layer for ND
14	TCP source port	34	MPLS label
15	TCP destination port	35	MPLS TC
16	UDP source port	36	MPLS BoS bit
17	UDP destination port	37	PBB I-SID
18	SCTP source port	38	Logical Port Metadata
19	ICMP type	39	IPv6 Extension Header pseudo-field
20	ICMP code	41	PBB UCA header field



OpenFlow Capable Switch

- Option 1: Switch der großen Netzerkäufer
 - HP 2920/3500 Switch Series > 1k €
 - NEC PF5240/PF5820 > 6k €
 - Brocade CER 2000 Series > 10k €
- Option 2: (Open Source) Software Switch

Name	OpenFlow	Aktiv von-bis
Stanford Reference Switch	1.0	2009-2011
Pantou	1.0	2010-2011
OFSwitch	1.3+	2012-
Open vSwitch	1.3+	2009-



OpenFlow Controller

Name	Northbound Interfaces	OpenFlow Versions
NOX	C++	1.0
POX	Python	1.0
Beacon	Java	1.0
Floodlight	REST, Java	1.0, 1.3
OpenDaylight	REST, OSGi	1.0, 1.3
Ryu	Python, REST, RPC	1.0, 1.2, 1.3, 1.4
FlowVisor	OpenFlow	1.0



Floodlight


[Dashboard](#) [Topology](#) [Switches](#) [Hosts](#)

Switch 00:00:5c:26:0a:5a:c8:b2

Nicira Networks, Inc.

Open vSwitch

1.4.3-bu303

S/N: None

Ports (5)

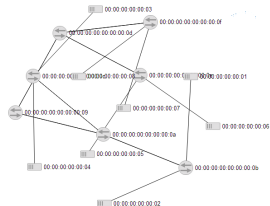
#	Link Status	TX Bytes	RX Bytes	TX Pkts	RX Pkts	Errors
6		11960221	4950669	90483	47846	
5		9702116	2018054	70172	26626	
7		11889614	4580560	69050	48367	
-2		1343200979	1523879336	2459019	1359336	
1		1627947094	1300029638	1404065	2533176	

Flows (8)

Cookie	Priority	Match	Action	Packets	Bytes	Age	Timeout
-687779669	-32768	src=00:00:00:00:00:00, dst=00:00:00:00:00:00, port=0	OUTPUT 6	21981	2264194	25683 s	0 s
-687779667	-32768	src=00:00:00:00:00:00, dst=02:22:22:22:22:22, port=0	OUTPUT 7	16316	1863740	8065 s	0 s
-687779668	-32768	src=00:00:00:00:00:00, dst=00:11:22:cc:cc:10, port=0	OUTPUT 6	42061	4251337	25683 s	0 s
9007198254740962	0	src=02:22:22:22:cc:10, dst=10:42:03:94:a0:82, port=7	OUTPUT 1	11	1022	11 s	5 s
9007198254740962	0	src=0c:26:0a:5a:c8:b2, dst=10:42:03:94:a0:82, port=2	OUTPUT 1	395214	1183245941	24382 s	5 s
9007198254740962	0	src=00:00:00:00:00:10, dst=00:23:69:42:26:09, port=6	OUTPUT 1	21905	2137919	12123 s	5 s
9007198254740962	0	src=10:42:03:94:a0:82, dst=0c:26:0a:5a:c8:b2, port=1	OUTPUT 2	668200	49039115	24311 s	5 s
9007198254740962	0	src=00:11:22:cc:cc:10, dst=0c:26:0a:5a:c8:b2, port=6	OUTPUT 2	39	3710	37 s	5 s


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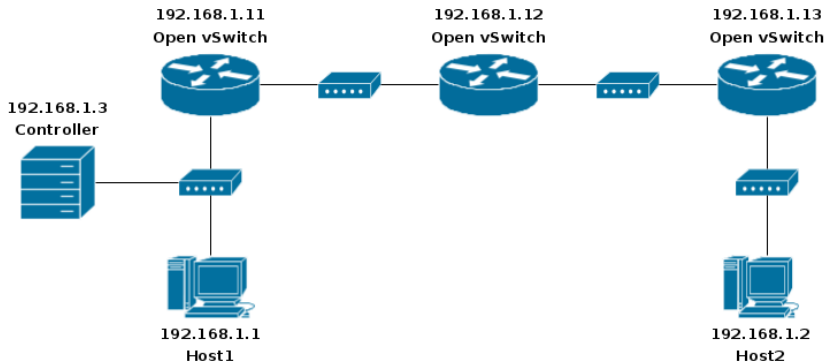
Network Topology



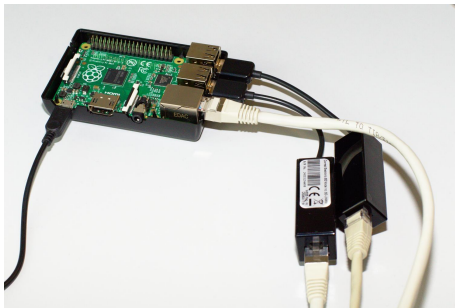
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Raspberry Pi

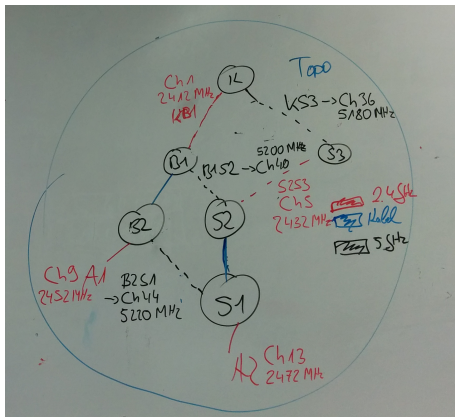


TP-Link Router



Wireless SDN

„Topology Discovery in Multi-Radio Multi-Channel Software Defined Wireless Mesh Networks“



Simulation mit NS3

