

The Path to SDN

Networking has seen more innovation in the past two years than in the past 20 years. This innovation is coming from the perfect storm of:

- 'Software-Defined Networking,' a new architecture in networking
- 'White box' and 'brite box' switching
- The popularization of advanced datacenter designs pioneered by Google, Facebook, Amazon, and other hyperscale operators

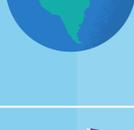
A Look Back at How It All Started

"Centralize what you can, distribute what you must" — Pradeep Sindhu, Founder, Juniper Networks

Pre-SDN (2009)

Cisco Maintains Switching Dominance

In 2009, Cisco owned a **69% worldwide** market share of the ethernet switch market. The remainder of market share was owned by IBM, Extreme, Dell, HP, Juniper, Arista, and Brocade.



Clients especially recently have come to us asking about alternatives to Cisco, not because they're unhappy with Cisco, because they're trying to introduce competition into the equation, especially when their budgets are tight.

Dave Passmore
Network, Data Center and Infrastructure Analyst
The Burton Group

2009

Academic Research

GENI funds OpenFlow research at universities across the country



December 2010



OpenFlow 1.0 is considered by the community to be a defining protocol of SDN, it was published at Stanford.

2011

First Commercial SDN Providers

Big Switch Networks and Nicira launch controller technologies, and HP introduces the first SDN prototype switch.

Companies investing in R&D for SDN technologies:

Big Switch, Contrail, Cumulus, HP, IBM, Insieme, Juniper, Nicira, Midokura, Pica8, and Plumgrid.

2012

SOFTWARE



HARDWARE



VMware acquires Nicira for **\$1.2B**

Juniper acquires SDN start-up Contrail for **\$176M**

Bare Metal Hardware
Hyperscale players Amazon, Facebook, Google, and Microsoft realize existing vendor technology no longer meets their unique hyperscale needs and develop their own approaches.

- External SDN Controllers
- Clos Fabric Designs
- Merchant Silicon and Bare Metal Switches

SDN: Fork in the Road

Commercial SDN software develops in two discrete paths:

OVERLAY

- VMware NSX
- Plumgrid
- Midokura
- Nuage
- Juniper Contrail

UNDERLAY

- Big Switch Networks
- Cumulus
- Insieme

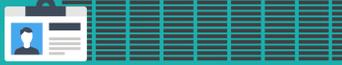
Hyperscale network organizations drove demands to think of new ways to manage at scale.

TRADITIONAL



DOZENS of switches

HYPERSCALE PLAYERS



THOUSANDS of switches

November 2013

Cisco Reacts to SDN and White Box Threat

Cisco purchases Insieme for **\$863M**



2014

Dell Open Networking Initiative

Dell announces its Open Networking Initiative. Dell is the first traditional vendor to decouple switch hardware and software.

Software offered on Dell open networking switches



Dell wants to fundamentally change the nature of networking by focusing on openness and the disaggregation of hardware and software

Tom Burns
VP & GM, Networking & Converged Infrastructure
Dell

Additional software added in 2015



June 2014

Facebook's infrastructure



1.2B+ people connected

Facebook Open Compute Project (OCP)

Facebook announces Wedge and FBOSS as its in-house approach to its datacenter networks.

We're big believers in the value of disaggregation – of breaking down traditional datacenter technologies into their core components so we can build new systems that are more flexible, more scalable, and more efficient. This approach has guided Facebook from the beginning, as we've grown and expanded our infrastructure to connect more than 1.28 billion people around the world.

Yuval Bachar & Adam Simpkins
Hardware Networking Engineer & Software Engineer
Facebook

July 2014

Purchase decision makers at medium and large North American organizations are planning to have SDN in live production:



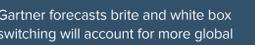
Dec 2014 – Mar 2015

Hardware and Software Disaggregation Accelerates
Juniper Networks announces disaggregation strategy with **OCX1100**, and HP announces disaggregation strategy, **Cumulus Network OS** on HP switches. Adds **Pica8** in August 2015.

"Brite-Box Switching"

'Brite' 'Baks' 'Switch-ing'
Industry term coined by **Gartner** to use when vendors decouple hardware and software.

Gartner forecasts brite and white box switching will account for more global datacenter port shipments by 2018



Infonetics Research estimates:

35M ports shipped

\$8.2B in datacenter switches sold in 2014

19% growth in ports



*These numbers are reflective of overall switch market

Mar 2015

Facebook steadily working to revolutionize data center hardware

1.39 BILLION people around the world are connected



\$2 BILLION saved in infrastructure costs over the last three years

Apr 2015

First public presentation from **Google** confirms use of SDN approach in production with projects Jupiter & Andromeda to manage hyperscale requirements. SDN implementation is based on:

- White Box Switches
- SDN Controller
- Clos Topology

We're actually been practicing software defined networking in our datacenter since before the term was really in existence, and I can tell you that in our latest generation data center network, Jupiter, we run of course SDN and OpenFlow.

Amin Vahdat
Technical Lead for Networking
Google

2015

SDN matures with hundreds of enterprise production deployments

OVERLAY

- VMware NSX
- Juniper Contrail
- Nuage VNS
- Plumgrid ONS
- Midokura MidoNet

UNDERLAY

- Cisco ACI
- Big Switch Networks' Big Cloud Fabric
- Arista Cloudvision

900+ customers

1000+ customers

US operator **AT&T** says that since implementing its SDN-enabled Network On-Demand service less than a year ago it has achieved a reduction in provisioning cycle times of up to

95%

SDN will enable greater efficiency, in which code is managed on a central basis, instead of in a more distributed form ... It will enable greater real-time network management and more finely grained application controls, boosting the efficiency of remaining hardware.

Shawn Haki
Head of Enterprise Network Platforms
Verizon

Early adopters realize advantages of investment in SDN. Proof of concept and pilot deployments in 2014, 2015. A significant number of carriers transition to significant adoption.

82%

of IHS carrier survey respondents either already deployed, are in the process of deploying, or at the very least plan to evaluate SDN in 2015.

SDN Roads Reconverge

Cisco and Big Switch offer unified physical and virtual SDN solutions that tie the overlay and underlay concepts back together.



OpenStack Unified Physical + Virtual SDN

- Cisco ACI
- Big Switch Big Cloud Fabric 3.0



VMware Overlay on NSX Workloads

- Arista
- Big Switch Networks
- Cumulus



Containers

- CoreOS
- Mesos
- Kubernetes
- Docker Container Networking + Big Switch Big Cloud Fabric

Oct 2015

HP launches open source **Network OS OpenSwitch**, new effort is supported by **Accton, Arista, Broadcom, Intel & VMware.**

Big Switch, Facebook, OCP, and NTT demonstrate first unified open Network Operating System (NOS) - Open Network Linux (ONL), FBOSS, Wedge hardware.



Dell + EMC
Dell announces intention to acquire EMC for **\$67B**

the largest tech acquisition to date

Traditional integrated technology players brace for changed IT landscape. A significant impact on networking category is expected

By the end of 2016, more than 10,000 enterprises worldwide will have deployed SDN in their networks, a tenfold increase from end-of-year 2014.

Gartner

The worldwide SDN market for the enterprise and cloud service provider segments will grow to over \$8 billion by 2018.

IDC Research

The datacenter switch market expected to exceed \$11 billion in 2019, making up roughly 44% of the switch market.

Dell'Oro Group

By 2019, just over one-quarter of all data-center switch parts that are sold will be on bare-metal devices.

IHS (Infonetics) Research