The Myth Of White-Box Network Switches
by Andre Kindness, February 20, 2015

KEY TAKEAWAYS

Vendors Have White-Box Switch Hardware As Part Of Their Portfolio
White boxes are another name for switches built from off-the-shelf components. All the traditional vendors have been offering white-box switches for a long time, and customers can reduce their raw costs by incorporating those switches.

Software, Research, Development, And Support Is Where The Costs Exist
Organizations that focus on standardizing and eliminating superfluous software features will lower costs faster than those that focus on reducing hardware, which accounts for less than 15% of network switch costs.

More Options And Flexibility Means More Responsibility
Vendor networking products offer customers tightly integrated networking solutions. Separating software and hardware provides more flexibility, but those organizations take on more of the effort that is usually the vendor's added value.
The Myth Of White-Box Network Switches
White-Box Network Hardware Offers Organizations More Flexibility And Choice, But That Comes With More Responsibility
by Andre Kindness
with Glenn O’Donnell and Michael Caputo

WHY READ THIS REPORT
Public cloud platforms have sent the networking industry into a froth of hyperbole. Over the past few years, companies offering x-as-a-service (XaaS) have been making claims that transitioning the network over to white-box switches reduced the network infrastructure costs by 90%. While white box and bare metal provide a unique value to XaaS companies, enterprise infrastructure and operations (I&O) organizations should be cautious about these claims and hidden tradeoffs. This report shines a light on vendor merchant silicon switches, steps through a cost breakdown of white-box and vendor switches, and analyzes the facts to draw attention to where the real costs exist. The research also examines the responsibilities I&O professionals must assume when white-box switches are incorporated into the enterprise network.

Table Of Contents
2 Compare Apples To Apples, Not Apples To Oranges
2 The Difference In Cost Of Goods Sold Is Negligible
Switch Variation Leads To Higher Costs
Cost Of Goods Sold Favors Vendors, Slightly
5 Software Is The Real Cost Factor
7 Flexibility And Choice Means More Responsibility
WHAT IT MEANS
8 Good Enough Is Good Enough For Your Enterprise

Notes & Resources
Forrester interviewed eight networking vendors, a network operating system vendor, two original equipment manufacturers, and a reseller.

Related Research Documents
Customer-Centric Strategies Require Business-Centric Network Hardware
December 9, 2014
Quick Take: Brocade Launches Networking’s First Commercial Open Source Software
September 23, 2014
Predictions For 2014: Servers And Data Centers
December 19, 2013
COMPARE APPLES TO APPLES, NOT APPLES TO ORANGES

Driven by the leading cloud and web companies, white-box network switches have experienced a meteoric rise in interest. Along with this hysteria, misconceptions about capital cost savings attributed to white-box switches over vendor switches have also ballooned. Most of the early switches were custom-built by vendors; however, over one-third of vendor switch models on the market today are actually built completely with off-the-shelf, commodity components. A switch is now considered customized or proprietary if the application-specific integrated circuit (ASIC) is custom-built for that purpose rather than common merchant silicon ASIC from Broadcom, Intel, or Marvell. While custom switches have custom ASICs, the reality is that most of the components — the connectors, fans, PHYs, and capacitors — are off-the-shelf components. In general, the industry has transitioned over to use commodity components inside network switches. The difference mostly lies in whether it has merchant or custom ASICs to add value. Basically, most cost savings analysis has been done based on apples-to-oranges comparisons, white-box switches versus custom ASIC switches.

Buyers tend to demonize vendors as companies that only offer proprietary solutions to lock customers in and charge them more. What many don’t know is that all the vendors offer merchant silicon ASIC switches, and the industry has offered off-the-shelf switches for years. The vendors just didn’t advertise these very well. A majority of HP’s switch models have merchant silicon in them and Arista’s entire product line uses merchant silicon. The real comparison should be made between white-box switches and vendor switches with merchant silicon inside them. Enterprises will then realize there is little cost difference between white box and vendor merchant silicon (VMS) switches. This is the true apples-to-apples comparison.

THE DIFFERENCE IN COST OF GOODS SOLD IS NEGLIGIBLE

To accurately compare white-box and VMS switches, eliminate factors that will affect the cost of goods sold (COGS) for a switch. We based our analysis on these mainstream attributes:

■ **Volume.** Prices for commodity components can vary dramatically based on volume. However, manufacturing resources are finite, and creating analysis on overly large orders isn’t practical. The best material costs come when orders are consistent and match the output of the original equipment manufacturers (OEMs) that build for multiple customers. Consequently, we based material costs on average selling rates of 10 GbE switches over the past six months, smoothed out over 12 vendors.

■ **Switch.** The market is full of commodity switches that run 10/100 Mbps connections up to 40 GbE with per-port pricing from $10 per to a few hundred dollars. Since most of the focus of white-box switches is within a data center, Forrester created an analysis around 48-port 10 GbE fiber switches with some 40 GbE connections for upstream connections. The average switch buffer was around 12 MB. These specifications are the most mainstream configurations from major vendors and white box manufacturers.
Network chips. Broadcom, Intel, and Marvell produce commodity network chips. Broadcom Trident II is the most widely used by white box and traditional vendors to create top of rack (ToR) switches. Broadcom Trident II is used on the following switches: 1) Accton AS5712-54X; 2) Arista 7250X and 7500E series; 3) Cisco Nexus 3100; 4) Dell S6000; 5) Extreme Summit X770; 6) HP Flex Fabric 5930 series; 7) Juniper QFX3500 and 5100 series; 8) Penguin Computing 4800 series; and 9) Quanta Computer’s T3048 series.

Using these three attributes, Forrester found the material cost for a 10/40 GbE switch comes in at around $2,100, whether it’s a white-box or VMS switch. The switches use off-the-shelf components, and 81% of the material costs can be associated with these four categories: 1) ASIC at about $550 per switch; 2) SFP/SFP+/QSFP+ connectors and cages at about $500; 3) CPU and associated memory at about $350; and 4) power supplies for full redundancy at about $300. Since three to four companies manufacture components for each category, little latitude exists to optimize the cost structure. Switch architecture and layout doesn’t vary much, either.

Switch Variation Leads To Higher Costs

This doesn’t mean all switches or Broadcom Trident II-based hardware are exactly the same. Identical configurations do not apply to all customers. For example, high frequency trading and manufacturing plants have completely different applications and services from each other. Therefore, vendors will design and produce switches for different types of customers. The switches will vary in one or more of the following ways:

- A variety of connection types. Data centers running Fibre Channel might want some of the ports to support 4 Gbps/8 Gbps. Other data centers might use copper and fiber connections, which require switches to support copper connections, too.

- Larger buffers. While most commodity switches support up to 12 mb of shared memory, some vendors offer up to 4 GB of buffers for environments that need to accommodate traffic bursts. For example, financial services that get inundated with data during certain times of the year will need more buffer space.

- Improved CPU performance. The CPU might vary based on the performance needs of the OS. Some vendors have built in extra capabilities to handle TCAM tables in a more efficient manner for faster packet processing.

- More advanced packet processor features. As companies strive to automate more tasks, more visibility is needed, which leverages timestamping, deduplication packets, packet stripping, and other advanced capabilities. This could require additional hardware like more memory, extra CPUs, additional PHYs, or other components.
Extra services. Some switches offer extra capabilities to host security, acceleration, or other services. Arista offers customers a 50 GB solid state drive to support logging or data collection; Facebook's Wedge supports an x86-based server connected to the board to accommodate a Linux-based operating system.

There are over 25 hardware variations of 10/40GbE switches with a wide price range. Each component or feature nuance can cause a dramatic effect on pricing since they alter the amount and types of components along with volume. A switch built for a particular type of customer or market means a lower run rate and lower volume discounts. In addition, this will increase the manufacturing, supply chain and warranty costs since these all are impacted by material costs.

Cost Of Goods Sold Favors Vendors, Slightly

While the material costs are similar, the COGS might be slightly less for vendors than for white-box solutions. Still, it's relatively insignificant to the final cost, which is approximately $2,600 (see Figure 1). For the networking industry, the direct cost associated with hardware encompasses these three areas:

Cost of manufacturing. The cost to manufacturer for both types of switches is similar. These commodity and white-box switches are basically produced from a handful of global OEM/ODM vendors, such as Accton, Alpha Networks, Foxconn Technology Group, and Quanta Computer. At any one of those OEMs, batches of Cisco, Dell, HP, and other switches are produced on the same assembly line, by the same people, and using the same tooling. Operations are highly automated, removing much of the labor expense.

Cost of supply chain. Leveraging supply chain synergies from other product lines, mainstream vendors have a 2% to 3% material cost advantage over white box producers. Component manufacturers create standalone pricing contracts with individual companies, not the OEMs that serve multiple companies, because the vendors make the final decision on components. This supply chain strategy only holds true for components such as ASICs, CPUs, fans, memory power supplies, and other high-priced parts. Sheet metal, screws, and light emitting diodes (LEDs) will be sourced through the OEM.

Support and warranty costs. The warranty and support cost run about 3% lower for vendor switches than their white box counterparts. VMS switch failure rates are lower, since they design to higher standards to accommodate extended warranties. In addition, vendors will run tests based on worst case conditions, which is typically when all the software features are turned on, producing the most heat. White-box switches don't test their devices to the same conditions since they will test only a set of features that are common across firmware.
For Infrastructure & Operations Professionals

The Myth of White-Box Network Switches

Software is the Real Cost Factor

Big Switch Networks, Cumulus Networks, and Pica8 offer network operating systems that run on the switches themselves. Cumulus has been certified on 10 different 10/40 GbE switches, the most of the three vendors. It offers its network operating system at an annual licensing fee of $1,000. The average refresh cycle for switches is around six years. An organization purchasing Accton’s switch with the Cumulus Linux operating system will spend around $13,332 over the six years. A comparable mainstream product (Cisco’s Nexus 3172PQ) will cost around $14,197 over the same period.

Hardware accounts for less than 15% of the cost. Most of the cost of switches is based on the software across the following indirect cost categories (see Figure 2):

- **Research and development (R&D) investment costs.** Nonrecurring engineering costs can average $500,000 to $5 million for switches. For this report’s benchmark switch, Forrester estimates R&D investment will be around $3.5 million. The R&D costs are higher for vendors, because vendors spend resources optimizing the switch for their software and meeting their warranty goals. For example, HP offers a lifetime warranty on its switches. Fans are the most common failure component, so HP spends more R&D time to incorporate and test fans with higher cycle times to keep its warranty costs lower. White box manufacturers focus more on the bottom line and will choose fans based on thermal conditions and price.

- **Operation costs.** The operational costs are significantly higher for traditional vendors, since those companies have larger sales, technical, and marketing departments that work directly with customers and value-added resellers (VARs). Most network vendors also offer training and certification programs, which is rare among white box vendors and network operating system vendors.
Support costs. Support costs are slightly lower for vendors because their R&D yields products needing less support. The higher level of software and hardware integration work, ease of use features, classes, and deployment services keeps support costs lower. Also, to augment support, these vendors offer extra services such as training classes that are priced separately. Their communities provide support that costs the vendor little more than nurturing these communities. Furthermore, software vendors will have to spend more time working with different hardware vendors, working through issues that arise from supporting different ASICs and component configurations.

Profit. The profit per unit will be higher with established vendors. White box pricing is based on volume, so their profits are smaller per unit. Since white box vendors are not tied to a specific piece of software, they are more likely to replace components or products as lower-cost options become available. Traditional vendors don’t have this option and have to ride out certain components.

Tax. Since the tax rate is based on profit, the obligation will be higher for vendors.

VARs. The costs associated with VARs will be slightly higher for white box since white box vendors will have to lean on the VARs to provide some of the service and support normally handled by traditional network vendors, such as integration and testing. In addition, there is a higher operating cost for VARs to manage more vendors. Therefore, the channel will expect a higher return on the products.

Figure 2 Street Price Breakdown Of 10/40 GbE Broadcom Based White-Box And Vendor Switches

<table>
<thead>
<tr>
<th></th>
<th>White-box operating system (Cumulus Linux for 6.6 yrs)</th>
<th>White-box hardware cost (Accton AS5712-54X)</th>
<th>White-box hardware operating system</th>
<th>Vendor (Cisco Nexus 3172PQ)</th>
<th>Final cost of white-box switch vs. traditional network vendor switch</th>
</tr>
</thead>
<tbody>
<tr>
<td>COGS</td>
<td>$0</td>
<td>$2,589</td>
<td>$2,589</td>
<td>$2,589</td>
<td>$2,589</td>
</tr>
<tr>
<td>Operating (execs, HR, marketing, engineers, supply chain)</td>
<td>$1,665</td>
<td>$1,000</td>
<td>$2,655</td>
<td>$3,595</td>
<td></td>
</tr>
<tr>
<td>Investment cost spread out over the life</td>
<td>$695</td>
<td>$252</td>
<td>$947</td>
<td>$1,100</td>
<td></td>
</tr>
<tr>
<td>Support</td>
<td>$600</td>
<td>$200</td>
<td>$800</td>
<td>$698</td>
<td></td>
</tr>
<tr>
<td>Tax burden</td>
<td>$1,150</td>
<td>$800</td>
<td>$1,950</td>
<td>$1,956</td>
<td></td>
</tr>
<tr>
<td>Profit</td>
<td>$1,100</td>
<td>$899</td>
<td>$1,999</td>
<td>$2,128</td>
<td></td>
</tr>
<tr>
<td>Value-added reseller</td>
<td>$1,400</td>
<td>$1,000</td>
<td>$2,400</td>
<td>$2,132</td>
<td></td>
</tr>
<tr>
<td>Final price to customer</td>
<td>$6,600</td>
<td>$6,739</td>
<td>$13,339</td>
<td>$14,198</td>
<td></td>
</tr>
</tbody>
</table>
FLEXIBILITY AND CHOICE MEANS MORE RESPONSIBILITY

Customers often cite cost as the best reason to choose white-box switches. This perception is unfounded. The real reason to choose white-box switches is flexibility and choice. By separating the network operating system from the hardware, white box and bare metal offerings provide companies another choice beyond the number of vendors to choose from or the number of models each vendor offers. Customers can choose operating systems and hardware as separate items and assemble their own complete solutions. This is an important element for XaaS providers that differentiate business based on having the most competitive data centers. These data centers constantly need to have the fastest, most powerful, and cheapest servers, storage, and networking hardware. Hardware has a short life cycle in this type of infrastructure, where equipment is replaced every eight to 12 months.

To make this model work, web-scale XaaS companies — with large purchasing power — pushed the networking industry to decouple software and hardware and create hardware that can be easily swapped out with the least amount of operation cost. Standardized, simple, and generic hardware forms a technology foundation for the business model of these companies.

Enterprises don’t have the resources or cost structure to operate on this time table (nor should they). The white box model comes with tradeoffs. Companies pushing for white box and bare metal alternatives have chosen to take on:

- **The design, testing, and qualification of network operating systems and hardware.** The speed and capabilities of a network switch depends equally on the hardware and software interaction. This is part of the R&D costs of vendor switches that transfers to customers. Web-scale providers take this R&D on themselves since there are no industry-compatibility tests for their highly customized software and hardware combinations.

- **Supply chain costs.** Companies like Amazon, Facebook, Google, and Rackspace do most of their buying in the US and working with a unique and small set of value-added resellers. The hyper-scale cloud providers are developing them as they build out data centers in different regions. Global enterprises will have difficulty finding distributors and VARs selling white box products, let alone getting them on any list of approved vendors. In addition, most enterprises work directly with vendors. OEM and ODM companies haven’t built out their business structure to support this method. Supply chain overhead, handled efficiently by traditional vendors, will be painful for most enterprises.

- **Development of network features.** A lot of advanced features, like HP’s Intelligent Resilient Framework (IRF) or Brocade’s Virtual Cluster Switching (VCS) technology, do not exist in the white box environment. The commercially available and open source network operating systems have a standard set of features, such as open shortest path first (OSPF) and IEEE 802.1Q.
providers had to develop their own advanced features and even some basic ones found in many switches today. These companies take on R&D normally performed by vendors. Many capabilities are considered competitive differentiators and are not shared.

- **Installation costs.** While most white-box switches are built on the Open Network Install Environment (ONIE), this is not the case for all of them. With ONIE loaded or not, these devices don’t have an operating system on them, so extra time is spent adding the OS before any configuration can start. In addition, a lot of plug-and-play features on vendor switches allow switches to be installed anywhere without much on-site skill. White box customers must alter their deployment methods to accommodate this change and the extra costs associated with this type of activity.

- **Support and service.** Multitiered support with globally distributed call centers is an option that is readily available from white box vendors. Edge-Core Networks provides three-year warranty replacement, although it doesn’t offer a statement on how long the warranty center will take to replace the hardware or the time frame of resolution. With software, the companies that purchase it assume all the troubleshooting and bug fixing for all the development they do. The software vendor will only fix its own bugs. Some companies have run into disagreements with the software vendor on where the bugs exist. In addition, finger-pointing is common between the software and hardware vendors.

- **Developing and deploying software and services around hardware.** Web-scale companies have highly standardized environments with little variation in hardware capabilities. Unlike enterprises, software is chosen or designed around the hardware. These companies don’t send out hardware requests for proposal based on details like certain power supply unit failover times, fiber and copper ports, and LED placement/color/behavior. A highly standardized infrastructure requires little deviation across the network, which translates into few options from white box solutions.

### WHAT IT MEANS

**GOOD ENOUGH IS GOOD ENOUGH FOR YOUR ENTERPRISE**

Enterprise I&O professionals should consider that their counterparts at Cloud providers have shown that enterprise networking infrastructure was being designed, bought, and deployed with too much emphasis on installing the biggest, fastest, and most feature-rich switch. Less is more in the XaaS world. These companies are making huge cuts in capital costs and running infrastructures with fewer resources, because cloud networking professionals are choosing to standardize while balancing cost with performance and features. This is not right for every company, but it provides credence that switches based on merchant silicon are a viable option for enterprises. VMS switches provide the lower costs and all the value that traditional vendors bring to the table.
ENDNOTES

1. Any electronic retailer carries common electronic components: a capacitor is an electronic component used to store energy; a PHY connects a link layer device to a physical medium such as an optical fiber or copper cable; or power supplies provide power to the electronic device.

2. The top of rack switch sits at the top of the server rack, providing links to all the servers and uplinks to distribution or spine of the network that might be at the end of the row. This is different from an end of row switch, which is larger and connects all the racks and servers in the row to a single device.

3. This report explains how the network equipment market is developing specialized products for certain vertical markets and associated specialized tasks. For more information, see the December 9, 2014, “Customer-Centric Strategies Require Business-Centric Network Hardware” report.

4. Ternary content-addressable memory (TCAM) is a specialized type of high-speed memory that searches its entire contents in a single clock cycle. The term “ternary” refers to the memory’s ability to store and query data using three different inputs: 0, 1, and X. The “X” input, which is often referred to as a “don’t care” or “wildcard” state, enables TCAM to perform broader searches based on pattern matching, as opposed to binary CAM, which performs exact-match searches using only 0’s and 1’s. Source: Margaret Rouse, “(TCAM) ternary content-addressable memory,” TechTarget (http://searchnetworking.techtarget.com/definition/TCAM-ternary-content-addressable-memory).


6. Data was gathered from networking vendors and original equipment manufacturer.


9. ONIE is a small Linux package whose only job in life is to aid with putting the correct OS on your white-box switch, whether that be a fresh install, upgrading, or changing distribution. There are a lot of different ways ONIE can download the target OS. With preloaded ONIE environment, you are free to choose any compatible network OS (NOS).

About Forrester

A global research and advisory firm, Forrester inspires leaders, informs better decisions, and helps the world’s top companies turn the complexity of change into business advantage. Our research-based insight and objective advice enable IT professionals to lead more successfully within IT and extend their impact beyond the traditional IT organization. Tailored to your individual role, our resources allow you to focus on important business issues — margin, speed, growth — first, technology second.

FOR MORE INFORMATION

To find out how Forrester Research can help you be successful every day, please contact the office nearest you, or visit us at www.forrester.com. For a complete list of worldwide locations, visit www.forrester.com/about.

CLIENT SUPPORT

For information on hard-copy or electronic reprints, please contact Client Support at +1 866.367.7378, +1 617.613.5730, or clientsupport@forrester.com. We offer quantity discounts and special pricing for academic and nonprofit institutions.

Forrester Focuses On Infrastructure & Operations Professionals

You are responsible for identifying — and justifying — which technologies and process changes will help you transform and industrialize your company’s infrastructure and create a more productive, resilient, and effective IT organization. Forrester’s subject-matter expertise and deep understanding of your role will help you create forward-thinking strategies; weigh opportunity against risk; justify decisions; and optimize your individual, team, and corporate performance.

IAN OLIVER, client persona representing Infrastructure & Operations Professionals

Forrester Research (Nasdaq: FORR) is a global research and advisory firm serving professionals in 13 key roles across three distinct client segments. Our clients face progressively complex business and technology decisions every day. To help them understand, strategize, and act upon opportunities brought by change, Forrester provides proprietary research, consumer and business data, custom consulting, events and online communities, and peer-to-peer executive programs. We guide leaders in business technology, marketing and strategy, and the technology industry through independent fact-based insight, ensuring their business success today and tomorrow.