CUMULUS

Achieve actionable insight into your network — from host to switch

BUILDING WEB-SCALE OPERATIONS WORKFLOWS WITH NETQ

Contents

Executive summary

As the demand for more scalable network architectures increases, web-scale networking is becoming a popular approach to manage rapidly growing capacity demands and more east-west traffic in public and enterprise clouds.

This movement to web-scale techniques has focused mainly on the configuration and deployment sides of the business, but the operations side has remained unchanged. Cumulus® NetQ is a highly-scalable, modern network operations tool set that provides visibility and troubleshooting of your overlay and underlay network in real-time — bringing web-scale efficiencies to operations.

This paper discusses the current environment in data center network operations, an introduction to Cumulus NetQ, why NetQ is the ideal solution for the modern cloud environment, and how NetQ can be used for a variety of purposes and benefits.

Defining web-scale networking and its place in the data center

According to Gartner, "Web-scale companies run massive data center networks, but they operate very differently from enterprises. I&O [Infrastructure and Operations] leaders that need to support digital business can use this research [on web-scale principles] to apply appropriate web-scale practices to improve data center network agility while reducing costs." In this 2017 report, Bring web-scale networking principles to your data center,[1] Gartner provides a comprehensive analysis of how web-scale companies differ from a traditional enterprise in terms of data center networking processes and technology.

At Cumulus Networks, we define web-scale networking as a modern, architectural approach to infrastructure adhering to a few key principles:

- **Open and modular with intelligence in software**
- **Scalable and efficient**
- **Simple and repeatable**
- **Reliable and functional**
- **Easy to manage**

Web-scale networking takes both the philosophical and tactical approaches of web-scale giants and brings them to businesses of all sizes. These approaches are founded in automation, scalability, standardized tool sets and disaggregation — allowing for choice and flexibility. One of the key ways businesses adopting web-scale principles increase efficiency is by putting a greater focus on NetDevOps.

NetDevOps principles emphasize increased collaboration and communication between engineering, operations and the network admin with automation and streamlined processes. This is a critical part of web-scale networking because it helps create efficiency and scalability.

Cumulus Networks has focused on bringing automation, scalability and efficiency to the data center with our best-in-class operating system, Cumulus Linux. Cumulus Linux is designed to make a network engineer's life easier and a CIO's budget more effective — thus covering the NetDev part of the equation. But where does the operator come into play? That's where Cumulus NetQ comes in. NetQ brings web-scale efficiencies and operational intelligence to network operations.

Gartner states that "web scalers view network operations through a completely different lens that allows them to achieve levels of scale and availability that are unachievable through standard enterprise practices." NetQ does exactly that.

This operational tool the provides end-to-end actionable insight is designed to help network operators sleep well at night and CIOs to innovate at the speed business demands. Validation within automated rollouts reduces the risk of programmatic configuration changes and helps operators avoid manual deployment errors — one of the main causes of network downtime. Both the CIO and the operator can innovate with peace of mind.

In short, Cumulus Linux brings web-scale efficiencies to designing and building your network, and NetQ extends web-scale benefits to network operations.

The current environment in networking

Scalability is at the forefront of business demands as companies rapidly increase in size and are required to manage more data, more efficiently. They need to build a network that can change as quickly as the business does, and they need to be able to increase capacity as they grow.

To respond to the evolving industry, many companies have started the web-scale journey by deploying a programmable fabric with automated configuration across an open network infrastructure.

By the year 2020, over 40% of enterprises will have a web-scale networking initiative.[1] In fact, 32% of the Fortune 50 have already adopted Cumulus Networks as their web-scale networking solution.

With automation being the key foundation, web-scale networking offers increased efficiency, supply chain freedom and more control while helping to reduce total cost of ownership. On average, customers who have embraced web-scale IT using Cumulus Linux were able to:

- **Deploy up to 95% faster**
- **Reduce total TCO by 60%**
- **Reduce CapEx by 45%**
- **Reduce OpEx by 74%**
- **Increase the amount of switches per operator from 50 to 200**[2]

However, these organizations are also facing some unknowns: They are worried about making ad-hoc changes that can disrupt the network, and they can't easily demonstrate network correctness. An even greater concern is that engineers at these organizations avoid making iterative improvements because they fear these changes will cause an outage. They see optimizations as risky and thus innovation is stunted.

Now more than ever before, the network must deliver richer application experiences to customers and connect a rapidly increasing number of users. These applications and services rely on an agile network to deliver compelling, brand building, revenue generating experiences. Yet with the onset of microservices, containers, and virtual machines, changes to the network happen constantly. If there's ever a connection problem, the impact is significant. Trying to identify what went wrong in this virtual, ephemeral network is like trying to find the proverbial needle in a haystack.

Sadly, we still see major application outages because of brittle, burdened networks. Network troubleshooting often requires manual, box-by-box intervention. The stats around network downtime are staggering:

- **Network outages occur 5 times each month —** Network Computing
- **80% of time wasted on manual network operations —** ONUG
- **"Business lose an estimated $4 million a year to network downtime" —** Infonetics
- **"97% agree that legacy networks can't keep pace with the changing demands of the business" —** HelpNetSecurity
- **A typical, mid-sized company could be losing about $1 million per year because of network downtime, and larger enterprises could squander more than $60 million.**

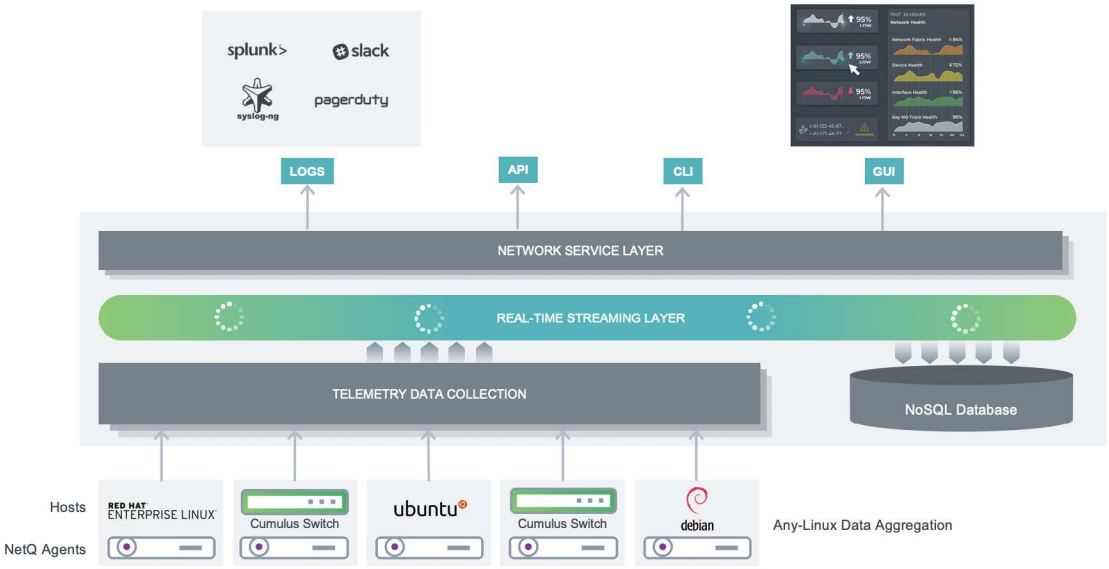
The issue is not the mentality of these engineers but rather the fact that traditional tools, such as ping and traceroute, were invented over 20 years ago. They are stuck in the dark ages and are heavily reliant on ancient management protocols and the basic system events that they provide. These tools are highly manual and reactive, they are using a box-by-box approach, and they are unable to match the rate of change that modern web-scale workflows require.

Modern, automated web-scale IT workflows require closed-loop fabric validation and real-time network status updates that keep up with a scaling data center. Organizations need a way to provide real-time fabric status, validate that the fabric behavior represents the desired configurations, and ensure ad-hoc changes don't disrupt the system. In short, they need to ensure the operations side of the business can keep up with their web-scale network. They need a web-scale operations tool.

Cumulus® NetQ is a highly-scalable, modern network operations tool set that provides visibility and troubleshooting of your overlay and underlay networks in real-time. NetQ, simplifies adoption of open networking and delivers actionable insights and operational intelligence about the health of your data center — from the container, virtual machine, or host, all the way to the switch and port. In addition, NetQ greatly reduces time-to-innocence by pinpointing and isolating faults caused by network state changes.

NetQ is designed to help give operators the same peace of mind that cloud and network architects and engineers are already experiencing.

Cumulus NetQ provides actionable insights from the host to switch



CUMULUS NETQ REAL-TIME TELEMETRY DATA COLLECTION AND DEEP ANALYTICS

Designed to help operationalize Cumulus Linux, Cumulus NetQ provides actionable insights into every trace and hop in the Linux-based data center—from the container, virtual machine, or host, all the way to the switch and port. The metadata it collects across these elements arms network operations teams with visibility and intelligence into the health of the network, to make sure everything is behaving as intended. As an agent-based telemetry technology, NetQ is designed to run on any Linux operating system or application across the data center — like Ubuntu and RedHat — expanding visibility from the Linux-based switch to the Linux-based hosts and containers.

NetQ is unique in this capability since it is the only telemetry agent in the market that is integrated with container orchestrators and the Netlink interface to the Linux Kernel, which provides real-time access to Linux networking events across the routed fabric. NetQ upgrades network operations from a manual, reactive, box-by-box approach to one that is an automated, informed and agile.

With Cumulus NetQ, networks can operate intelligently and scale with ease. Now networking teams can:

- **Get actionable insight across the data center stack — from the host to the switch**
- **Validate connectivity before rolling into production and reduce the risk of propagating inaccurate configurations**
- **Run a single Show, Trace, or Check command to troubleshoot the entire routed network**
- **Identify container blind spots that would otherwise go unseen with container tracing**
- **Get alerted about network issues right from Slack, PagerDuty, Spunk and more**
- **Build a networking operations model that scales seamlessly**
- **Drastically improve diagnostics methods and time to resolution**
- **Utilize an extensible, open interface to directly query the metadata NetQ collects using SQL-like commands**

The system uses a three-pronged approach to validating networks:

NetQ performs 3 primary functions:

- **Data collection: real-time and historical telemetry and network state information**
- **Data analytics: deep processing of the data**
- **Data visualization: rich graphical user interface (GUI) for actionable insight**

GAINING VISIBILITY INTO THE ENTIRE STACK WITH ROBUST VISUALIZATION

The NetQ system comes equipped with agents for Cumulus Linux switches, a telemetry server (VM) and a robust graphic user interface (GUI). The GUI will allow you to visualize your network health, inventory devices, view alarms and more.

The extensive feature set, including:

- **Web-scale networking delivered via elastically scalable framework that parallels the largest tier-1 web-scale cloud companies**
- **Advanced telemetry collects real-time and historical management data to reduce the time and effort required to resolve network issues.**
- **Deep analytics provides network-wide protocols, services status and individual device performance details enabling faster issue resolution and increased confidence in the network operation**
- **Microservices simplifies building and maintaining of applications through modularization, increases productivity, offers flexibility in choosing technologies, and simplifies cloud-based upgrades and bug fixes.Any-Linux data aggregation delivering more data than any other operations tool set, with a view of how the complete set of data impacts the network.**

- **User interfaces:**

  Rich GUI-based interface simplifies operations and increases operator efficiency by quickly highlighting issues through visualizations and alerts to speed their resolution

  Seamless integration with third-party software such as Splunk, PagerDuty, Slack and others

SOLVING THE OPERATIONS PROBLEM

NetQ is a fabric-validation system designed to bridge the gap between deployment and operations and to give network operators the analytics, telemetry and tools they need to keep the network running optimally and with improved regularly.

Where exactly is the gap? It's in the operations process. The key principles of network operations have remained the same decade after decade. Essentially, a network operator wants to answer two simple questions:

1) Can A talk to B?

2) Can A talk to B optimally?

Operators use ping and traceroute to test the responsiveness of each node and measure latency. So, when an issue arises in the network, an operator must then log in from one box to another, trying to find the problem one box at a time.

Imagine what this looks like for a second from an operator's perspective. The operator gets a call at two am that there is a performance issue with the network. Half asleep, she grabs some coffee and rushes to the office. From there, she is logging into each box attempting to trace mac-addresses and trying to figure out what caused the issue. This is taking hours and when she finally finds the issue, she has no idea what caused it.

This process is very manual so it can be tedious and slow. Most issues take at least 30 minutes to resolve and can cost up to $1 million an hour.[3] Operators need a way to quickly find the issue, fix it and ensure it never happens again.

Instead of logging in box by box and piecing information together, NetQ streamlines the process in several ways. NetQ aggregates data from across all Cumulus Linux nodes in a network, so you can query and diagnose issues affecting the whole network faster, analyze outages and discover why switches can't communicate or why the network is performing sub-optimally. NetQ returns a wealth of data about your layer 2 or layer 3 IP network.

What does this mean to your current operations processes? Closed-loop validation. You can prevent mistakes before they get automated in production with fabric validation, get alerted of issues in real time so that you can proactively fix them before the network goes down, and go back in time to run live traces for root cause analysis.

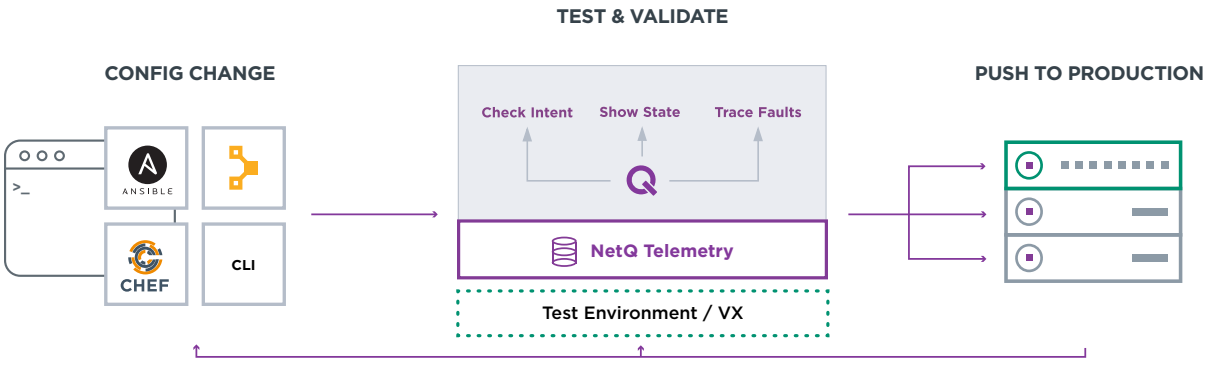
Just like Cumulus Linux, NetQ gives you full freedom of choice and flexibility. Since NetQ works seamlessly with other Linux applications, you can automate this process by including NetQ in your existing automation scripts to help validate the new configuration before deploying it to your network.

NetQ is designed to run on any Linux operating system or application across the data center — like Ubuntu, Cent0S and RedHat — expanding visibility from just the network to the hosts. This allows remote access to all fabric-wide data from anywhere in the data center without logging into the network devices or telemetry VM. Not only does this provide unparalleled visibility, it allows you to delegate network validation to adjacent teams such DevOps or Security Ops (SecOps).

The NetQ Agent works the same whether it's being used on physical servers or in Docker containers. When you install the NetQ Agent in a Docker container, it pulls Docker data as it would pull data from a Cumulus Linux switch. NetQ contains a number of show commands for displaying information about the containers on your network.

In summary, NetQ uses agent-based, telemetry technology to provide actionable insight from the Linux host to the Linux switch. NetQ is preventative, proactive and diagnostic, giving network operations peace of mind that they can reduce, discover and remediate network issues faster than ever before. The following section will cover these three workflows in more detail.

Using NetQ for web-scale workflows



WORKFLOW 1. PREVENTATIVE

With automation, configurations can be easily rolled out at scale. But if the configurations contain an error, you could end up automating an error into production and at scale.

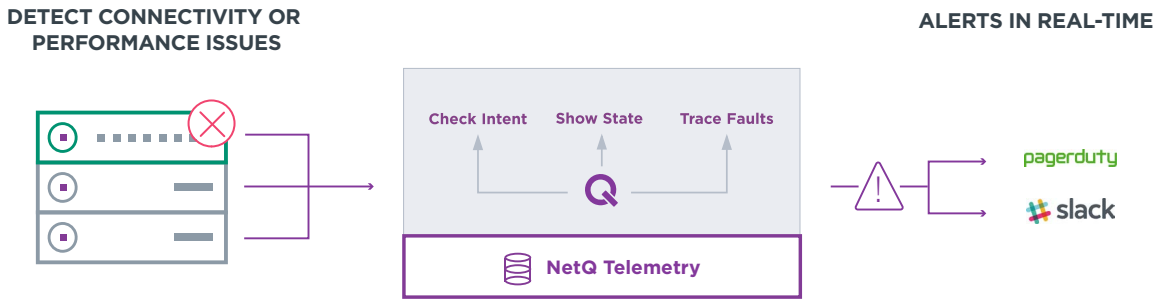
NetQ detects undesired network state when rolling out configurations into production — manually or with an automation tool — so you can quickly rollback to previous configurations in case an error occurs. You'll be able to easily confirm that the configurations accurately represent what the network is intended to do and avoid network downtimes.

From an automation perspective, you are already using tools like Ansible, Puppet and Chef for configuration changes and initial provisioning. Now you can use NetQ commands in those automation scripts to validate that these changes go as expected.

NetQ allows you to move with higher speed and confidence so you can keep up with automation and other web-scale initiatives.

> **How do I do this?** Use "check" & "show" commands in your automation playbook to validate network state prior to making the change in your own virtual environment as well as after config changes have been pushed in production. Rollback config changes or continue based on results.

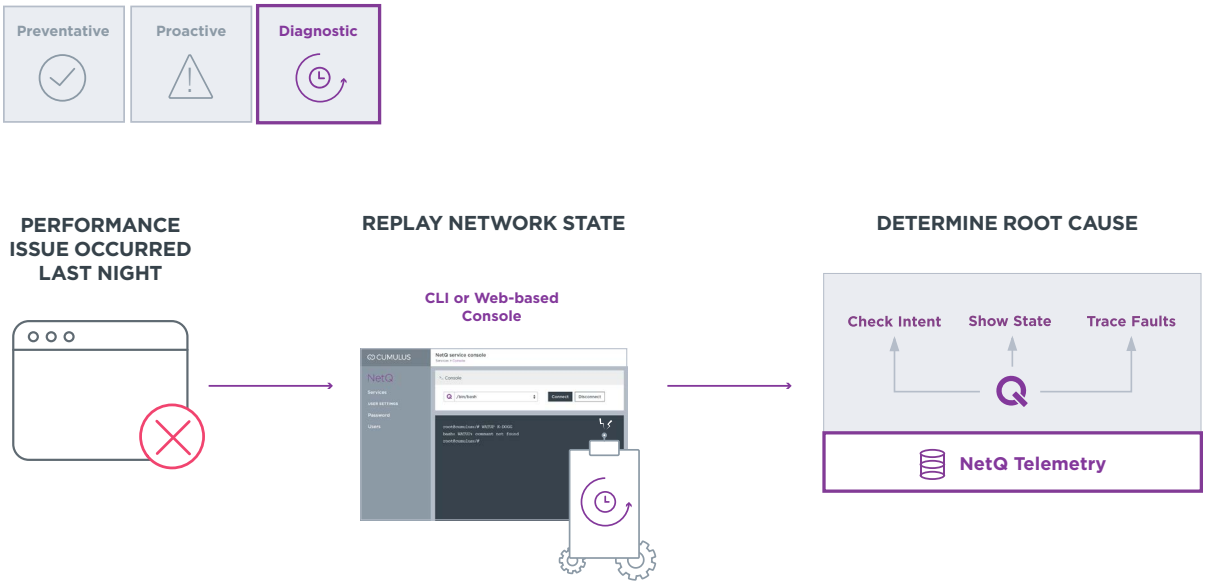
PROACTIVE



Network downtime often occurs when there is deviation of intended network state, which is often hard to precisely identify. NetQ provides real-time alerts for intent deviation with precise fault-point detection.

It algorithmically checks for faulty network behavior that results in packet loss or connectivity issues, which is a symptom of network downtime, and then sends real-time alerts to notify users that a network state deviation has occurred and exactly where. This root-cause specificity allows the user to precisely detect network faults and allows for faster remediation time.

WORKFLOW 3. DIAGNOSTIC



Go back in time to replay network state, see the fabric-wide event changelog and find root-cause state deviations. The telemetry server maintains data collected by NetQ agents making fabric-wide events available for analysis. This allows you to replay and analyze network-wide events for better visibility and to correlate patterns.

NetQ not only allows you to replay network-wide events back in time, but also allows for the ability to trace network paths and see network state at a time in the past — just like a time machine. This allows for root-cause analysis and optimization of network configs for the future.

Plus, with NetQ you can delegate access to adjacent teams. That means the network operator, engineers, cloud architects, security operations and DevOps teams all have equal access to information, without perturbing the network. Any specified party can log in to prove the network is good or easily locate the time and place of a fault — all without risking disruption. You'll simply view a single screen to access telemetry and network state without touching the network.

FABRIC-WIDE CAPABILITIES		
	Intractable fabric-wide questions	***NetQ's algorithmic solution***
Host	Where is this container located? Open Ports? What image is being used? Which containers are part of this service? How are they connected? ToR Impact on Service?	show Docker container show Docker container service show Kubernetes deployment trace container connectivity
Overlay	Is my overlay configured correctly? Is my control-plane configured correctly? Can A reach B over an overlay/underlay path?	check/show vxlan, check evpn/lnv
L3	Is BGP working as expected? Is there a STP loop? Can IP A reach IP B?	check/show BGP show stp trace l3
L2	Is CLAG configured correctly? Is there a STP loop? Is there a MTU mismatch? How does Mac A reach B?	check/show CLAG show stp check/show vlan check mtu trace L2
OS	Are all switches licensed correctly? Do all switches have NetQ agents running?	check/show cl-license check/show agents
Interfaces	Is my link down? Are all bond links up? What optics am I using? What's the peer for this port? Which ports are empty? Is there a link mismatch? Any links flapping?	show interfaces Check interfaces
Hardware	Have any components crashed? What switches do I have in the network?	check/show sensors show Inventory

NetQ brings web-scale efficiencies to your business

NetQ completely streamlines network validation using fabric-wide telemetry. This industry-first visibility and efficiency brings a variety of business benefits to your organization. Because NetQ is algorithmic and can be configured to work with your existing automation tools, operating workflows are streamlined — reducing costs and limiting risk. The operator enjoys a new sense of confidence and peace of mind using simplified check, show and trace commands, and the organization becomes more productive as other team members easily log in to analyze the network without risking disruption. This closed-loop validation offers efficiencies in preventive, proactive and diagnostic workflows, offering your business the following benefits:

- **Simplified scaling of Cumulus Linux**
- **Open, disaggregated network**
- **Speed mean-time-to-innocence**
- **Maximize flexibility and control**
- **Reduce OpEx**
- **Remove complexity**
- **Reduce downtime**
- **Increase productivity**

There are a variety of ways that NetQ can be implemented in order to streamline your operations and take the next step in web-scale networking. In addition to seamless integration with Cumulus LInux, NetQ is designed to run on any Linux operating system or application across the data center — like Ubuntu, CentOS and RedHat — expanding visibility from just the network to the hosts. Just like Cumulus Linux, NetQ gives you full freedom of choice and flexibility.

We've also seen that NetQ will benefit a variety of employees. First and foremost, the network operator will be able to avoid mistakes before they are automated, resolve issues faster, analyze with complete visibility how issues were created, elevate issues seamlessly and get alerted proactively. In addition to the operator, the cloud admin will get a unified view of the entire data center network and the devops/sysadmin will be able to integrate with existing CI/CD tools and be able to access comprehensive network information without actually touching the network (limiting risk and maximizing resources).

Conclusion

As data center networks adopt web-scale principles, they've become more scalable, agile and efficient than ever before. With these modern networks becoming faster and more automated, network operations need to keep up with the speed of automation. Network architects and operators need to be able to optimize configurations without worrying about risk so the organization can continually innovate and scale.

The traditional, manual operations process cannot keep up with the speed of automation and web-scale initiatives come to a grinding halt. With NetQ, operation teams can now monitor and manage the network at the speed your business demands.

NetQ enables web-scale agility by algorithmically answering tedious, intractable questions with infrastructure-wide correlations for precise fault-point detection. This closed-loop validation application can reduce downtime and improve network efficiency. NetQ is:

NetQ performs 3 primary functions:

- **Data collection: real-time and historical telemetry and network state information**
- **Data analytics: deep processing of the data**
- **Data visualization: rich graphical user interface (GUI) for actionable insight**

With Cumulus Linux and NetQ, we are bringing web-scale efficiencies to designing, building and operating your network.

Interested in trying NetQ? Schedule a free demo at cumulusnetworks.com/products/netq or simply contact your dedicated sales representative.

Sources

1..“Bring web-scale concepts to your data center.” Joe Skorupa & Andrew Lerner. Gartner report. November 2016.

2. Web-scale vs. Traditional Networking Total Cost of Ownership Report.” Cumulus Networks. November 2016.

3. Cost of Hourly Downtime Soars: 81% of Enterprises Say it Exceeds $300K On Average”. August 2016. Information Technology Intelligence Group

ABOUT CUMULUS NETWORKS®

Cumulus Networks is leading the transformation of bringing web-scale networking to enterprise cloud. Its network switch, Cumulus Linux, is the only solution that allows you to affordably build and efficiently operate your network like the world’s largest data center operators, unlocking vertical network stacks. By allowing operators to use standard hardware components, Cumulus Linux offers unprecedented operational speed and agility, at the industry’s most competitive cost. Cumulus Networks has received venture funding from Andreessen Horowitz, Battery Ventures, Capital, Peter Wagner and four of the original VMware founders.

For more information visit cumulusnetworks.com or follow @cumulusnetworks.

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