


## FINANCIAL NEWS RELEASE

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### **Broadcom Ships Tomahawk® 3, Industry's Highest Bandwidth Ethernet Switch Chip at 12.8 Terabits per Second**

*World's First 32 x 400GbE / 128 x 100GbE Switching Silicon Unleashes Next Wave of Hyperscale Cloud Build-out for Deep Learning and Storage Disaggregation*

SAN JOSE, Calif. and SINGAPORE, Dec. 19, 2017 (GLOBE NEWSWIRE) -- Broadcom Limited (NASDAQ:AVGO), today announced that it has delivered the StrataXGS® Tomahawk® 3 switch series, demonstrating an unprecedented 12.8 Terabits/sec of Ethernet switching performance in a single device -- double the bandwidth of any other switch silicon available in the market today. The Tomahawk 3 series represents the industry's first shipping product that supports high-density, standards based 400GbE, 200GbE, and 100GbE switching and routing for hyperscale cloud networks, fortifying Broadcom's position as the market leader in raw Ethernet performance, silicon execution, and switch product velocity. Remarkably, the Tomahawk 3 switch series was developed, manufactured, and shipped to customers a mere 14 months following the introduction of the previous 6.4Tbps product generation, while delivering 40% lower power consumption per 100GbE switch port and up to 75% lower cost per 100GbE switch port.

The growth of hyperscale cloud networks is at an upward inflection point, with the sheer number of hyperscale data centers expected to double by 2020, and the amount of machine-to-machine traffic within such data centers expected to increase 5 times over that period[1]. Emergent workloads for deep learning, using massively distributed neural networks and alternative computing nodes, are demanding a quantum leap in bandwidth to dense 100/200/400GbE links spanning high-radix, ultra-low-latency network topologies. The nascent trend towards disaggregated, high-density flash storage, interconnected with compute nodes via NVMe-over-Fabrics (NVMeoF) and RDMA over Converged Ethernet (RoCEv2), is concurrently driving step functions in network throughput and collapsed end-to-end access times. With its market leading switching performance, 100/200/400GbE port density, and rich feature set optimized for cloud use cases, Broadcom's Tomahawk 3 solution is ideally suited to serve as the backbone for the next generation scale-out of hyperscale data center networks.

#### **Key attributes and benefits of the new StrataXGS Tomahawk 3 Series:**

- Enables the next major leap in hyperscale data center network throughput, supporting 32 x 400GbE, 64 x 200GbE, or 128 x 100GbE line rate switching and routing on a single chip
- Delivers disruptive gains in hyperscale CAPEX and OPEX efficiency: 40% reduction in power per 100Gbps, and up to 75% lower cost per 100Gbps, versus alternatives
- New, state-of-the-art, integrated 12.8Tbps shared-buffer architecture offers 3X to 5X higher incast absorption and provides the highest performance and lowest end-to-end latency for RoCEv2 based workloads
- Industry-leading Broadview™ Gen 3 integrated network instrumentation feature set and software suite, providing full visibility to network operators into packet flow behavior, traffic management state, and switch internal performance
- Comprehensively supports all packet processing and traffic management requirements for next-gen hyperscale network use cases: >2X IP route forwarding scale, 2X ECMP scale, Dynamic Load Balancing and Group

Multipathing, In-Band Network Telemetry, Elephant Flow detection and re-prioritization

- Robust connectivity using 256 instances of the industry's best performing and longest-reach 50G PAM-4 integrated Serdes core, enabling long-reach (LR) East-West optical links and Direct-Attached-Copper (DAC) in-rack cabling in the data center, fully compliant to new IEEE standards for 50/100/200/400GbE
- Implemented with unparalleled silicon area and power efficiency on proven, high-volume 16nm process technology node, ensuring fastest time to CY2018 production network deployment for hyperscale customers

"The Tomahawk franchise is the flagship for cutting-edge, single-chip performance and integration among Broadcom's multi-vectored Ethernet switch silicon portfolio, tailored to the unique and rigorous demands of hyperscale data center operators," said Ram Velaga, senior vice president and general manager, Switch Products at Broadcom. "I am proud of our world-class engineering team for innovating and delivering the 12.8Tbps Tomahawk 3 chip in a record 14 months after we released Tomahawk 2. We've applied great focus and diligence working with our hyperscale customers to ensure this product is the ideal fit for their upcoming high-radix 100/400GbE deployments and aggressive Terabit-per-dollar and Terabit-per-Watt targets. Broadcom is proving yet again that customers can rely on us to lead the industry on switch silicon performance and execution at every generation."

"Broadcom continues to execute on Ethernet switch ASSPs matched to the priority needs of hyperscalers: faster port speeds, dense network radix, extended serdes reach, robust buffering and load balancing, scalable forwarding, software-defined instrumentation, slashed cost and power per Gbps, and most of all, time to market," said Bob Wheeler, principal analyst at The Linley Group. "Tomahawk 3 delivers on these requirements, meeting the anticipated onslaught of deep learning and RDMA-based storage workloads over 400GbE-upgraded cloud networks. Being the first to deliver a 12.8Tbps switch—enabled by 56Gbps PAM4 serdes in 16nm technology—is a major achievement, and it extends Broadcom's leadership position in hyperscale networking."

## Availability

Broadcom is now shipping Tomahawk 3 12.8Tbps (BCM56980) and 8.0Tbps (BCM56982) devices to qualified customers.

## Industry Quotes

### Cloud Network Operators and Original Equipment Manufacturers (OEMs)

#### **Albert Greenberg, Corporate Vice President, Microsoft Azure Networking, Microsoft Corporation:**

*"Microsoft Azure is one of the world's largest cloud infrastructures and it requires the latest and most innovative technology to deliver faster, more reliable and cost effective services to our customers. This involves ongoing collaboration with industry leaders to advance optical technology. Broadcom's achievement of getting the network fabric to 400GbE and individual switching nodes to 12.8Tbps is an important step in infrastructure evolution and we applaud their efforts."*

#### **Yiqun Cai, Vice-President, Alibaba Infrastructure Services:**

*"Alibaba's demand for infrastructure services is experiencing substantial growth, which requires faster, smoother and denser Ethernet connectivity within our expanding global data center footprint. Performance-leading switch silicon has been critical to enabling Alibaba's scale-out deployment of leaf-spine topologies with higher network throughput and performance. We are excited to see the arrival of the 12.8Tbps Tomahawk 3 switch generation which will advance our data center fabrics and help us reach new heights in performance, visibility, and economies of scale for hyper-scale cloud networks."*

#### **John McCool, Chief Platform Officer, Arista Networks:**

*"Broadcom's Tomahawk architecture is at the heart of many of Arista's most popular switching platforms. Tomahawk 3 carries these products forward with an industry leading 12.8Tbps of bandwidth on a single chip. We expect a very positive customer reception for Tomahawk 3 and look forward to seeing this chip in volume"*

production.”

**Liu Chao, Senior Director, System Technologies Department, Baidu:**

*"Higher network performance is a critical factor for accelerating distributed deep / machine learning and RDMA-based applications within data centers. By establishing a new peak in switch chip throughput at 12.8 Terabits per second and supporting as many as 32 ports of 400GbE or 128 ports of 100GbE with full RoCEv2 support, the Tomahawk 3 solution enables data center networks to scale to tomorrow's demanding machine-to-machine workloads. Using Broadcom's innovation in switch silicon, Baidu can architect and build best-in-class network infrastructure."*

**Anand Athreya, EVP and Chief Development Officer, Juniper Networks:**

*"Juniper's extensive routing and switching portfolio combines best-of-breed silicon technology with Junos, the industry's most advanced network operating system, to address the leading-edge requirements of our customers. We are happy to partner with Broadcom to develop solutions based on Tomahawk 3, an industry first at 12.8 Terabits per second, that delivers best-in-class switching performance, density, and power efficiency at 100GbE and 400GbE for mega-scale cloud data centers."*

**Yuval Bachar, Principal Engineer, Global Infrastructure Architecture & Strategy, LinkedIn Corporation, A Microsoft Company:**

*"The race to 400GE in the cloud is on, and Broadcom has demonstrated with its 12.8Tbps Tomahawk 3 chip that it continues to be the industry pacesetter for achieving switch development leadership, end user requirements optimization, and integration in a single piece of silicon. With Tomahawk 3, the vision for all 50G-PAM4 based data center interconnects, with enhanced forwarding, load balancing, buffering, and congestion control capabilities for expanding hyperscale workloads, is now set to become reality."*

**Wade Shao, Deputy Director, Network Architecture Center, Tencent:**

*"Three years ago, we deployed the first 32 x 40GE switches to meet our cloud infrastructure needs. Now with Broadcom's release of the new Tomahawk 3 chip, we are able to pack ten times the bandwidth into the same equipment form factor and interconnect our compute and storage using new 50G PAM4 based Ethernet speeds such as 200GE and 400GE. Tencent appreciates Broadcom for its roadmap velocity, its commitment to improving switch ASIC performance, and its strong ecosystem of hardware and software solution partners to support hyperscale deployment."*

**Hardware Solution Providers and ODMs**

**CC Lee, President, Accton Technology Corporation:**

*"The first-silicon release of Broadcom's Tomahawk 3 is exciting news for the cloud networking industry and for us at Accton. We recognize the magnitude of the engineering achievement to develop and sample a 12.8 Terabit switching ASIC in 16nm technology with such velocity, and we see first-hand the strong interest from hyperscale operators to align their 2018 network infrastructure plans to this impressive new product generation. Accton, and its subsidiary Edgecore Networks, are proud to lead the charge within the networking hardware ecosystem by engineering high-density 400GbE and 100GbE platforms based on Tomahawk 3 for our valued hyperscale customers."*

**Steven Dorwart, Vice President, Service Provider Solutions, Celestica Inc.:**

*"Celestica has collaborated closely with Broadcom in developing a rich portfolio of open networking platforms based on Broadcom's Trident, Tomahawk, and Jericho series of network switches. With the impressive speeds and feeds of the new Tomahawk 3 family, combined with Celestica's innovations in high-performance hardware design, our customers can achieve important gains in network fabric throughput, capex, and opex efficiency. We look forward to offering a new wave of Tomahawk 3 based platforms that will enable our customers to benefit from this next generation of cloud networking equipment."*

**Jeff Chen, CEO, Delta Networks Inc.:**

*"Broadcom's groundbreaking Tomahawk 3 switch series is enabling a new generation of fixed and chassis systems at never-before seen densities of 50, 100, 200, and 400GbE ports. We at DNI are thrilled to be working with Broadcom to bring to market megascale-ready, Tomahawk 3 based systems having all-50G-PAM-4 electrical signaling, new compact interconnect technologies such as QSFP-DD, comprehensive data center networking features, and excellent performance per Watt. We are proud to be a participant in this revolutionary product development for the industry and we expect great mutual success through our cooperation with Broadcom."*

**Mike Yang, Senior Vice-President of Quanta Computer Inc. and President of Quanta Cloud Technology:**

*"The rate of innovation in the network switching space is at an all-time high. Broadcom has again established market leadership by producing and delivering the world's highest performing single-chip Ethernet switch in the Tomahawk 3 generation, optimized specifically for the cloud. Because of our leading-edge portfolio of compute, storage, and networking products, QCT is the ideal solutions provider to harness the innovative capabilities of this new Ethernet chip technology and deliver state-of-the-art 32x400GbE and 128x100GbE platforms for our web-scale customers worldwide, with best-in-class quality, economics, and time-to-market."*

**Optics & Interconnect Solution Vendors**

**Joshua Yeh, General Manager, Transmission Network and Equipment business unit, Applied Optoelectronics Inc.:**

*"Broadcom's introduction of Tomahawk 3 ushers in the next wave of hyperscale networking which combined with PAM4 based optical modules will deliver cost effective 100G and 400G connectivity. We expect that the bandwidth growth which will be enabled by the Tomahawk 3 will be quickly adopted by cloud operators, as no changes are required to their existing installed fiber infrastructure. 100G and 400G transceivers based on AOI's low-cost 100G directly-modulated laser (DML) technology provide a strong economic incentive for cloud operators to upgrade their infrastructure."*

**Maryam Aminian, General Manager, Optical Communications division, Foxconn Interconnect Technologies Ltd.:**

*"Tomahawk 3 is a key enabling technology for next generation cloud optical networks. Its 50G PAM4 per-lane capability leads the industry for deployable 50GE, 100GE, 200GE and 400GE interconnect. Optical transceivers supporting these rates, including 400G QSFP-DD and OSFP configurations, will be sampling in 2018, bringing Tomahawk 3 based solutions to the forefront of tomorrow's high speed networks."*

**Philip Gadd, VP/GM, Intel Silicon Photonics:**

*"The sampling of 12.8 Tbps switch silicon with 50G SERDES is a pivotal moment for the industry, enabling data center operators to upgrade and scale their network infrastructure in order to keep up with the exponential growth in data traffic. Our customers are eager to evaluate these next generation switches together with Intel's 400G open standard CWDM8 and DR4 silicon photonics modules, and we look forward to accelerating the industry adoption of these next data rates."*

**Greg Young, CEO, Luxtera:**

*"The 400G market transition is vital for cloud data centers to continue scaling bandwidth to meet increasing customer demand. Broadcom's Tomahawk 3 switch ASIC, along with Luxtera's cost-effective, standards compliant, silicon photonics-based 400G/PAM4 optical transceiver products are key elements of the robust ecosystem required for a successful 400G ramp."*

**About Broadcom Limited**

Broadcom Limited (NASDAQ:AVGO) is a leading designer, developer and global supplier of a broad range of analog and digital semiconductor connectivity solutions. Broadcom Limited's extensive product portfolio serves four primary end markets: wired infrastructure, wireless communications, enterprise storage and industrial & other. Applications for our products in these end markets include: data center networking, home connectivity, broadband access, telecommunications equipment, smartphones and base stations, data center servers and storage, factory automation, power generation and alternative energy systems, and displays. For more information, go to [www.broadcom.com](http://www.broadcom.com).

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[1] Cisco Global Cloud Index: Forecast and Methodology, 2015-2020 White Paper,  
<https://www.cisco.com/c/dam/en/us/solutions/collateral/service-provider/global-cloud-index-gci/white-paper-c11-738085.pdf>

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