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THEJUDAGROUP INVESTMENT RESEARCH

ONUG 2015 TAKEAWAYS

SLOW DC SDN PROGRESS; GOOD START TO SD-WAN

We attended Open Networking User Group (ONUG), where enterprise network executives from several verticals including financial services, retail and healthcare discuss open networking/SDN initiatives. We have attended ONUG over the last 3 years, and while users are somewhat further along the path to implementing SDN, progress remains slower than expected given challenges around technology, deployment complexity, and ROI, with SD-WAN being an exception, given operational simplicity and compelling ROI.

The following are our ONUG takeaways

1. **SDN in the DC** adoption continues to be slow, given a combination of technology issues, complexity of new architectures and lack of clarity on ROI – we believe the parallels to benefits created by server virtualization are limited. Several large enterprises have OpenStack projects and are evaluating network virtualization (NV) as part of these POCs.
2. In the NV category, enterprises indicated they are buying VMWare NSX as part of an ELA for use in ESX environments, with microsegmentation (east/west security) and increased VM density being key use cases while Nuage appears to be vendor of choice especially in OpenStack POCs, and deployments requiring scale and inter DC connectivity. Arista appears to be underlay switch vendor of choice in NV deployments. In the integrated P+V category, enterprise were more positive on Cisco ACI than in the past, with users indicating they are trialing ACI and that completeness of solution, operational simplicity and lower TCO could offset lock in concerns. Big Switch appears to be gaining traction as a physical fabric switch and controller vendor for monitoring and cloud fabric.
3. **SD WAN** was a major focus and is seeing relatively quick adoption by large enterprises with significant deployments likely beginning in 2015 – we believe this is driven by clear economic benefits of using the public internet for branch connectivity versus expensive MPLS connections, as well as ease of centralized management. Viptela and Glue have emerged as early leaders in this market followed by CloudGenix, Velocloud and Nuage
4. **White box switches** were somewhat less of a focus – while deployments are broadening gradually, volumes in the enterprise remain very modest. We believe this is in large part due to aggressive upfront pricing (excludes cost of optics and support) by incumbents, led by Cisco, making capex savings on white box switches less compelling. Cumulus is the leading supplier of network OS followed by Pluribus, Pica8 and Broadcom ICOS, with each vendor getting traction in select niches. In addition to ODMs such as Quanta and Acton, Dell is emerging as a leading supplier of white box switches to enterprises.
5. **L4-7** services were emphasized as being key to deployment of SDN. Enterprises indicated that firewalls and ADCs are seeing increasing use cases in east west applications likely driving unit growth. F5 and Palo Alto appear best positioned among incumbents and Avi, Versa, vArmour and Illumio appear to have traction among startups. However, move to distributed virtual instances could be deflationary given lower unit pricing and higher utilization creating some risk to incumbent DC firewall and ADC vendors.

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COMMUNICATIONS TECHNOLOGY

DATA NETWORKING

INDUSTRY UPDATE

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DETAILS

NETWORK VIRTUALIZATION PARALLELS TO SERVER VIRTUALIZATION ARE LIMITED. One of the frequent questions/comments we get from investors are related to parallels between server virtualization and network virtualization – the story line goes 'just like server virtualization was negative for server hardware vendors, network virtualization will negatively impact networking vendors. While it could take longer than expected, there is no doubt about the final result given we have already seen this play out in server virtualization'. While there are some parallels between server and network virtualization, we believe the investment community is drawing these parallels too far along for the following reasons

1) **The commoditization of servers happened in 3 phases of which only one currently applies to the networking industry** – We believe the 3 phases of server commoditization were i) the move from proprietary processors to Intel x86 chipsets; ii) the move from proprietary versions of Unix OS to Linux; iii) virtualization of the physical server. We believe Broadcom's Trident family of chipsets, which are being used by most switch vendors for TOR (top of rack) switch silicon, has become the x86 of the networking industry. While network OS suppliers such as Cumulus and Big Switch are attempting to become the Linux of the networking industry, the OS running on most DC switches is still being provided by switch hardware vendor. While some cloud operators with software expertise are deploying bare metal switches and network OS separately similar to the server model and several enterprise users are evaluating these solutions, we do not see this model gaining broad traction in the enterprise market in the int-term given complexity around purchase, integration and support as well as competitive pricing from switch vendors. Finally we believe the server virtualization model doesn't really apply to network hardware for reasons we explain below.
2) **Network virtualization does not provide the upfront capex benefits that server virtualization did** – Server virtualization allowed users to significantly improve server utilization (utilization of servers had traditionally been low) by dividing into multiple virtual servers which in turn allowed them to purchase fewer servers to process the same number of workloads creating significant upfront capex savings. This significant upfront capex savings created a strong value economic proposition for server virtualization driving adoption. Network virtualization on the other hand does not create significant upfront capex benefits – a user still needs to buy as many switches to connect servers as he/she used to and the switches still need to support all the

protocols needed in the DC; in fact some of the complexity on switches increases since they now need to support VXLAN switching and routing. We believe network virtualization does add significant value in terms of improving agility (networks have been in the way of agile application deployment) and lowering opex given it reduces the need for manual network configuration. We believe there could be longer-term capex benefits as i) migration of intelligence to the virtual network layer could allow users to deploy simpler cheaper physical switches and extend time between upgrades as new features could be rolled out without new hardware; and ii) as east-west traffic grows, security and load balancing features built into products like NSX could save capex that would have to be spent on buying firewalls and ADCs to managed east-west traffic (enterprises for the most part do not purchase L4-7 appliances to manage east-west traffic today). However we believe the upfront capex saving parallel to server virtualization does not extend since network virtualization represents an incremental spend for enterprise network users.

NETWORK VIRTUALIZATION DEPLOYMENTS PROGRESSING SLOWER THAN EXPECTED. Our ongoing dialog with enterprise network executives indicate that network virtualization deployments are progressing slower than these executives had anticipated a couple of years ago. VMware NSX had been the early leader in the network virtualization market and the primary solution that enterprise network operators had been evaluating – despite VMware having acquired Nicira two years ago, we believe there are relatively few sizable production deployments of NSX outside of Nicira's initial cloud customers.

In addition to the normal challenges with new technology adoption we believe the reasons for slower adoption of NSX include

i) **L3 challenges** – NSX uses two protocols, STT and VXLAN, for control plane and encapsulation. When the VXLAN based traffic requires L3 features and L4-7 services the VXLAN based traffic needs to be terminated and converted using a gateway into a format that allows it to communicate with routers, firewalls and ADCs. The gateways needed for this conversion have been software based which limits their ability to scale and have therefore been a bottleneck in scaling NSX based networks. Also given VMware does not have routing expertise it does not effectively enable mobility of workloads between geographically dispersed DC.

ii) **Limited coordination between the physical and virtual layer** - this is an issue with the overlay model in general given the virtual layer (vswitch on the server) and physical layer (physical switches) operate

independently and therefore need to be managed separately. While OVS-DB is emerging as a standard that allows a controller to manage both the physical and virtual layers the functionality provided by OVS-DB is quite limited and Cisco does not currently support OVS-DB in the Nexus 9K.

iii) **Pricing** – As discussed earlier, we believe network virtualization results in higher upfront capex with value more in agility and opex savings – users indicated while VMware has lowered NSX pricing significantly from initial levels, deployment of NSX still results in significant incremental capex versus current architectures. While increased agility and lowered opex are focus areas for enterprises, we believe the need for incremental upfront capex to deploy network virtualization has created significant scrutiny on ROI for these solutions and our dialog with users indicate that ROI metrics are unclear which has likely delayed deployment.

NSX CUSTOMER TRACTION APPEARS TO BE DRIVEN BY MICROSEGMENTATION AND ELAs. We believe NSX is the early leader in the network virtualization market given the product has been in the market the longest among competitors (initial versions of the product beginning trialing in early 2012), and VMware mentioned a $200 mln annual order run rate and 400 paying customers for NSX a couple of quarters ago. Our dialog with enterprise network executives however has yielded mixed reviews on NSX with users mentioning challenges with scaling, L3 features and ROI given relatively high price. We did not hear of many large deployments (over 1000 servers or 10K VMs) among ONUG participants even though they tend to be early adopters, and believe even some of early Nicira's early cloud customers including Rackspace and NTT have chosen not to deploy NSX broadly due to scale and pricing issues.

We would point out that i) microsegmentation is one of the primary use cases discussed by VMware for NSX and that use case involves deploying vShield, VMware's distributed firewall, which had significant revenues even before VMware's acquisition of Nicira and is now included as part of NSX; ii) several ONUG participants, including some of NSX's largest customers, indicated they purchased NSX through an ELA rather than as a standalone purchase. We believe NSX will continue to gain broader traction, especially with customers deploying network virtualization on ESXi hypervisor, though size of deployments and revenues related to stand alone NSX sales are likely to be limited over the next 12 months.

NUAGE WINNING LARGE PUBLIC AND PRIVATE CLOUD DEALS. Our dialog with enterprise users indicates that Alcatel/Lucent Nuage is gaining solid traction with significant wins in financial services and cloud verticals, especially in the

case of OpenStack deployments. Users indicated that Nuage's advantages include strong L3 capabilities (Nuage uses BGP/MPLS for control plane allowing L3 services to be performed within the SDN fabric and workload mobility between DC) automation, templating of applications, and significantly lower pricing vs. NSX. We believe Nuage is emerging as the clear #2 in the network virtualization overlay controller market with large competitive wins versus NSX. Other vendors with moderate traction in the network virtualization market include Juniper/Contrail (traction mostly in the carrier and cloud vertical), Plumgrid (wins in carrier OpenStack deployments) and Midokura (primarily in Japan). We believe Big Switch is also gaining early traction with its Big Cloud Fabric (BCF) integrated P+V solution which includes a controller, v-switch and Switch Light network OS running on a bare metal P-switch – several early deployments of BCF appear to be for the physical switch fabric with NSX potentially used for overlay as well as specific use cases lead by OpenStack, VDI and Big Data.

USER VIEW ON ACI MORE POSITIVE WITH COMPLETENESS AND SIMPLICITY OF SOLUTION AND PRICING OFFSETTING LOCK IN CONCERNS. We believe enterprise user view on Cisco's ACI, an integrated P+V solution, is turning more positive with several ONUG participants indicating that they are trialing or plan to trial ACI, and some indicating that they have chosen ACI as their SDN solution. While users continue to be concerned about lock in, given deploying ACI requires using both the APIC controller and Nexus 9K switches, they have indicated that i) ACI initial cost is below that of vendor neutral solutions since Cisco is matching other switch vendors on switch hardware pricing, and APIC pricing is below that of other controllers, including NSX; and ii) the integrated nature of ACI makes it easy to deploy and operate. We would point out that ONUG participants tend to be among the most sophisticated enterprises and have traditionally emphasized open multi-vendor solutions – a growing willingness among some of these participants to evaluate and potentially deploy ACI is likely indicative of the complexity of deploying multi vendor solutions as well as the capabilities and favorable pricing of the ACI solution. We expect large enterprises to adopt SDN gradually and expect a significant percentage of them to deploy ACI given it is a solution that eliminates the challenges involved in operating a new multivendor architecture.

APIC CODE MATURING WITH GROWING DEPLOYMENTS AND MEANINGFUL REVENUE LIKELY IN H2 C'15. APIC (Cisco's controller for ACI) has now been shipping for a little under three quarters and has 580 customers; we believe APIC is in production with 10s of customers including some large deployments with telcos/cloud operators (over 1000 10G ports). Early feedback indicates i) customers are impressed with the broad range of features offered by the ACI

architecture, but are also finding the move to ACI to be complex and challenging given it represents a major shift from the way enterprise networks have traditionally been deployed – we believe Cisco is investing significantly in support to help customers move to ACI mode; ii) customers are initially using ACI primarily to manage the physical fabric with move to managing virtual and L4-7 services in the future; iii) APIC code is still maturing with some customers that are taking it into production indicating that they are having 'typical new product challenges' including stability issues, which are expected to alleviated with a major new software release expected in summer. We expect a broader set of customers to deploy APIC in H2 C'15, and expect APIC and software upgrade to ACI mode on 9K switches (up to a 50% premium on switch hardware pricing) to generate meaningful incremental revenues in H2 C'15.

COMPELLING ECONOMICS DRIVING SD-WAN DEPLOYMENTS. SDN in the WAN was a key theme at ONUG with several users across financial services, retail and health care indicating they are in POCs and in some cases even deployments with SD-WAN solutions. SD-WAN solutions create a unified WAN control plane for CPE spread across branches and campuses enabling rapid service provisioning, unified security policy and lower costs by orchestrating capacity, leveraging the public internet and multiple carriers, and in some cases replacing expensive traditional CPE (primarily Cisco ISR branch routers).

While SD-WAN solutions entered the market after DC SDN solutions, they are experiencing more rapid adoption given they have strong ROI (they allow enterprises to offload traffic selectively from expensive MPLS connections to VPNs over the public internet) and significantly simplify provisioning and management of branch connectivity. Deployment models include vendors selling custom CPE (Viptela and VeloCloud, though VeloCloud also has a virtual CPE model) or deploying virtual CPE (CloudGenix and Nuage) software on COTS as well as internally developing L4-7 services and partnering with leading vendors. Users indicated that they are using SD WAN solutions to deploy hybrid MPLS and public internet connectivity, though some users indicated that they have tested mission critical traffic over public internet connections, including consumer broadband and 4G wireless connectivity, and have seen strong performance.

Viptela is emerging as the early leader in this market with some large enterprise wins and carrier partnerships for managed services, followed by CloudGenix, VeloCloud and Nuage; Glue Networks has partnered with Cisco to provide control plane/orchestration for Cisco ISRs and is being deployed in conjunction with Cisco at large enterprises. Cisco is addressing this market with its iWAN and performance routing solutions which are being deployed by several large enterprises, but the Cisco offerings do not have a good central management

solution (they rely on Glue for orchestration) and work only with some versions for Cisco campus/branch routers.

AUTOMATION AND PROGRAMMABILITY KEY TO REALIZING BARE METAL VALUE. We believe white box and bare metal switches remain an area of interest for enterprise users though white box switches were less of a topic of focus at this ONUG versus past events. We believe a variety of enterprises including traditionally conservative verticals such as financial services are evaluating bare metal switches and network OS from vendors such as Cumulus, Big Switch, Pluribus, Pica8 and Broadcom and we believe deployments are gradually broadening though volumes remain small. We believe the idea of deploying bare metal switches with network OS has been attractive to SDN early adopters given i) lower capex when compared to offerings from incumbent switch vendors, especially after including cost of software/support and accessories including optics and cables; ii) programmability that could allow users to automate network functions and drive significant opex savings, similar to those seen with server automation.

Our dialog with ONUG participants however indicates that incumbent vendors lead by Cisco have been willing to close the pricing gap with bare metal switches + network OS and in some cases even match those prices. We would point out that discounting on branded switches typically tends to be high on switch hardware rather than software/support and accessories, and when all in cost is considered price differential between branded switches and bare metal switches can be significant (25% lower capex versus branded switches from leading vendors can turn into up to a 50% capex savings after adding in cost of services and accessories). Also users have indicated that Dell's participation in this market with offerings that include Dell hardware and OS from Cumulus or Big Switch have reduced concerns/challenges around procurement and support. Despite these factors, ONUG participants indicated that the relatively small upfront capex differential between switches from incumbent vendors and bare metal switches is currently not enough to offset tradeoffs (limited feature set, hardware and OS integration and support risks) associated with deploying bare metal switches over branded switches. Several users however indicated that they will likely continue to evaluate bare metal switches and the automation capabilities offered by a Linux OS could generate significant opex savings that could make the economics of bare metal switches compelling.

L4-7 IMPLICATIONS. One of the most common investor questions we receive related to SDN is 'what does this architectural shift mean for L4-7 vendors, especially those providing security and load balancing?'

We would make the following observations

i) Most L4-7 services today are deployed for north-south applications at the DC perimeter and the move to network virtualization creates significant new needs for east-west firewalling and load balancing which will likely increase the TAM for L4-7 services

ii) The need to deploy any application anywhere in the DC and have the services associated with the application be available dynamically requires these east-west traffic related L4-7 services to be virtualized rather than be deployed in physical appliances. The move to distributed virtual instances versus physical appliances could be deflationary given lower unit pricing and higher utilization creating some risk to incumbent DC firewall and ADC vendors

iii) The east-west L4-7 services will be applied by the controller in the hypervisor – it will be key for firewall and load balancer vendors to partner effectively with leading controller vendors such as Cisco and VMware – we believe F5 and Palo Alto have been the partners of choice for the controller vendors and are well positioned to benefit from the TAM expansion. Among startups we believe Avi is gaining traction in the ADC market while vArmour and Illumio are gaining traction in the intra DC security market.

iv) While Cisco and VMware are partnering with leading firewall and ADC vendors, they are also have or are developing internal solutions, especially in the case of firewalls – this creates risk that over the long-term stand-alone firewall (and potentially ADC) vendors get disintermediated out of some east-west, and eventually some north-south opportunities, as controller vendors package their own L4-7 services into their SDN solution.

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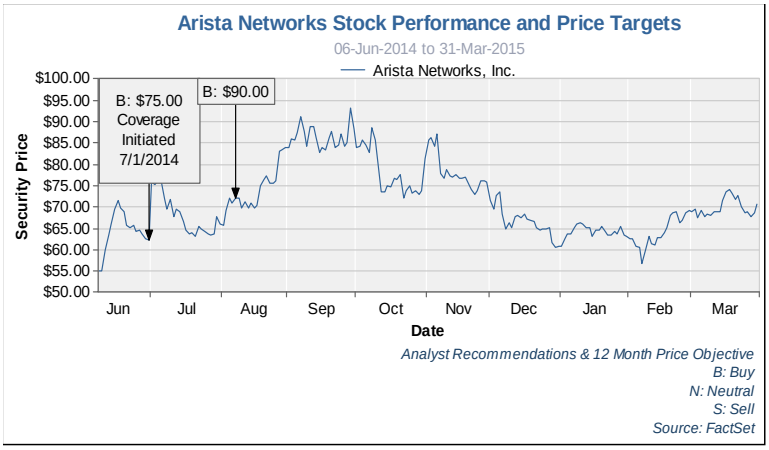

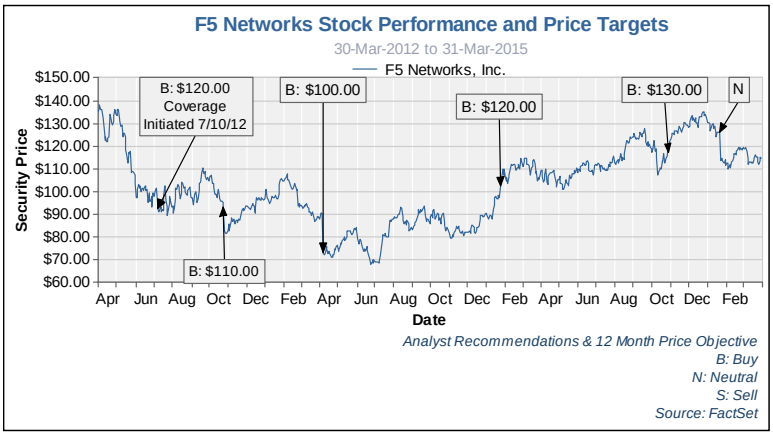

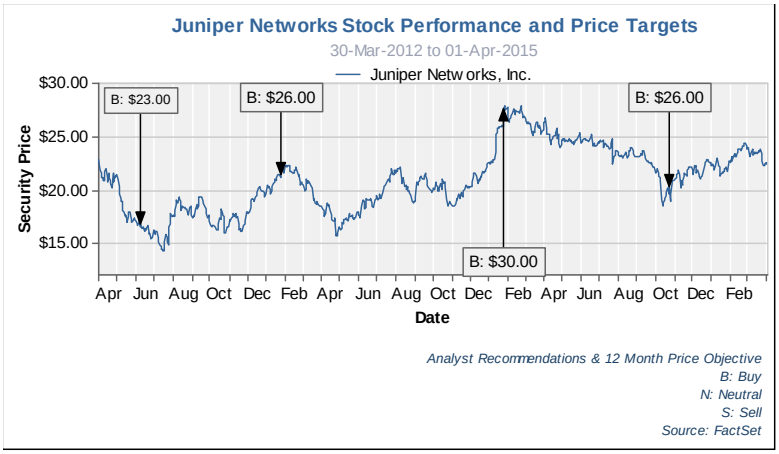

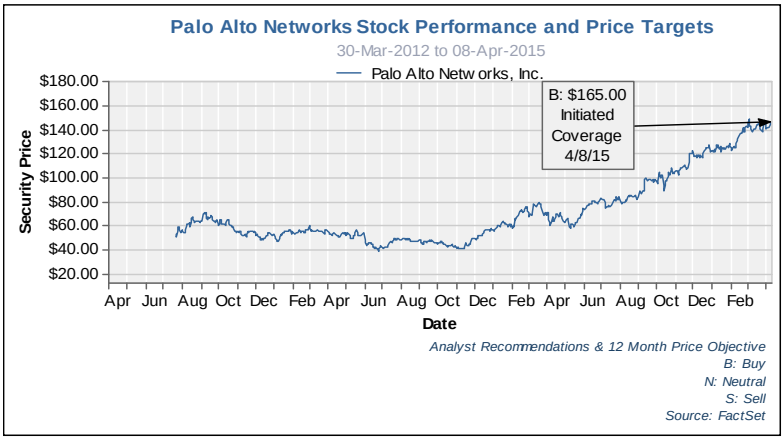

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