Case Study

Higher Education Network Administrators
Higher Education

TNSR and pfSense Plus Software Fulfill ASUTR Edge Router Needs

High-Performance Software Router Delivers Compelling Throughput and Economics for 10 Gbps - 100 Gbps Video and Encrypted Traffic Needs of Arkansas State University Three Rivers

Higher education institutions are looking at ways to reinvent themselves after tuition and enrollment declines over the past several years. One key objective is to provide real-world computing infrastructure for students with real-time access to data, the Internet and other resources via laptops, tablets and smartphones. Hybrid learning environments, connected classrooms for online resource access, efficient distance learning, open access to campus digital libraries, and anytime / anywhere network connectivity and response times are all now table stakes for a modern educational experience.

To accommodate these needs, colleges and universities have had to undergo a transformation – one that redefines the digital services they offer to students. Unfortunately, EDUCAUSE reports[1] that "many IT budgets have been reduced, just as institutions are more dependent on IT than ever before, contributing to a growing institutional digital divide."

Affected IT departments have struggled to upgrade networks to modern expectations with network connectivity speeds remaining sluggish. Adding insult to injury, students empowered by social media can spotlight poor IT performance - exposing subpar learning experiences, which can impede an institution's ability to recruit top students.

Arkansas State University Three Rivers (ASUTR) is no exception to these challenges.

ASUTR is a public, two-year institution of higher education located in Malvern, Arkansas. The college is recognized as Arkansas' first official technical college and offers more than 50 programs of study in academic, career and technical disciplines - through some 150 staff members - to approximately 2,200 students across four campuses in Malvern, Benton, and Sheridan, Arkansas.

In March 2020, the IT department began a situational analysis with the goal of improving the campus network with three key initiatives in mind:

- Upgrade the four-campus backbone network from a 1 Gbps infrastructure to 10 Gbps WAN / LAN with ability to affordably grow to 100 Gbps
- Ensure routed traffic would have the performance to support a substantial amount of video and audio traffic related to the increased usage of Blackboard Collaborate and Zoom
- Support high-performance, site-to-site IPsec VPN connections to other technology providers in conjunction with a new enterprise resource planning (ERP) system

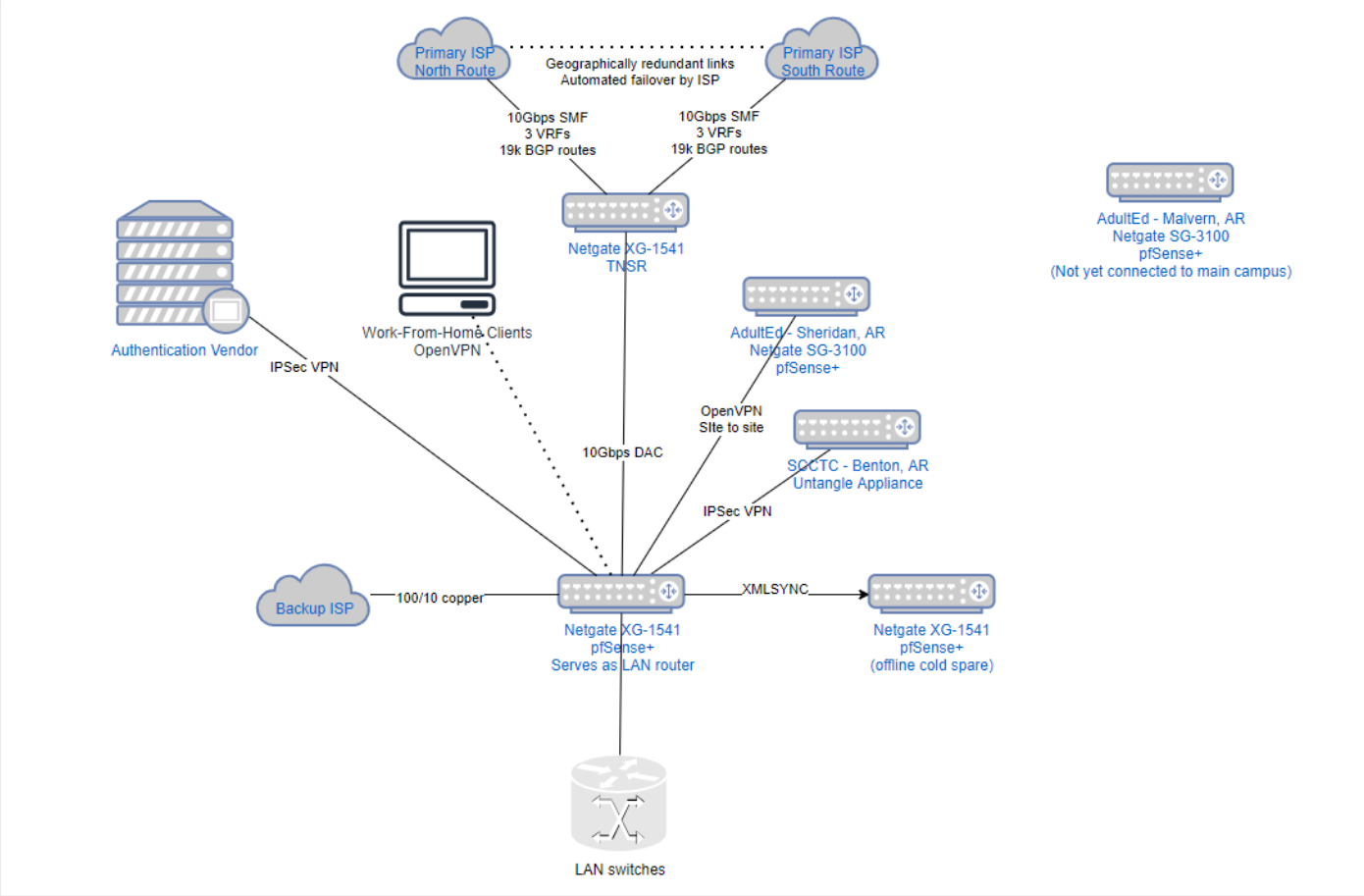

Figure 1. ASUTR's new backbone network with Intel architecture CPU-based servers to handle 10Gbps network links

Challenge

A few months after its planning started, ASUTR saw a significant shift to remote learning, resulting in a major impact to network requirements. The immediate strain of so much remote traffic would soon overwhelm its existing network infrastructure, which consisted of a single 1 Gbps Internet service link connected to an end-of-life name brand router and pfSense® Plus firewalls deployed on a mix of older model brand name and white box servers.

This patchwork of older networking equipment kept up with data demand when ASUTR only needed a single 1 Gbps internet connection, but it meant the school needed a complete upgrade to make full use of two recently provisioned 10 Gbps internet connections.

ASUTR called in Intel® Network Builder ecosystem partner Netgate® to provide a routing system (See Fig. 1) that scales to 10 Gbps speeds and higher. The solution would also need to fit the budgetary needs of the university. With so much pandemic-driven higher education financial uncertainty, and every department scrambling to adapt, the budget would be even harder to sequester.

Choosing the Best of Three Solutions

ASUTR had three solutions to choose from:

Option 1: An internet service provider (ISP)-managed name-brand router. Working as a network-as-a-service model, this option would include hardware, software, support, monitoring, maintenance, software refreshes, etc. - resulting in less work for an already strained IT team. Unfortunately, it was very expensive - on the order of five to 10 times more than the lowest cost option over a five-year lifespan. Further, because all requests would need to be implemented by the ISP, this solution would be difficult to manage and scale - change requests for even the simplest change could take from hours to days to complete.

Option 2: Purchase a brand name solution. ASUTR already had equipment from this vendor, so one of the positives with this option was familiarity with product and user interface and an edge gateway packed with rich router and firewall functionality. But this was even more expensive than the ISP-delivered service; it was easily 100 times more than the lowest-cost option over a five-year lifespan. Redundant hardware and license costs were exorbitant and ASIC-based solution constraints would make scaling both expensive and disruptive.

Option 3: The solution ASUTR chose was based on TNSR® and pfSense® Plus from Netgate®. TNSR is a high-performance, virtual network function (VNF)-based software router using FD.io's open source Vector Packet Processing (VPP), to which Netgate is a leading contributor. TNSR combines VPP's extraordinary packet processing performance with Data Plane Development Kit (DPDK) and other open-source technologies to provide a turnkey high-performance software router that enables businesses and service providers to address today's edge and cloud networking needs at extremely low cost.

Benefits of VPP

The prevailing packet processing model for decades has been 'kernel-based.' Packets are received on a network interface and sent straight into the computer's operating system (OS) - all the way to the core of the OS (the kernel) - for determination on how they should be processed within that device.

Kernel processing of packets is designed around the principle of receiving one packet at a time, fetching an instruction from an instruction cache, performing that instruction on the packet, fetching the next instruction, performing that instruction, and so on. Once that packet is processed, the next packet enters and goes through the same routine.

In high-performance servers, packet forwarding with Linux tops out at 2 million packets per second (Mpps) – a throughput level that can easily be reduced by intracore locking and other effects.

VPP moves the packet processing workload out of kernel space and into user space. User space is where programs and libraries reside and it provides more capacity to manage cache-based instruction sets.

Here is the key performance breakthrough. Rather than serially processing each packet through the entire processing graph, VPP fully processes the vector of packets through the first graph node before moving on to the next graph node. The first packet in the vector 'warms up' the instruction cache, so remaining packets can be processed extremely fast - sharply reducing the processing time for each subsequent packet in the vector.

This leads to very high performance for processing a single packet, and statistically reliable performance in processing a large number of packets over time. Additionally, VPP will often prefetch what it knows to be the next packet, ensuring that the CPU doesn't stall while the next packet is fetched from RAM. As a result, throughput is high and latency is consistently low.

Deployed on Netgate 1541 appliances, the TNSR software is powerful enough to fully utilize the built-in Intel® Xeon® D processor and accommodate the most demanding traffic processing conditions. Netgate 1541 appliances contain an eight-core Intel® Xeon®-DE D-1541 2.1 GHz CPU with 32GB of memory (which enables up 32,000,000 active connections), four 10GbE SFP+ ports, and two Intel i350-AM2 1GbE RJ45 LAN ports. This translates directly to excellent 1 Gbps and 10 Gbps performance for classroom video and high-performance site-to-site connections.

As an example, routing over secure tunnels is difficult to achieve with high performance and low latency, typically forcing buyers into very expensive products based on ASICs or FPGAs to achieve the real throughput need. TNSR software, combined with Intel commercial-off-the-shelf (COTS) CPUs shatters this paradigm, enabling the following router throughput performance[2]:

	iPerf3[3]	IMIX[3]
L3 Forwarding	18.95 Gbps	18.73 Gbps
Firewall (10,000 ACLs)	18.71 Gbps	18.95 Gbps
IPsec VPN (AES-GCM-128 with Intel® QuickAssist Technology (Intel® QAT)	11.42 Gbps	8.04 Gbps

Table 1. TNSR performance on a Netgate 1541.

pfSense Plus* software is a leading open-source firewall, router, and VPN solution for network edge and cloud secure networking with more than 3 million installations protecting homes, businesses, governments, educational institutions and service providers. The software offers significant performance advantages (see Table 2) and is equipped with many router and firewall features typically found only in expensive commercial routers. Additionally, it offers flexible VPN solution options, is known for its robustness and stability, and is highly extensible with third-party packages to support block lists, content filtering, intrusion prevention, policy-based routing and more. The solution is easy to install and maintain via web GUI.

	iPerf3[4]	IMIX[4]
L3 Forwarding	18.80 Gbps	15.10 Gbps
Firewall (10,000 ACLs)	18.64 Gbps	12.30 Gbps
IPsec VPN (AES-GCM-128 with Intel® QuickAssist Technology (Intel® QAT)	9.30 Gbps	1.77 Gbps

Table 2. pfSense Plus software performance using Netgate 1541.

Conclusion

Like many other organizations, higher education institutions around the world have had their IT infrastructure come under substantial performance pressure due to a massive increase in remote worker/student demands. While it may have been acutely strained due to the pandemic, high-volume remote student and worker network traffic is here to stay. Until recently, the 10 Gbps (or larger) network connections needed to support massive video bandwidth - or strenuous site-to-site IPsec connections - have historically only been affordable to the largest, most sophisticated business, education, and government entities. The game is now changed.

Netgate TNSR software - an astoundingly fast VNF router - can achieve packet performance numbers previously thought to have required ASICs or FPGAs. Further, having TNSR underpinned by powerful Intel Xeon D processors in the Netgate 1541 collapses both initial solution purchase price and lifetime total cost of ownership as an organization's throughput needs increase.

ASUTR discovered that TNSR is the right solution for its high-speed connections coming in from the ISP - which supports all off-campus remote student traffic. With unbeatable price / performance, familiar command line interface (CLI), single vendor business assurance via Netgate appliance deployment, TNSR is a clear winner for any organization - but particularly those with rapidly escalating bandwidth needs and constrained IT budgets.

pfSense Plus software addresses ASUTR's network security and multi-campus WAN/LAN needs given its rich feature set with no expansion costs, ease of use, and reliability.

Combined with Intel CPU, NIC and crypto acceleration technology, secure networking solutions are made not only performant and scalable, but highly cost-effective for even the most demanding organizational needs.

Learn More

pfSense

TNSR

Netgate 1541

Intel® Network Builders

ASUTR

Intel® Xeon® D processors

Intel® QuickAssist Technology (Intel® QAT)

Notices & Disclaimers

[1] https://er.educause.edu/blogs/2020/10/educause-quickpoll-results-it-budgets-2020-21

[2] https://www.netgate.com/appliances#compare-products

[3] https://www.netgate.com/tnsr-software/how-to-buy#appliances (leveraging a CPIC-8955 cryptographic accelerator card for Intel® QuickAssist Technology, and based on TNSR software release 22.02).

[4] https://www.netgate.com/tnsr-software/how-to-buy#appliances (leveraging a CPIC-8955 cryptographic accelerator card for Intel® QuickAssist Technology, and based on pfSense Plus software release 22.01).

Intel technologies may require enabled hardware, software or service activation.

No product or component can be absolutely secure.

Your costs and results may vary.

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