White Paper

Communications Service Providers

VizuaMatix Creates Network-Based Digital Wellbeing Services

vxSafenet uses Intel® technology for data plane and deep packet inspection for communications service providers services that let parents keep their children safe on the internet and manage screen time

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Increased use of social media sites and parental concern about the amount of their children's screen time and access to inappropriate content have driven the market for parental control and digital wellbeing applications. According to a report from Fortune Business Insights, the global parental control software market size was valued at $1.25 billion in 2023. The market is projected to grow to $1.40 billion in 2024 and to $3.54 billion by 2032[1].

Industry leaders include a number of market-focused independent software vendors (ISVs) and over-the-top (OTT) vendors. There is also an opportunity for communications service providers (CoSPs) with their broad customer reach and broadband services that provides bundling potential.

But CoSP-offered parental control and digital wellbeing services typically support only a basic feature set or are content filtering mobile apps that are more intrusive than is necessary to protect children's internet rights. With their sole focus on this market, OTT and ISV competitors have been able to stay ahead of CoSPs in new feature development.

A New Approach

VizuaMatix offers CoSPs a new approach that shifts from rigid control to digital autonomy based on a child-rights centered co-piloting approach for parents. In today's digital age, the VizuaMatix solution provides effective ways for parents to engage with their children non-intrusively, ensuring cyber security and managing screen time more effectively.

The solution is based on VizuaMatix's sophisticated deep packet inspection (DPI) technology, high-performance data plane and other tools and technologies that go beyond traditional content filtering solutions. The solution includes a network-based sensor that sits between a child's traffic and the internet, effectively managing content inspection and monitoring screen time and data usage.

To demonstrate the performance of its core vxDPI-NG technology, VizuaMatix, an Intel® Industry Solution Builders Partner, tested the performance of its DPI capabilities on servers powered by 4th Gen Intel® Xeon® Scalable Processors.

Advanced DPI Technology Powers vxSafenet

The VizuaMatix next generation DPI (vxDPI-NG) (Figure 1) is AI-powered and enables VizuaMatix to effectively detect and control children's web traffic both in the CoSP core network and at the network edge. This hybrid approach ensures that child user policies can be implemented seamlessly when the child's device is connected to the mobile network as well as home Wi-Fi.

The vxDPI-NG Probe processes only opt-in child subscriber traffic for the specific purpose of enabling parental control and promoting digital wellbeing. It collects network traffic and packet information solely to identify traffic patterns, apply content filtering, and enforce usage policies.[2]

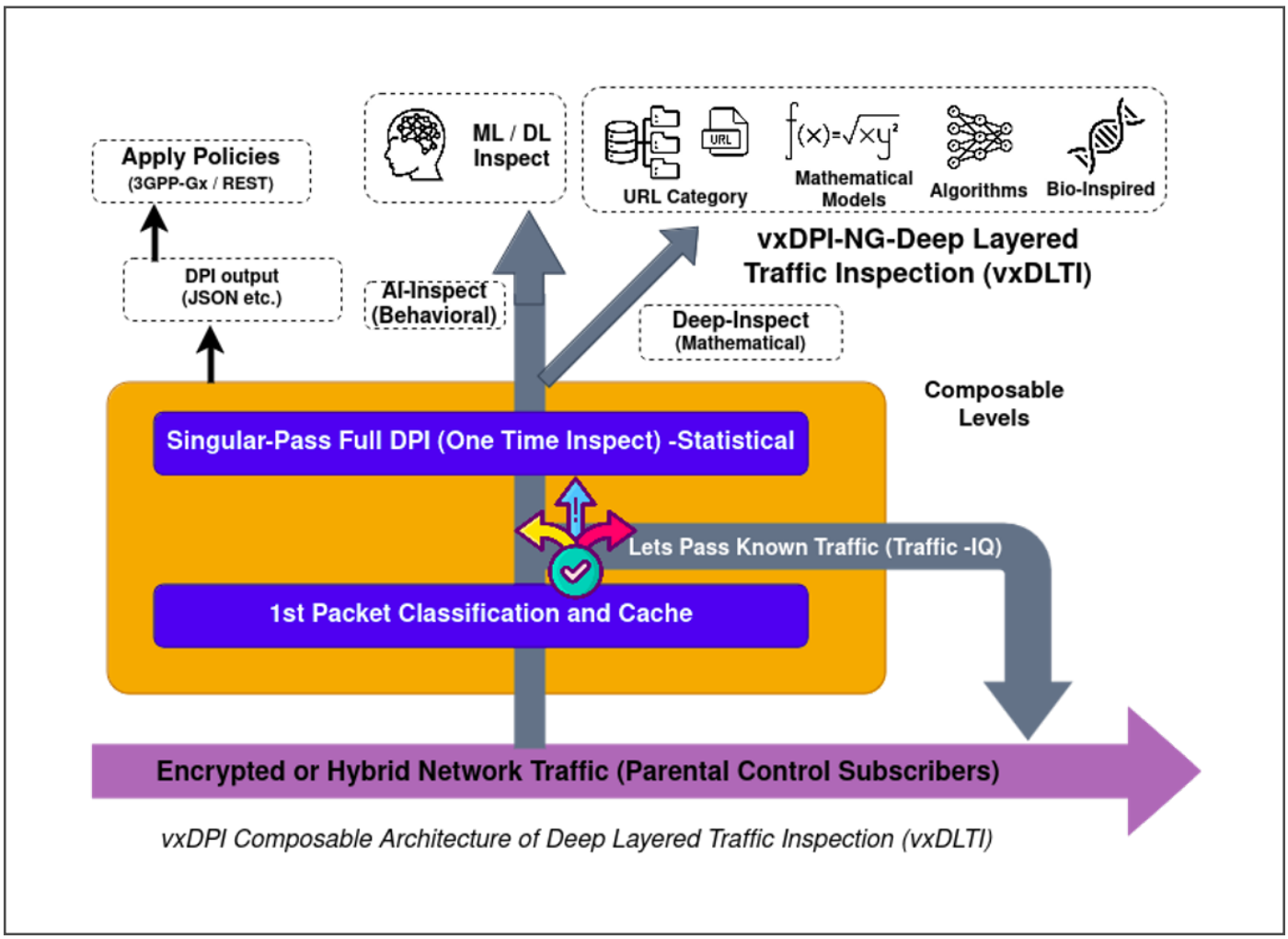

Figure 1. vxDPI composable architecture of deep-layered traffic inspection (vxDLTI).

Figure 2 shows how vxDPI fits into a parental control ecosystem and how other value-added services can be integrated, presenting new business opportunities thanks to this holistic approach. The vxDPI network-level content detection and classification capabilities are combined with a highly accurate and up-to-date URL database with more than 109 million categorized URLs. The 3GPP-compliant platform is an advanced policy and charging control (PCC) ecosystem and has a built-in provisioning engine that can be easily integrated into the PCC system within a CoSP's BSS/OSS.

vxDPI-NG features a probe for a CoSP's RADIUS user authentication service that provides subscribers information including International Mobile Equipment Identity (IMEI), location information, and Mobile Station International Subscriber Directory Number (MSISDN).

The software can identify endpoints by device type and subscriber. It can extract granular metadata that is needed for cyber security protection including domain fronting, evasive traffic, domain generation algorithm (DGA), and others. vxDPI-NG can also deliver data flow-level security risk identification.

vxSafenet Creates Country-Wide Safe Zone

The leading mobile telecom operator in Sri Lanka has deployed vxSafenet broadly throughout the country to create a nationwide internet safe zone for children. Here are some details on the scope and impact of the deployment:

- Core network: 4G and 3G network with 5G in testing
- Children protected: 55,402
- Total traffic volume processed: more than 940 TB
- Harmful website access attempts blocked: more than 206 million
- Child users <10 years: 44%
- Child users >10 year and < 18 years: 56%

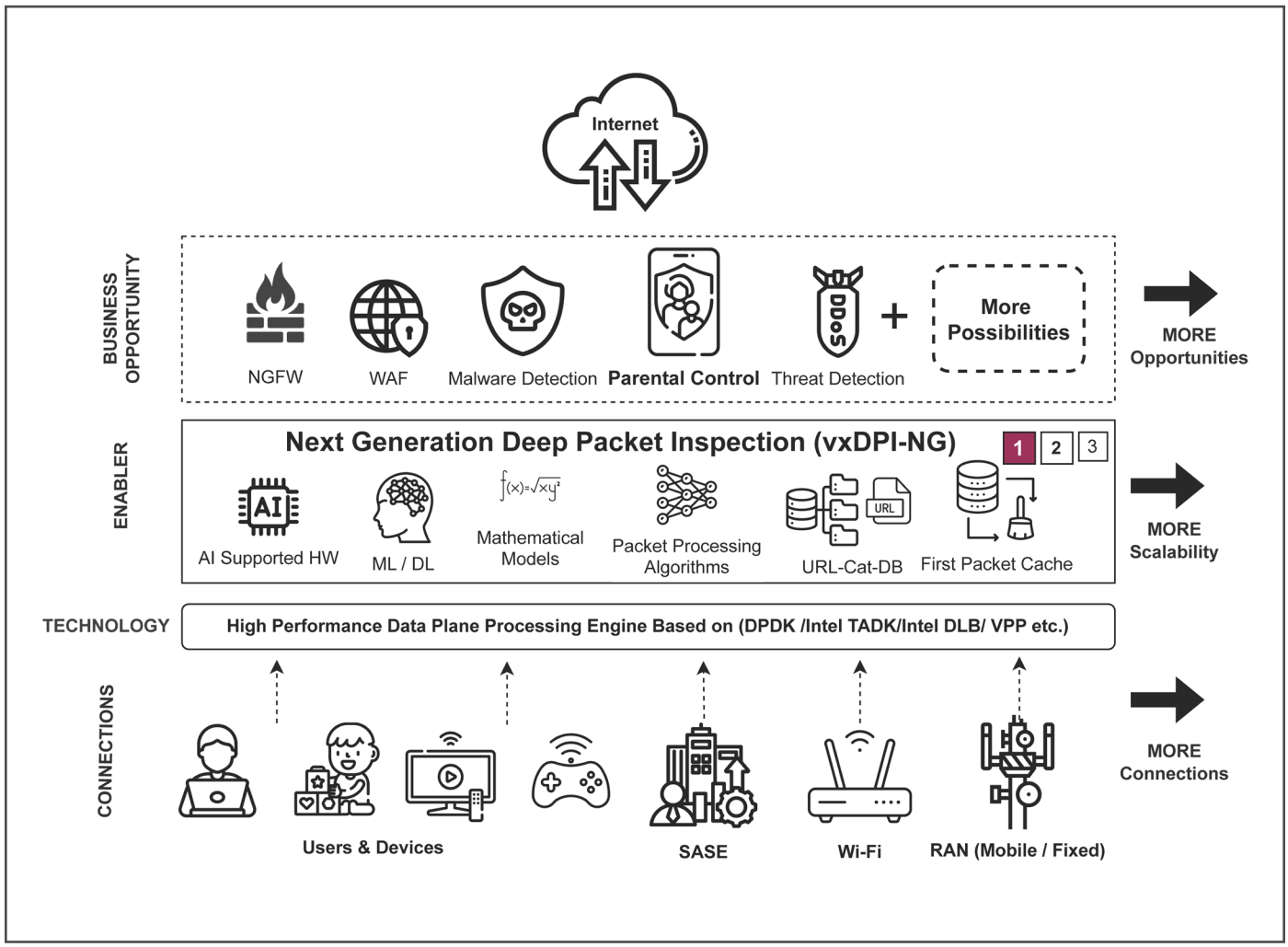

Figure 2. vxSafenet's performance comes from the data plane processing engine that is at the heart of the solution. When running in the CoSP network, vxSafenet covers all of the connections that could be used in a parental control application. For additional services based on the DPI, CoSPs can customize their service with technology from the VizuaMatix ecosystem (top level).

Intel Software Powers vxDPI-NG Data Plane

vxDPI-NG uses Intel software libraries (see Figure 3) to create a high-performance data plane for event-based packet flow distribution that, unlike packet pipelining, ensures that packets from a given flow can be only outstanding on a single core at a given time.

This data plane is a packet distribution mechanism that facilitates DPI that ensures each subscriber data packet is treated uniquely and is available for policy implementations. Packet flows are dynamically pinned to cores, using load balancing to migrate flows between cores when required. This preserves flow order and allows the processing software to operate in a lock-free manner. This approach also provides atomic-level control in the packet processing pipeline.

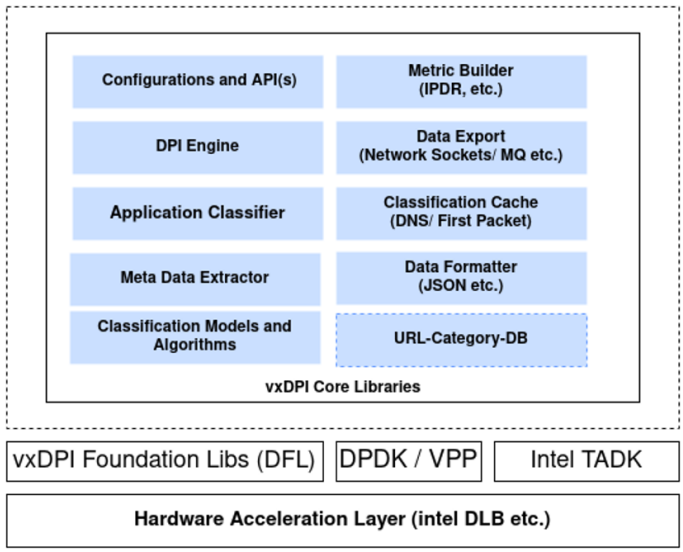

Figure 3. vxDPI software component stack.

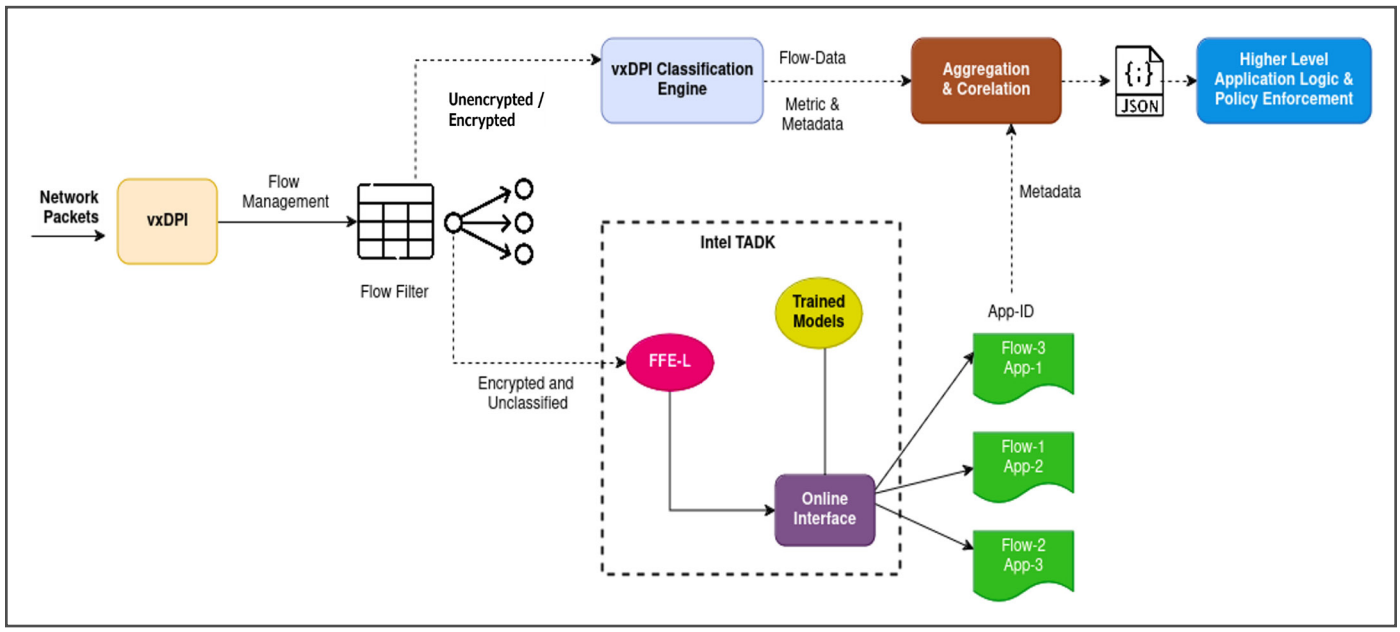

Figure 4. vxDPI traffic processing workflow.

The Intel technologies used in the data plane include (see also Figure 4):

- Intel® Traffic Analysis Development Kit (TADK) offers optimized libraries and tools for network traffic analysis and classification on which VizuaMatix can build its own DPI (or AI/ML) models. TADK also can extract network flow features and classify the flow using either DPI information or an AI/ML model.
- Data Plane Development Kit (DPDK) event-dev library adds support for event-driven packet processing programs to DPDK which provides better load balancing of data flows than poll mode packet programming.
- Intel® Dynamic Load Balancer (Intel DLB) provides efficient hardware-based load balancing by dynamically distributing network data across multiple CPU cores as the system load varies.

Intel CPUs Bring DPI Performance, Features

VizuaMatix uses the 4th Gen Intel® Xeon® Scalable processor in vxDPI-NG applications because it is designed with performance for compute-intensive tasks. These processors offer increased memory bandwidth compared to previous generations, which ensures that the large data sets used in DPI can be accessed and processed without bottlenecks enabling faster and more efficient packet analysis.

Another significant advantage of the 4th Gen Intel Xeon Scalable Processor is its support for PCIe 5.0, which doubles the I/O data transfer rate of PCIe 4.0. PCIe 5.0 delivers higher data throughput between the processor and high-speed network interface cards (NICs) and accelerators, significantly improving the performance of DPI applications.

Intel® Advanced Matrix Extensions (Intel® AMX) is a technology embedded in the 4th Gen Intel Xeon Scalable processor that accelerates the vxDPI-NG's AI and ML workloads, to support the advanced threat detection and anomaly analysis.

By offloading these complex computations to the processor, Intel AMX enables more efficient use of computational resources, freeing up the main processing power for core DPI tasks. This capability both enhances the performance of security algorithms and reduces overall system latency, making DPI-based network monitoring and threat mitigation systems more responsive and effective.

Furthermore, the CPU family's robust load balancing functionality enhances the scalability and efficiency of DPI applications in multi-core environments. With intelligent resource allocation and distribution, it ensures that workloads are evenly distributed across processor cores, minimizing the risk of performance bottlenecks.

This feature is particularly beneficial in high-traffic environments where maintaining consistent performance is critical. By optimizing the use of available resources, the 4th Gen Intel Xeon Scalable processor helps to maximize the throughput and reliability of DPI systems, enabling them to handle the demands of modern network security and traffic management with greater efficiency.

Testing vxDPI-NG on 4th Gen Intel Xeon Scalable Processors

VizuaMatix designed the test setup to simulate the real-world deployment scenario of a CoSP's network by using the open source TRex traffic generation software[3]. The device under test (DUT) is using vxDPI-NG application embedded with the DPDK event-dev library on a multi-core server. The test setup was able to generate and analyze 100Gbps traffic. The DUT was the Configuration-A server that utilized the 4th Gen Intel Xeon Scalable processors.

Test Design

The test team selected several popular apps/services with traffic encrypted and non-encrypted for validation (see Table 1). The results were categorized based on traffic identification and overall throughput under the simulated load.

App-Type	No of pkts	Pkt Size (Bytes)
BitTorrent	151	1060
Bittorrent_TCP_Handshake	9	66
DNS	3	83
genericEBay	730	1069
Facebook_ssl	115	408
GoogleBrowsing	27	324
Gmail-ssl	89	440
GoogleMaps	25	557
HTTP_YAD2_33_CP	16	116
LW_HTTP	9	102
genericNetflix	11000	1514
SMTP_IXIA	98	253
genericTCP	65	400
genericUDP	102	442
YouTube_ssl	224	689

Table 1. Apps used for vxDPI-NG tests listed with number of packets sampled and packet size in bytes.

Test 1: Performance Comparison

The first test compared the performance on DUT Configuration-A, a server powered by two Intel Xeon Gold 6438N processors, with DUT Configuration-B, a server powered by two Intel Xeon Scalable 8260M processors.

The test case consisted of live traffic profiles recorded in the form of packet capture (PCAP) samples that were stored in the stateless profile configurations section of TRex. Stateless mode was chosen because it supported performance and could scale up for high bandwidth (~200 Gbps) across many realistic flows, compared to relying on one large "elephant" flow.

DUT Configuration Profile

- Flow and subscriber tracking within time-ordered hash tables
- DPI full classification enabled
- Support of all of classification signatures based on different applications, protocols, and attributes
- DPI application runs on one logical core in order to gather median throughput per logical core
- JSON serialization enabled for app-id and metadata extraction

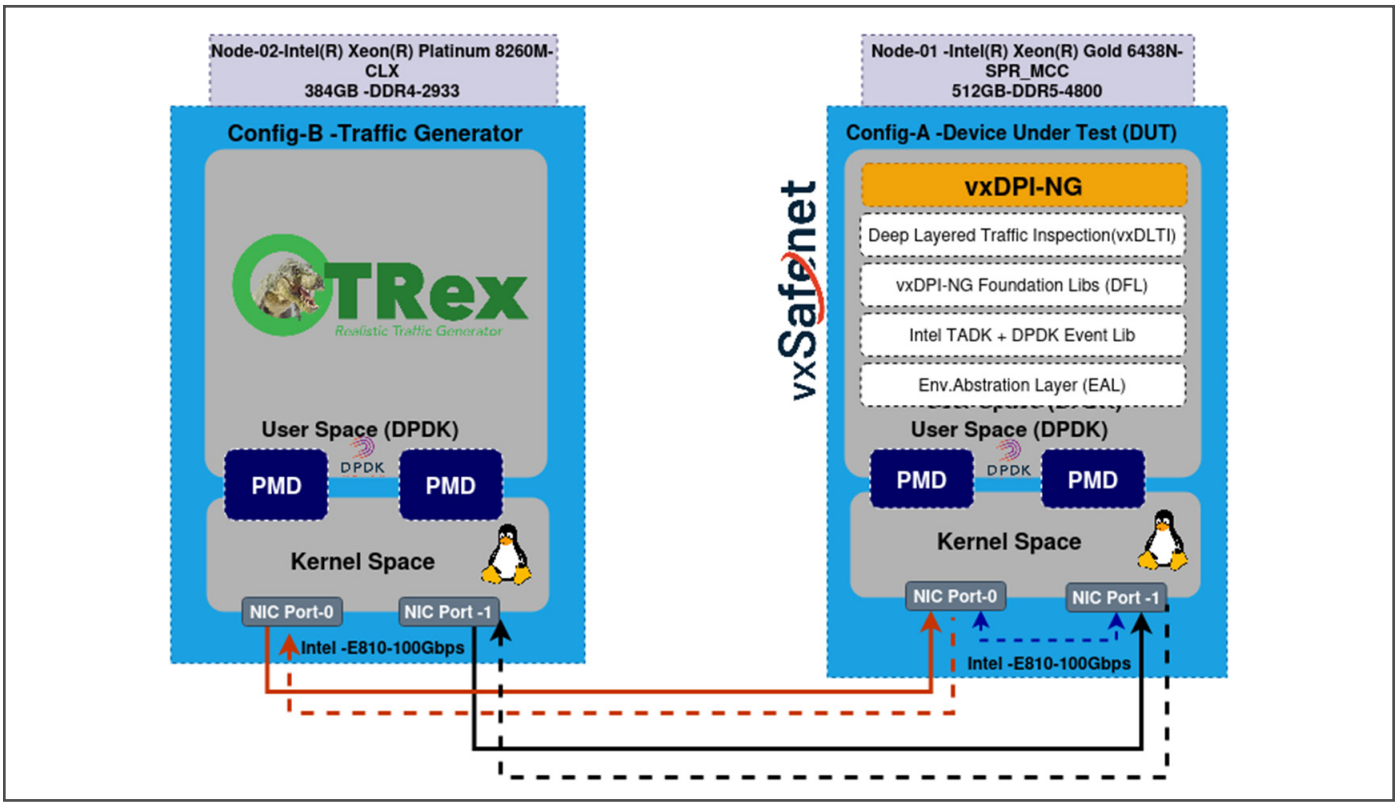

Figure 5. vxDPI traffic processing workflow.

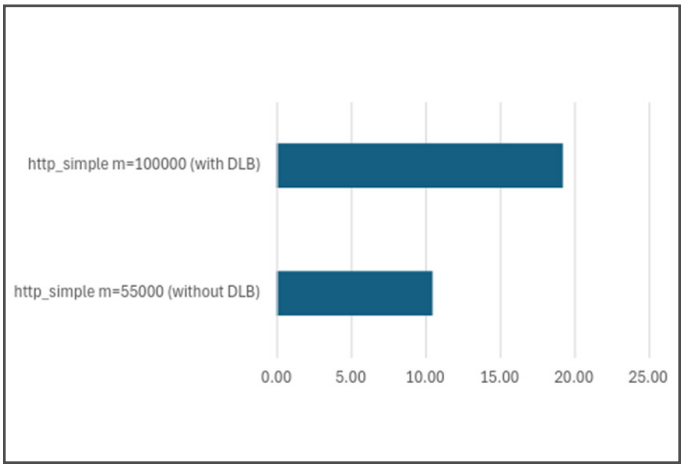

Figure 6. Packet forwarding throughput in Gbps with and without Intel® DLB (higher is better).

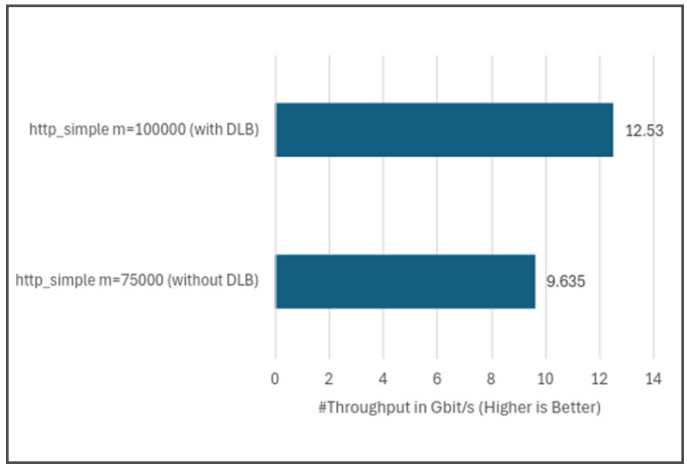

Figure 7. vxDPI throughput (per logical core) with full DPI classification engine and metadata enabled with Intel DLB.

Test Results

The first test conducted by VizuaMatix measured the performance of the DUT with a data flow comprised of a randomly selected mix of packet sizes (see Figure 6). The packets were not encrypted and had no DPI classification. This test measured the performance impact of dynamic load balancing. The result is that a single core on the DUT achieved nearly 20 Gbps performance with load balancing and just over 10 Gbps without Intel DLB. This means that only one core is necessary to fill a 25GbE network interface, or five cores to fill a 100 GbE interface. This test formed a baseline for comparison to the results of the following tests.

Figure 7 shows the results of adding full DPI classification to the scenarios tested in Figure 6. The results show a decrease in throughput when compared to the test results in Figure 6 because DPI requires additional CPU processing.

The test results presented in Figure 8 shift from a generic data flow to flows from specific applications, including Microsoft Teams, YouTube, Facebook, iMix with 1518-byte packets, internet traffic, and the random packet-size data stream from previous tests. The results show throughput in Gbps with full DPI classification along with metadata inspection. The best performance was the large packet size iMix data stream. This makes sense as there are fewer packets to process. Throughput is from a single core on the DUT server.

Figure 9 shows the same data types and tests as Figure 8 but measured in millions of packets per second.

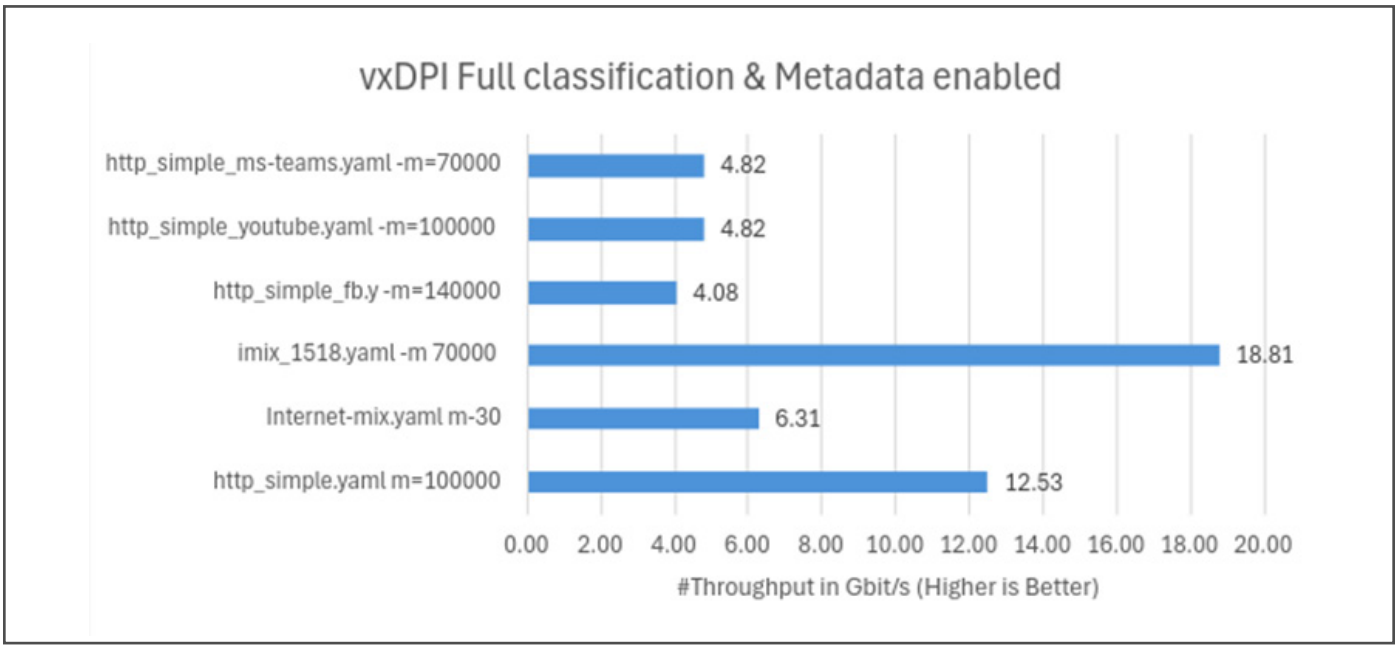

Figure 8. Throughput in Gbps of data flows emulating real world mobile apps (higher is better).

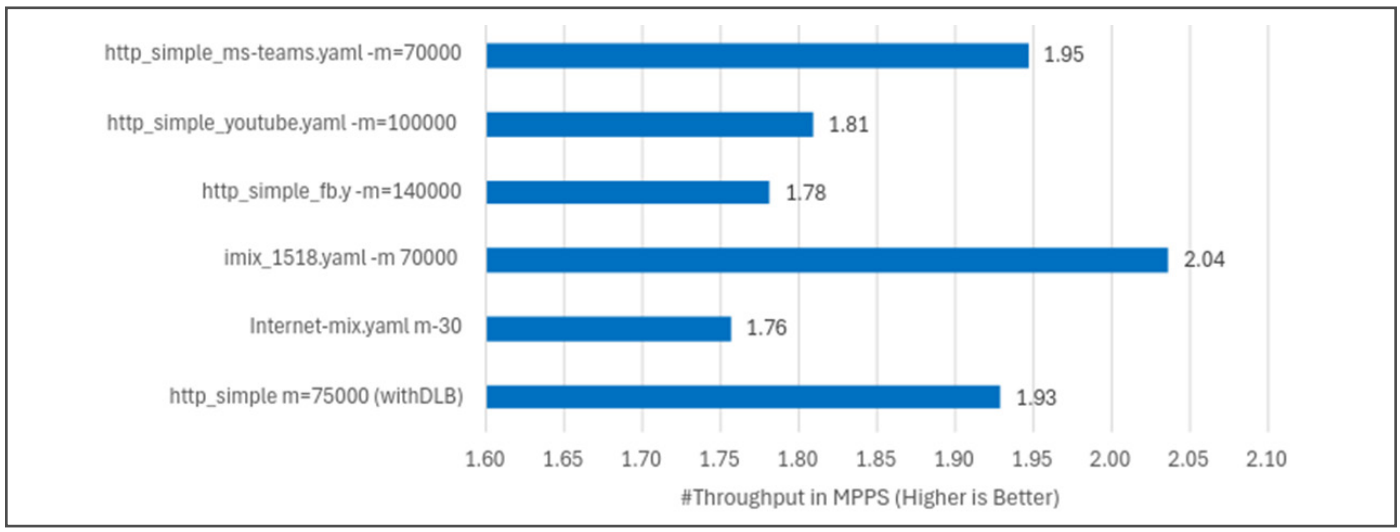

Figure 9. Throughput in millions of packets per second (Mpps) of data flows emulating real world mobile apps (higher is better).

Conclusion

Parental-control services is a big and growing market and one where CoSPs have a natural advantage in terms of cross selling to their existing customer base. VizuaMatix offers CoSPs a white label service that leverages its advanced vxDPI-NG technology for performance and features. The per-core performance in testing conducted by VizuaMatix shows CoSPs the excellent throughput data and lets them know just how many cores they will need to offer this service on their network.

Learn More

VizuaMatix Home Page

vxSafenet

4th Gen Intel® Xeon® Scalable Processor

DPDK

Intel® DLB

DPDK event dev

Intel Industry Solution Builder

[1] https://www.fortunebusinessinsights.com/parental-control-software-market-104282

[2] VizuaMatix privacy policy: https://www.vizuamatix.com/_files/ugd/591340_1f065a2cbc984b5eb36488827668b1bf.pdf

[3] DUT Configuration-1: 1-node, 2x Intel® Xeon® Gold 6438N processor with 32 cores and 64 threads. Total DDR5 memory was 512 GB (16 slots/ 32GB/ 4800 MHz); microcode 0x2b0004d0; Intel® Hyper-Threading Technology - enabled; Intel® Turbo Boost Technology - enabled. BIOS version: Dell Inc. Version 1.4.4. Software: OS was Ubuntu 22.04.4 LTS; kernel was Linux 6.5.0-28-generic. Benchmark/workload software: vxDPI-NG-v0.24.06; Compiler was gcc (Ubuntu 11.4.0-1ubuntu1~22.04) 11.4.0; Libraries were DPDK 22.11.0. and TADK-tadk_v23.03. Other software: ICE driver 1.11.14, iavf driver 3.2.3-k and ICE firmware 4.10. Test conducted by VizuaMatix on November 2024.

DUT Configuration-2: 1-node, 2x Intel® Xeon® Platinum 8260M processor with 24 cores and 48 threads. Total DDR4 memory was 384 GB (12 slots/ 32GB/ 2933 MHz); microcode 0x5003303; Intel® Hyper-Threading Technology – disabled; Intel® Turbo Boost Technology – enabled. BIOS version: Intel Corporation SE5C620.86B.02.01.0012.070720200218. Software: OS was Ubuntu 20.04.5 LTS; kernel was Linux 5.4.0-139-generic. Compiler was gcc (Ubuntu 9.4.0-1ubuntu1~20.04.2) 9.4.0; Libraries were Trex v3.02. Test conducted by VizuaMatix on November 2024.

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