Solution Brief

Intel® Xeon® Processor 5500 Series

Router Solution

Integrating Services at the Edge

Test results show that one Intel® Xeon® processor 5500 series with quad-core technology can forward traffic at 20 Gbps.

The latest Intel® multi-core processors enable flexible and cost-effective routers for service providers. That is exactly what they need to allow them to quickly create and deploy new, sophisticated, revenue-generating services, a trend illustrated by Figure 1. The industry is transitioning away from network devices dedicated to forwarding packets and towards integrated service devices capable of multiple functions beyond routing. This evolution is allowing service providers to easily offer services like enhanced security; voice, video and conferencing; sophisticated traffic management; and even triple play. Service providers also need to be fast and flexible so they can thrive in evolving markets.

The challenge for router and switching vendors is how to design a common, scalable platform despite the tendency to spread workloads – applications, control plane and data plane – across a diverse mix of hardware and software components. Historically, a family of router products incorporated numerous board designs using a range of processing silicon, such as CPUs, DSPs, FPGAs and ASSPs, each requiring dedicated firmware and software. This system architecture approach invites inefficiencies with respect to scalability, engineering costs and maintenance, component reuse, integration, inventory and ongoing compatibility.

An alternate solution is to consolidate all the workloads required for service-rich edge and metro edge routers onto an Intel® multi-processor, multi-core platform. The revolutionary performance gains from multi-core processors are now being applied to data plane workloads. As described in the following router platform proof-of-concept discussion, one Intel® Xeon® processor 5500 series with quad-core technology can readily process 20 Gbps traffic and still have CPU capacity. And adding services with Intel® processors takes minimal effort because most services are already written to run on x86 processors, meaning integration of new services by router vendors or end users is straightforward. Also, Intel® architecture is flexible, so router manufacturers can save engineering costs by developing a wide range of products derived from one code base that supports multiple functions. Solutions can scale by just adding processor cores and network adapters, and offer the flexibility to integrate nearly any new service. Finally, adding new network-aware services built around one sophisticated processor provides significant management and space advantages over purchasing separate products to acquire individual functions. The combined Intel architecture advantages are good for Internet service providers around the world.

Overview of the Router Platform

Intel engineers assembled the router platform proof-of-concept using off-the-shelf hardware components and open source software. A description of the platform and the resulting packet forwarding performance is provided. Note that the flexibility of the router is based on its software, and that carefully tuned software developed by router vendors may perform even better than the results presented here.

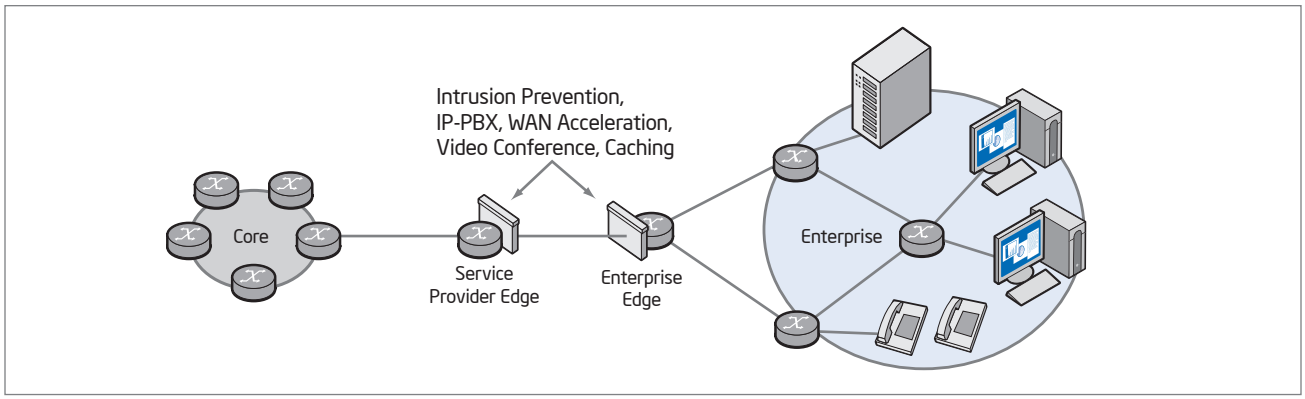

Figure 1. New services being deployed at the edge.

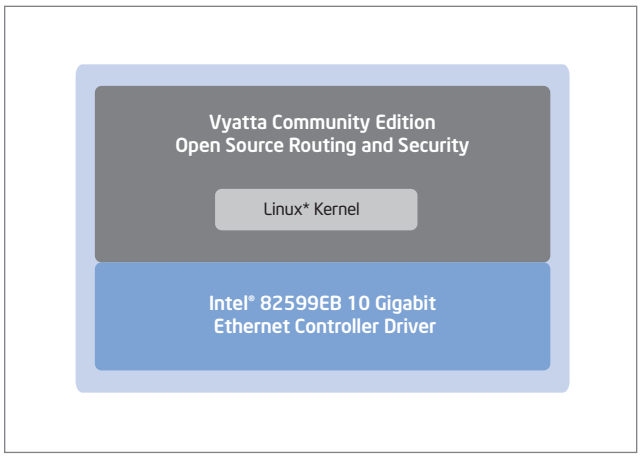

Figure 2. Key software components.

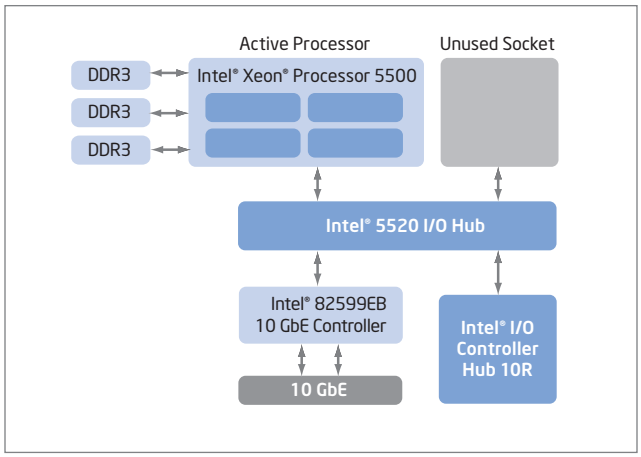

Figure 3. System under test – Intel® Server Board 5520HC configuration.

Platform Description

Routing is performed by Vyatta Community Edition software, which is open source routing code that runs on a Linux* Kernel and the Intel® 82599EB 10 Gigabit Ethernet Controller driver, as shown in Figure 2. This commercial off-the-shelf (COTS) software and drivers is a baseline that any development team can duplicate. The hardware platforms are based on the Intel Xeon processor 5500 series with quad-core technology, as illustrated in Figure 3. The processor accesses the server class Intel 82599EB 10 Gigabit Ethernet Controllers across PCI Express* v2.0.

Packet-Forwarding Results

Using COTS software, a single Intel® Xeon® processor 5540[Δ] can forward 1518-byte packets at 20 Gigabits per second (Gbps) and still have CPU capacity. Performance was measured using the Intel® Server Board S5520HC shown in Figure 3. Intel® Hyper-Threading Technology[1] was enabled to create two logical cores for each physical core, and processing was distributed across the eight logical cores. The throughput is shown in Figure 4. Packet forwarding, as a function of packet size, ranges from 2.8 million, 64-byte packets to 1.6 million, 1518-byte packets per second. Gbps also varies as a function of packet size from 1.8 Gpbs with 64-byte packets to 20 Gbps for 1024-byte and larger packets. Throughput details are shown in Table 1 (shown on the next page)[2], which also shows CPU utilization. Custom software can achieve much higher performance. Also note that only one of the two Intel Server Board S5520HC sockets was populated. Another processor could have been installed to perform other services.

Intel® Xeon® Processor 5500 Series Enhancements

While developing the Intel Xeon processor 5500 series, Intel made changes to the microarchitecture that increased overall performance and power efficiency without adding more cores. This latest processor has four processor cores, like its predecessor the Intel® Xeon® processor 5400 series, but with dramatically improved performance. The performance increase is a result of various architectural enhancements: adding a thread per processing core, integrating L3 cache memory on-chip and integrating a DDR3 memory controller. These enhancements translate into improved routing performance, as described in Table 2 (as shown on the next page).

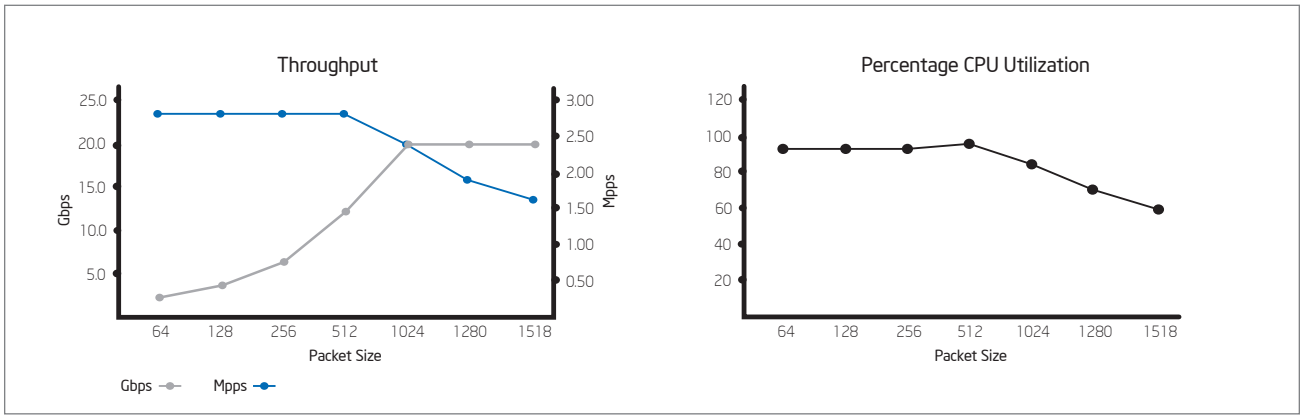

Figure 4. Bi-directional packet-forwarding results.

Features of Intel® Xeon® Processor 5500 Series Architecture	Benefits for Networking Applications
Intel® Hyper-Threading Technology[2]	Delivers two processing threads per physical core for a total of eight threads, which enables more flows to be processed simultaneously.
Multi-level cache, including the addition of L3 (last-level) cache	Allows the cores to efficiently share data in the cache, which is dynamically allocated to the processing cores in accordance to their workload.
Integrated DDR3 memory controller	Offers memory performance up to 25.6 Gigabytes per second, needed for providing network services at the packet level.
More efficient processor algorithms	Recovers lost performance due to stalls (dead cycles), which benefits multi-threaded routing algorithms that typically access data in a random fashion as opposed to sequentially. ▪ Faster handling of branch mispredictions ▪ Improved hardware prefetch ▪ Better load-store scheduling
Enhanced branch prediction	Fetches and executes instructions without waiting for branches to be resolved, which speeds up the execution of the outer and inner loops used by many networking algorithms.

Table 2. Intel® Xeon® processor 5500 series features and benefits.

Advanced Ethernet Controller Features

Providing an offload to Intel processors, the Intel® 82599 10 Gigabit Ethernet Controller reduces I/O bottlenecks and improves the overall packet-forwarding performance. The Intel 82599EB 10 Gigabit Ethernet Controller will write packet data directly into memory (DMA) and, optionally, will get the packet descriptor loaded into cache. In addition, the Intel® Receive Side Scaling is available to evenly distribute flows across the selected processor cores and intelligently queue data without processor intervention. Intel Receive Side Scaling calculates a binary hash-based on the 5-tuples: protocol, source and destination IP, and source and destination port – that is used to direct all of the packets from a given flow to a specific processor core, as shown in Figure 5. The Intel Receive Side Scaling holds packets in queues, which help to keep packets from getting dropped when processor cores become heavily loaded. The Intel Receive Side Scaling, combined with IRQ affinity support from the operating system, sends message signaled interrupts (MSI-X) to the processor cores when packets require processing and forwarding.

Cost-Effective Router Solution

Equipment manufacturers looking for an economical way to deliver a router for integrating services at the edge can consolidate all the necessary workloads onto a single Intel multi-core processor. The Intel Xeon processor 5500 series and Intel Receive Side Scaling provide 20 Gbps packet-forwarding throughput and run the service applications required by service-rich edge and metro edge routers. The revolutionary performance gains from Intel multi-core processors can be applied to data plane, control plane and service application workloads, producing impressive results. The router solution discussed in this brief is flexible, scalable and cost-effective because it easily integrates new services, scales performance by adding more processor cores, and lowers hardware cost by consolidating multiple workload types onto one device. As a result, equipment manufacturers can benefit from faster time-to-market, a scalable product family, and lower engineering and product costs.

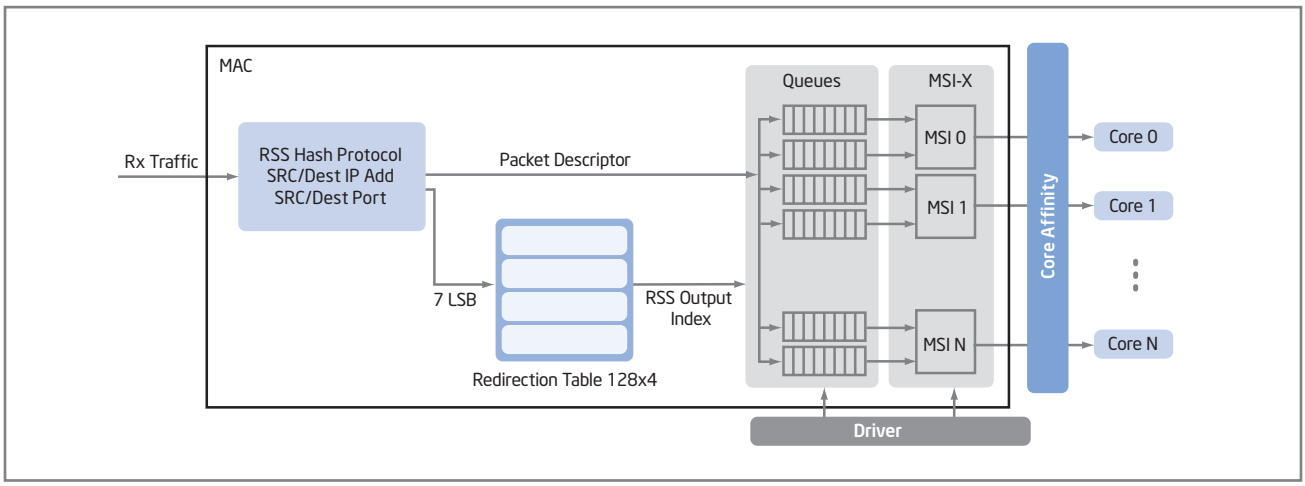

Figure 5. Intel® Receive Side Scaling – Flow distribution.

For more information on routing and switching solutions, please visit www.intel.com/netcomms/solutions/ipservices-wireless/index.htm

For more information on embedded Intel® processors, please visit www.intel.com/embedded/index.htm

For more information on Vyatta, please visit www.vyatta.com

[Δ] Intel® processor numbers are not a measure of performance. Processor numbers differentiate features within each processor family, not across different processor families. See www.intel.com/products/processor_number for details.

[1] Intel® Hyper-Threading Technology (Intel® HT Technology) requires a computer system with an Intel® Processor supporting Intel HT Technology and an Intel HT Technology enabled chipset, BIOS, and operating system. Performance will vary depending on the specific hardware and software you use. See www.intel.com/products/ht/hyperthreading_more.htm for more information including details on which processors support Intel HT Technology.

[2] Performance tests and ratings are measured using specific computer systems and/or components and reflect approximate performance of Intel® products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance. Buyers should consult other sources of information to evaluate the performance of systems or components they are considering purchasing. For more information on performance tests and on the performance of Intel products, visit http://www.intel.com/performance/resources/benchmark_limitations.htm

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