Intel® Xeon® Processor Technology and Intel® Solid-State Drives

Just in time for Time-Shifted TV video streaming. An Espial* case study with Intel® Solid-State Drives and Intel® Xeon® Processor 5500 series.

White Paper

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Storage

Executive Summary

TV viewers have come to expect a web-like experience for TV programs—they want to watch their favourite programs on their own schedule. To meet this shift in customer expectations, Cable MSO and Telecommunications operators are rolling out Time-Shifted TV services for their subscribers using powerful video-on-demand platforms such as Espial MediaBase.* Time-shifted TV is an especially demanding application as it requires high-performance servers with powerful processors, disk drives, and network cards to support real-time video capture and streaming.

Intel partnered with Espial* to evaluate the throughput improvement possible with Intel® Xeon® processor 5500 series-based platforms coupled with Intel® Solid-State Drives (SSDs) for both standard and high-definition video streaming. Espial tested the Intel® X25M-80 GB high-performance SSDs product as an alternative to the traditional hard disk drives (HDDs) or DRAM used to store the video files. The evaluation compared Intel® Xeon® processor 5400 series-based servers with HDDs to next generation Intel® Xeon® processor 5500 series-based servers with Intel SSDs.

The evaluation was conducted during Q4 2008 at Espial labs using Espial MediaBase; an intelligent, on-demand video platform. The evaluation demonstrated:

- An Intel Xeon processor 5500 series-based system with eight Intel X25M-80 GB SSDs can achieve 2400 SD streams or about 9 Gb/s of network throughput at less than 20% CPU utilization.
- An Intel Xeon processor 5500 series-based system with SSD configuration can achieve the same throughput in a quarter of the space and about a quarter of the power of the rotating disk solution.[1]

In summary, next generation Intel components provide advantageous cost performance that is essential for service providers to roll out Time-Shifted TV services while containing operational and capital expenditures.

More detailed findings from the evaluation are published in this paper.

1. Assuming equivalent disk storage capacity is not required.

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Business Overview

TV subscribers are increasingly behaving like Internet users—they want access to their favourite programs when they are ready to watch them. To meet this shift in customer expectations, Cable MSO and Telecommunications operators are rolling out on-demand services for their subscribers. This includes simple video-on-demand (VOD) services as well as Time-Shifted TV services. This shift to Time-Shifted TV and high-definition demands significantly more performance from the video delivery system. For Time-Shifted TV services, the VOD system needs to both record and transmit high-definition video in real-time. Espial MediaBase is a proven video-on-demand platform that helps operators retain customers and increase revenues. Deployed by operators around the world, it provides the on-demand platform for a responsive user experience that maintains subscriber loyalty and attracts new customers every day. Espial's applications set the standard for IPTV with:

1. A next-generation, high-performance, scalable architecture that results in industry leading user responsiveness
2. An open application platform that allows operators or system integrators to develop new and differentiated applications
3. Supporting an extensive set of ecosystem partners with ease of third-party integration via open APIs
4. An open architecture that allows applications to be run:
    a. On the customer's choice of blade or rack server hardware
    b. Using the latest PCIe 2.0* peripheral cards
    c. Using the newest storage technologies including Intel® SSDs and 6.0 Gb/s HDD

Top Business Issues

Espial's competitive position depends on cost-effective hardware solutions. Espial differentiates by optimizing their video streaming application on leading industry server and storage technology. Espial assesses the effectiveness of technology on three primary vectors:

- **Number of video streams per server:** This measure is critical for Espial to keep an edge on delivering the most competitive solution.
- **Video quality delivered to the end user over an IP network:** IPTV end users demand video quality to be equal to or better than the quality they have with cable or digital TV. Video quality is measured using Media Delivery Index (MDI) and related statistics.
- **Total watts used per server or watts per video stream on a server:** Operators need to keep cost of operations as low as possible. Watts used per server becomes especially critical as the video streaming demand requires servers to be moved to the edge of the network.

Espial's current video streaming solution is based on the Intel Xeon processor 5400 series. Each server is typically deployed with two L5420 processors and 12-48 hard disk drives. This configuration faces the following challenges:

- **Hard disk drive video streaming throughput limits:** Espial configures the data on the hard disks to optimize the throughput for streaming both off and on to the hard disk drive. The ability of a hard disk drive to deliver randomly accessed data is referred to as Input/Output Operations per Second (IOpS). The two Intel Xeon 5420 processors can process more video streams than can be supported by the IOpS rate of the 12 or 48 hard disks.
- **Under utilization of hard disk capacity:** Because of the need to achieve high IOpS per hard disk drive, the solution requires the more expensive 15K RPM SAS drives with less disk capacity, versus the more cost effective 7.2K RPM SAS drives with higher capacity.
- **Under utilization of rack space:** Commercial hard drive configurations utilize two Rack Units (RU) of space to support 12 hard disk drives. This configuration is necessary for the standard serviceability required by hard disk drives.

Intel® Technology

Intel® Xeon® Processor Platform

Intel's next-generation microarchitecture represents the next step in processor energy efficiency, performance, and dynamic scalability. Designed from the ground up to take advantage of Intel® hafnium-based 45nm hi-k metal gate silicon technology, the Intel Xeon processor 5500 series also introduces Intel® QuickPath technology.

Intel has expanded and redefined what's possible for technologies to come with respect to:

- Dynamic scalability, managed cores, threads, cache, interfaces, and power for energy-efficient performance on demand;
- Design and performance scalability for server demands with support for eight cores and up to 16 threads with simultaneous multi-threading (SMT), scalable cache sizes, system interconnects, and integrated memory controllers;
- Scalable shared memory of Intel QuickPath technology features memory distributed to each processor with integrated memory controllers and high-speed point-to-point interconnects to unleash the performance of next-generation Intel multi-core processors; and
- Multi-level shared cache improves performance and efficiency by reducing latency to frequently used data.

Additionally, the Intel Xeon processor 5500 series has three new features that apply to Espial's needs for media streaming:

- Scalable performance from one-to-16 (or more) threads and from one-to-eight (or more) cores;
- Dynamic scalability, managed cores, threads, cache, interfaces, and power for energy-efficient performance on demand; and
- Scalable and configurable system based on Intel QuickPath Architecture.

Intel QuickPath Architecture is a platform architecture that provides high-speed connections between microprocessors and external memory, and between microprocessors and the I/O hub. Intel QuickPath Interconnect runs at speeds up to 6.4 Gigatransfers/second, delivering up to 25.6 Gigabytes/second (GB/s) of bandwidth per link. Four times greater than Intel's prior generation front-side bus interconnect technology.

Intel® Solid-State Drives

The Intel® SATA SSD delivers leading performance in industry standard 1.8" and 2.5" form factors while simultaneously improving system responsiveness for client and enterprise applications over hard disk drives. By combining Intel's leading NAND flash memory technology with an innovative high performance controller, Intel delivers an SSD for native Serial Advanced Technology Attachment (SATA) hard disk drive drop-in replacement with enhanced performance, reliability, ruggedness, and power savings.

Since there are no rotating platters, moving heads, fragile actuators, unnecessary spin up time, or positional seek time that can significantly slow down the storage subsystem, the Intel® X25 SATA SSDs enable fast read/write access times and significant I/O, as well as performance improvement when compared to rotating media.

Intel 2.5" SSD

Intel delivers two types of SSDs based on Intel® NAND flash memory Single-Level Cell (SLC) and Multi-Level Cell (MLC) components:

- The Intel® X25-E SSD primarily targets high-end workstations, desktops, gaming, and various server/storage applications which have high data write workloads. Key attributes include extremely high performance, low power, enhanced reliability, and improved ruggedness as compared to standard 10K and 15K RPM hard drives. The Intel® X25-E SATA SSD is available in an industry standard 2.5" form factor that is electronically, mechanically, and software compatible with existing SATA and Serial Attached SCSI (SAS) slots and cables.
- The Intel® X18-M/X25-M SATA SSDs primarily target SATA-based laptop PCs, highly rugged mobile client devices, as well as thin and light, mini/sub-notebooks and server/storage applications which have a read-mostly workload. Key attributes include high performance, low power, increased system responsiveness, high reliability, and enhanced ruggedness as compared to standard mobile SATA hard drives. Intel® X18-M/X25-M SATA SSDs are available in 1.8" and 2.5" form factors that are electronically, mechanically, and software compatible with existing 1.8" and 2.5" SATA slots and cables. Our flexible design allows interchangeability with existing mobile hard drives based on the SATA interface standard.

Evaluation Use Case and Configurations

Evaluation Architecture

The evaluation was designed to compare a traditional HDD-based VOD server to a next-generation VOD server using SSD devices. Both server configurations shown below can stream 10 Gbps from memory. The evaluation was designed to identify differences in streaming performance when using SSDs or HDDs to provide all of the read I/O bandwidth.

The hardware configurations are shown below. The upper diagram shows Espial MediaBase 9.0* on Red Hat 5.0* while the lower illustration shows Espial MediaBase 9.0 running on Red Hat 5.2.* The systems were configured to have equal streaming capacity. The difference in storage capacity was ignored as it was not relevant for this evaluation scenario.

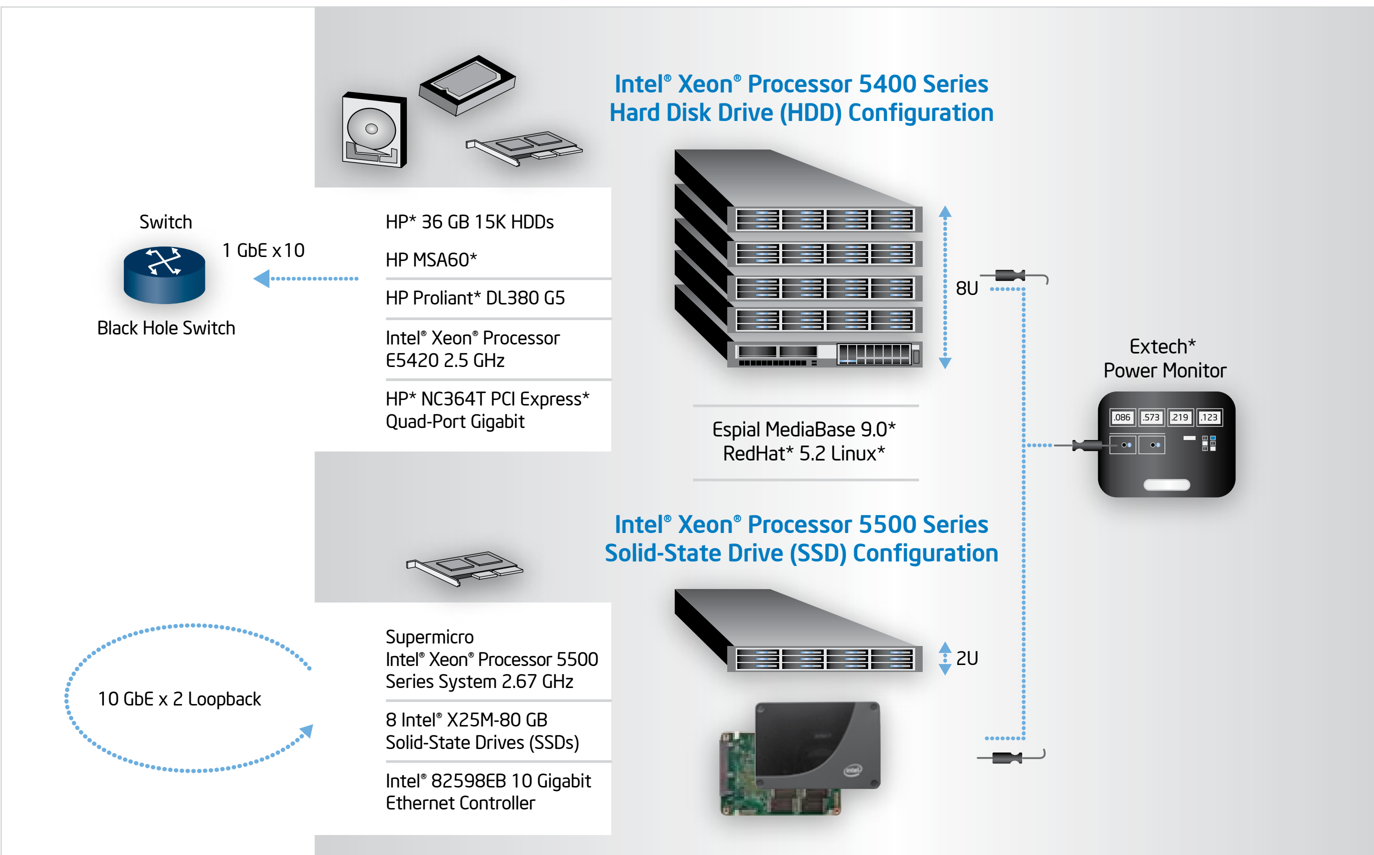

Figure 1. Evaluation configuration.

Standard definition MPEG 2 videos were loaded onto the Espial MediaBase file system. Each video required an average bandwidth of approximately 3.8 megabits per second.

An Extech Power Meter* was connected to each system under test to determine the power use of the systems.

A Linux* shell script was used to stress test the server with an incremental number of video streams. The data packets from streamed video were discarded in a network black hole; packets were sent to an IP address which immediately dropped them. In each case, one video stream was sent to a PC running a VLC player. The video was displayed on the screen to ensure the quality of the stream was maintained during the test run. Videos were added in multiples of twenty-five until being ramped up to the maximum streams. The maximum was determined when adding more streams started giving late bit rate errors identifying the bottleneck at disk subsystem which was not able to handle additional streams.

Configurations

Two primary configurations were tested with the use case.

Configuration	Server Platform	Server Processor	Server Memory	Disk Configuration
Intel® Xeon® Processor 5400 Series w/ HDDs	HP Proliant* DL380 G5	Intel® Xeon® Processor 5420 2.5 MHz	12 GB	36 - HP* 15K RPM 72-GB Hard Drives
Intel® Xeon® Processor 5500 Series w/ SSDs	Supermicro	Intel® Xeon® Processor QC 2.67 GHz 95W QPI 1066	12 GB	8 - Intel® X25-M 80-GB SSDs

Table 1. Configurations tested.

Table 1 shows the details of the components in the tested HP Proliant* DL380 G5 server configuration. The HDDs and SSDs were only equipped for the specific test. In both cases, the HDDs were configured as three groups (12 disks in each) of hardware RAID 6.

Component	Vendor	Units	Product
Intel	Intel	2	Intel® Xeon® Processor 5420 2.5 GHz 12 MB Cache
Chipset	Intel	1	Intel® 5000P Chipset
Baseboard	HP	1	HP Proliant* DL380 G5, 8 DIMM slots
Memory	HP	6	HP* FBD PC2-5300 2 GB
Boot Controller	HP	1	HP Smart Array* Storage P400
Boot Drives	HP	2	HP* 72 GB SAS 10 K RPM
Network Interface Card	HP	3	HP NC364T PCI Express Quad-Port Gigabit*
Server Enclosure	HP	1	HP Proliant* DL380 G5 2U Rack
Host Bus Adapter	HP	1	HP Smart Array* P800/512 BBWC
Hard Disk Drives	HP	36	HP* 72 GB 15K RPM 3.5"
Storage JBOD	HP	3	HP StorageWorks* MSA 60 12 3.5" x 4 SAS

Table 2. HP Proliant* DL380 G5 Server Configuration.

Table 2 shows the details of the components in the tested Intel® Xeon® processor 5500 series customer reference board. In both cases, the SSDs were configured as one group of software RAID 0.

Intel® Xeon® Processor 5500 Series-Based Configuration

Component	Vendor	Units	Product
Processor	Intel	2	Intel® Xeon® processor 5500-EP QC 2.67 GHz
Chipset	Intel	1	Intel® X58 Chipset-EP Dual Socket
Baseboard	Supermicro	1	Supermicro* 18 DIMM SLOTS
Memory	Hynix	6	Hynix* DDR3 1066 2 GB
Boot Controller	Intel	1	Intel® ICH9R
Boot Drive	Hitachi	1	Hitachi* SATA 500 GB 7200 RPM
Network Interface Card	Intel	3	Intel® 82598EB 10 GbE NIC
Host Bus Adapter	LSI	1	LSI* SAS 3081E-R
Solid-State Drives	Intel	8	Intel® X25-M 80G SATA
Enclosure	Supermicro	1	Supermicro* 825X 2U Rack

Table 3.

Table 3 shows the details of the components in the tested Intel® Xeon® 5500 processor early access platform. In both cases, the SSDs were configured as one group of software RAID 0.

Evaluation Results

Performance Results

As described in the evaluation architecture section, the goal of the performance runs is to determine the maximum number of video streams that each of the configurations in Table 1 can support. The peak performance for both configurations along with associated energy and space requirements is summarized in Table 4.

Configurations

Two primary configurations were tested with the use case.

Configuration	Standard Def MPEG 2 Streams	Network Throughput	Power Consumption	Space
Intel® Xeon® Processor 5400 Series w/ HDD	2350 SD Streams	8.8 Gb/s	991 Watts	8U
Intel® Xeon® Processor 5500 Series w/ SSD	2400 SD Streams	9.0 Gb/s	273 Watts	2U

Table 4. SD Video Streams per System.

From this data, three conclusions can be drawn:

1. An Intel Xeon processor 5500 series-based server with eight Intel SSDs can support the equivalent video streaming throughput as Espial's existing HP Proliant DL380 G5* with 36 15K RPM HDDs. The single 10 GbE interface was the limiting factor in scaling. Both the Intel Xeon processor 5500 series and the SSDs had additional performance bandwidth.

2. The Intel® Xeon® processor 5500 series-based system is approximately 25 % more efficient at streaming video than the equivalent Intel Xeon 5400 series-based system, using MDI as a means to set the upper limit on streams per 10 GbE interface (7.5 Gb/s versus 9.375 Gb/s as shown in Table 4).

3. Assuming equivalent capacity of SSDs is not necessary, the Intel Xeon processor 5500 series-based system can operate with one quarter of the power in quarter of the space.

Conclusion

New Processor and SSD technologies from Intel dramatically improved streaming performance while reducing power consumption for the Espial MediaBase Video-On-Demand platform. This provides a great opportunity for cable and telco operators to confidently deploy Time-Shifted TV services. They can be confident that Espial MediaBase will meet the demanding capture and streaming requirements of Time-Shifted TV services while reducing their capital and operational expenditures. Espial MediaBase is uniquely positioned to realize the benefits of hardware innovation by component and hardware suppliers such as Intel, Hewlett-Packard, and IBM. Every 18-24 months, Espial MediaBase can harness the performance gains of processors following Moore's Law and also take advantage of innovations that are rapidly reducing energy consumption across a wide array of server components and technologies.

Specifically, the evaluation results illustrated that:

- An Intel Xeon processor 5500 series-based system with 8 Intel X25 M-80 GB drives can achieve 2400 SD streams or about 9 Gb/s of network throughput at less than 20% CPU utilizaton.
- Assuming equivalent disk capacity is not required, the Intel Xeon processor 5500 series-based system with SSD configuration can achieve the same throughput in 75% less space and about 75% less power.

Based on the evaluation data and analysis result, the Intel Xeon processor 5500 series-based server and Intel X25M-80 GB SSDs provide a cost effective solution for Espial MediaBase streaming workloads which are predominantly read workloads from storage.

For more information on Intel® Xeon® Processor Technology, visit www.intel.com/xeon

For more information on Intel® Solid-State Drives, visit www.intel.com/go/ssd

For more information on IP Services and Wireless Telecom Infrastructure, visit www.intel.com/netcomms/solutions/ipservices-wireless/index.htm

For more information on Espial MediaBase visit www.espial.com/products/media_base/

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