Performance of VSIPL Functions and SAR Algorithms on Multiple Generations of Intel Processors

Peter Carlston, Embedded Computing Division, Intel Corporation
peter.carlston@intel.com

Summary

This paper gives the results of Synthetic Aperture Radar (SAR) and Vector Signal and Image Processing Library (VSIPL) benchmark studies using a Freescale processor and three generations of Intel processors.

VSIPL Benchmark Systems and Methodology

Systems under test (SUT) for the VSIPL benchmarks included the following:

- GE Fanuc DSP230 board (Freescale MCP 8641D) and AXISLib VSIPL release 2.3
- HP 2530P laptop (Intel® Core™ 2 Duo SL9400) and NA Software VSIPL beta for Intel Architecture
- Acer Aspire AS5741-6823 laptop (Intel Core i5-430M) and NA Software VSIPL AVX Beta
- Intel customer reference board (Intel Core i7-2710QE) and NA Software VSIPL AVX Beta
- GE Intelligent Platforms DSP280 board (Intel Core i7-2715QE) and AXISLib-AVX Beta 1.0

The first three processors have two cores each and roughly similar power dissipation numbers. The Intel Core i7 processors both have four cores. (Complete system configuration information has been omitted from this abstract.) Measurements were collected for ten VSIPL functions over a range of sizes. Data was single precision, complex, floating point. VSIPL tests were conducted using only a single core of each processor to facilitate comparison.

VSIPL Test Results

Results will be given for each SUT in terms of total time and the calculated MFLOPS of each function and size. Figure 1, for example, graphs the 1D FFT results for the five processors. It also shows the gains realized between libraries compiled for 128-bit SIMD registers ("SSE") and the 256-bit vector registers ("AVX") introduced with the second generation Intel Core micro-architecture in 2011.

The major findings may be summarized as follows:

- The 2008 Core 2 Duo processor was about 2X faster than the MCP8641D on most functions (except vector sine, cosine, and square root). This primarily reflects the faster clock speed of the Intel processor.

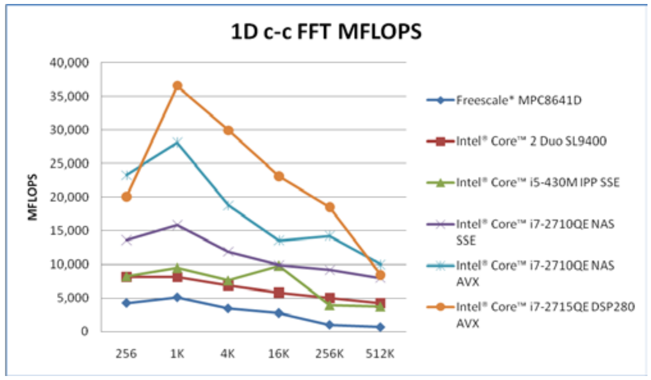

Figure 1: 1D, complex-complex FFT Results.

- The 2010 Intel processor generation provided very little performance gain over the older processors on these workloads.
- The enhanced micro-architecture of the 2011 Intel processors enabled substantially better performance on all the VSIPL functions studied. The Core i7s, for example, performed 2-3X better than the Core 2 Duo across all functions. Micro-architecture enhancements include greater instruction decode and load/store bandwidth, the wider vector registers, and a new high speed, high bandwidth, ring bus between the core(s), memory and I/O controllers, etc.
- The highest percentage increases are generally seen with short vector lengths. As the length of the vectors increases the complete data set no longer fits within the last level cache, so the data must be loaded from slower main memory. The algorithm thus becomes more memory-dependent than processor-dependent.
- This factor is especially noticeable with the Freescale processor since it has a fixed 1 MB last level cache per core. The Intel Core 2 and i7 processors both have 6 MB of shared last level cache, all of which is available to the single core used in these tests*.

* Tests conducted by GE Fanuc/GE Intelligent Platforms, and N.A. Software, Ltd. Single thread performance. Data in warm caches where possible. Averages of 100 and 1000 iterations. See complete test configuration information provided in the full paper. Software libraries, drivers, operating systems, and compilers used are not fully tuned for performance and additional performance gains may be possible. Except for the DSP280 board, data is at fixed CPU clock frequency and may change with Intel® Turbo Boost Technology enabled.

SAR-SARMTI Benchmarks

Two complete radar algorithms were also used to compare the performance of 2010 and 2011 Intel processors.

Benchmark systems were the same Core i5 and Core i7-2710QE boards used in the VSIPL tests. Both SAR algorithms were developed by NA Software/InfoSAR, and were multi-threaded and optimized separately for Intel SSE and AVX systems running Linux. (Again, complete hardware and software configuration details will be provided.)

Raw SAR image data was a 6 km x 6 km PiSAR X-Band image of Tsukuba, Japan. (4096 x 4096 pixels; 1 pixel = 1.5m). Moving objects were inserted manually. Data was first fed to the SAR processor's range compression stage. The compressed output data then became the input to the azimuth compression stage used in these tests. This was done to shorten the overall processing time so live demos would complete more quickly. Then a 768m x 768m area of the resulting image was selected for further processing by the SARMTI algorithm. Figure 2 shows the resulting image, with the precise locations of the all moving objects indicated by green circles.

Figure 2: Moving objects resolved directly from X-Band SAR data by SARMTI

As Figure 3 shows*, the Core i7 is over 2X faster than the 2010 Core i5 processor on a core-for-core basis for these demanding workloads. Note that the four thread timings for the Core i5 utilize Intel Hyper-Threading technology, since 4-core versions were not available. Also notice that performance scales quite nicely with the additional 2 physical cores available in the Core i7.

* Tests conducted by NA Software, Ltd. Please refer to complete system configuration information which will be provided in the full paper. Software libraries, drivers, operating systems, and compilers used are not fully tuned for performance and additional performance gains may be possible. Data is at fixed CPU clock frequency and may change with Intel® Turbo Boost Technology enabled.

	System	2 Threads (Cores)	4 Threads
		Seconds	
SAR	Intel Core i7	0.059	0.027
	Intel Core i5	0.135	0.121
	i7 Speedup	2.3 x	4.4 x
SARMTI	Core i7	6.03	3.841
	Core i5	15.197	13.667
	i7 Speedup	2.5 x	3.5x

Figure 3: Results of SAR and SARMTI Tests