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Application Note: Sandy Bridge vs. Ivy Bridge - *A Defense & Aerospace COTS Perspective Comparison*

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Sandy Bridge vs. Ivy Bridge: A Defense & Aerospace COTS Perspective Comparison

In January, 2011, Intel announced the first of its new family of Core® i7 x86 Quad-core processors, code-named “Sandy Bridge.” The high-performance multi-core processor was rapidly embraced in the rugged embedded COTS market for use in single board computer and digital signal processor (DSP) modules designed for use in compute intensive Defense & Aerospace applications. The multiple cores helped system designers address the SWaP-constrained environments typically found in military applications, and the ability to leverage the extensive Intel Architecture eco-system of software and development tools helped ease and speed system design and integration. The introduction of “Sandy Bridge” also provided a pathway into Intel’s ongoing technology roadmap, a great advantage to designers of systems for long-lifecycle military programs for which the problem of longevity of supply and COTS component obsolescence are a continuous challenge.

Intel Architecture Multi-Core Compatibility

A key benefit of Sandy Bridge’s role in the Intel roadmap for Mil-COTS systems emerged 15 months later with the introduction of the “Ivy Bridge” processor, its first successor under Intel’s innovative “Tick/Tock” roadmap. Compared to Sandy Bridge, Ivy Bridge provided COTS system designers with an improved Performance/Watt ratio. Even better, the new Ivy Bridge quad-core processor provided pin-compatible backward compatibility with the earlier Sandy Bridge. This unprecedented level of compatibility also extended to the processors’ associated PCHs. For board designers such as Curtiss-Wright this level of multi-generational compatibility enabled us to fast-track the development of the next generation of SBCs and DSP engines using the current generation of Intel processor, replacing it with its successor when it became available.

Table 1: Sandy Bridge vs. Ivy Bridge Comparison

Processor Name	Sandy Bridge	Ivy Bridge
Born on Date	Announced Jan 2011	Announced April 2012
Compatibility	FW compatible with IB	BW compatible with SB
Tick/Tock	Tock 32nm	Tick 22nm
Transistor Architecture	Planar Transistor	Tri-Gate ‘3D’ Transistor
Power	45 W Quad-core at 2.1 Ghz	35 W Quad-core at 2.1 Ghz
Clock Speed	2.1 GHz	2.1 GHz
PCIe Speed	PCIe 2.0 (5.0GT/s)	PCIe 3.0 (8.0GT/s)
Graphics Performance	HD3000 (DX 10.1)	HD4000 (DX 11)
	Exec Units (GPUs) 12	Exec Units (GPUs) 16
	OpenGL 3.0	OpenGL 3.1
	2 Displays supported	3 Displays supported

This new level of compatibility across successive generations of multi-core Intel processors greatly simplified the ability and attractiveness of replacing existing Sandy Bridge-based modules with superior next-generation technology.

Image courtesy of DefenseImagery.mil

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Sandy Bridge vs. Ivy Bridge: A Mil/Aero Perspective Comparison

Although Intel offers many variations of its Sandy Bridge processor to meet the unique requirements of the numerous markets that it serves, including the laptop, desktop, game console and server markets, for the Mil/Aero industry it is the mobile (or embedded) variants that are of most interest. And of these variants, drilling down further, it is those processors that provide support for ECC memory which deliver the best fit for use in deployed system applications.

In addition to the pin-for-pin compatibility discussed above, the newer Ivy Bridge processor also provided significant improvements in a wide range of feature areas including:

- Transistor Architecture
- Power
- PCIe
- Graphics Performance

Transistor Architecture

In addition to making significant progress on reducing processor die size, with the introduction of Ivy Bridge, Intel also achieved valuable reductions in processor power requirements. The earlier Sandy Bridge architecture used classic Planar Transistor technology. One well known trait of the classic Planar Transistor, which can be undesirable in some applications, is tendency for current to leak when the transistor is off. Ivy Bridge features a revolutionary new transistor design, Tri-Gate '3D', that both mitigates the leakage concern and allows for a smaller die size. What's more, the new transistor technology is claimed to consume up to 50% less power than the classic planar transistor – resulting in a processor package that delivers the same amount of processing horse power but with a significantly reduced power footprint.

Table 2: Transistor Architecture Comparison

Sandy Bridge	Ivy Bridge
Tock 32nm	Tick 22nm
Planar Transistor	Tri-Gate '3D' Transistor

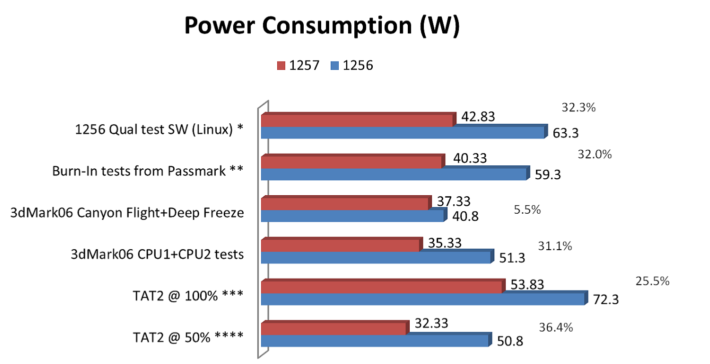
Power

In Mil/Aero applications SWaP is critical, as high performance systems must operate in extreme temperature conditions in space-constrained environments. For these applications, Ivy Bridge delivers considerable advantages over the earlier Sandy Bridge processor in that it requires less power while providing equal, or slightly superior, processing performance.

Table 3: Power and Clock Speed Comparison

Sandy Bridge (1256)	Ivy Bridge (1257)
45 W Quad-core at 2.1 Ghz	35 W Quad-core at 2.1 Ghz
2.1 GHz	2.1 GHz

As shown in the Power Consumption comparison graph below, the Ivy Bridge processor outperforms Sandy Bridge by as much as 35%. This power savings significantly lowers the system's overall power budget – delivering more processing power while producing less heat.



PCIe

The Ivy Bridge processor is the first to support PCIe 3.0. Although the extra speed on those x16 lanes is compelling, most board designs that swapped in Ivy Bridge for Sandy Bridge did not also swap out the PCIe switch. The swap to Ivy Bridge does, though, set the stage for next generation SBCs to support PCIe 3.0.

Table 4: PCIe Speed Comparison

Sandy Bridge	Ivy Bridge
PCIe 2.0 (5.0GT/s)	PCIe 3.0 (8.0GT/s)

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Graphics Performance

In addition to its superior CPU performance/clock speed, Ivy Bridge also features significantly improved graphics performance. Intel achieved this by adding increasing the efficiency and adding more Exec Units (GPUS) as well as supporting DX 11. Intel claims a 50% gain in graphics performance with the Ivy Bridge's HD4000 compared to Sandy Bridge's HD3000. This graphics improvement is of great value to Mil/Aero embedded system designers because it enables low to mid-performance graphics requirements to be handled natively by the processor, which eliminates the need for an expensive external graphics device. Additionally, Ivy Bridge can support up to three displays. However, because Sandy Bridge did not have this capability, most current Sandy Bridge-based SBC designs do not take advantage of the ability to control a third display.

Table 5: Graphics Performance Comparison

Sandy Bridge	Ivy Bridge
HD3000 (DX 10.1)	HD4000 (DX 11)
Exec Units (GPUs) 12	Exec Units (GPUs) 16
OpenGL 3.0	OpenGL 3.1
2 Displays supported	3 Displays supported

The Advantages of Ivy Bridge

In summary, the key advantage that Ivy Bridge offers to Mil-Aero COTS system designers is its ability to deliver greater performance at the same clock speed. Because the two generations of processors are pin-for-pin interchangeable, the lifetime of Sandy Bridge-based products is more easily extended. And when appropriate, the older technology can be replaced with the next generation variant, providing superior performance with a much improved thermal foot print.

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