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• Requires a system with Intel® Turbo Boost Technology. Intel Turbo Boost Technology and Intel Turbo Boost Technology 2.0 are only available on select Intel® processors. Consult your system manufacturer. Performance varies depending on hardware, software, and system configuration. For more information, visit http://www.intel.com/go/turbo
• Requires a system with a 64-bit enabled processor, chipset, BIOS and software. Performance will vary depending on the specific hardware and software you use. Consult your PC manufacturer for more information. For more information, visit http://www.intel.com/info/em64t
Introducing Avoton

• Intel’s second generation 64-bit server SOC
  – Manufactured in Intel’s low power SOC 22nm process
  – Combining Intel’s server expertise with our client/mobile SOC building blocks and processes

• Based on the next-generation Intel Atom known as Silvermont

• Focused on enabling high density with high performance
  – 2, 4, and 8C SKUs at 5-20 Watts targeting scale out workloads
  – An Industry leading performance and performance per watt efficiency at high densities

• Targets the growing micro server and storage segments to provide IA solutions in the data center from top to bottom
2-8 Silvermont Cores
  - Shared 1MB L2 / module
  - Up to 2.4GHz + Turbo
  - OOO architecture

Silvermont System Agent
  - Up to 25.6GB/s BW
  - Crossbar Architecture
  - Goodbye FSB, hello IDI

Fully Integrated South Complex
  - Intel On-chip System Fabric
  - Enterprise PCIe and GbE

x86 Software Compatibility
Introducing Rangeley

- Rangeley is the Comms Infrastructure derivative of Avoton

- Extends the Avoton baseline with:
  - Comms reliability profile
  - Longer product lifecycle
  - Enhanced Thermal Profiles
  - QuickAssist Technology to accelerate communications workloads
Rangeley: Accelerating Communications Workloads

- Rangeley enables acceleration through software & hardware innovations

- Intel® Data Plane Development Kit (DPDK) provides:
  - Open Source Data Plane libraries optimized for Rangeley HW
  - Low-overhead run-time environment

- Intel® QuickAssist Technology (QAT)
  - Intel API to QAT accel HW and Intel optimized SW
  - Enabled for direct access or via open source frameworks
  - Integrated hardware acceleration including
    - Ciphers: AES, DES/3DES, Kasumi, RC4, Snow3G
    - Authentication: MD5, SHA1, SHA2, AES-XCBC
    - Public Key: Diffie-Hellman, RSA, DSA, ECC

Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products.
# Silvermont Micro-Architecture

## BENEFITS

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Performance</td>
<td><strong>Without</strong> Sacrificing Power Efficiency</td>
</tr>
<tr>
<td>Power and Performance Improvements</td>
<td></td>
</tr>
<tr>
<td>Fast and Efficient Access to Memory</td>
<td></td>
</tr>
</tbody>
</table>

## FEATURES

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Out-of-Order Execution Pipeline</td>
<td></td>
</tr>
<tr>
<td>Macro operation execution pipeline</td>
<td></td>
</tr>
<tr>
<td>Improved instruction execution latencies and throughput</td>
<td></td>
</tr>
<tr>
<td>Smart pipeline resource management</td>
<td></td>
</tr>
<tr>
<td>Efficient Branch Processing</td>
<td></td>
</tr>
<tr>
<td>Accurate branch predictors</td>
<td></td>
</tr>
<tr>
<td>Fast recovery pipeline</td>
<td></td>
</tr>
<tr>
<td>Low Latency, high bandwidth caches</td>
<td></td>
</tr>
<tr>
<td>Out of order memory transactions</td>
<td></td>
</tr>
<tr>
<td>Multiple advanced hardware prefetchers</td>
<td></td>
</tr>
<tr>
<td>Balanced core and memory subsystems</td>
<td></td>
</tr>
<tr>
<td>IDI replaces lower performing Front-Side Bus</td>
<td></td>
</tr>
</tbody>
</table>

---

**Up to 2X the Single Threaded Performance or 5X Lower Power**

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1. Lower power statement based on the geometric mean of a variety of power and performance measurements across various benchmarks. Benchmarks included in this geometric mean are measurements of workloads including SPECint® rate_base2000 & SPECcpu® rate_base2000; EEMBC® workloads including CoreMark®, SunSpider® and page load tests on Internet Explorer®, Firefox®, & Chrome®; Dhrystone®; Android® workloads including CaffeineMark®, AnTutu®, Linpack®, and Quadrant® as well as measured estimates; on Silvermont preproduction systems compared to Atom processor Z2580. Individual results will vary. SPEC® CPU2000® is a retired benchmark. Other names and brands may be claimed as the property of others. 2X configuration: SPECint®_rate_base2006: Atom S1260(8GB,HDD), Atom C2750(16GB, HDD).
The Evolving Atom Architecture: New Instructions and Technologies

**Performance**
- Intel® Core™ 2 64b ISA + Core™ Westmere
- SSE4.1, SSE4.2, POPCNT, PREFETCHW

**Virtualization**
- VMFUNC enables guest code to invoke VM Function

**Security**
- Intel® Core™ Westmere
- AES-NI, PCLMULQDQ
- Intel® Secure Key (RDRAND)

**New Instructions**
- Real Time Instruction Tracing
- TSC Deadline Timer

**New Technologies**
- Intel® VT-x2:
  - Extended Page Tables
  - Virtual Processor IDs
  - Unrestricted Guest

**Intel® OS Guard**

Fully Compatible with the Breadth of IA Software Installed Base
Silvermont System Agent (SSA): Enabling Multicore Atom SOCs

- Focused on modular design and scalability
- Datapath to System Memory
- SSA manages cache coherency
- NHM-style crossbar architecture
- IO Root and path to IO for Cores
- Path for interrupts to Cores

Balanced Core and Memory Subsystem for Bandwidth and Power
Avoton Memory Technology

• Avoton supports 1 or 2 channels of DDR3/DDR3L
  – Speeds up to 1600 MT/s
  – 25.6 GB/s of peak bandwidth
  – Capacity of up to **64GB** (using 2DPC UDIMM/S0-DIMMs per channel)

• Enterprise class features include:
  – Robust DRAM failure protection including:
    – ECC (SEC-DED)
    – Patrol and Data Scrub Capabilities
  – Internal data path parity protection (to IO or Core)
  – Low power modes (CKE, self-refresh, thermal management)
  – Data Scrambler for signal integrity and basic data protection
Intel On-chip System Fabric (IOSF): A scalable IO Fabric with IA compatibility

- Intel’s converged infrastructure for SOCs
  - Enabling greater reuse across client and now server designs
  - Highly scalable for performance, power and connectivity

- Unique benefits of IOSF
  - Fully supports PCIe headers and ordering rules
  - Supports existing software and OSes without modification

IOSF merges the best features of PCIe and other SOC fabrics
Integrated Enterprise Ethernet

- Based on Intel’s Powerville (i350) design
  - widely deployed Ethernet solution
  - Supported by existing software installs
  - Integration drives lower power & higher density vs. LOM solution
- Extended to provided greater backplane bandwidth with 2.5GbE
- Enables in-band management via SMBus or NC-SI to BMC or MMC to reduce TCO
- PCIe AER implementation provide server RAS capabilities

<table>
<thead>
<tr>
<th>Components / Features</th>
<th>Powerville</th>
<th>Avoton Integrated Powerville</th>
</tr>
</thead>
<tbody>
<tr>
<td>Host Interface</td>
<td>PCIe Gen2(5.0GT/s)</td>
<td>Internal SoC Fabric</td>
</tr>
<tr>
<td># of ports</td>
<td>4 (no PCIe bridge) and 2</td>
<td>4</td>
</tr>
<tr>
<td>Package</td>
<td>17x17mm and 25x25mm</td>
<td>Integrated into Avoton</td>
</tr>
<tr>
<td>Peak Throughput</td>
<td>1000BaseX: 1 Gbps per port (max of 4Gbps)</td>
<td>1000BaseX: 1 Gbps per port (max of 4Gbps) 2500BaseX: 2.5 Gbps per port (max of 10Gbps)</td>
</tr>
<tr>
<td>VMDq</td>
<td>8 per port</td>
<td></td>
</tr>
<tr>
<td>IO Virtualization (SR-IOV / VMDc)</td>
<td>1 PF, 8 VFIs per Port</td>
<td>N</td>
</tr>
<tr>
<td>Jumbo Frames</td>
<td>9KB</td>
<td></td>
</tr>
<tr>
<td>#queues/port</td>
<td>8 queues/port</td>
<td></td>
</tr>
<tr>
<td>MSI-X, LLI</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Manageability</td>
<td>SMBus, NC-SI, WOL</td>
<td>SMBus, NC-SI, WOL</td>
</tr>
<tr>
<td>IEEE 1588</td>
<td>Yes (per packet)</td>
<td></td>
</tr>
<tr>
<td>Environmental</td>
<td>RoHS, HF</td>
<td></td>
</tr>
<tr>
<td>L2 MAC address Filters</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>MAC / VLAN Anti-spoofing</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Auto-ARP</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Integrated Cu PHY</td>
<td>Y</td>
<td>N (external)</td>
</tr>
</tbody>
</table>

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Integrated High-Speed IOs

• 16 lanes of PCIe enabling flexible connectivity
  – Gen2 bandwidth providing up to 80Gbps (~64Gbps effective) total bandwidth
  – 4 enterprise class PCIe Root Ports
  – Supporting full bifurcation: 1x16, 2x8, 1x8, 2x4, 4x4
    – Degraded mode down to x1 lanes per RP
  – 256B Max Payload Size with Efficient TLP packing

• 6 total lanes of SATA
  – 2 ports support of SATA 3 achieving 6 Gbps bandwidth
    – Capitalizing on increased SSD capabilities
  – 4 ports support of SATA 2 achieving 3 Gbps bandwidth
    – Providing broader connectivity for rotational storage
# PCH Integration

<table>
<thead>
<tr>
<th>Interface</th>
<th>Capabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB2</td>
<td>• 4 ports USB 2.0, 1.1</td>
</tr>
<tr>
<td></td>
<td>• EHCI controller with RMH</td>
</tr>
<tr>
<td>Intel (x86) Software Compatibility</td>
<td>• Provides full compatibility with existing software</td>
</tr>
<tr>
<td></td>
<td>• RTC, 8254, 8259, IO APIC, LPC, HPET, UART, SPI</td>
</tr>
<tr>
<td>Power Management Controller</td>
<td>• PMC to control handshakes with platform</td>
</tr>
<tr>
<td></td>
<td>• Drive full node power flows</td>
</tr>
<tr>
<td></td>
<td>• 8051-based controller with secure patch capabilities</td>
</tr>
<tr>
<td>SMBus controllers</td>
<td>Support for 3 SMBus interfaces (beyond GbE):</td>
</tr>
<tr>
<td></td>
<td>• Legacy uses (SPD presence detect, platform sensors)</td>
</tr>
<tr>
<td></td>
<td>• PECI over SMBus</td>
</tr>
<tr>
<td></td>
<td>• HOST master</td>
</tr>
</tbody>
</table>

*Traditional IA feature set provides software compatibility and usability*
Silvermont: A Big Step Forward

Saltwell vs. Silvermont

Silvermont provides a tremendous performance lift over the previous generation (Saltwell)

Combined with Avoton’s increased integration, improved system agent and improved memory system, Avoton achieves significant gains over Centerton

Based on the geometric mean of a variety of power and performance measurements across various benchmarks. Benchmarks included in this geomean are measurements on browsing benchmarks and workloads including SunSpider* and page load tests on Internet Explorer*, Firefox*, & Chrome*, Dhrystone*, EEMBC workloads including CoreMark*, Android* workloads including CaffeineMark*, AntTutu*, Linpack* and Quadrant* as well as measured estimates on SPECint* rate_base2000 & SPECfp* rate_base2000, on Silvermont preproduction systems compared to Atom processor Z2580. Individual results will vary. SPEC CPU2000* is a retired benchmark. * Other names and brands may be claimed as the property of others.

Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products.
Intel® Atom™ processor C2750 delivers performance gains up to 14X

Configuration: SPECjbb2003/2013: Atom S1260(8GB,HDD),Atom C2750(16GB,HDD). Memcached v1.4.15: Atom S1260(8GB,2xHDD), Atom C2750(8GB,1xHDD). Dynamic Web Benchmark: Atom S1260(8GB,SSD,1GbE), Atom C2750(32GB,SSD,10GbE). SPECint_rate_base2006: Atom S1260(8GB,HDD), Atom C2750(16GB, HDD). STREAM: Atom S1260(8GB,HDD), Atom C2750(32GB, HDD). Intel internal measurements as of July 2013. Results are estimated by Intel using the SPEC benchmark software cited and are provided for informational purposes only. Any difference in system hardware or software design or configuration may affect actual performance.

Refer to backup for additional details.

* Other names and brands may be claimed as the property of others.
Intel® Atom™ C2000 Processor Family

General Purpose Computing Performance

**SPEC CPU2006:**
- Measures integer and floating point operations performance
- Contains 12 integer and 17 floating point applications
- Compute intensive, concentrates on the CPU and memory
- Disk I/O and network not measured
- “Rate” determines the throughput, i.e. how many tasks can be completed in parallel.

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Dynamic Web Benchmark:
- Measures build and serve web page interface using the LAMP stack
- LAMP combination of free and open source software
- Principle components to build a web server:
  LAMP = Linux (operating system) Apache (HTTP server) MySQL (database s/w) PHP, Perl, or Python

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Configuration: Dynamic Web Benchmark: Atom S1260(8GB, SSD, 1GbE), Atom C2750(32GB, SSD, 10GbE), Marvell Armada(4GB, HDD, 1GbE), Calxeda ECX-1000(4GB, SSD, 1GbE). Intel Internal measurements as of August 2013. Refer to backup for additional details.

* Other names and brands may be claimed as the property of others.
How did we get here?

Combination of Process Technology + Architecture

<table>
<thead>
<tr>
<th>The Silvermont Core</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major performance improvements were achieved with power-efficiency as the primary goal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Process Technology Leadership w/ 1271</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVN uses the same SOC base process as phones/tablets</td>
</tr>
<tr>
<td>- Super-low leakage</td>
</tr>
<tr>
<td>- Different optimization point than used on Xeon line</td>
</tr>
<tr>
<td>- Not as high frequency, but better power efficiency</td>
</tr>
<tr>
<td>- Collaboration with the Fab to tweak/tune to optimal behavior</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Leveraging Expertise from Across the Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leveraging the low-power techniques and HW from SOC’s</td>
</tr>
<tr>
<td>Bringing together the knowledge from Xeon, Client, Tablets, and Phones</td>
</tr>
</tbody>
</table>
Consistency Across Product Lines

Algorithmic and Interface Consistency w/ XEON®

Enables server OEMs to leverage data-center infrastructure
Socket RAPL and Turbo – Same base algorithm/interface as SNB/IVB
Same architectural PECI interfaces for power/thermal management/optimization
Improved memory thermal management for dense deployments

SOC Power Management for Servers

- PCIe L1, Power-off
- SATA2/3 Partial/Slumber/Power-off
- Ethernet “EEE” w/ Cu PHY, P2, Power-off
- USB Suspend, Power-off
- Gating of unused IO’s
50+ Atom C2000 System Designs

**Microserver**
- CETC
- DELL
- hp
- HUAWEI
- inspur 浪潮
- NEC
- PENGUIN COMPUTING
- SUPERMICRO®
- Quanta

**Entry Network**
- ADVANTECH
- Axiomtek
- C-DOT
- ERICSSON
- iBASE
- KTNF
- Portwell
- Nexcom
- Spirent
- SBS
- soekris
- ZNYX

**Cold Storage**
- ASRock
- CETC
- DELL
- HUAWEI
- Foxconn
- inspur 浪潮
- NEWSYS
- Sanmina
- Sugon
- TYAN
- Quanta
- wiwynn
- zt Systems

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Intel Inside the Data Center

• The new Atom Processor Family extends Intel’s portfolio of products that service the diverse needs of the data center
  – Adds to Xeon, MIC, Storage, and Networking products

• Avoton provides power efficient performance and density across the micro server and storage segments

• Rangeley is the first Avoton derivative extending Atom into communication products
Thanks!
**Configuration**

**Integer Throughput (SPECint\(^*_rate\_base2006\))**

**Atom S1260**: FOR.INTEL. cpu2006.1.2.ic14.0.2aug2013
Supermicro\(^*\) 5017A-EF with one Intel\(^*\) S1260 processor (2-core 2.0GHz), EIST Enabled, Hyper-Threading Enabled, 8GB memory (1x 8GB DDR3-1333 UDIMM ECC), 250GB SATA 7200RPM HDD, Red Hat Enterprise Linux 6.4. Estimated Score: SPECint\(^*_rate\_base2006\)=18.90

**Atom C2750**: FOR.INTEL. cpu2006.1.2.ic14.0.15aug2013
Intel\(^*\) Mohon Peak Alpha platform with one Intel\(^*\) Avoton processor (8-core 2.4GHz, 20W, B0-stepping), Turbo Boost Enabled, 16GB memory (4x 4GB DDR3-1600 UDIMM ECC), 250GB SATA 7200RPM HDD, Red Hat Enterprise Linux 6.4. Estimated Score: SPECint\(^*_rate\_base2006\)=106

**Atom C2730**: FOR.INTEL. cpu2006.1.2.ic14.0.15aug2013
Intel\(^*\) Mohon Peak Alpha platform with one Intel\(^*\) Avoton processor (8-core 1.7GHz, 12W, B0-stepping), Turbo Boost Enabled, 16GB memory (4x 4GB DDR3-1600 UDIMM ECC), 250GB SATA 7200RPM HDD, Red Hat Enterprise Linux 6.4. Estimated Score: SPECint\(^*_rate\_base2006\)=87.9

**Marvell ARMADA XP\(^*\)**: CPU2006 v1.2 compiled with gcc version 4.6.3(Ubuntu/Linaro 4.6.3-1ubuntu5
Wiwynn\(^*\) SV118 with one Marvell\(^*\) Armada\(^*\) XP MV78460 (4-core 1.333GHz, <10W), 4GB memory (1x 4GB DDR3-1600L @ 1333MHZ UDIMM ECC), 250GB SATA 7200RPM HDD, Ubuntu 12.04 for ARM. Estimated Score: SPECint\(^*_rate\_base2006\)=5.98

**Calxeda ECX-1000**: Boston\(^*\) Virdis server with one Calxeda EnergyCore ECX-1000(4-core 1.4GHz ), 4GB memory (1x 4GB DDR3-1333 Ubuffered ECC), 250GB SATA 7200RPM HDD, Ubuntu 13.04 for ARM. Score: SPECint\(^*_rate\_base2006\)=11.8

\(^*\) Other names and brands may be claimed as the property of others.
Configuration

**Dynamic Web Performance and Perf/W:**

**Atom S1260:** DBC SDP w/Intel® Atom™ S1260 (2.0GHz, 2C), Hyper-Threading Enabled, 1x8GB DDR3-1333 MHz UDIMM ECC, BIOS version D134.4, Fedora* 17, Linux Kernel 3.3.4-5fc.x86_64, Apache 2.2.22, PHP 5.4.7, Boot Drive 1x 150GB SSD, Addl Drive 2x 150GB SSD, 2xGbe, Score: 1522, Estimated node power=20W, PPW=76.1

**Atom C2750:** MPK SDP w/Intel® Atom™ C2750 (2.4GHz, 8C, B0), Turbo Enabled, 4x8GB DDR3-1600 MHz UDIMM ECC, BIOS version 24D03, Fedora* 17, Linux Kernel 3.3.4-5fc.x86_64, Apache 2.2.22, PHP 5.4.7, Boot Drive 1x150GB SSD, Addl Drive 1x 800GB SSD, 1x10GbE, Score: 11351

**Atom C2730:** MPK SDP w/Intel® Atom™ C2730 (1.7GHz, 8C, B0), Turbo Disabled, 4x8GB DDR3-1600 MHz UDIMM ECC, BIOS version 22D05, Fedora* 17, Linux Kernel 3.3.4-5fc.x86_64, Apache 2.2.22, PHP 5.4.7, Boot Drive 1x150GB SSD, Addl Drive 1x 800GB SSD, 1x10GbE, Score: 8778, Estimated node power=19W, PPW=462

**Calxeda* ECX 1000:** Boston Viridis* w/Cortex* A9(1.4GHz, 4C), 1x4GB DDR3-1333 MHz UDIMM ECC, BIOS version ECX-1000 2.2.10, Ubuntu* 13, Linux Kernel 3.8.0-19-generic#30-Ubuntu SMP arm v7, Apache 2.2.22, PHP 5.4.9-4ubuntu2.1, Boot Drive 1x250GB HDD 7K RPM, Addl Drive 1x 450GB SSD, 2x1GbE, Score: 2831, Estimated node power=11, PPW=257.4

**Marvell* Armada XP:** Wiwynn* SV118 with one Marvell* Armada* XP MV78460 (4-core 1.333GHz, <10W), 4GB memory (1x 4GB DDR3-1600L @ 1333MHz UDIMM ECC), 2TB SATA 7200RPM HDD, Addl Drive 1x2TB HDD, Fedora 18, Linux Kernel 3.20-1617-armadaxp, Apache 2.4.3 (Fedora), PHP 5.4.9, 1x1GbE, Score=1351

* Other names and brands may be claimed as the property of others.