Intel Core i7
Overview

● Background
● i7 Architectures
  ○ Technical Specs
  ○ Performance
● Questions
● Sources
Background

- First appeared in 2008
- Successor to the Core 2 systems
- Released with the new Nehalem Microarchitecture currently Haswell
- Changed its naming scheme from Core 2 to
  - i3 - low-level performance
  - i5 - mid-range performance
  - i7 - high-end performance
Core i7 - Nehalem

● Technology
  ○ Hyper-Threading
    ■ Intels way to improving parallelization in computers
    ■ For each core, there are two virtual/logical cores
    ■ Shares workloads between them
    ■ Main function is to decrease the number of dependent instructions on the pipeline
    ■ Uses superscalar architecture
Core i7 - Nehalem

- Technology
  - Hyper-Threading cont.
    - Works by duplicating certain sections of the processor
      - those that store the architectural state
      - not anything dealing with the main execution resource
    - Making it appear as several logical processors on one core
  - 4-12 MB L3 cache
Core i7 - Nehalem

- **Technology**
  - Second-level branch predictor and translation lookaside buffer
  - Native quad- and octal-core processors
  - Intel QuickPath Interconnect (replaces the FSB)
  - 731 - 774 million transistors
  - 64 KB L1 cache/core (32 KB L1 Data + 32 KB L1 Instruction) and 256 KB L2 cache/core
Core i7 - Nehalem

- Technology
  - Integration of PCI Express and DMI into processor (replaces the northbridge)
  - Integrated Memory Controller supporting 2 or 3 channels of DDR3 SDRAM or four FB-DIMM2
  - 2nd Generation Intel Virtualization Technology
    - Extended page table support
    - virtual processor identifiers
    - non-maskable interrupt-window exiting
Performance and Power  (Compared to Penryn the previous architecture)

- 10-25% more single-threaded performance
- 20-100% more multithreaded performance at the same power level
- 30% lower power consumption for the same performance
- 15-20% clock-for-clock increase in performance per core on average
Core i7 - Nehalem

- **Performance and Power** (Compared to Penryn the previous architecture)
  - Overclocking is possible to get better performance
  - Incorporated SSE 4.2 SIMD instructions (parallelization)
    - Introduced 7 new 4.1 SIMD instructions (built of the core 2)
  - Reduces atomic operation latency by 50% attempting to remove atomic overhead
Core i7 - Sandy Bridge

- Technology
  - 32 KB data + 32 KB instruction L1 cache
  - 256 KB L2 cache
  - Shared L3 cache includes processor graphics
  - 64-byte cache line size
  - Two load/store operations per CPU cycle for each memory channel
  - Optimized branch predictor
Core i7 - Sandy Bridge

Technology
- improved performance for transcendental mathematics, AES encryption and SHA-1 hashing
- 256-bit/cycle ring bus interconnect between cores, graphics, cache and system agent domain
- Advanced vector extensions - 256-bit instruction set with wider vectors
- Intel Quick Sync Video, better hardware support for video encoding/decoding
Core i7 - Sandy Bridge

● Technology
  ○ Up to 8 physical cores or 16 logical cores with hyper-threading
  ○ Integration of the graphics and memory controller into a single die
  ○ 14-19 stage instruction pipeline
  ○ 1.16 - 1.27 Billion transistors
Core i7 - Sandy Bridge

- **Performance and Power** (Compared to Nehalem the previous architecture)
  - 11.3% better performance at clock to clock
  - Around twice the integrated graphics performance
Core i7 - Ivy Bridge

● Technology
  ○ Didn’t change that much from Sandy Bridge, just a shrink it technology (smaller die size)
  ○ 22 nm Tri-gate transistor (“3-D”) technology
    ■ up to 50% less power consumption at the same performance level as 2-D planar transistors
  ○ Introduction for 16-bit floating point conversion instructions
  ○ 1.4 - 1.86 Billion transistors
Core i7 - Ivy Bridge

● Technology
  ○ PCI Express 3.0 support
  ○ RAM support up to 2800 MT/s in 200 MHz increments
  ○ GPU has 6 - 16 execution units
  ○ Intel HD Graphics with DirectX 11, OpenGL 3.1, and OpenCL 1.1 support
  ○ 3 Display support
Core i7 - Ivy Bridge

- **Performance and Power** (Compared to Sandy Bridge the previous architecture)
  - 3-5% increase in CPU performance when compared to clock for clock
  - 25-68% increase in integrated GPU performance
Core i7 - Haswell

- Technology
  - Wider Core: 4 ALUs, 3 AGUs, 2 branch prediction units, deep buffers, higher cache bandwidth, improved front-end
  - More instructions
  - Instruction decode queue, holds instructions after they have been decoded, is no longer statically partitioned between the two threads that each core can service
Core i7 - Haswell

- Technology
  - Graphic Support for DirectX 11.1 and OpenGL 4.0
  - Support for DDR4 RAM
  - Variable Base Clock
  - Support for Thunderbolt technology
  - Fully integrated voltage regulator, moving another component off the motherboard
  - New advanced power-saving system
  - 1.4 - 2.27 Billion transistors
Core i7 - Haswell

Haswell

- 56 µop Decode Queue
- 192 Entry Reorder Buffer (ROB)
- 4 µops
- 168 Integer Registers
- 168 AVX Registers
- 48 Entry Branch Order Buffer
- 72 Entry Load Buffer
- 42 Entry Store Buffer
- 60 Entry Unified Scheduler
Core i7 - Haswell

Haswell

60 Entry Unified Scheduler

Port 0: ALU Branch Shift
Port 1: 256-bit VMUL VShift
Port 5: ALU Fast LEA
Port 6: 256-bit VALU VShuffle
Port 1: 256-bit FMA FADD
Port 5: 256-bit VALU VBlend
Port 6: ALU Branch Shift

Port 0: 256-bit FMA FBlend
Port 1: 256-bit FMA FADD
Port 5: 256-bit FShuffle FBlend
Core i7 - Haswell

- Performance and Power (Compared to Ivy Bridge the previous architecture)
  - About 8% better vector processing performance
  - 6% faster single-threaded performance
  - 8-23% more power draw while under load in the desktop versions
  - 15 degrees C hotter
Performance and Power (Compared to Ivy Bridge the previous architecture)

- 6% increase in sequential CPU performance
- 20% performance increase over the integrated HD4000 GPU
- Total performance improvement on average is about 3%
# Core i7 - Technical Specs

<table>
<thead>
<tr>
<th>Codename</th>
<th>Brand name</th>
<th>Cores (Threads)</th>
<th>L3 Cache</th>
<th>Socket</th>
<th>TDP</th>
<th>Process</th>
<th>Busses</th>
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<td>Ivy Bridge (Mobile)</td>
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Sources

Intel Core (http://en.wikipedia.org/wiki/Intel_Core)
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