32nm Westmere Family of Processors

Stephen L. Smith
Vice President, Director of Group Operations
Digital Enterprise Group
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Highlights from Paul Otellini Speech Today

- Intel is making the largest-ever investment in a single process technology in the U.S. to support advanced manufacturing facilities upgrades. and the move to its next-generation, 32nm chip manufacturing technology.

- Intel is investing approximately $7 billion this year and next on 32nm manufacturing technology, bringing our total by the end of next year to approximately $8 billion (for 32nm investment in the U.S.).

- This new investment is made against the backdrop of Intel’s combined capital and R&D investment in the U.S. of more than $50 billion since 2002.

- This new multi-billion-$ investment to upgrade facilities in New Mexico, Arizona and Oregon will ensure U.S. state-of-the-art chip technology manufacturing.
  - Oregon (D1D, D1C, and AFO)
  - New Mexico (Fab 11x)
  - Arizona (Fab 22-32 megafab)

All dates, product descriptions, availability, and plans are forecasts and subject to change without notice.
Tick-Tock Development Model:
Sustained Microprocessor Leadership

- **Intel® Core™ Microarchitecture**
  - **Merom**
    - NEW Microarchitecture
    - 65nm
  - **Penryn**
    - NEW Process Technology
    - 45nm
  - **Nehalem**
    - NEW Process Technology
    - 45nm
  - **Westmere**
    - NEW Process Technology
    - 32nm
  - **Sandy Bridge**
    - NEW Process Technology
    - 32nm

- **Intel® Microarchitecture codename Nehalem**

- **Future Intel® Microarchitecture**

*TOCK* *TICK* *TOCK* *TICK* *TOCK* Forecast

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Intel 32nm Production Ready in 2009

Today’s News

- Intel is demonstrating the first working 32nm based microprocessor, in both mobile and desktop systems

- Great 32nm process and product health is enabling Intel to accelerate 32nm product ramp
  - Westmere mobile and desktop processor production in Q4’09
  - 32nm enables increased performance and power flexibility

- Intel® processors based on Westmere will ramp into mobile, desktop, and server segments over time, as the 32nm process ramps

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Westmere

Westmere: Nehalem migrated to 32nm process

Client: brings Nehalem through the mainstream
- Increased performance across single and multithread usages (vs. today’s Intel Core 2 product family)
- Enables processors (Codenamed Gulftown) with 6 cores supporting 12 threads on the desktop roadmap
- Smaller processor core size
- New Multi-Chip Package with graphics integrated in processor

Server: extends leadership platforms
- Clarkdale*: refresh 1 socket servers
- Westmere based refresh for 2 socket servers
- Westmere based refresh for 4+ socket servers

Further Demonstrating Intel Product and Process Leadership

* Client branded product supported for servers

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Transitioning to Mainstream

2008

- High End Desktop
  - Intel Core i7

- Mainstream Desktop
  - Lynnfield

- Thin & Light Notebook
  - Clarksfield

2009+

- 4 Cores / 8 Threads
- 2 Cores / 4 Threads with Integrated Graphics

- Clarkdale
- Arrandale

45 nm High-K

32nm High-K

Repartitioned Client Platform Volume Ramp Vehicle

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### Nehalem/Westmere Client Roadmap

<table>
<thead>
<tr>
<th>2009</th>
<th>2010+</th>
</tr>
</thead>
<tbody>
<tr>
<td>X58 Platform</td>
<td>2010 HEDT Platform</td>
</tr>
<tr>
<td>Intel® Core i7 Extreme Processor (4C/8T)</td>
<td>32nm Gulftown Processor (6C/12T)</td>
</tr>
<tr>
<td>Intel® X58 Express Chipset</td>
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</tr>
<tr>
<td>Intel® Core i7 Processor (4C/8T)</td>
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<tr>
<td>Intel® X58 Express Chipset</td>
<td></td>
</tr>
<tr>
<td>Piketon / Kings Creek Platforms</td>
<td>Calpella Platform</td>
</tr>
<tr>
<td>32nm Clarkdale (2C/4T)</td>
<td>Clarksfield (4C/8T)</td>
</tr>
<tr>
<td>Intel 5 series Chipset</td>
<td>32nm Arrandale (2C/4T)</td>
</tr>
<tr>
<td>Future Intel® micro-architecture codename Sandy Bridge</td>
<td>Intel 5 series-M Chipset</td>
</tr>
</tbody>
</table>

**32nm Westmere extends Nehalem through the mainstream**

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Intel® Xeon® Enterprise Roadmap

2009

- Expandable 7000 Sequence
  - Boxboro-EX Platform*
    - Nehalem-EX Processor*
    - Boxboro-EX Chipset
  - Tylersburg-EP Platform
    - Nehalem-EP Processor
    - Tylersburg & Dual-IOH Chipsets
  - Foxhollow Platform
    - Lynnfield Processor
    - Intel 5 series Chipset

2010+

- 32nm Westmere Based Processor
  - 32nm Clarkdale Processor**

Future Intel® micro-architecture codename Sandy Bridge

32nm Upgrades Across All Intel® Xeon® Segments:
Entry (EN), Efficient Performance (EP) & Expandable (EX)

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* Targeted for production in 2H'09
** Client branded product supported for servers
Mainstream Client Platform Repartitioning

Penryn based 3-Chip Solution

- Processor
- FSB
- Intel® 4 Series Chipset
  - iGFX
  - MC
  - Display
  - ICH
- Clocks
- PCIe Graphics
- Display

Westmere based 2-Chip Solution

- Processor
- PCIe Graphics
- Intel® Flexible Display Interface
- DMI
- DDR 3
- Intel® 5 Series Chipset
  - iGFX
  - IMC
- Display
  - Clock Buffer
  - ME
- I/O

Repartitioning of the Client Platform
Greater Performance and Lower Power via Higher Integration
First 32nm Westmere Products

Key Features
- Intel® Turbo Boost technology
- Intel® Hyper-Threading technology (2 Cores, 4 threads)
- Integrated graphics, discrete / switchable graphics support
- Integrated Memory Controller (IMC) - 2ch DDR3

Not all features are available on every processor line item
Westmere: AES New Instructions

- Use additional transistor budget to add new capabilities
  - Similar to adding SSE4.1 in Penryn (45nm tick)
- 7 new instructions for accelerating encryption/decryption algorithms
  - Carryless multiply (PCLMULQDQ)
  - 6 instructions for AES
- Example client usage
  - Enables full disk encryption

Early Intel Analysis shows significant Speedup on Encryption
Tick-Tock Development Model: Sustained Microprocessor Leadership

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<tr>
<td>NEW Microarchitecture 65nm</td>
<td>NEW Process Technology 45nm</td>
<td>NEW Microarchitecture 32nm</td>
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<td>Done</td>
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</table>

**Summary:**
- 32nm process technology on track for Q4’09 production readiness
- 32nm enables increased performance and power flexibility
- Westmere-based processors will span across Desktop, Mobile, and Server

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Back-Up
# Nehalem and Westmere Decoder Ring

<table>
<thead>
<tr>
<th>Segment</th>
<th>Nehalem (45nm)</th>
<th>Westmere (32nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Desktop</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-End</td>
<td>Bloomfield (4C / 8T)</td>
<td>Gulftown (6C / 12T)</td>
</tr>
<tr>
<td>Mainstream</td>
<td>Lynnfield (4C / 8T)</td>
<td>Clarkdale (2C / 4T + iGFX)</td>
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<tr>
<td><strong>Mobile</strong></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Clarksfield (4C / 8T)</td>
<td>Arrandale (2C / 4T + iGFX)</td>
</tr>
<tr>
<td><strong>Server</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expandable</td>
<td>Nehalem-EX (8C / 16T)</td>
<td>Future Westmere Based Processor</td>
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<tr>
<td>Scalable</td>
<td></td>
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<tr>
<td>(typically 4+ sockets)</td>
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<tr>
<td>Efficient</td>
<td>Nehalem-EP (4C / 8T)</td>
<td>Future Westmere Based Processor</td>
</tr>
<tr>
<td>Performance</td>
<td></td>
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<tr>
<td>(typically 2 sockets)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entry (EN)</td>
<td>Lynnfield (4C / 8T)</td>
<td>Clarkdale (2C / 4T + iGFX)*</td>
</tr>
<tr>
<td>(typically 1 socket)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Client branded product supported for servers
Westmere Family
Mainstream Desktop / Mobile Processor

Key Features¹:
- Intel microarchitecture codename Nehalem on 32nm
- Multi-Chip Package (MCP) processor with:
  - processor cores built on 32nm 2nd generation high-k metal gate process
  - integrated graphics controller & memory controller built on 45nm high-k metal gate process
- Intel® Turbo Boost technology
- Intel® Hyper-Threading technology (2 Cores, 4 threads)
- Intel® Smart Cache
- Integrated memory controller (IMC)
- Integrated, discrete / switchable graphics support
- Advanced Encryption Standard (AES) acceleration
- Compatible with the Intel® 5 series chipset based platforms due to be released in 2H’09

¹ Not all features are available on every processor line item

Intel® 5 series Chipset

Worlds First 32nm Based Processor

Intel® FDI:  Intel Flexible Display Interface
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