The New Age of Computing Continuum Experience

Dr. Rama Shukla
Vice President
Intel Corporation

Intel Architecture Group
Santa Clara, Ca, USA
The Semiconductor Revolution

Intel sees no end to Moore’s Law
The Semiconductor Revolution........

- Made everything **Digital**
- Computing became more **Pervasive**
- **More devices** per user
And Created Continuum of Consumer Experiences

A Consistent, Familiar & Seamless Experience Across Multiple Devices

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Computing Continuum Revolution

Power Efficient Performance
Security
Superior Graphics

Connectivity
Consistency
Computing Continuum Putting Demands on Data Center: New Uses for Computing

- Flickr: 30.4M Photos viewed per day, 152 TB/day
- YouTube: 2 Billion Videos viewed per day, 25 PB/day
- Facebook: 8.6B Pages viewed per day, 1.7 PB/day
- Twitter: 146M Tweets per day, 1.4 TB/day*

Source: IDC
Other brands and names may be claimed as the property of others.
*for pages viewed per day
Workload Diversity Drives Need for Flexible, Intelligent Clients & Client-Aware Cloud

Consume, Create and Collaborate

Desktop
Laptop
Smart Phone
Netbook
Tablet
AIO

Consume and Communicate

TV
Tablet
Netbook
IVI

"On the Go" Access and Communications

And it all wants to be faster, smaller and lower power

Power Consumption

Performance

Context, Compute, Capabilities ... Using the Right Tools for the Job

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New Experiences Drive Need For Innovative Technologies and Performance

Sensing & Analysis Technologies:

• Visual analysis
  – Camera detection of faces; facial orientation; other visual cues (height, age, gender)

• Acoustical analysis
  – Array of microphones captures audio; words parsed using rules of grammar

• Scene analysis
  – Combination of visual and acoustical analysis to predict higher-level aspects of the conversation

• Dialogue management
  – Probabilities updated and next question queued

More “human” like interaction with devices
Market Trends in Video

User-generated Content

Online Video Consumption

Surveillance Trends

Netflix* has 14 million subscribers with 34% year over year growth

Facebook* receives 415,000 video uploads a day

By 2013, Video will be 90% of all Consumer IP traffic*

*Source: Pew Internet & American Life Project survey conducted from March 26-April 29, 2009.
*Source: eMarketer.com
*Source: Cisco Visual Networking Index: Forecast and Methodology, 2008-2013
*Other names and brands may be claimed as the property of others.

Video usage & demand continues to rise rapidly
Humanizing Video Data

for deconstructing & analyzing video content

- Ability to recognize objects, patterns & behaviors
- Ability to sort, filter, and tag with Meta-Data

Increase in Computing Requirements:

- Evolution from analog to digital creates compounding compute requirements
- Performance/power optimized solutions required
- Enabling Video Contextual search
An Insatiable Need For Computing

PetaFlop Systems of Today Are
The Client And Handheld Systems 10 years Later

1 ZFlops
100 EFlops
10 EFlops
1 EFlop
100 PFlops
10 PFlops
1 PFlop
10 TFlops
10 TFlops
1 TFlop
100 GFlops
10 GFlops
1 GFlop
100 MFlops
10 MFlops
1 MFlop
100 PFlops
10 EFlops
1 EFlop
100 PFlops
10 PFlops
1 PFlop
10 TFlops
10 TFlops
1 TFlop
100 GFlops
10 GFlops
1 GFlop
100 MFlops

Weather Prediction

Genomics Research

Medical Imaging

Source: www.top500.org

Forecast

PetaFlop Systems of Today Are
The Client And Handheld Systems 10 years Later

Source: www.top500.org
Compute Continuum: Redefining Connectivity

- Not just connecting to the Internet, but moving data/images and content seamlessly between devices
- Wi-Fi, Bluetooth, Near Field Communications, etc to share content consistently across a continuum of devices/cloud

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The Security Challenge

- Where everything is digital, the computer becomes the tool of the thief
- And they want to access our:
  - Wallets, credit cards and bank accounts
  - Private data and our identities
  - Content

- The computer becomes a weapon of mass destruction
  - Access top secret data
  - Destroy infrastructure and military capabilities

Identity Protection & Fraud Deterrence
Detection & Prevention of Malware
Securing Data & Assets
User Experience Across the Continuum Demands Platform Consistency

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More Breakthroughs Needed
Computing Continuum: Breakthroughs Needed

- Power efficiency: Reaching Exascale computing
- Programming and Memory Model
- Highly parallel, Embedded or Traditional CPU?
- Seamless SW Ecosystem across devices/usages
- "Smart" computing: perceptual, context aware, video/speech analytics, biometrics
Si-Process Technology Marches On

Source: Intel
Strained Silicon

High k Metal gate

Tri-Gate
22nm Silicon Technology Breakthrough
Benefits Broad Range of Intel Architecture Devices

New 22nm 3-D transistors deliver unprecedented performance improvement and power reduction for Intel’s product portfolio

• 37% performance increase at low voltage vs. 32nm planar transistors*
• Consumes only half the power at the same performance level as 2-D transistors on 32nm planar chips*

22 nm Benefits Smallest Handhelds to Powerful Cloud-based Servers

* Based on Intel Internal Data
This is Even a Bigger Challenge Moving Forward

Big Computers Traditionally Get Smaller Over Time

TFLOP Machine today

- 5KW
- Disk
- Com
- Memory
- Compute

4450W

100W

100W

150W

200W

Decode and control
Translations
...etc
Power supply losses
Cooling...etc

10TB disk @ 1TB/disk @10W

100pJ com per FLOP

5KW

0.1B/FLOP @ 1.5nJ per Byte

200pJ per FLOP

TFLOP Machine then

- 5W
- ~2W
- ~3W
- 2W
- 3W

~15W

<1W
The Challenge to Exascale Systems Starts with Power

The Challenge: 1000x Improvement in Performance With a 10x Increase in Power

<table>
<thead>
<tr>
<th>Operation</th>
<th>Approx Energy Today</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instruction Execution</td>
<td>5-10 nJ</td>
</tr>
<tr>
<td>FP operation</td>
<td>200 pJ</td>
</tr>
<tr>
<td>Byte read from cache</td>
<td>10-20 pJ</td>
</tr>
<tr>
<td>Byte read from DRAM</td>
<td>1.5 nJ</td>
</tr>
<tr>
<td>Byte over IC fabric</td>
<td>5 pJ/hop—250 pJ+</td>
</tr>
</tbody>
</table>

6.95MW

1.759PF

4GW

530MW*

$1M

Oak Ridge National Labs

1MW = $1M

* Assuming 21% Power/Perf CAGR
Multiple Ways to Approach the High Performance Computational Challenge

- Highly Parallel
- Embedded Processors
- Traditional CPUs

Goal Is to Make the Implementation Irrelevant Under the Same Programming and Memory Model
SoC: Systems Approach to Low Power

- One Programming Model
- Rethink System level Memory Architecture

Not Just CPU & Graphics, but All the System Ingredients
A Holistic Perspective of the Challenge

Future Systems Must Be Balanced, Dynamic, and Adaptive
Create Self Aware Systems

Key Parameters
Such as heartbeat, Goals, Algorithms, etc

Analysis & Optimization Engine

• **Introspective**: Observes itself, reflects on its behavior and learns
• **Goal Oriented**: Client specifies the goal; System figures out how to get there
• **Adaptive**: Computes delta between goal and observed state; takes action to optimize
• **Self Healing**: Continues to function through faults and degrades gracefully
• **Approximate**: Does not expend more effort than necessary to meet goals

Exascale Software Study: Software Challenges in Extreme Scale Systems
Reinventing the PC Again

Ultra Thin

Ultra Secure

Ultra Responsive

7X Graphics Improvement*

> 10 Hours Battery Life*

The Attributes of a Tablet, the Performance of a PC. All Day, Every Day.

* Projections based on 2013 platforms. Actual results may vary due to OEM/ODM designs and system configurations.
Delivering the Next Exponential Increase in Visuals

* Graphics, Media, Imaging

Expect Another 12X Improvement in Processor Graphics by 2015*

* Projecting 12X graphics improvement from 2011 to 2015 in the 'new notebook design target' power envelope.
The “No Compromise” Consumer PC Experience

Sleek, Cool, Super Responsive and a Full PC
• Thin and light at mainstream price points
• Best in class CPU and graphics performance
• Great visual and media experience
• Instant On and Always On /Always Connected
• World-class battery life
• Full keyboard – convertible to full touch
• Sensors

Other brands and names may be claimed as the property of others
PC: the personal companion that just keeps getting better😊

**Today**
- Always On / Always Connected
- Fast Flash Standby
- Turbo
- Thunderbolt

**2012**
- Touch User Interface
- Context Aware - Sensors
- Near Field Communication
- Stylish Designs

**2013**
- World-class Battery Life
- Sensor Based Sync & Media Sharing
- Mobile Gaming and Video Conferencing
- Security for Online Gaming and Media Sharing

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Resulting in Better User Experiences

**BENEFITS FOR USERS**
- Consistent experience across devices
- Devices work together seamlessly
- Security and privacy protection across Intel devices

**Secured information at your fingertips**

**BENEFITS FOR DEVELOPERS**
- Portability of software and tools across platforms
- Compatibility for applications
- Faster TTM
- Leverage large Intel Architecture developer community

Focus on the problem, not the format
Summary

• We are now living in a world of connected computing continuum, best is yet to come!

• Moore’s Law is alive and fueling the “compute continuum” revolution

• Insatiable demand for high-performance/power efficient computing, both in devices and data center infrastructure

• Silicon advancements alone are insufficient: usage/experiential models driving new expectations of compute continuum world.
Risk Factors

The above statements and any others in this document that refer to plans and expectations for the second quarter, the year and the future are forward-looking statements that involve a number of risks and uncertainties. Words such as “anticipates,” “expects,” “intends,” “plans,” “believes,” “seeks,” “estimates,” “may,” “will,” “should,” and their variations identify forward-looking statements. Statements that refer to or are based on projections, uncertain events or assumptions also identify forward-looking statements. Many factors could affect Intel’s actual results, and variances from Intel’s current expectations regarding such factors could cause actual results to differ materially from those expressed in these forward-looking statements. Intel presently considers the following to be the important factors that could cause actual results to differ materially from the company's expectations. Demand could be different from Intel's expectations due to factors including changes in business and economic conditions, including supply constraints and other disruptions affecting customers; customer acceptance of Intel's and competitors' products; changes in customer order patterns including order cancellations; and changes in the level of inventory at customers. Potential disruptions in the high technology supply chain resulting from the recent disaster in Japan could cause customer demand to be different from Intel's expectations. Intel operates in intensely competitive industries that are characterized by a high percentage of costs that are fixed or difficult to reduce in the short term and product demand that is highly variable and difficult to forecast. 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