“The future is about data”
Total Data Crossing the Internet

150,000,000,000,000,000,000,000,000 Bytes* Through 2009

175,000,000,000,000,000,000,000,000 Bytes* In 2010 Alone

* Source: http://www.cisco.com/assets/cdc_content_elements/networking_solutions/service_provider/visual_networking_ip_traffic_chart.html
By 2015...

More Users

>1 Billion More Netizen's

More Devices

>15 Billion Connected Devices

More Data

>>1 Zetabyte Internet Traffic


2. Source: Gartner June 2010, CAGR from 2009 to 2014
The Lifecycle of Data

- Generate
- Protect
- Store
- Transport
- Compute
- Apply
GENERATE

Make it easy to create, sense, and access sources of new information.

Tech Challenges

- Non-textual data
- Ubiquitous low-cost sensors
- Power-efficiency
- Context awareness
- Data mining & synthesis
PROTECT

Secure data end-to-end, assuring both privacy, confidentiality, integrity, and authenticity.

Tech Challenges

- Efficient encryption
- Data isolation
- Data Protection
- Authentication
- Access control
- Data loss prevention
- Information policy
TRANSPORT

Scale network capacities and open up new modes of communication.

Silicon Photonics links
COMPUTE

Make computation faster, more flexible and more efficient

Tech Challenges

- Parallelism & throughput
- Cloud & Distributed computing
- Programming models
- Scalability
- Re-configurability
- Energy-efficiency
- Resilience

Open Cirrus Cloud Testbed

48-core chip
Intel Labs Braunschweig
STORE

Efficiently store massive amounts and know what to throw away

Phase-change memory

SSDs

Tech Challenges
- Data dispositioning
- Memory technologies
- Read/write speed
- Distributed storage
- Standards
- Federation
APPLY
Use massive data to improve the way people live, work, play.

OPPORTUNITIES
- Augmented Reality
- Smart grids
- Immersive 3D
- Medical visualization
- Smart digital assistants
- Business intelligence
- Natural HCI

Intel Visual Computing Institute Germany
The future is about knowing what’s next
From analyzing human generated data...
To harness machine generated data

Harnessing Compute to Predict Weather

1985
48 Hour Warning Window
300 Mile Radius

TODAY
48 Hour Warning Window
100 Mile Radius
From Mega Opportunity

Solving the World’s Enduring Problems

- Accurate Weather Prediction
- Timely Cancer Detection
- Affordable Genome Sequencing
To sensing human gait

Predicting Life-Threatening Falls Before They Happen
From Personal Level

Image Recognition

Speech Recognition

Mobile Augmented Reality

Continuous Speech Recognition

Gesture Recognition

Text Recognition

Hand Gestures / Body Pose

Parthenon: More Info
5th Century BC
Temple of Greek Goddess Athena

For the comparison against the detailed simulator, we chose 8 benchmarks from the SPEC 2000 Benchmark Suite [22] to form heterogeneous multiprogrammed workloads for each fine-grained multithreaded core being simulated. Table 3 shows the simulated workload of each core for our first study. We ran our detailed simulator such that each core executed at least 400 million instructions.

For our hardware comparison, we evaluated homogeneous workloads consisting of a varying number of threads, each running a memory intensive application (mcf). We also evaluated several heterogeneous workloads consisting of multiple instances of two types of applications to ob-
And Beyond...

Source: Prof. Liang-Gee Chen, NTU
The future is about “intelligence”
Channeling Info into Insight

- Medical Scans
- Social Media
- News & Journals
- Satellite Images
- E-commerce
- TV & Video
- Sensors & Surveillance

Transport

Compute

Insight

- Business intelligence
- Biodiversity trends
- Virtual travel guides
- Language translation
- Health monitoring
- Augmented reality
- Video analytics
- Extreme weather prediction
Context is Everything

What Am I Doing?
Where Am I Going?
Why Am I Here?
How Am I Feeling?
When Do I Need To Leave?
Who Am I With?

Why Am I Here?
What Am I Doing?
Where Am I Going?
How Am I Feeling?
When Do I Need To Leave?
Who Am I With?
Fundamentally Transforming the Relationship between Humans & Computers with Context

Who is this person? How do I know him?

What's interesting around here?

What's his batting average?

What are my friends up to?

Your flight is cancelled...
Inferring the Context

HARD SENSING
- In Front of Laptop
- Running, Walking, Sitting, etc
- Commuting, Chatting, Listening to Music, Dark, Light, Indoor, Outdoor
- Location (GPS, WIFI, BT)

Activity Fusion Algorithm

SOFT SENSING
- Device Activity: Call, Editing, Surfing, Email
- Calendar: free, In meeting, etc
- Browsing
- Social Networking
Aggregating Context ...

... Over Time

Activity
- Working on computer
- Commuting
- In meetings
- Socializing

People
- Rahul
- Junaith
- Beppe
- Jon
- Alex
- Jen

View Changes Over Time

Overlays: Emotion, Noise, Talkative, Laughing, Alone

... Across Devices
Cognitive framework for managing context

- Applications
- Context Engine
- Data Store
- Context Proxy Service
- Sensor Abstraction
- Sensors: Physical, Application Data and Web services
- Extensible Analyzing & Inferencing

Intel

Domain specific analytics

Smart Agent

Analytics Engine

Big Data
The future is about collaborations
Cloud, Edge, and Devices
The Client Aware Cloud

Optimized delivery of cloud experience depends on the endpoint capabilities of the client devices.

- Performance
- Security
- Memory
- Graphics
- Networking
- Screen size

- Consume, Create and Collaboration
- Public, Private and Hybrid Clouds
- Consume and Communicate
- On-the-go Access and Communications
Ex: Mobile Augmented Reality

- Get video & location
- Draw overlay
- Analyze images
- Secure wireless
- Check tagged image DB
- Search for similar photos
- Look for context

* Other names and brands may be claimed as the property of others.
Client-to-Cloud security layers

**Assurance and Compliance**
- Data Use Policy Enforcement
- Compliance Reporting
- Pro-active SEIM integration & Alert

**Trust and Control**
- AuthN & AuthZ at edge tied to IdM
- Federated Trust
- Data confidentiality, PKI, Encryption

**Perimeter Defense**
- Secure Hypervisor
- Anti-Virus and Malware
- Content Threat Protection
- Secure API Management

**Client Security**
- Protection from Malware
- Secure Federated Session
- Secure Client/Browser Exec Environment

Effective Client-to-Cloud Access Involves Connecting Layers of Cloud Security
Intelligent Universe - Cooperating Smart Agents
Powering The future
Is the Infrastructure Ready?

In The Last 5 Years Alone:

20x Performance/Watt

Half The Platform Idle Power

15:1 Consolidation

We Have Made Tremendous Progress...
But Not Enough...

Security
70% of Respondents Saying Security is Top Concern In Moving to Public Cloud

Efficiency
Today’s Technology Would Require Building 45 New Coal Power Plants to Support 2015 IT Infrastructure

Manageability
IT will spend ~$2T on deployment & operations thru 2015 unless smarter infrastructure radically simplifies management of virtualized environments.

Lock-In
the451group August 2010
“We have seen lock-in return as a top concern....routinely seeking alternatives to proprietary virtualization and cloud computing technology”

Infrastructure Must Evolve to Address IT Challenges

1. IDC Market Analysis, January 2010.
2. Source information is backup.
* Other names and brands may be claimed as the property of others.
Near Threshold Voltage Operation

Peak energy efficiencies at NTV and fine-grain power management

Potential For...

• More always-on / instant wake devices
• Intelligent everyday devices with battery/solar powered CPUs
• Longer battery lives for mobile computing
• Scalable many-core chips for the datacenter
• Meeting extreme-scale compute challenges
Claremont: Near Threshold Voltage IA Processor

First processor to demonstrate benefits of Near Threshold Voltage circuits

IA concept chip can ramp from full performance to ultra low power (<10mW)

Scales to over 10X the frequency when running at nominal supply voltage

Enables Ultra Low-power Devices with Wide Dynamic Operating Range
Establish “Trustworthiness”

- **Anti-Malware Defense in Hardware**
  Improve prevention, detection of malware on IA platforms

- **Hardware Support for Trusted Software**
  Enable trusted execution, confidentiality & integrity

- **Authenticate Once and Be Done**
  Balance ease of use and protection of user identity

- **Secure the Network**
  Balance privacy and trust across the network
Energy-Efficient Scalable I/O

Silicon Photonics Link

Electrical twinax cable
Cloud Benchmarks
HiBench

HiBench: A Realistic and Comprehensive Hadoop Benchmark Suite

1. Micro Benchmarks
   - Sort
   - WordCount
   - TeraSort

2. Web Search
   - Nutch Indexing
   - Page Rank

3. Machine Learning
   - Bayesian Classification
   - K-Means Clustering

4. HDFS
   - Enhanced DFSIO

Source: Jason Dai et al
HiTune: Dataflow-Based Hadoop Performance Analyzer

The user develop the application based on the MapReduce dataflow graph

The Hadoop framework dynamically maps the dataflow graph to the underlying cluster

HiTune automatically instruments Hadoop tasks/framework to collect runtime information

- At binary level (i.e., no source code changes)
- Low overheads (<2%)
**Intel’s Cloud 2015 Vision**

**FEDERATED**
Share data securely across public and private clouds

**AUTOMATED**
IT can focus more on innovation and less on management

**CLIENT AWARE**
Optimizing services based on device capability
Catalyst for Change

Open & Interoperable Solutions Essential

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

Steering Committee

BMW  China Life  Deutsche Bank  JPMorgan Chase & Co.

Marriott  NAB  Shell  Terremark  UBS

Member Companies

Over 70 members across the globe

* Other names and brands may be claimed as the property of others.
Intel® Cloud Builders

Easing Cloud Deployments via Proven, Interoperable Solutions for IT
Open Cirrus* Cloud Computing Testbed

Collaboration between industry and academia, sharing
- hardware infrastructure
- software infrastructure
- research
- applications and data sets

Sponsored by HP, Intel, and Yahoo! (with additional support from NSF)
15 sites currently, target of around 20 in the next two years

* Other names and brands may be claimed as the property of others.
Breaking Barriers to Academic Collaboration

Intel Science & Technology Centers (ISTCs)

- ISTCs funded for 3+2 years and span multiple institutions
- Encourage collaboration among the best researchers in the field
- Four Intel funded researchers per center work on-campus
- Encourage collaboration between Intel and academia
- Public domain IP and open source software increase impact

* Other names and brands may be claimed as the property of others.
The Intel Science and Technology Center for Cloud Computing

Phil Gibbons
Intel Labs
Principal Researcher
ACM Fellow

Greg Ganger, CMU
Stephen J. Jatras Professor of Electrical and Computer Engineering

* Other names and brands may be claimed as the property of others.
ISTC-SC: Community of Talented Security Researchers
Faculty, Graduate Students, & Intel

David Wagner
- UCB PI

John Manferdelli
- Intel PI
Intel-NTU Connected Context Computing Center

• Kicked off: Jan 26, 2011

• Vision

End-end solution for intelligent and secure interaction and information sharing amongst connected devices

• Mission

Address core challenges for acquisition/communication platforms, context analysis, and smart interaction that will increase the rate and breadth of M2M adoption across
• 24 NTU professors + 4 from other universities
• 120 post-doctor, Ph.D., M.S., and B.S. research assistants
• Each project has one Intel researchers working closely with NTU professors
Summary

• Massive data and machine intelligence will shape the future of computing

• Cloud infrastructure will be automated, federated, and client aware

• There is ample room for industry and university collaborations
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Relative performance is calculated by assigning a baseline value of 1.0 to one benchmark result, and then dividing the actual benchmark result for the baseline platform into each of the specific benchmark results of each of the other platforms, and assigning them a relative performance number that correlates with the performance improvements reported.

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Hyper-Threading Technology requires a computer system with a processor supporting HT Technology and an HT Technology-enabled chipset, BIOS and operating system. Performance will vary depending on the specific hardware and software you use. For more information including details on which processors support HT Technology, see here.

Intel® Turbo Boost Technology requires a Platform with a processor with Intel Turbo Boost Technology capability. Intel Turbo Boost Technology performance varies depending on hardware, software and overall system configuration. Check with your platform manufacturer on whether your system delivers Intel Turbo Boost Technology. For more information, see http://www.intel.com/technology/turboboost.*

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