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Cloud Computing Today

With Unanswered Questions –

• Secure?
• Reliable & Available?
• Standards Ready?
• If yes, who ensures it?

More Visual Content

On the Move

Delivered Independent of time or place

On Anything

With More Flexibility

Everything as a Service from the Cloud

But Connects Me to Everything

Cloud Computing Today
On the Move
Delivered Independent of time or place
With Unanswered Questions –
• Secure?
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On Anything
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IDF2011
INTEL DEVELOPER FORUM
Security and Privacy Is the Biggest Obstacle

High Risk Threats
- Well resourced, motivated cyber warriors
- Aggressive and Pervasive
- Referred to as Advanced Persistent Threat

Medium Risk Threats
- Criminals to steal identity and money
- Varying technical sophistication

Low Risk Threats
- Internet Pollution
- Threats against every user

• Do you know where your data is?
• Who can see it?
• Who can modify it without a trace?
• Who can aggregate, summarize, and embed it for purposes other than yours?
Energy Efficiency Is A Big Issue

- **2006**: Data Centers account for 1.5% of total US Energy Consumption

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**Efficient Data Center Energy Use**
- Servers
- Network/Storage
- Building/Lighting
- CRACs, UPS, etc.

**Power Breakdown in a Server Platform**
- 31% CPUs
- 22% PCI+GFX
- 26% Memory
- 11% PSUs
- 5% Fans
- 4% Planar & VRs
- 2% HDD
- 1% Other
- 2% Other

US Environmental Protection Agency Report on Server and Data Center Energy Efficiency – Aug 2007
Think About Energy Efficiency Differently

Focus All the Way From "Grid to Gate"
But Enough Factors Indicate that Transformation to Cloud Computing is Inevitable
Surge In Devices, Users, and Social Networking

2.5 Billion Connected Users by 2015

>10 Billion Connected Devices By 2015

Source: Gérald Santucci, Head of Unit European Commission DG INFSO 20 Years of ICT Revolution: The Unceasing 'Grail Quest', March 2009 Cisco Visual Networking Index
“More video uploaded to YouTube in the past 2 months than if ABC, CBS and NBC had been airing new content 24/365 since 1948.”

— Gartner

“Big Data last 5 years: 800% growth; 80% unstructured → effective tiering needed.”

— Gartner
Surge in Sensors

- Downloaded Apps Require Sensors
- ~1B GPS, ~900M Accel, ~600M Compass, ~450M Gyros by 2014
Surge in Video Traffic

Mobile Traffic Today

- 40% Video
- 90 PB/month
- 7M paid video subscribers

2015 Mobile Traffic

- 66% Video
- 3600 PB/month
- 700M paid video subscribers

Source: Gérald Santucci, Head of Unit European Commission DG INFSO 20 Years of ICT Revolution: The Unceasing ‘Grail Quest’, March 2009
Cisco Visual Networking Index
Along With the Cloud’s Key Characteristics

Elasticity

Self Service

Pay As You Go
So, What are the Key Technical Areas to Focus On?
Creating a Strong Foundation For Cloud Computing

Match WL With Platform and Automate

- No “The” WL in the Cloud
- Embrace Mixes of Different Platforms specialized for different classes of applications
- Automate to maximize efficiency & robustness as cloud scales – across HW, SW, and Problem Diagnosis

Big Data and Analytics

- Future Computing dominated by continuous ingest, integration, and analytics of large, growing, and live data

Client Aware Computing

- Not Just Centralized Computing
- Adaptively distribute functionality among DC, Local Servers, and Edge Devices

While Keeping A Focus On Security At All Times
Match Workload With the Platform

Embrace Heterogeneity

Explore & extend range of apps for platforms by overcoming OS limits, memory limits, and scalability issues in specialized platforms of heterogeneous nodes.

Integrate New Memory Technologies

Explore how cloud apps can exploit new NVM technologies such as Restive Memories to overcome memory scaling issues.
The Focus Areas of Automation

Resource Scheduling & Task Placement
Devise mechanisms and policies to maximize energy efficiency, interference avoidance, data availability and locality

Software Correctness & Productivity
Automated tools for software upgrade management, runtime correctness checking, and programmer productivity

Problem Diagnosis
Explore new techniques for diagnosing problems at cloud complexity and scale
Develop Methods to Quantify and Measure Usage

- Customer workloads vary in their infrastructure demands: Typically: Memory Utilization, Storage IO, Network Throughput

- Current measurement metric for Cloud Providers – Number of Systems and Time Used

- The Future: HW/SW co-designed solutions to monitor data for better scheduling & metering
So, What Does Big Data Look Like?
An Example: The Semantic Web

**Main Stream Web**

- Links to Resource
  - Links to Resource
  - Links to Resource
  - Links to Resource

**Semantic Web**

- Has Manual
- Software Requires
- Document
- Library
- Author Requires
- Person
- Image
- Address
- Image
- Place

**Web of Data**

Computers Understand the Meaning of Data On the Web – See the “Big Picture”

Requires Graph Databases for Geospatial and Temporal Search of Semantic Stream

Evolving New Topics and Linguistic Differences Make This Challenging

**Big Data is - Diverse, No Schema, Uncurated, Inconsistent Syntax and Semantics**

1 Amplab – Dr. Patterson
Towards Efficient Frameworks for Big Data

• Popular current big data frameworks very inefficient
  – 3-13x slower after optimization
• Bunch of reasons why
  – Artifacts of implementation
  – Costs for desired features
  – Unexpected I/O effects

Frameworks for Advanced Machine Learning Algorithms
Focus on selective iteration and exploitation of dependencies among data-items in the data set being analyzed

Characterization & Better Programming for Big Data Apps
Focus on areas such as processing of data from the web, social network interactions, malware analysis, video image processing, and HPC apps
The Storage Challenges With Big Data

Persistent Data
What needs to be stored and for how long?

Data Organization
• Many-to-One Network Issue:
  Multiple simultaneous reads to pick up every stripe
• Energy Efficiency Issues:
  Servers need to be powered on all the time
Clients Must Be Cloud Aware and Vice Versa

• Edge devices will be directly involved in many “cloud” activities
  – May even form clouds of their own
• Bridge to physical world: Edge devices bring sensors, actuators, “context” to the cloud

Cloud Assisted Mobile Client Computations
Enable applications whose execution spans client devices, local servers, and the cloud

Wide Area Replication, Consistency, and Deduplication
Address edge connectivity issues by creating new ways to eliminate wasted bandwidth and reduce latency
Balancing Compute & Client Side Analytics

- Leveraging local resources reduces the data center workload and associated network traffic
- Increases the VDI scalability and enhanced quality of service for end users

- Monitored Cores and monitored data from servers in data centers increases at a steady pace
- Significant analytics required to manage, make sense, and take action
- Client Side Analytics – the only alternative
More Unknown Than Known Out There

Predict – But Find a Way to Recover

Prevent the Security & Trust Infractions

Detect the Security & Trust Infractions

Recover quickly and gracefully from the Security & Trust Infractions
The Future is a World of Many Clouds

• The Cloud – while still evolving – enables many possibilities

• Challenges in Cloud Computing has so far mostly kept it to social networks; Security and Privacy tops the list

• Three Key Focus Areas:
  1) Match WL with the Platform & Automate
  2) Big Data & Analytics
  3) Client Aware Computing
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