Innovation and Cloud Computing

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Outline

- Innovation and Cloud Computing
- Windows Azure **Platform** Overview
- Azure Academic Research Engagements

100 Years of Innovation

- **Health**: public sanitation, aspirin, antibiotics, vaccines, lasers, organ transplants, medical imaging, genome, genomics, epigenetics, cancer genomics (TCGA consortium)….
- **Energy**: electricity, electric grids, nuclear, … green. . .
- **Transportation:** roads, airplanes, helicopters, … space exploration…
- **Communications**: radio, TV, phone, mobile phones, . .
- **Electronics**: transistor, computers , internet, WWW, ..
- **Computing has been at the center of innovation during the last 50 years…**
- **Successful technologies are those that become "*invisible*" . . . .**

Pace of Innovation

- It took about **55 years** to spread the use of automobiles to ¼ of the US population…

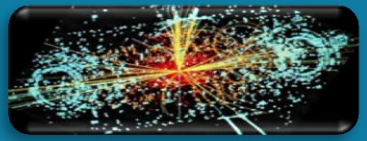
- … **35** years for the telephone …
- … **22** years for the radio …
- … **16** years for the PC …
- … **13** years for the cell phone …
- … **7** years for the Internet…
- … **3** years for “cloud computing” to take center stage

The Data Deluge

Experiments

Hadron Collider
15 PB/year

Simulations

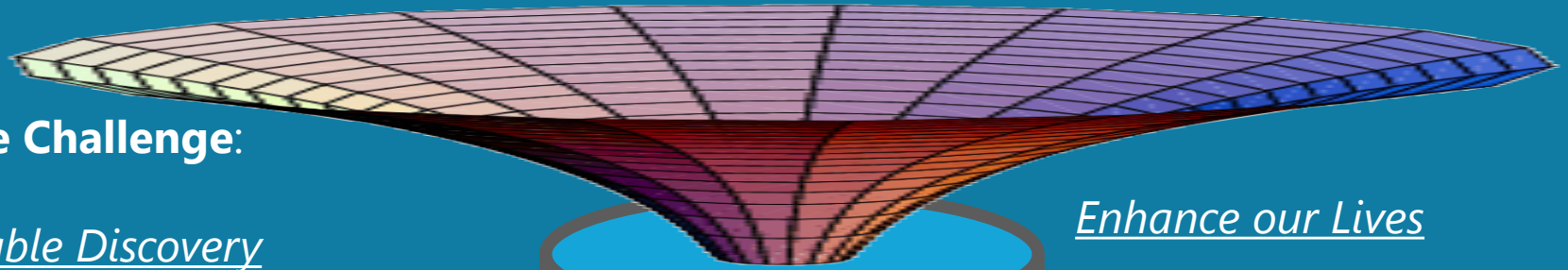


Molecular Dynamics Anton

Archives

Literature

Instruments



The Challenge:

Enable Discovery

Deliver the capability to mine, search and analyze this data in near real time.

Petabytes
Doubling every 2 years

Enhance our Lives

Participate in our own heath care. Augment experience with deeper understanding.

Big Data is Massive…

- Facebook:
  - 130TB/day: user logs
  - 200-400TB/day: 83 million pictures

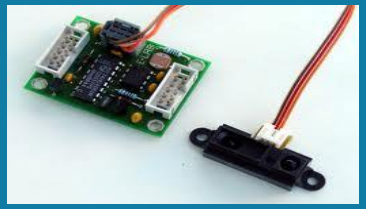
- Google: > 25 PB/day processed data

- Data generated by LHC: 1 PB/sec

- Total data created in 2010: 1.ZettaByte (1,000,000 PB)/year
  - ~60% increase every year

…and Grows Bigger and Bigger!

- More and more devices



- More and more people

- Cheaper and cheaper storage
  - ~50% increase in GB/$ every year

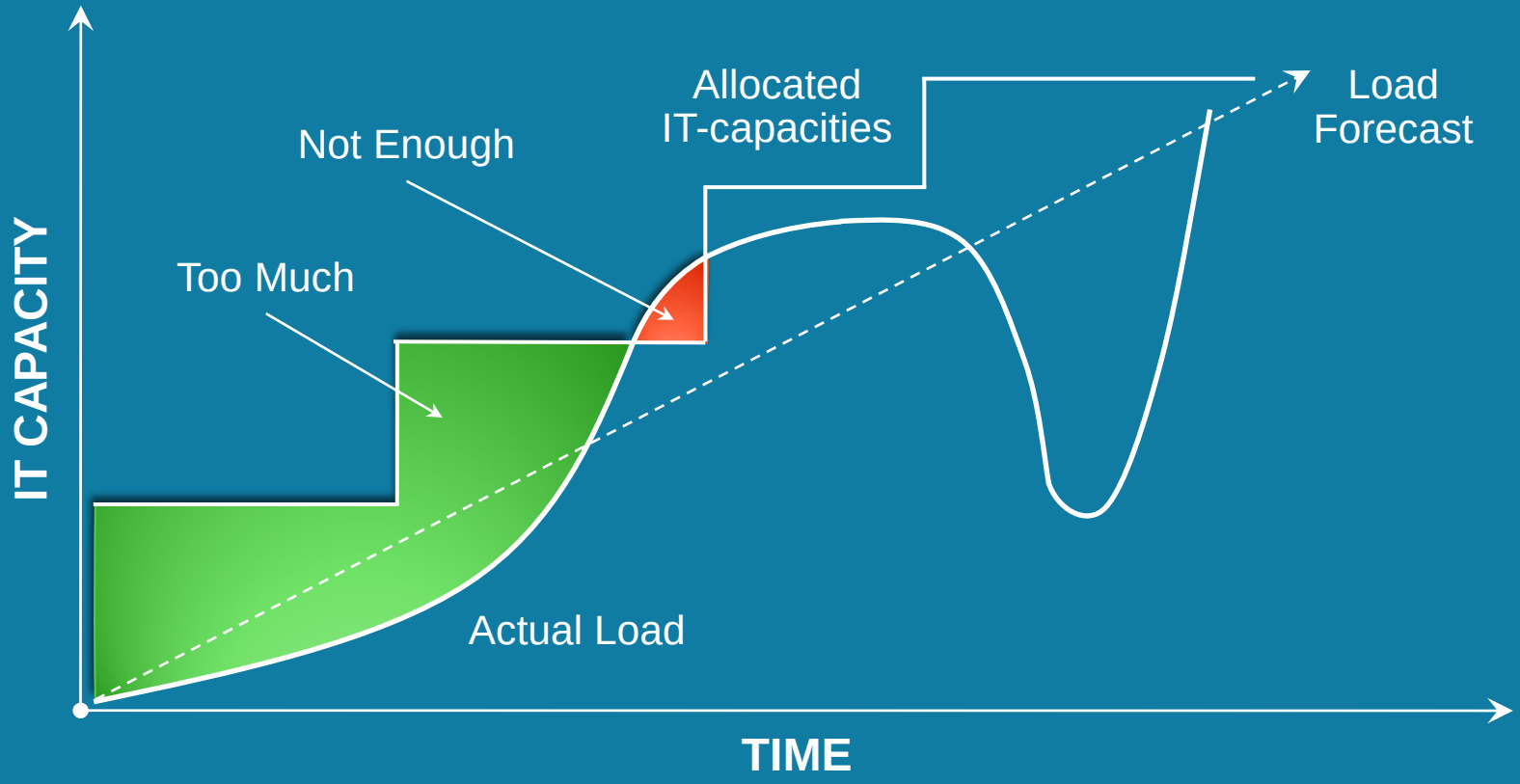
Cloud Computing

Large scale and on-demand computing via the internet, serving a variety of loads, connecting to a variety of devices and end points.

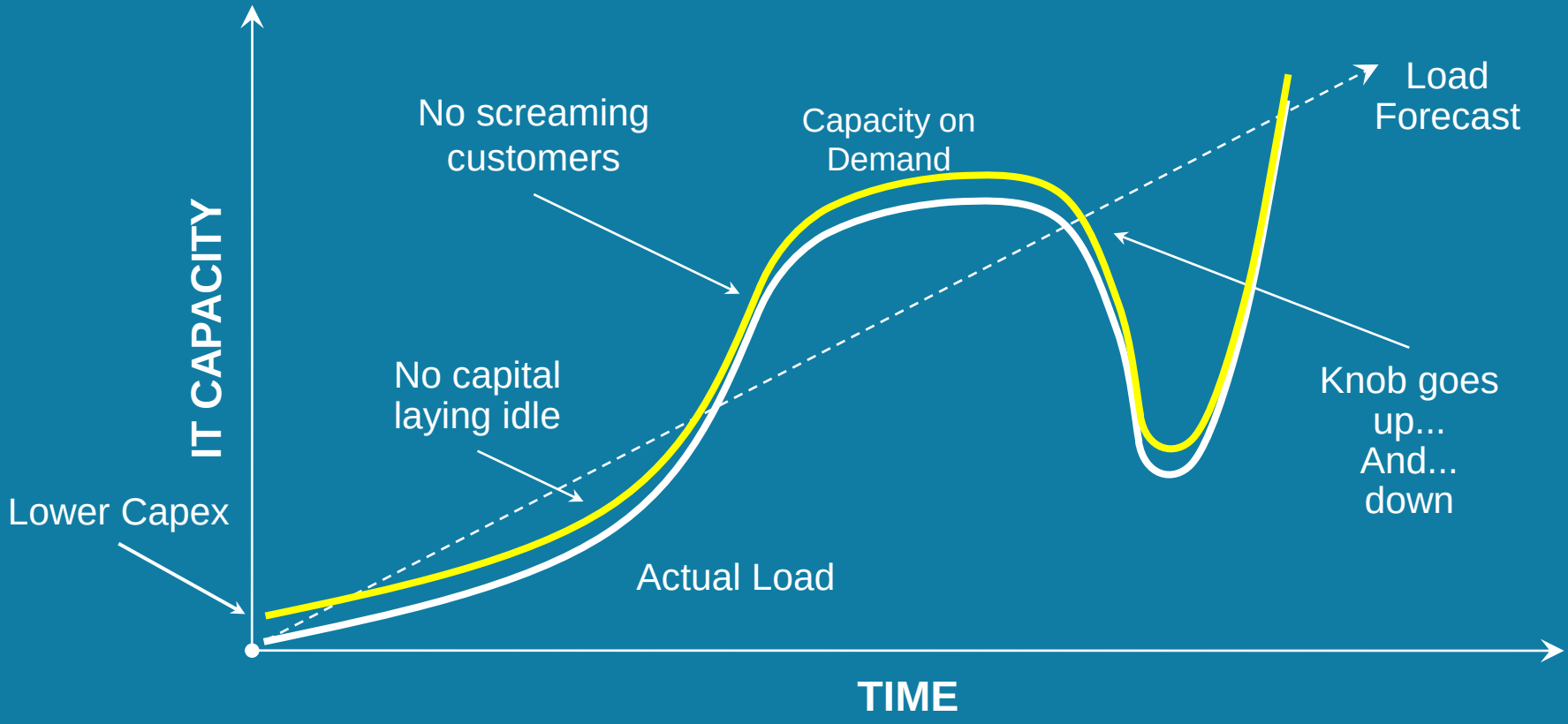
- A ***model*** of ***computation*** and ***storage*** based on ***elastic access*** (pay as you go) to vast remote data center capabilities
- An ***infrastructure*** that provides a framework to manage scalable, reliable, on-demand access to applications
- The "***invisible***" backend to many applications, including mobile
- Historical roots in today's Internet apps
  - Search, email, social networks
  - Files storage (Live Mesh, Mobile Me, Flicker,…)

- A way for **organizations** and for **individuals** to build scalable web presence without making huge investments in IT infrastructure

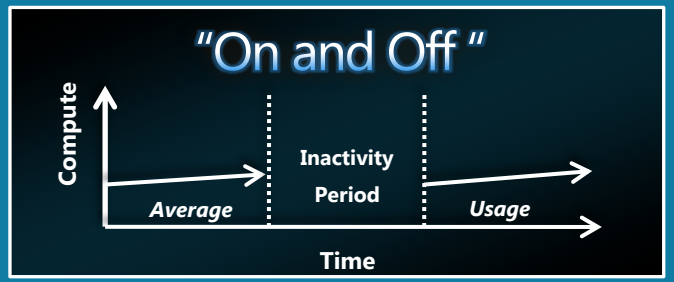
The IT Dilema



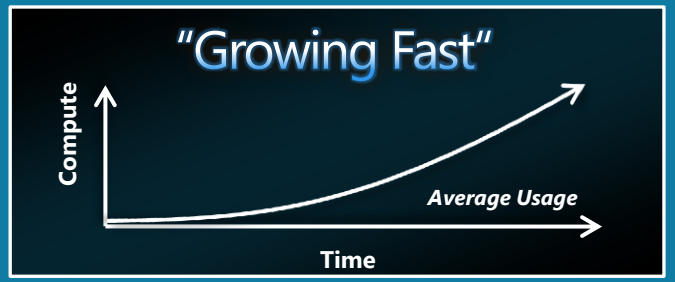
Adapting Capacity to Demand



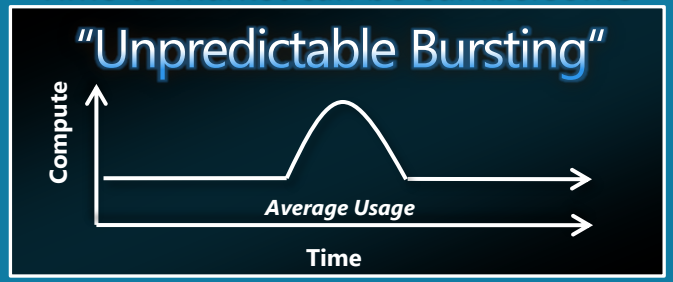
Cloud Computing Patterns



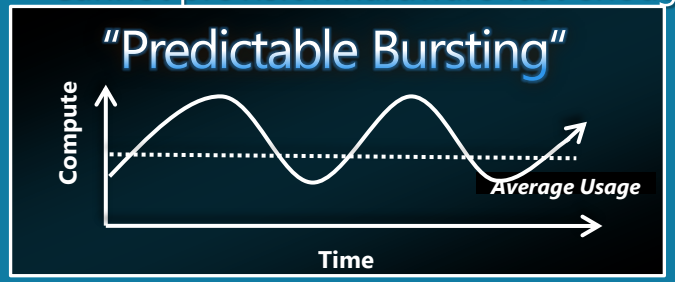
- On & off workloads (e.g. batch job)
- Over provisioned capacity is wasted
- Time to market can be cumbersome



- Successful services need to grow/scale
- Keeping up w/ growth is big IT challenge
- Cannot provision hardware fast enough



- Unexpected/unplanned peak in demand
- Sudden spike impacts performance
- Can't over provision for extreme cases



- Services with micro seasonality trends
- Peaks due to periodic increased demand
- IT complexity and wasted capacity

Cloud Services

"IaaS"

Infrastructure-as-a-Service

host

"PaaS"

Platform-as-a-Service

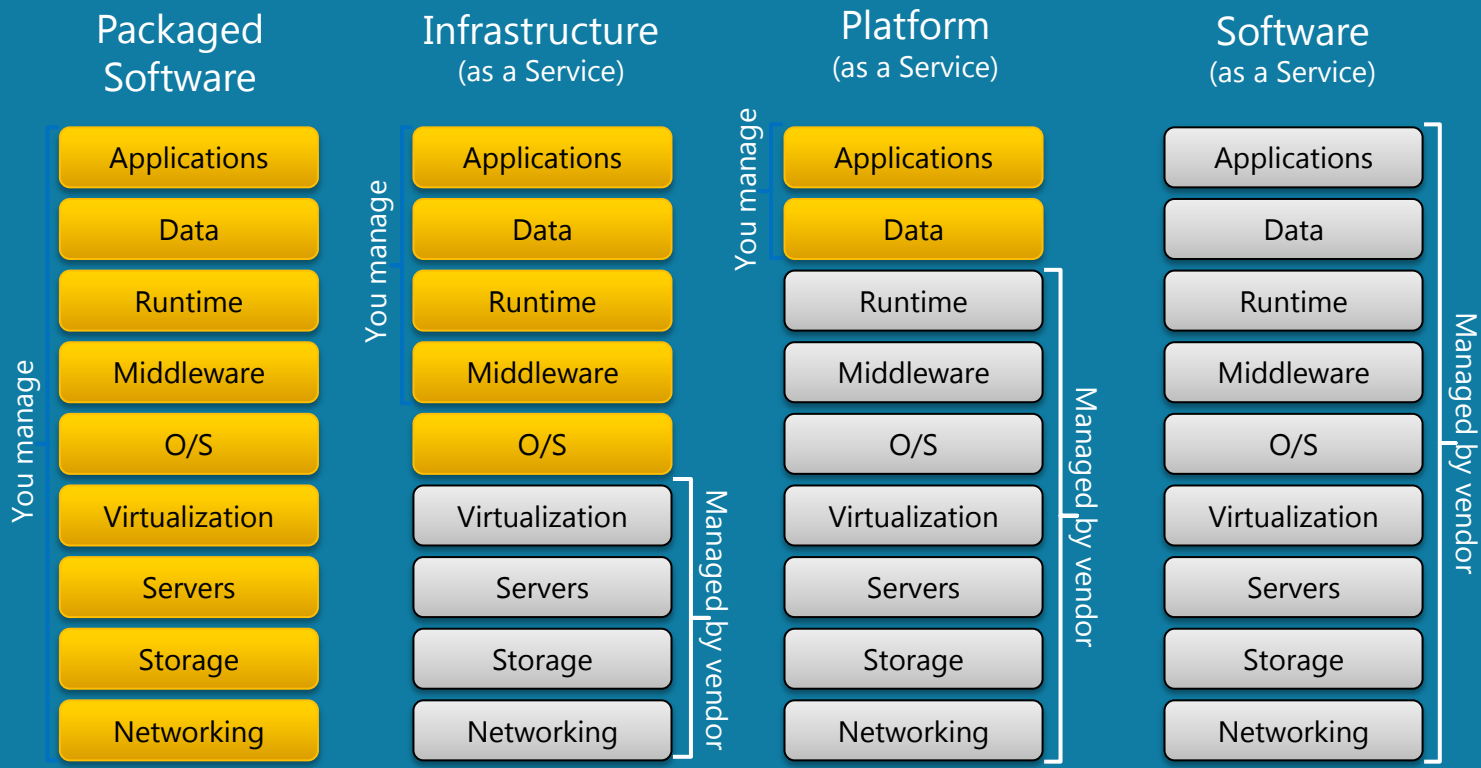
build

"SaaS"

Software-as-a-Service

consume

Cloud Services



Today Clouds are Built on Huge Data Centers

- Range in size from "edge" facilities to megascale.
- Economies of scale
  - Approximate costs for a small size center (100-1000 servers) and a larger, 100K or more server center.

Technology	Cost in small-sized Data Center	Cost in Large Data Center	Ratio
Network	$95 per Mbps/ month	$13 per Mbps/ month	7.1
Storage	$2.20 per GB/ month	$0.40 per GB/ month	5.7
Administration	~140 servers/ Administrator	>1000 Servers/ Administrator	7.1

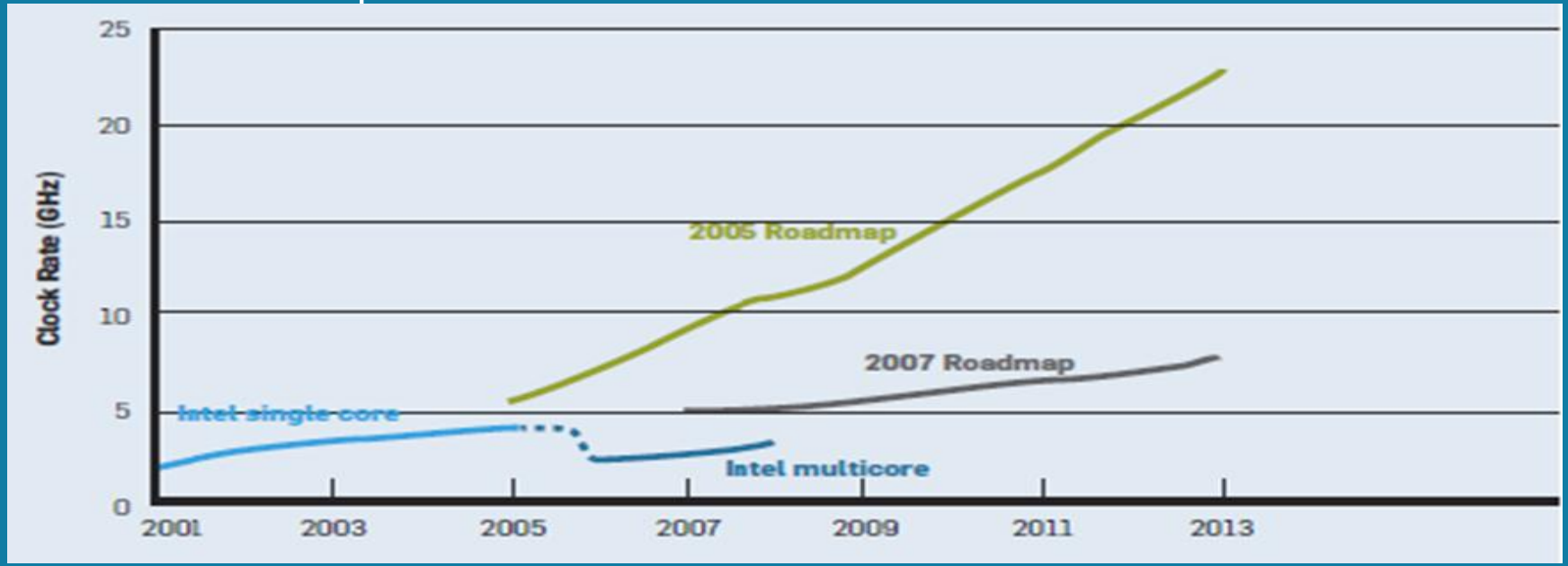
Modern data centers are **about 11.5 times** the size of a football field

Advances in DC Deployment

- Conquering complexity
  - Building racks of servers & complex cooling systems all separately is not efficient.
  - Package and deploy into container units:

Once-in-a-life-time opportunity

- Increasing performance lead to CPUs that were fast but inefficient.
- CPU clock rates at the (power) limit of what a single chip can dissipate.
- Parallel computing {multi,many}-core is the most promising approach to increase performance

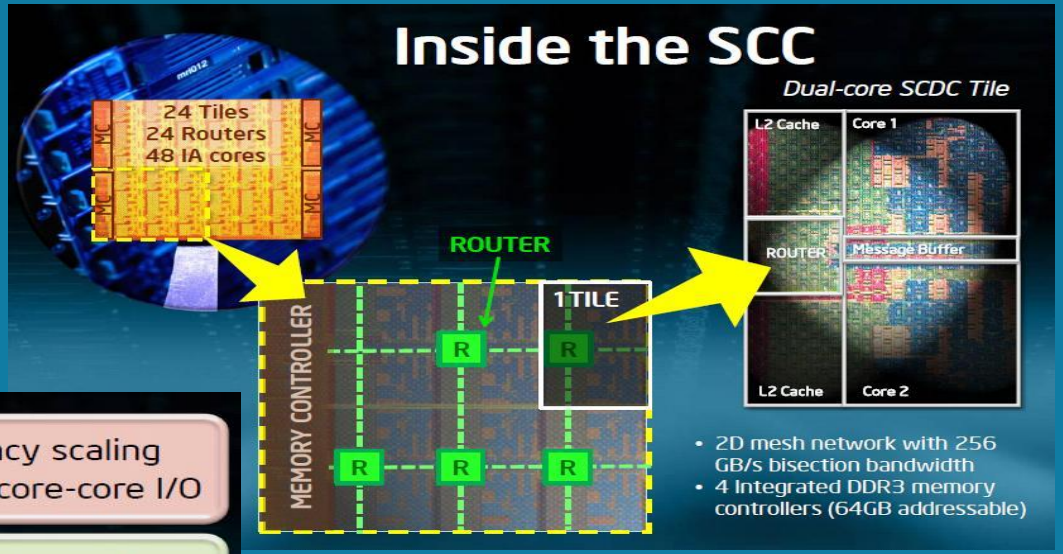


Once-in-a-life-time opportunity

- Parallel computing is a fundamental paradigm shift that breaks the 50-year tradition of software development. Research in this area could have deep implications for applications, programming models, architectures, and OS
- New **applications** that exploit the computational power of parallelism and concurrency at the **client**
- Develop new types of programming models, languages, and tools that can be used to build those applications
- Identify the architectures that will be able to support the new generations of programming models and applications
- Understand how the increased numbers of (possibly heterogeneous) processing units could be combined into a single system

Single-Chip Cloud Computer

December 2009



Energy Efficiency	▪ Dynamic voltage/frequency scaling ▪ 1/3 power reduction for core-core I/O
Design Complexity	▪ Array of small IA-based tiles could lead to more agile, flexible designs
Programming Models	▪ Message-passing, shared virtual memory, map-reduce, and actors
Application Development	▪ Working with Microsoft & others for academic, industry innovation

Windows Azure Platform

Windows Azure

- Scalable compute and storage
- Automated service management
- Familiar tools, technologies, languages

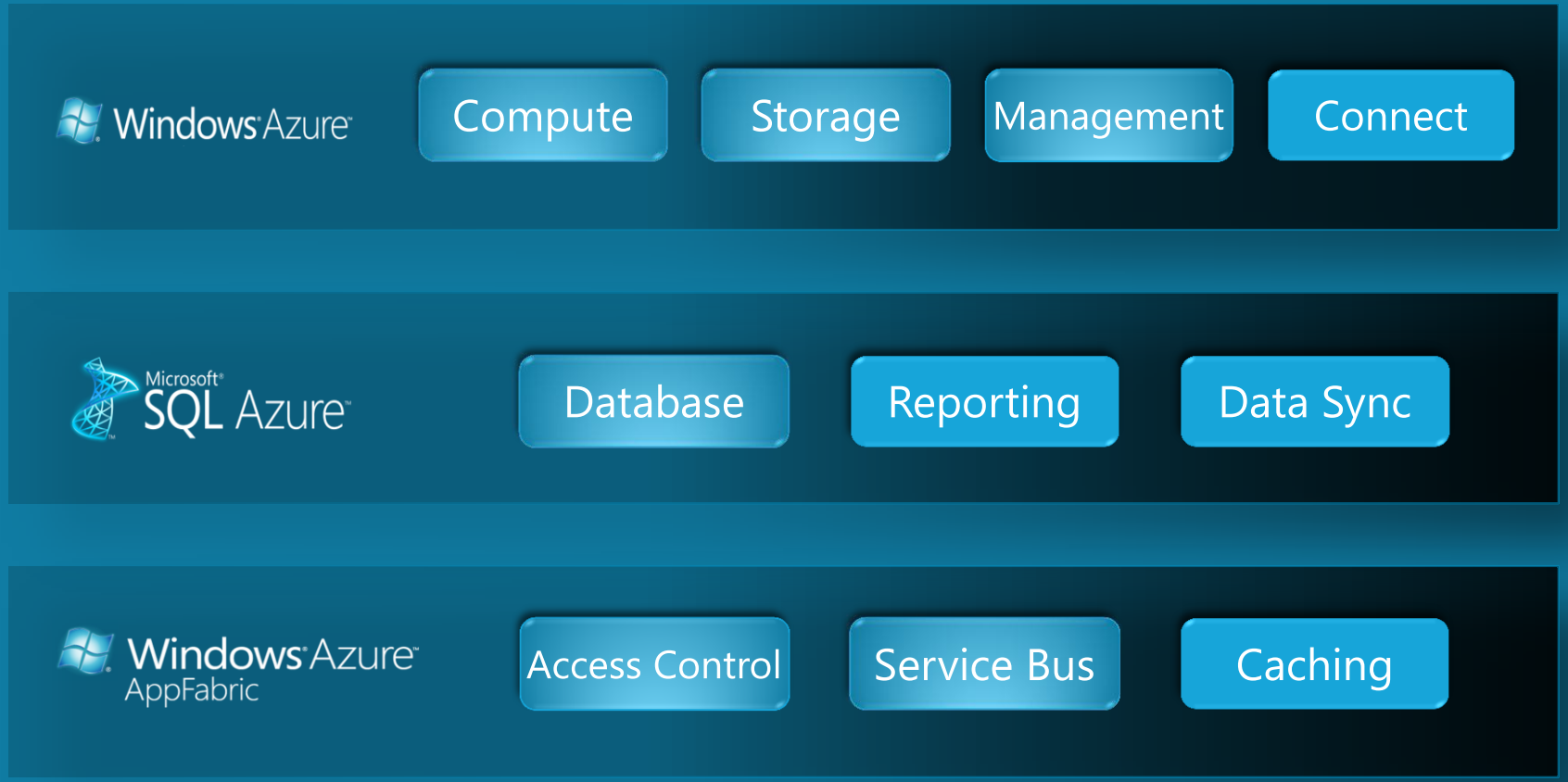
Microsoft SQL Azure

- Relational storage for the cloud
- Consistent development model
- Automated database management

Windows Azure AppFabric

- Connect existing apps to the cloud
- Connect through network boundaries
- Easily control authorization to apps

Windows Azure Platform



demo

Hello Azure

Demo: Hello Azure

What you saw…

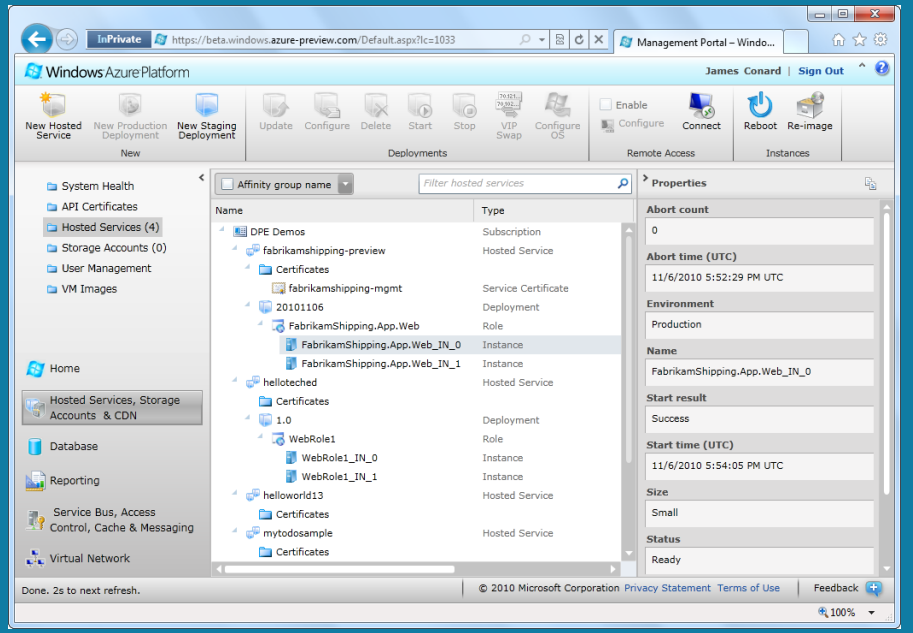
- Simple web app
- Visual Studio 2010
- Roles & instances are models in XML config
- Local F5 debugging
- Deployed to the cloud
- Management Portal
- Switched from staging to production

What Windows Azure provided

- Environment to design, test, and run the app
- Machines, rack space, switches, connectivity
- Automated deployment & configuration
- Isolation, redundancy, load balancing
- Abstraction & Flexibility

Windows Azure Platform Portal

- User friendly portal for Windows Azure Platform services
- More visibility and control
- Supports multiple service administrators (co-admins)
- Enable and connect to Windows Azure instances using Remote Desktop



Tools needed

- VS2010 with SP1 (KB983509)
- http://www.microsoft.com/windowsazure
- Microsoft Azure 1.5
  - Installer will ask for DBMS (MySQL or SQL Server)

Windows Azure Storage

- Scalable storage in the cloud
  - 100tb per storage account (3 replicas of data)
  - Auto-scale to meet massive volume and throughput
- Accessible via RESTful Web Service API
  - Access from Windows Azure Compute
  - Access from anywhere via internet
  - Supporting .NET Client Library
- Various storage types
  - Table - group of entities (name/value pairs)
  - Queue - Simple non-transactional message queue
  - Blob - Large binary storage
  - Drives - NTFS VHD mounted into Compute instance

SQL Azure Database

- Familiar SQL Server relational database model delivered as a service
  - Support for existing APIs & tools
  - Built for the cloud with high availability & fault tolerance
  - Easily provision and manage databases across multiple datacenters
- SQL Azure provides logical server
  - Gateway server that understands TDS protocol
  - Looks like SQL Server to TDS Client
  - Actual data stored on multiple backend data nodes
- Logical optimizations supported
  - Indexes, Query plans etc..
- Physical optimizations not supported
  - File Groups, Partitions etc…
- Transparently manages physical storage

Reporting & Data Sync

- SQL Azure Reporting
  - SQL Server Reporting provided as a service
  - Reports authored using existing tools (BIDS) and uploaded to the cloud
  - Reports can have rich Data Visualizations (Maps, Charts, Tablix) and be exported to variety of rendering formats (Excel, Word, PDF)
  - Reports can be rendered as part of an app using the Report Viewer control
  - Directly view the reports in the browser
  - Web Service interface to render and manage reports
- SQL Azure Data Sync
  - Provides geo-replication
  - Adds sync between SQL Server and SQL Azure
  - Builds on Sync Framework

Summary

- **Windows Azure Platform** is a comprehensive **PaaS** offering including:
  - **Windows Azure**
  - **SQL Azure**
  - **Windows Azure AppFabric**
- Commercially available today in 41 countries and 6 data centers
- In the future Windows Azure & SQL Azure will be available on-premises as an appliance
- Continuing to expand the set of services and features

Cloud Computing Academic Research Engagements

Goals

Help to accelerate scientific exploration, discovery and results.

Broaden the research capabilities of scientists, foster collaborative research communities to accelerate scientific discovery globally.

Build partnerships with government-sponsored research agencies and university consortia to provide cloud services to academic and research communities worldwide

Help researchers interact with massively scalable data analysis tools and services directly accessible from their desktops, laptop or other mobile devices in the same way they now interact with Web search and other online resources.

Cloud Engagement Research – 83 Projects and Growing

Seattle

Project HQ

Penn
Louisiana
Washington
New York
New Mexico
North Dakota
California
Colorado
Michigan
Texas

WA DC

National Science Foundation

Florida
Georgia
Mass.
Virginia
North Carolina
South Carolina
Indiana
Delaware

Europe

- Brussels
- Venus-C
- England - University of Nottingham
- Inria in France
- Plus Italy, Spain, Greece, Denmark, Switzerland, Germany

China

Japan

InfoPlosion

- Tokyo
- Kyoto

Taiwan- starting

Australia

Partners

- NICTA
- ANU
- CSIRO

Partnerships

- More than 70 projects under national programs with
  - NSF (28)
  - European Union (29)
  - Japan (6)
  - Australia (8)
  - China and Taiwan (. . .)

NSF (28)

- Inferring Pattern and Processes of **Genome Evolution** through Cloud Computing
- **GIS Vector Data Overlay Processing** on Azure Platform
- Porting the **Structure-Adaptive Materials Prediction** (**SAMP**) to the Azure Platform
- **Cooperative Developer Testing** with Test Intentions
- Towards automated and assurable **enterprise network migration**
- **Data Intensive Grid Computing** on Active Storage Clusters
- Moving Polarizable **Force Field Simulations** to the Microsoft Azure Platform
- Maximizing the Utility of Orthologs and Phylogenetic Profiles for Systems-Scale **Comparative Genomics.**
- Web-scale Language Modeling Features for **Machine Translation**
- Stork **Data Scheduler** for Azure
- Exploring **Social Classification** on Microsoft Azure
- Where the **Ocean Meets the Cloud**: Ad Hoc Longitudinal Analysis and Collaboration Over Massive Mesh Data
- Transforming Morphological Systematics From Desktop to Web Applications: Development of the Online Workspace **Morphobank.org** 3.0
- Semantic Web Informatics for Species in Space and Time

European Commission (29)

- Systems Biology
- Drug Discovery
- Bioinformatics
- Civil Engineering: Building Information Management.
- Civil Engineering: Structural Analysis of Buildings.
- Civil Protection and Emergencies.
- Data for Science: Aqua maps.
- UK: Project Horizon
- France: INRIA

Japan Info-plosion (6)

- Largest funding program from the Japanese Ministry of Education for informatics research on cloud computing in Japan.
- More than 300 attendees participated in the Info-Plosion symposium on 03/06/2011, in Tokyo, Japan.
- TSUBAKI, a text search engine developed by Prof. Kurohashi from Kyoto University, enables deep search by using NLP technology.
  - TSUBAKI **required more than 10,000 (CPU) cores on Windows Azure**.
  - Predicate-Argument Structure Analysis of Huge Web Corpora for Improving the Search Engine Infrastructure.
  - Indexing a large Web document collection with modality/factuality information document retrieval on the TSUBAKI search engine.
- Other projects:
  - A parallel workflow system for multi-cloud environment
  - Ubiquitous Content Management Technology R&D.
  - Inter-Cloud Large-Scale Data Transfer.

Issues and Solutions

Microsoft Azure連携プロジェクト

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