Taking High Performance Computing to the Cloud: Windows HPC and Windows Azure

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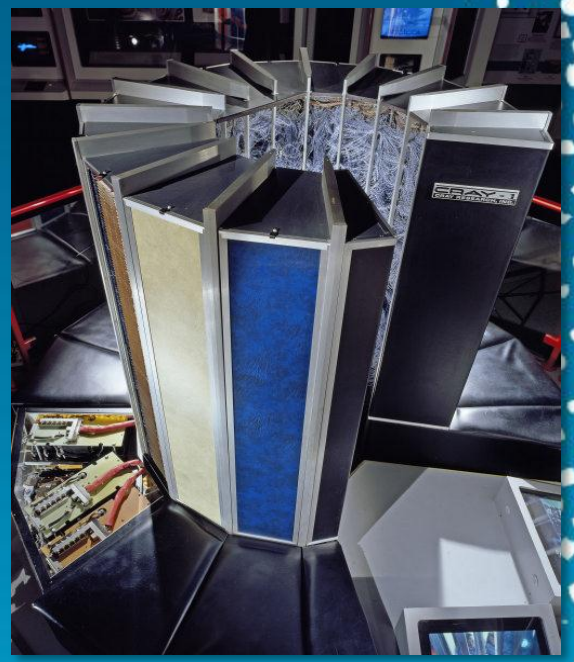
Agenda

- Goals
  - Understand on-premises HPC vs in Windows Azure
  - Learn what's best suited for burst to Azure from HPC
  - See how to scale up and out in the Cloud
- How we'll get there
  - Introduction
  - Applications in Azure
  - Applications on-premises
  - Azure and HPC integration
  - Summary

Introduction

What is High Performance Computing?

- Solve large computational problems
- HPC is best described as massively parallel
- High bandwidth, low latency, cluster-based
- Becoming critical part of R&D for businesses
- Traditionally required specialized staffing



	1991	1998	2008
Sample System	Cray Y-MP C916	Sun HPC10000	X64 Server
Performance	~10 GFlops	~10 GFlops	~10 GFlops
Price	$40,000,000	$1,000,000	$1,000
Customers	Government Labs	Large Enterprises	Every Engineer & Scientist

Zero-One-Infinity Goal for Computational Workload

- 0: Your Initial Investment or barrier for entry
- 1: Utilization Efficiency of your Application (100%)
- ∞: Scale your Application to as many cores as possible

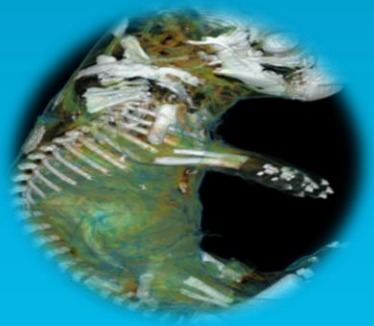
Barrier to entry for technical workloads

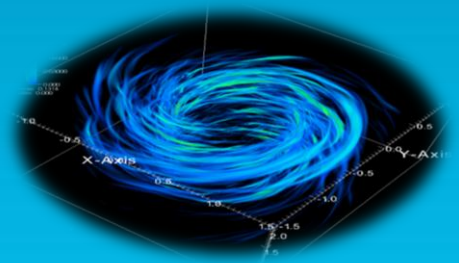
- Advances in technical computing and research are powered by access to computing resources

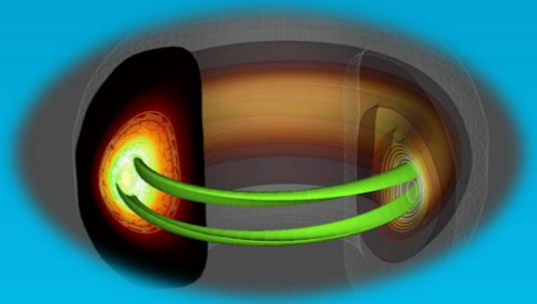
Fast, powerful hardware cheaper more readily available, but…

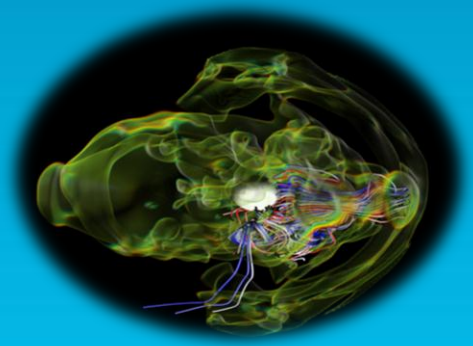
Windows Azure lowers the startup and administrative costs to almost nothing

How Do we take existing technical workloads onto azure?





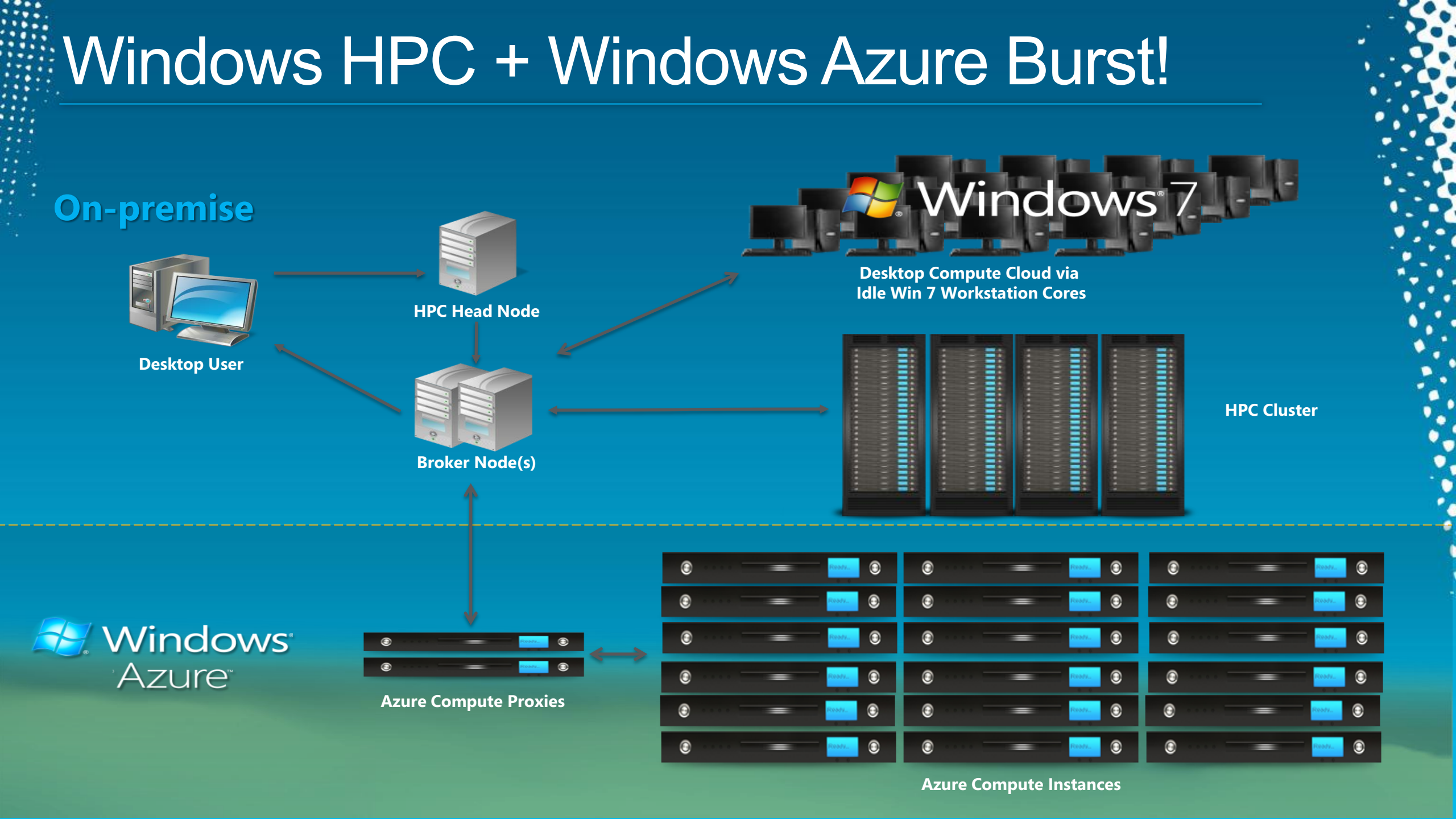




My Cray CX1 Cluster vs. Windows Azure

	My CRAY CX1	Windows Azure Only
Initial cost:	Planning, Hardware, Space, Power, Cooling, $10000s	Get an account.
Cost of ownership:	Maintenance, Staff, Power, Backups, Internet, Storage, Down time, Disk failures, Paying for idle computing!	Pay as you go, limited only by your budget
Suitable Applications:	MPI problems require high speed network. HPC Batch Scheduler System	Applications without much traffic. No HPC batch submission engine
Node interconnects:	20 Gbps Infini-band!	1 Gbps Ethernet
As an officemate:	No!	Silent and Invisible
CPU & Memory Hardware:	Dedicated 8 nodes with 8 cores &16gb	N+1 nodes 8 cores &16gb
Access to My data:	LAN Connection	Internet Connection first upload LAN Connection if already in blob

Windows HPC + Windows Azure Burst!

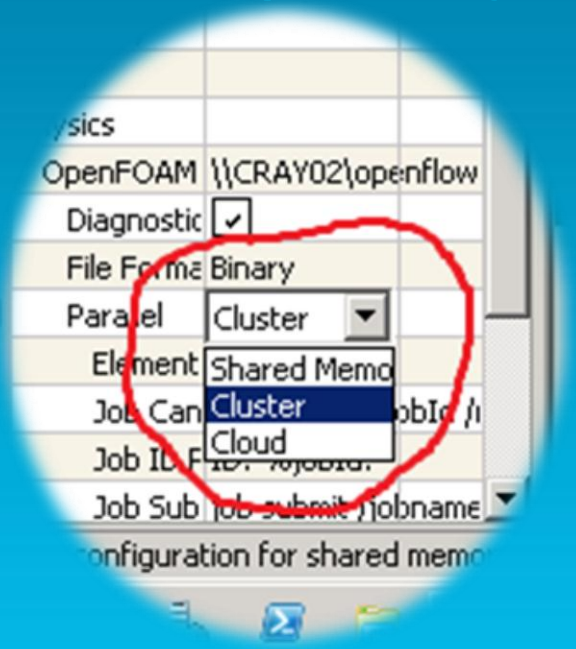


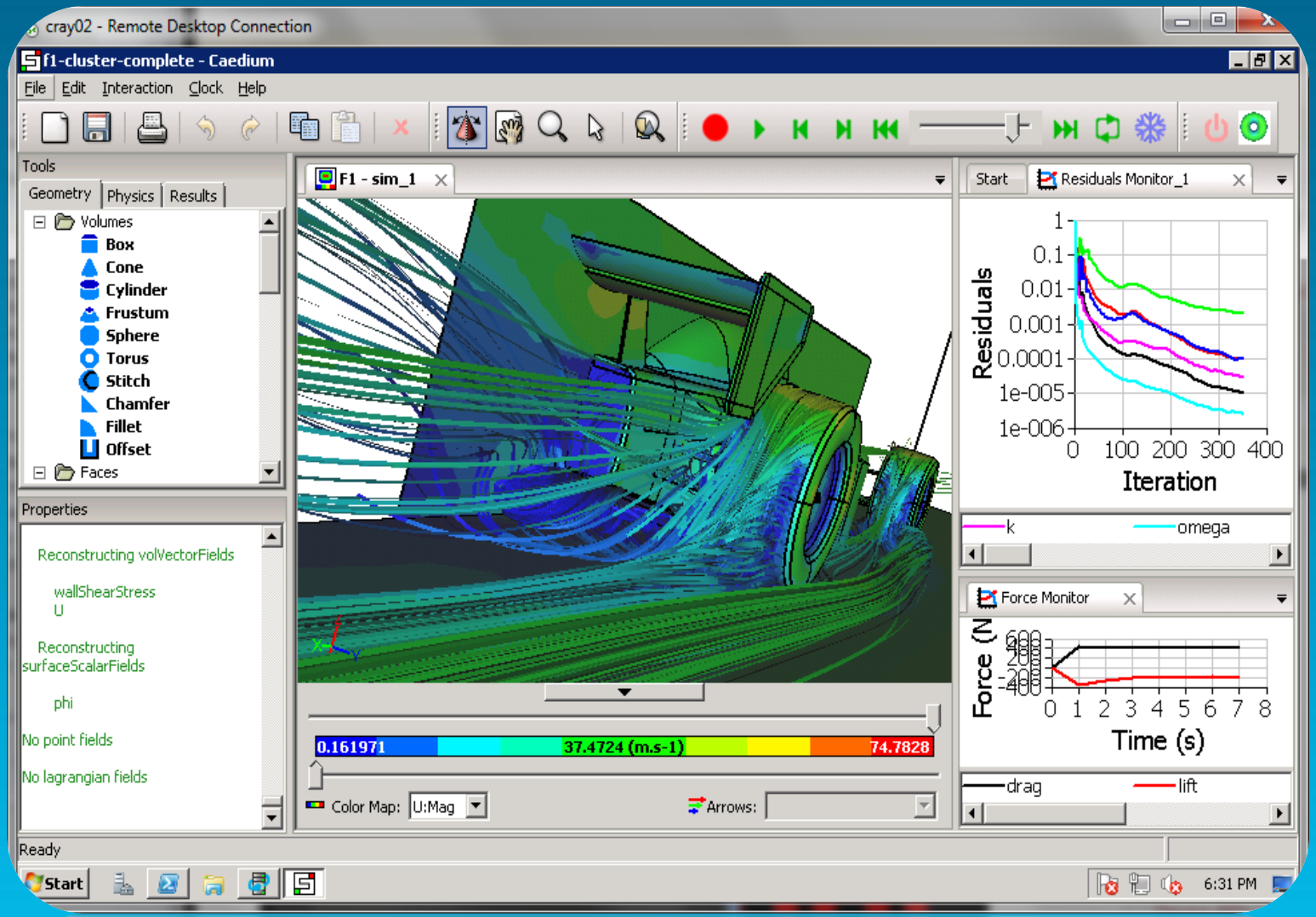
Simplicity of Microsoft HPC Compute Intensive Paradigms

Run on:

- Client
- Cluster
- Cloud

Transparently

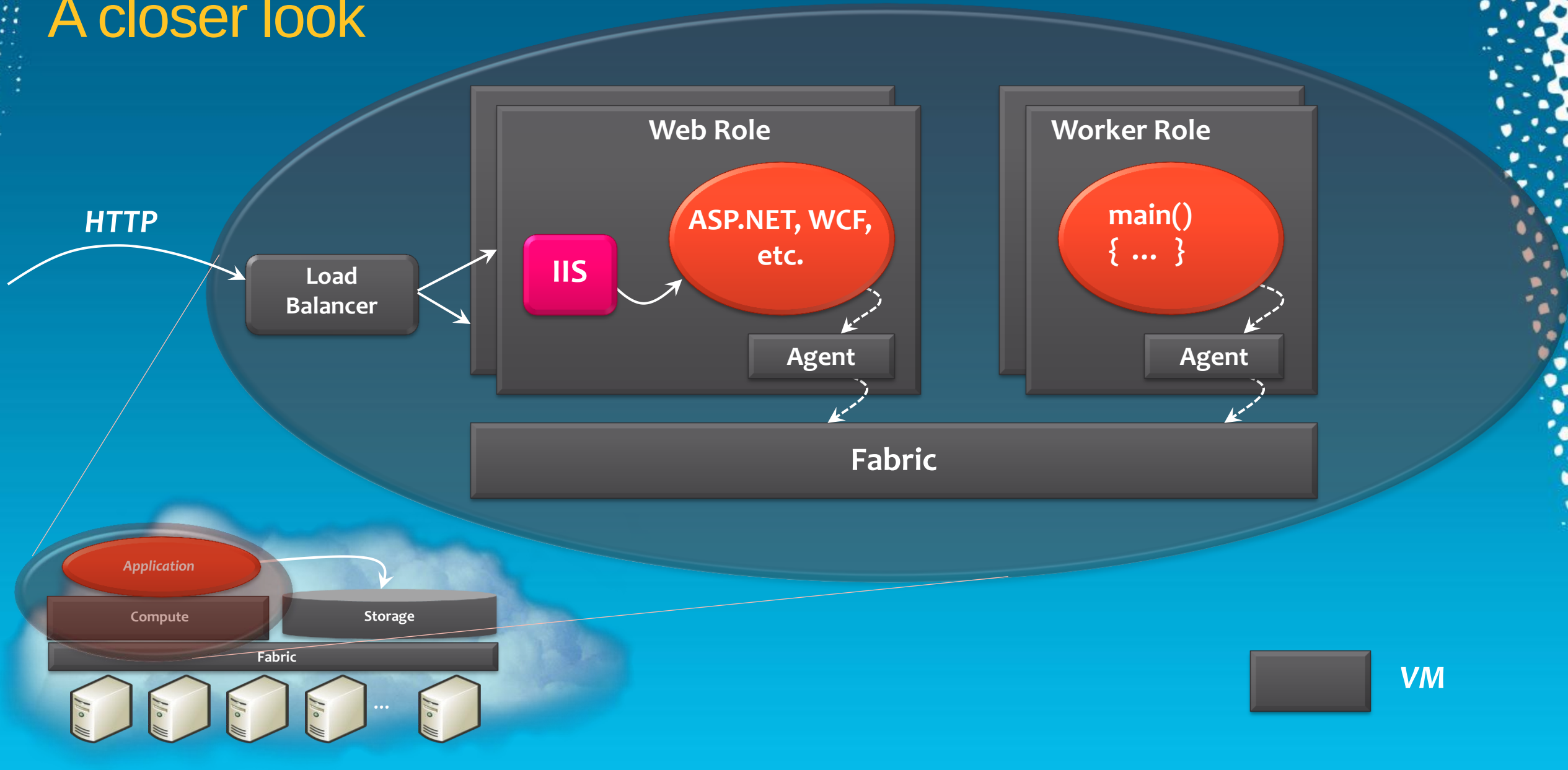




Applications in Azure

Windows Azure Services

A closer look



TaskParallel Application: Traveling Salesman

Resources

- One Azure instance (multi-core)

Limitations and challenges

- Scaling beyond a single Node
- Scheduling is manual

Applications on-premises

MPI Application: OpenFoam Computational fluid dynamics

Resources

- Dedicated nodes
- InfiniBand network

Limitations and challenges

- Cost of ownership
- Fixed number of resources

Infiniband running at 20Gbps!

demo

MPI Application: Weather Forecast

Resources

- Dedicated nodes
- InfiniBand network
- External data source

Limitations and challenges

- Cost of ownership
- Fixed number of resources

demo

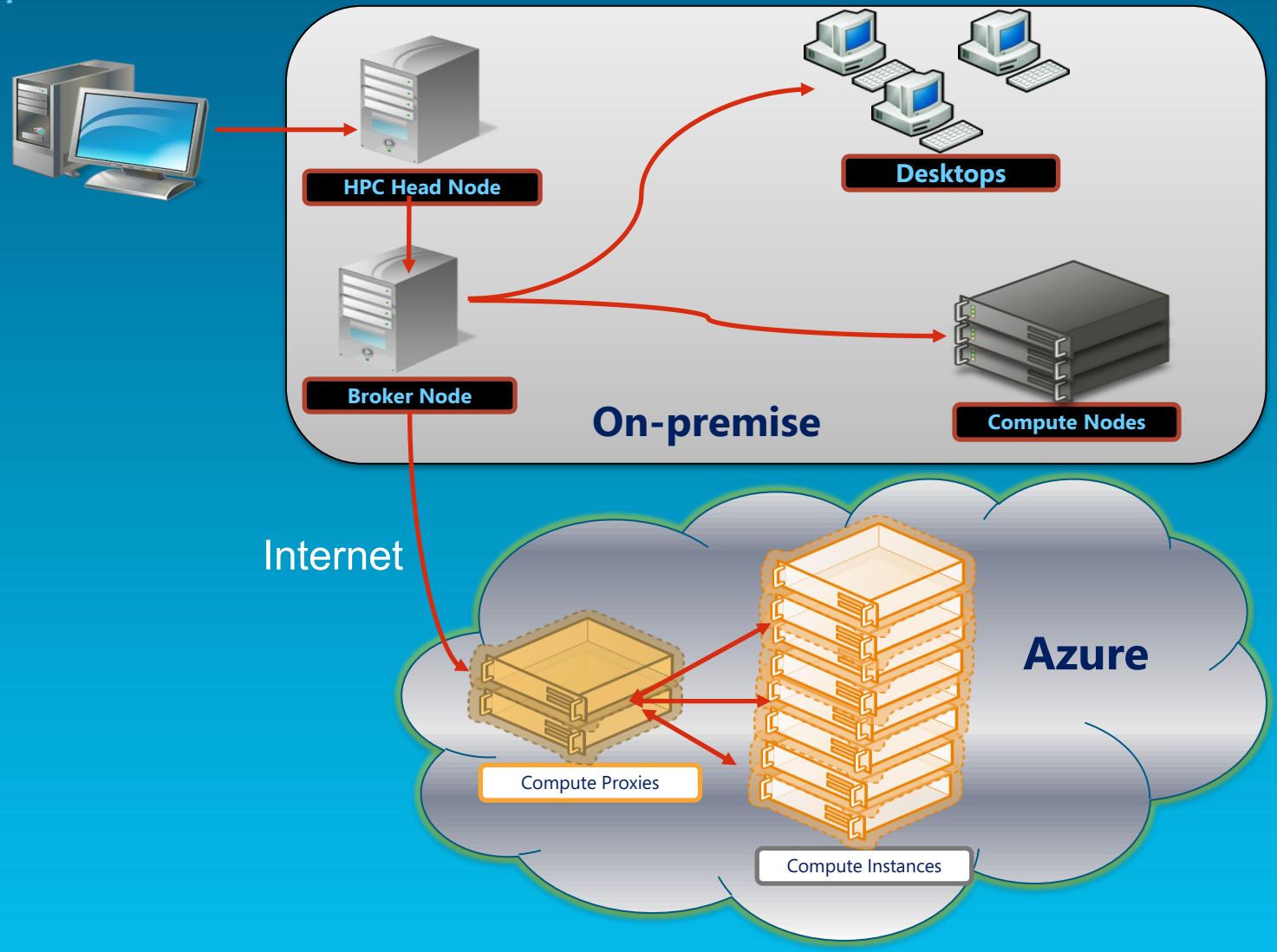
Azure and HPC integration

- Embarrassingly parallel, no data
- Embarrassingly parallel + data
- Embarrassingly parallel + complex data
- Sharing HPC results through Azure

Windows HPC on Azure

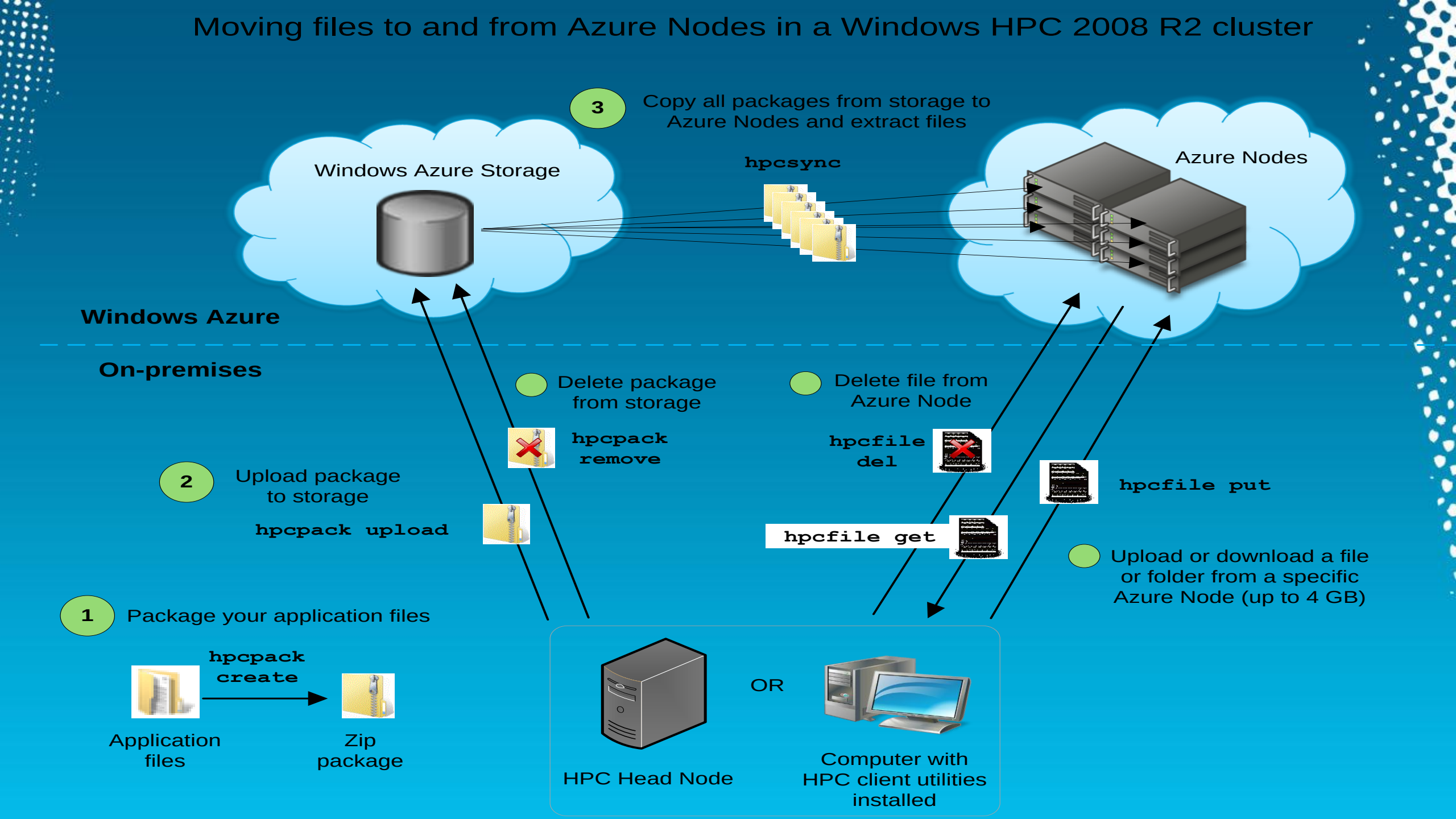
Mixed Mode Deployment On-premise and Azure

Compute Nodes On-Premise and in Azure Simultaneously



- **"Burst" into cloud on-demand while keeping control over data and corporate policies**
- **Pay only for what you use**
- **A stepping stone to hybrid and public clouds.**
- **Dynamically adjust how much runs on-premise and in the cloud**
- **Azure computer instances include both worker role and VM role**

Moving files to and from Azure Nodes in a Windows HPC 2008 R2 cluster



SOA app: Asian Options

Embarrassingly parallel, no data

Work

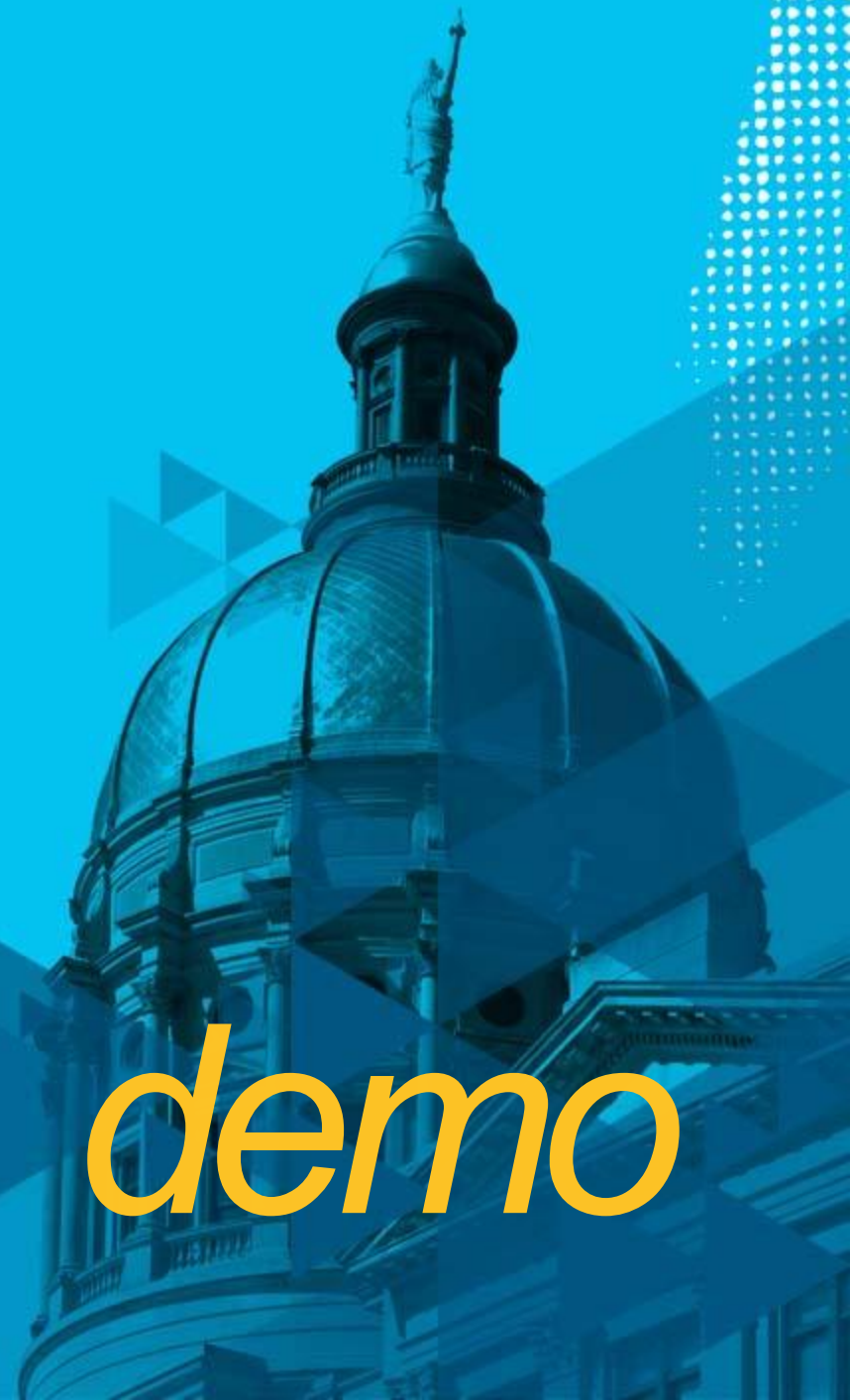
- No code change!

Resources

- Azure & Dedicated Node instances
- HPC head node

Benefits

- Flexible resources
- Scaling and scheduling handled by HPC



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Parametric app: Movie Rendering

Embarrassingly parallel + data

Work

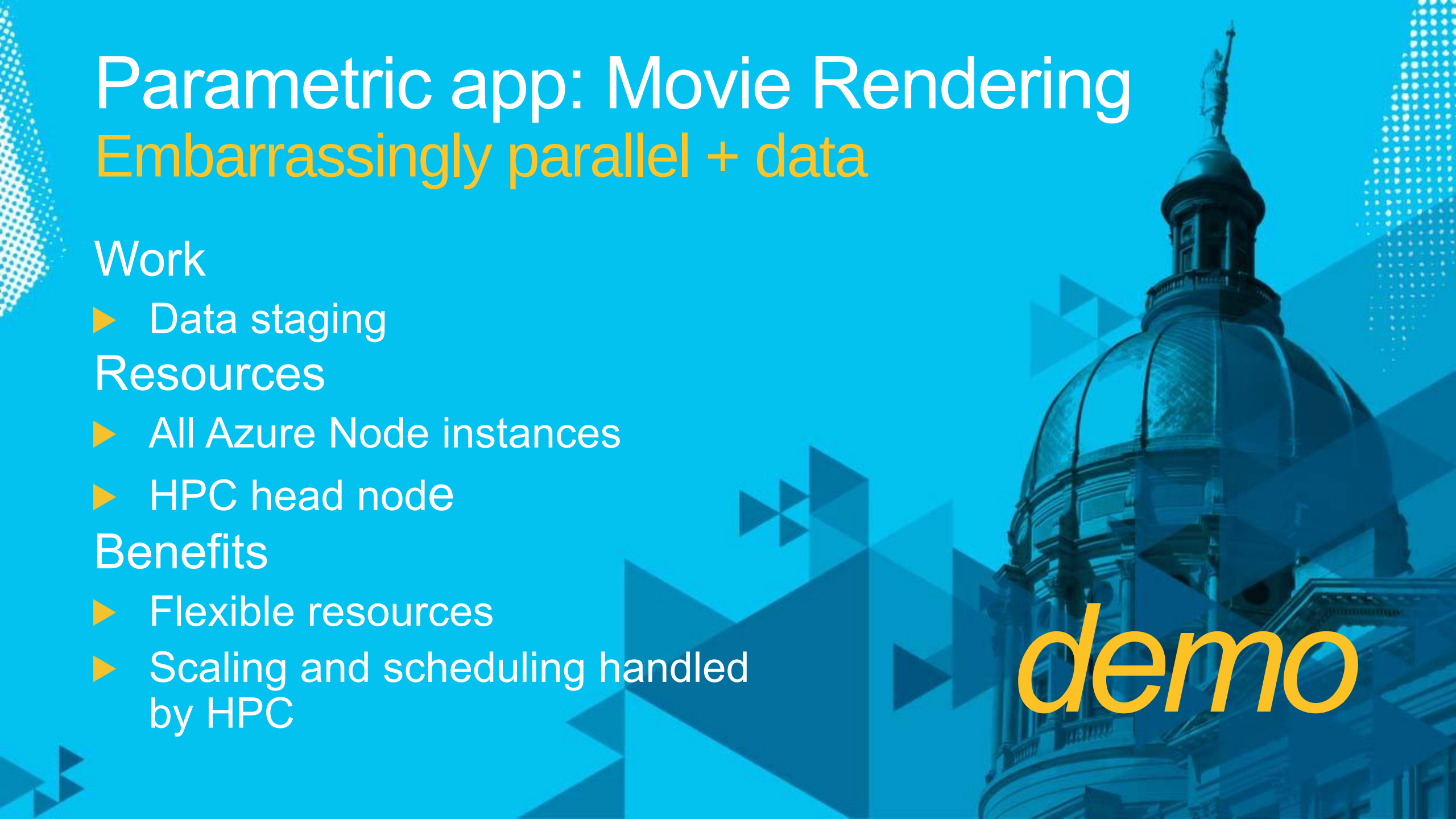
- Data staging

Resources

- All Azure Node instances
- HPC head node

Benefits

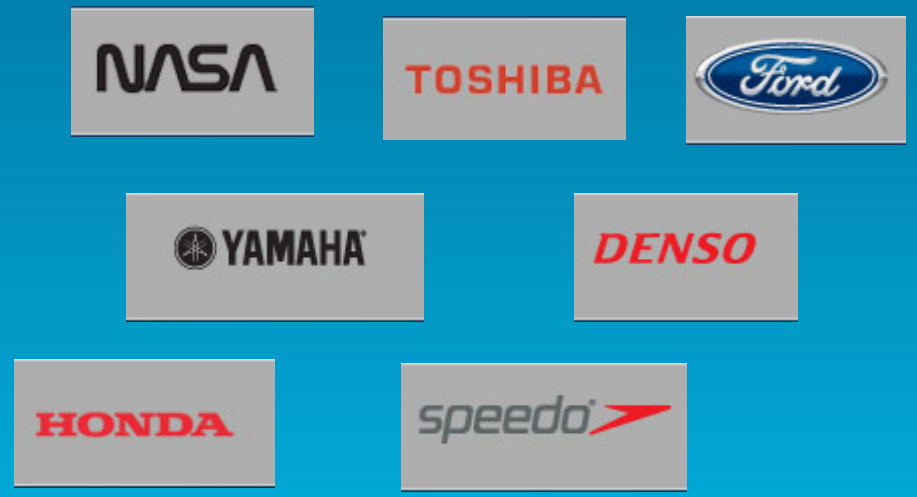
- Flexible resources
- Scaling and scheduling handled by HPC



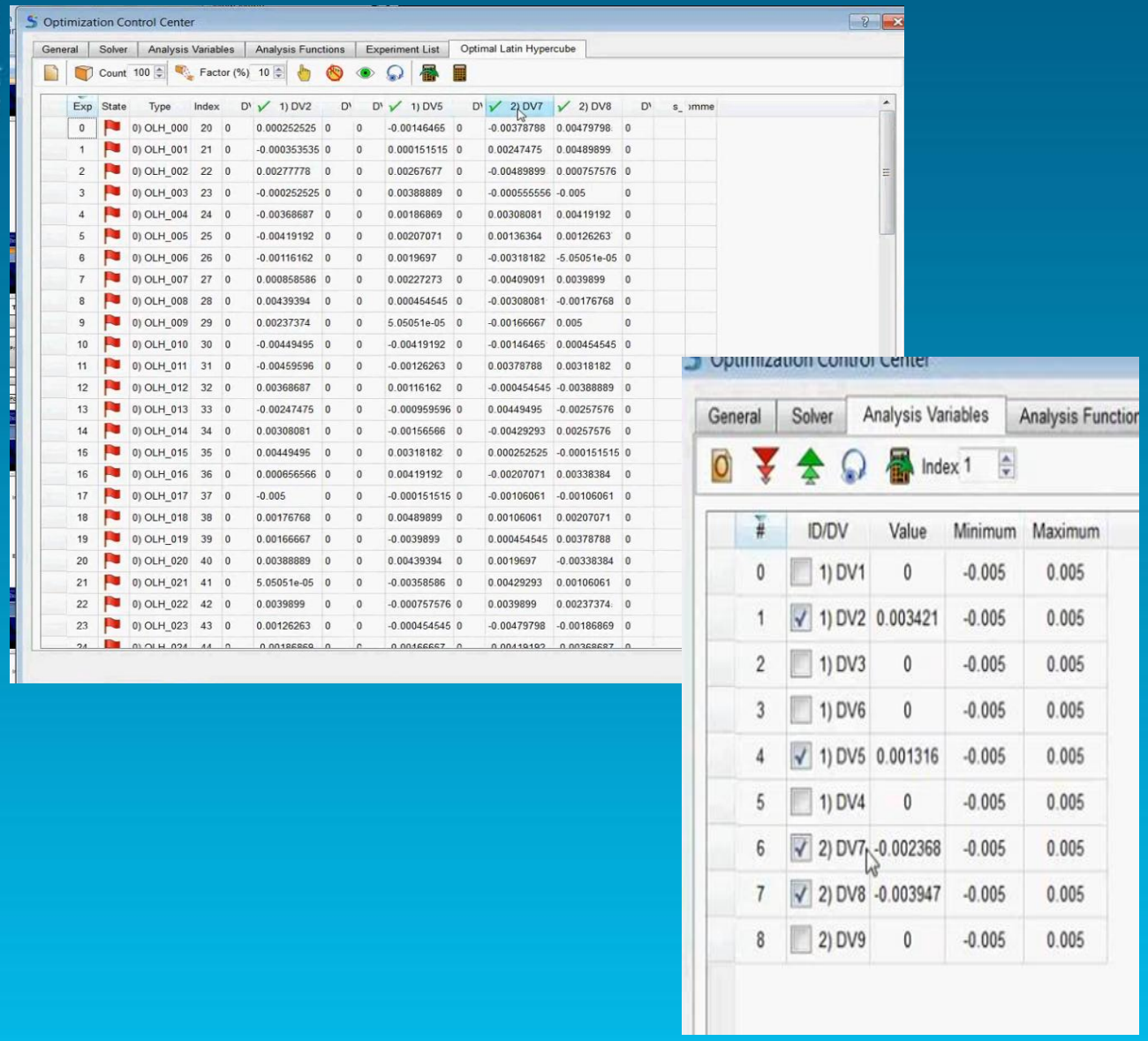
An example : Better Faster Product Design

Shape Optimization with Sculptor

- Cut design times
- Cut design costs
- Provide better products
- Geometric optimization
- New trend in design



Latin HyperCube – compute what you can afford

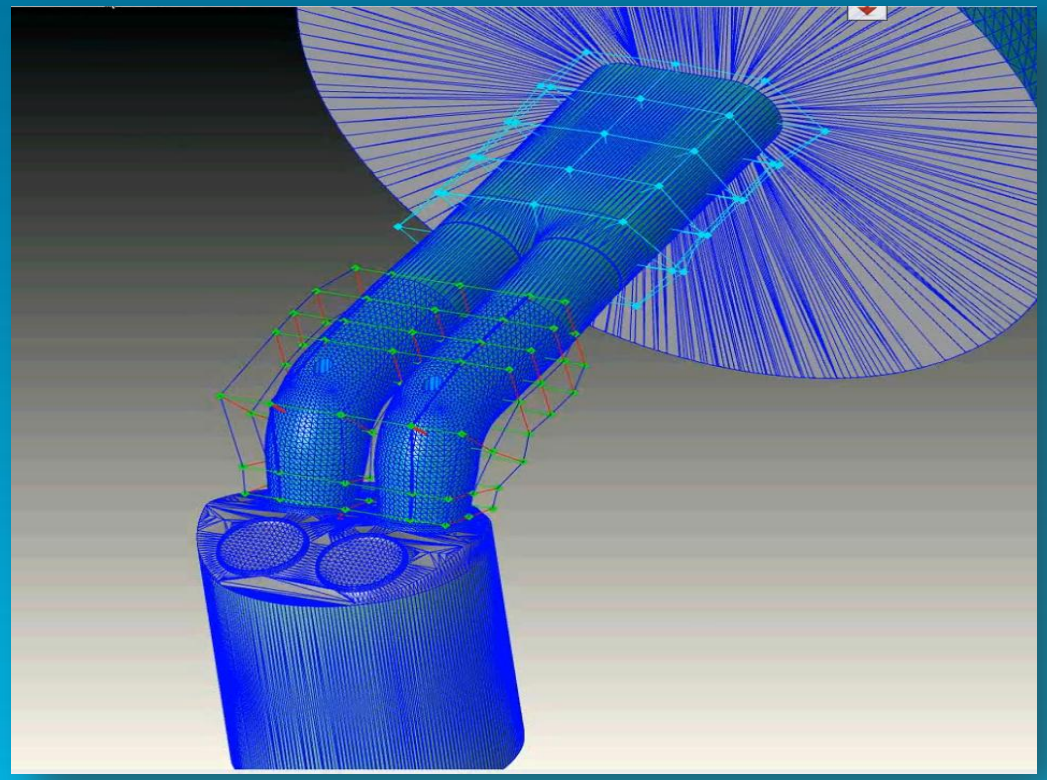


Latin hyperCube sampling

- A Statistical method
- Know your cost up front
- Know you time to solution
- More design insight
- Best statistical accuracy

Automotive Intake Manifold Design

- 3% performance enhancement vs. over 60 humans working for months to get less than 0.6%.



- Change shape of intake
- Improve flows
- Better gas mileage
- Better performance

Courtesy of Ford Motor Company

Sharing results: Earthquake simulation

MPI on-premises + data shared in Azure

Work

- Transfer data to SQL Azure
- Visualization app

Resources

- HPC cluster
- SQL Azure
- Visualization app hosted in Azure

Benefits

- Share results

demo

Summary

Nine Tips for Best Practices

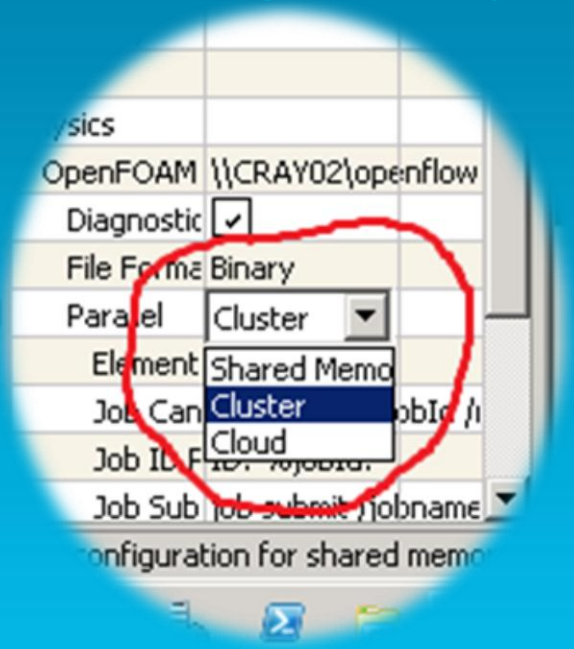
- Always consider total cost of ownership when making decisions
- Use .Net Parallel Libraries to take advantage of multi-core on Azure
- Use HPC Azure burst solution for scaling out to multi-node
- Embarrassingly parallel CPU intensive jobs are best suited for Azure
- Parametric sweep engine is a powerful yet simple way to scale
- Have multi-user design considerations for HPC Apps as a service
- Hide cloud from your users by providing a transparent experience
- Minimize data transfer between on-premises and the cloud
- Be creative and focus on what you can do on Azure today

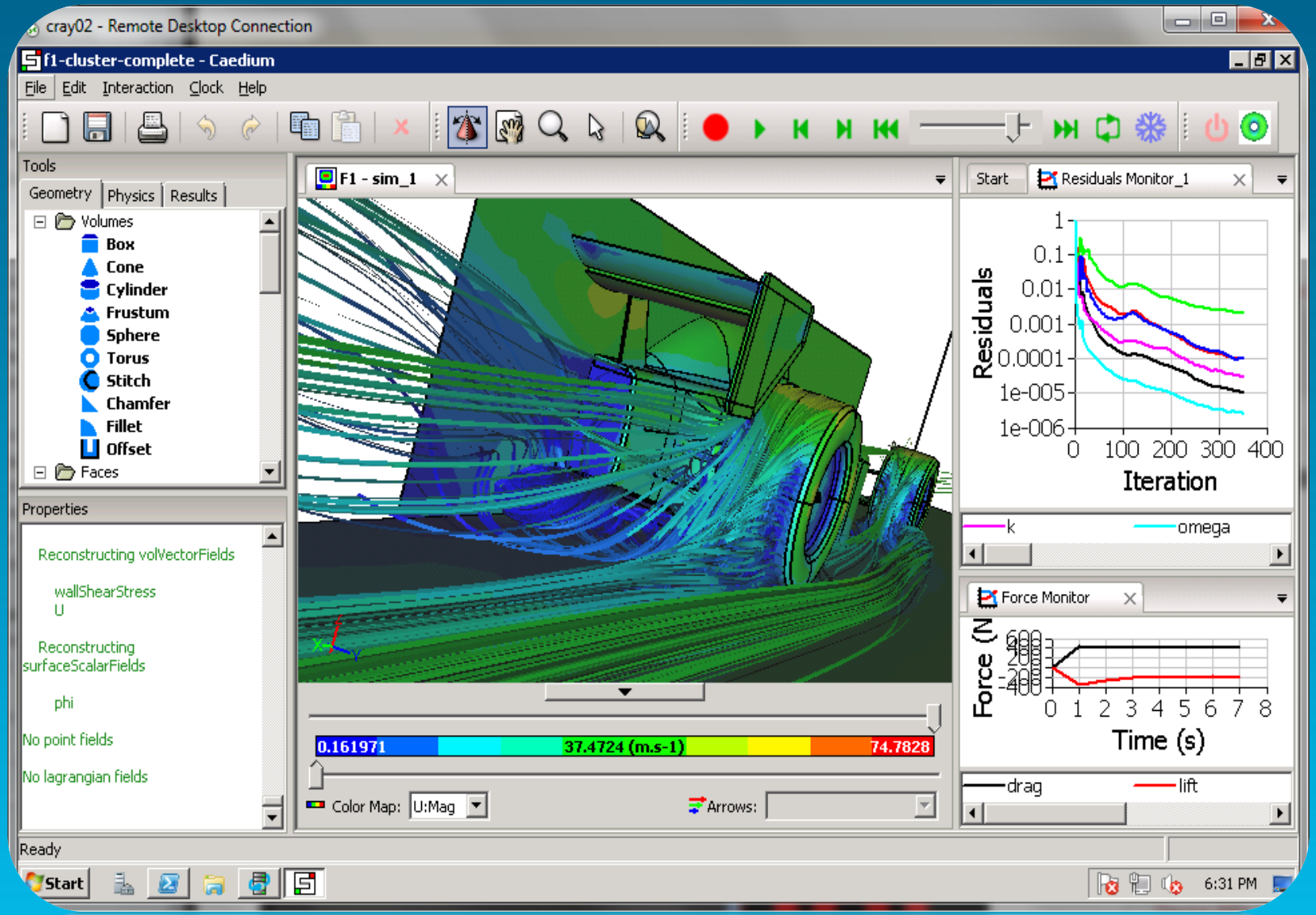
The Microsoft Windows Computing Experience

Run on:

- Client
- Cluster
- Cloud

Transparently

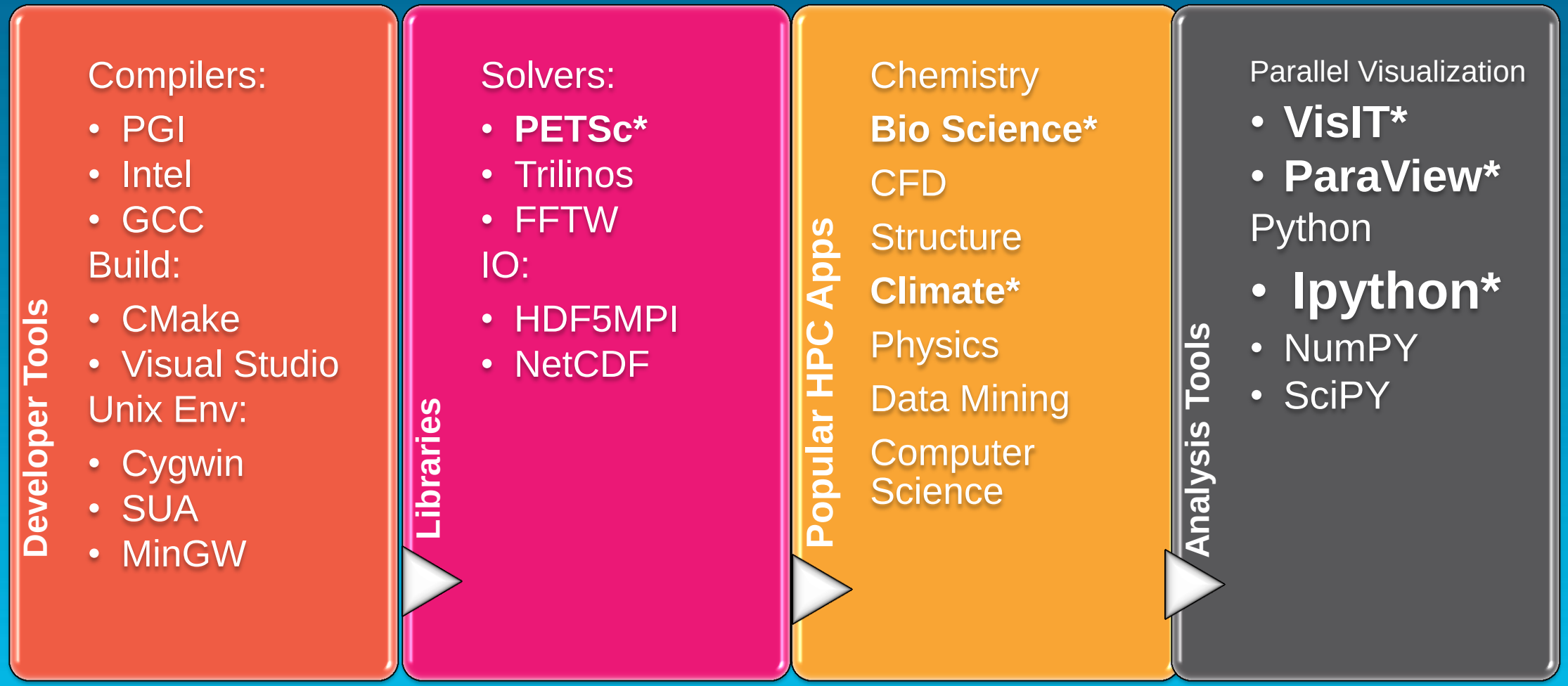




Developer Benefits of Windows

- Easier binary distribution
  - Compile once, run everywhere
  - from laptop, to desktop, to Windows HPC, to Windows Azure
- Better tools, first class developer support
  - Visual Studio and other tools make development easier
- More potential new users and developers
  - Run on World's most popular OS
  - Reveal issues by exercising code on commercial platform

Building a Healthy App Ecosystem to Support HPC and Azure



HPC Server 2008 R2 Roadmap

Windows HPC Server 2008 R2

July 2010

Microsoft HPC Server 2008 R2

- Excel on HPC clusters
- Schedule jobs to workstations
- Business critical SOA
- Scale to 1000+ nodes out-of-the-box
- Dual boot clusters
- Diskless compute nodes
- Extensible diagnostics and troubleshooting framework
- Flexible, customizable color-coded Heat map

Dec 2010

Microsoft HPC Server 2008 R2 SP1 & LINQtoHPC CTP

- Integration with Windows Azure:
  - "Burst" SOA and Parametric sweep jobs to Azure as worker roles.
  - All compute nodes in Azure with head-node only on-premise.
- User activity scheduling for workstation nodes
- C# cluster SOA debugger for VS 2010.

June 2011

Microsoft HPC Server 2008 R2 SP2*

- LINQ to HPC for large scale data analytics
- MPI runtime in Windows Azure
- Azure VM role
- New job scheduler policies
  - Lend/Borrow resource pools
  - Over/under subscribe nodes
- Common data for SOA Apps
- Multi-domain support for workstation nodes
- Web Portal for job submission and job status
- Smart Card authentication

The Matrix can not be told, **try** it yourself!

- **Subscribe** to my blog http://blogs.msdn.com/hpctrekker
- **Read** Application Models and Data Considerations
- Download SP2 Beta from http://connect.microsoft.com
- Get a free Trial of Azure for 30 days
- Download and try out the Azure Burst Samples
- Implement your own solution and let us know!

Track Resources

- My Blog: http://blogs.msdn.com/hpctrekker
- The Azure Burst Samples and White paper
- Windows HPC ResourceKit
- Windows HPC Server TechCenter

Track Resources

- Cloud Power - http://www.microsoft.com/cloud/
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