Meet the most demanding HPC and AI needs with the help of Microsoft Azure

Luka Debeljak
Sales Manager, Azure Applications & Infrastructure
Microsoft APAC

Fumiki Negishi
HPC/AI Sales Director
Intel Asia-Pacific Japan
Agenda

- Requirements when moving Big Compute to the Cloud
- Azure Infrastructure for Big Compute and HPC workloads
- Azure Batch for SaaS and New Cloud-native Apps
- Big Compute and Artificial Intelligence
Big Compute and HPC workloads

Industries
- Aerospace
- Automotive
- Financial Services
- Science
- Manufacturing
- Energy
- Media & Entertainment

Workloads
- Car crash simulations
- Rendering
- Audio & video transcoding
- Genomics
- Data ETL
- Test execution
- Financial risk simulations
- Image analysis
- Deep learning & AI training
- Engineering stress analysis
- Oil reservoir simulation
- Compiled MATLAB
- Computational fluid dynamics
- Motorsports simulations
- OCR
#1 – Zero waiting in line for compute

**Compute Demand vs. Cluster Size**

- **Cluster Size**
- **Wasted Resources**
- **Compute Demand**
- **Missed Opportunity**

**The Architecture**

- **Public Cloud**
- **Single Instances**
- **Multiple Single Instances**
- **Compute clusters**
- **Local HPC Cluster**
- **Job Broker**
- **Client**

*“Burst” to cloud for high demands*

*No local cluster exists, Local cluster exists*

*Transparent to end user where job is executing*
#2 – Ask questions of any scale

Ask the right question, regardless of scale

Customers use 100s to 1,000s of cores to answer business-critical questions they couldn’t have done before.
#3 – Users with unique requirements are OK

Trivial to support different use cases

Different RAM ratios, GPU, FPGA, Application/OS needs

Move workloads that don’t fit internally to Cloud
#4 – Cloud gets faster & cheaper over time...
#5 – Time and Cost are the sole metrics that matter
#6 – Accelerating answers, accelerates people

**SCALABLE COMPUTING (in hours)**

- Computing: 720 hours
- Analysis: 720 hours
- Computing: 720 hours
- Analysis: 720 hours

**2880 hours / 120 Days to Decision**

**ANTICIPATED BENEFIT (in hours)**

- Computing: 8 hours
- Analysis: 720 hours
- Computing: 8 hours
- Analysis: 720 hours

**1456 hours / 60.6 Days to Decision**
#6 – Accelerating answers, accelerates people

SCALABLE COMPUTING (in hours)

- Computing: 720 (hours)
- Analysis: 720
- Computing: 720
- Analysis: 720

2880 hours / 120 Days to Decision

POST ADOPTION: AGILE DESIGN PROCESS

Computing & Analysis

- Higher Quality Output, Iterative Analysis, Less Context Switching
#7 – Every smart person gets their own sandbox

Old: Shared internal cluster
- Competition for resources
- Waiting in line for compute
- Shared downtime

New: Cluster Per Researcher
- Remove bottlenecks
- Cost controls to manage $
- No waiting = 2x faster users
Microsoft Azure and Big Compute
42 Azure regions
Azure

**Core infrastructure – Infrastructure-as-a-Service (IaaS)**
- Compute
- Security
- Storage
- Networking

**Advanced workloads – Platform-as-a-Service (PaaS)**
- Web + Mobile + Media
- Internet of Things
- Microservices
- Containers
- Serverless

**Tools**
- Developer tools
- DevOps
- Portal + scripting

**Azure Stack + Hybrid**
- Trusted
- Productive
- Intelligent

- Identity
- Data + Analytics
- Artificial intelligence
- Cognitive services
- High performance computing
Application types

Embarrassingly parallel:
- Applications do not communicate
- May share common store & data
- May have dependencies
- E.g. Monte Carlo simulations, transcoding, rendering

Tightly coupled:
- Applications communicate; mainly use MPI
- Requires low latency, high bandwidth networking for scale
- E.g. car crash simulation, fluid dynamics, AI training
Azure HPC: Two main types

Self-managed

Cloud burst

On-premises

Compute nodes in the cloud

Cluster on the cloud

On-premises

All HPC resources in the cloud

Fully-managed

HPC as a service

On-premises

All HPC resources in the cloud

Client

Client App or Web portal

Azure Batch
No-compromise HPC and AI VMs

H
- Up to 16 cores, 3.2 GHz **E5-2667 V3 Haswell processor**
- Up to 224 GiB DDR4 memory
- **FDR InfiniBand** (56 Gbps, 2.6 microsecond latency)
- 2 TB of local SSD

F
- Up to 72 cores, 3.7 GHz **Intel Xeon Scalable (Skylake)**
- Up to 144 GiB DDR4 memory
- **Accelerated Networking** (30 Gbps VM-to-VM)
- 500 GB of local SSD

NC
- Up to 4 NVIDIA Tesla K80 GPUs
- Up to 24 cores
- Up to 224 GiB memory
- Up to 1440 GiB of local SSD
- FDR InfiniBand

NCv2
- Up to 4 NVIDIA Pascal P100 GPUs
- Up to 24 cores
- Up to 448 GiB memory
- Up to 3 TB of local SSD
- FDR InfiniBand

ND
- Up to 4 NVIDIA Pascal P40 GPUs
- Up to 24 cores
- Up to 448 GiB memory
- Up to 3 TB of local SSD
- FDR InfiniBand

NV
- Up to 4 NVIDIA Tesla M60 GPUs
- Up to 24 cores
- Up to 224 GiB memory
- Up to 1440 GiB of local SSD

NCv3
- Up to 4 NVIDIA Tesla V100 GPUs
- Up to 24 cores
- Up to 448 GiB memory
- Up to 1344 GiB of local SSD
- FDR InfiniBand
Azure is an Intel-powered Platform

Makes clouds faster
Intel® Xeon® processors for Azure compute and storage

Makes cloud smarter
Intel® Field-Programmable Gate Arrays (FPGA)

Makes clouds safer
Intel® SGX enhances security with encryption data during computation

Accelerates networking for more efficiency:
Intel® Silicon Photonics 100G PSM4

Maximizes performance across operating systems:
Clear Linux* OS for Intel® Architecture

Enables the future of AI:
Intel® Open Source machine learning frameworks and libraries
More compute for your Powerful Applications

Be more productive running your business applications using the right workloads

High-performance compute
High-performance compute workloads; modeling; simulations; genomic research

Intel® Xeon® processor E5-2667 v3 with DDR 4 memory
Intel® Xeon® processor E5-2670

Azure H and A8-11 Series

Compute intensive
High CPU-to-memory ratio; massive large-scale computation; deep learning

Intel® Xeon® Platinum 8168 processor

Fv2 VM family

SAP workloads
SAP applications across Dev/Test and production scenarios. SAP NetWeaver; SAP S4/HANA; SAP BI

Intel® Xeon® E7-8890 V4 processors

SAP HANA VM family

Memory optimized
Large database workloads; ERP; SAP; data warehousing solutions

Intel® Xeon® E5-2673 v4 processors

Azure GS, G, DSv3, Ev3 and DS Series
High Performance Computing in Azure

Running H-series and Fv2-series VMs on Intel architecture delivers scalable, unparalleled performance for your complex engineering and scientific workloads.

- Break free from the limitations of on-premises infrastructure
- Analyze large-scale data
- Run simulations and financial models
- Reduce time to market
Intel® Xeon® Scalable processors in Azure

Intel® Xeon® Platinum 8168 is Intel’s fastest processor in the public cloud. Combine it with the new Fv2-series VMs, and you get the fastest VMs in Azure.

Ideal for compute-intensive workloads

- Financial workloads
- Scientific analysis
- Genomics
- Geothermal visualization
- Deep learning

Intel® Xeon® Scalable processor
Intel® AVX-512
Intel® QAT
Intel® Arria® 10 FPGAs

for the most high-demand apps for workload-optimized performance to speed up data compression and cryptography for ultra low latencies
Why InfiniBand RDMA matters?

![Graph showing Radioss Crash Simulation code results (Lower is better). The x-axis represents the number of cores, ranging from 1 to 8, and the y-axis represents run time in seconds, ranging from 0 to 12000. The graph compares Linux RDMA On Azure and Bare metal performance.](image-url)
Why InfiniBand RDMA matters?

Nodes with Ethernet Vs A9 run time for crash models/jobs

Lack of RDMA (InfiniBand)
### Supported applications, solvers, services, platforms and frameworks

#### Cloud Workstation:
- Workspot
- Intel
- Citrix
- NVIDIA
- teradici

#### Deep Learning and AI Training:
- Mellanox
- NVIDIA
- Caffe
- Chainer
- Tensorflow
- SCK
- CNTK
- torch
- Intel

#### Cloud Rendering:
- Autodesk Maya
- SolidAngle Arnold
- Intel
- V-Ray
- 3ds Max
- NVIDIA

#### Supported OS:
- SUSE
- CentOS
- Ubuntu
- Windows

#### HPC Simulation and Analysis:
- d3View
- Altair
- rescale
- NVIDIA
- CONVERGE CFD Software
- UberCloud
- Bright Computing
- ESI
- Altos
- Fujitsu
- Siemens
- SIMULIA
- MSC Software
- Intel
- Mellanox
- LSTC
- Total CAE
- ANSYS
- SCK
Cycle Cloud: HPC cluster as a service
Azure Batch
Enable applications and algorithms to easily and efficiently run in parallel at scale

Azure Batch

- Rendering
- Media transcoding & pre-/post-processing
- Test execution
- Monte Carlo simulations
- Genomics
- Deep Learning
- OCR
- Data ingestion, processing, ETL
- R at scale
- Compiled MATLAB
- Engineering simulations
- Image analysis & processing
# How these services are built in Azure: Using Azure Batch

## User application or service

<table>
<thead>
<tr>
<th>Get and manage VMs</th>
<th>Install task applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manage and authenticate users</td>
<td>Start the tasks</td>
</tr>
<tr>
<td>Move task input and output</td>
<td>Queue tasks</td>
</tr>
<tr>
<td>Task failure? Task frozen?</td>
<td>Scale up and down</td>
</tr>
</tbody>
</table>

## Cloud Services

- **PaaS Cloud Services**
- **IaaS Virtual Machines**

## Hardware

All hardware is provided by the cloud platform.

**Significant amount of effort** spent managing compute resources, security, data movement, job running, and application lifecycle, **not related to your actual workload or business**.
Azure Batch: HPC as a Service

User application or service

Azure Batch

- App lifecycle, job dependencies, data movement, task rescheduling, user management & authorization
- VM management and job scheduling

Provided by the cloud platform
- Don’t worry about the “plumbing”
- Focus on the workload/app
- Access higher-level capabilities
- Minimize the required cloud or Azure experience

PaaS Cloud Services

IaaS Virtual Machines

Hardware
Azure Batch focus areas

- **Elastic**
  - Capacity on demand
  - Jobs on demand

- **Scale**
  - 1 to 10,000’s VMs
  - 1 to millions of tasks

- **Efficient**
  - Scale according to load
  - Pay by the minute

- **Cost effective**
  - No charge for Batch; pay for used resources
  - No head node
  - Use low-priority VMs
Azure Batch capabilities

- Access via API’s, CLI’s, and UI’s:
  - .NET, Java, Node.js, Python, REST
  - PowerShell, x-plat Azure CLI
  - Azure Portal, Batch Labs x-plat client UI

- Choice of VMs:
  - Windows or Linux
  - Standard or custom images
  - Windows pool can use AHUB
  - Use low-priority VMs

- Rich app management:
  - Get apps from blobs, Batch app packages, package managers, custom VM images
  - Docker container images

- Pool scaling:
  - Manual or automatic

- VM networking:
  - Pool VMs can be in a VNET

- Job scheduling:
  - Supports both embarrassingly parallel and tightly coupled MPI jobs
  - Run > 1 task in parallel per node
  - Detect and retry failed tasks
  - Can set max execution time for jobs and tasks
  - Task dependencies
  - Job prep and cleanup tasks

- Monitoring:
  - VM monitoring and auto-recover
  - Metrics and logs available via Portal and API
Batch low-priority flexibility

Lower cost, with guaranteed baseline capacity

Lowest cost, while maintaining capacity
R - doAzureParallel

https://github.com/Azure/doAzureParallel

- Scale up R execution using Batch
- Parallel backend package for popular `foreach` package
- Each iteration of `foreach` loop runs as a Batch task
Batch Rendering

Autodesk 3ds Max / Maya

Integrated Client Plugin

- Upload assets
- Submit job
- Return outputs

Azure Batch

- Monitoring
- Reporting
- Single bill

VM

- Renderer

3DS MAX

VM

- Renderer

VM

- Renderer

Solid Angle

Arnold
Azure Batch AI Training
Train and Deploy Custom AI End-to-End

Your Data (Images, Text, Logs, Time Series…) + Training With Scale-Out GPU Clusters on Demand = Intelligence In Your Apps and Data Services
Azure Batch
AI Training Service

- Managed Service
- Supports Role Based Access Control
- Hierarchical Quota Management
- Easily Provision VMs at scale
- Load based automatic scaling
- Run experiments in Parallel
- Run in Containers or directly on VM
- Run any toolkit (CNTK, Tensorflow, Caffe, Chainer...)
- Only compute cost. Service is free
Azure Batch Shipyard

https://github.com/Azure/batch-shipyard

- Drive Batch using Python command line tool and JSON recipes (no development or API usage required)
- Supports Linux Docker container images & Singularity
- Data movement:
  - Azure Files, Azure Blobs, NFS, GlusterFS
- Create and manage NFS and GlusterFS file systems
Genomics acceleration in Azure
A revolution in genomic analysis

How
A Microsoft team worked with researchers at the Broad Institute to review the algorithms in the Burrows-Wheeler Aligner (BWA) and the Genome Analysis Toolkit (GATK)

Results
Using Microsoft’s expertise in software development, they discovered how to greatly increase efficiency and speed, without compromising accuracy

Solution
A fully-managed service on Azure that enables clinicians and researchers to focus on getting the results they need, faster and reliably

Benefits
• Run BWA and GATK analysis up to seven times faster
• Run in parallel, at any scale, with a single line of code
• Leave behind the complexity of managing infrastructure

“As this type of information is used more often in the clinical setting, the emphasis on speed becomes much stronger.” – Geraldine Van der Auwera, Broad Institute
Azure Data Platform optimized for Intel architecture and for Customers

Data Sources
- Structured and unstructured
- Operational data
- Data warehousing
- Big data processing

Data virtualization

XEON and FPGAs

Data integration

Data Insights
- Business intelligence
- Advanced Analytics & AI

On-premises

Cloud

Operational data

Data warehousing

Big data processing

SQL Server

Azure SQL Database

Azure Document DB

SQL Server

Data Warehouse

Azure SQL Data Warehouse

HDInsight

Data Lake
Project Brainwave

Project Brainwave is a powerful platform for an accelerated AI cloud

- Deep-learning platform
  Powered by Intel® 12NM Stratix 10 FPGAs

- Record-setting performance
  Over 130,000 compute operations per cycle
Powerful Alliance for your Digital Transformation

AZURE + INTEL

Productive
Intel and Microsoft co-engineering to offer differentiated Azure services powered by the latest Intel Xeon processors

Hybrid
Flexible and consistent hybrid cloud solutions with Intel Xeon Scalable processors, from Azure to Azure Stack

Intelligent
Innovative AI, Data, and Analytics services optimized with Intel technologies

Trusted
Unique Security Cloud Services enabled by Intel SGX technology
Next Steps

Got some new ideas?

Microsoft Big Compute

Microsoft HPC