# Engineering Simulation in the Cloud

## HPC, CAE, CFD

Art Sedighi, Ph.D. (Dr. S.)

Sr Partner Solutions Architect
**AWS**

HPC = High Performance Computing
CAE = Computer Aided Engineering
CFD = Computational Fluid Dynamics

# Agenda

- Engineering Simulation Overview
- Why Cloud
- AWS Services
- Customer Success Stories (time permitting)

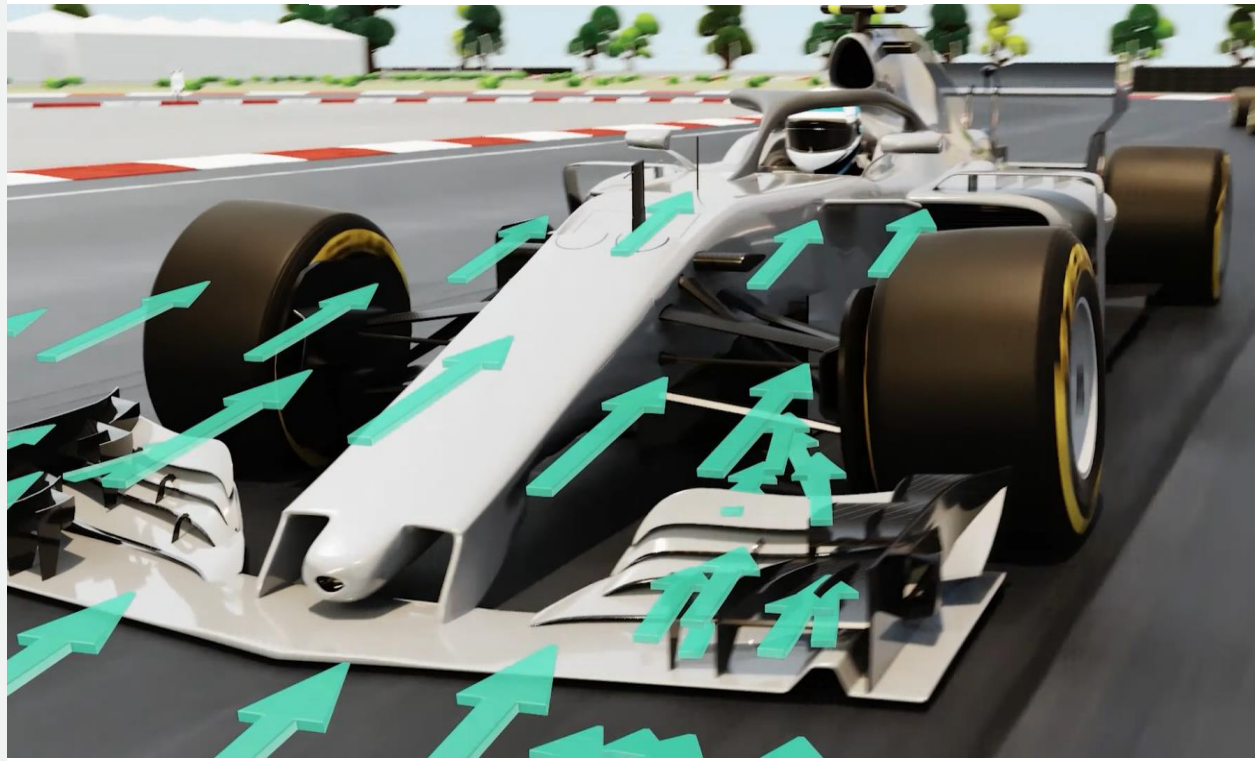
# Engineering Simulation Overview

# Engineering Simulation

Customers use Engineering Simulation for **virtual testing of hardware products**

Also referred to as
“Computer Aided Engineering” (CAE)

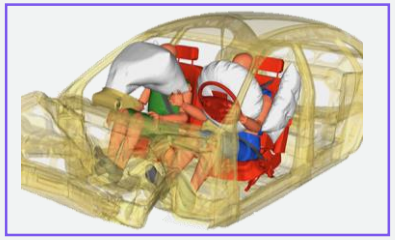
“High Performance Computing” (HPC) is infrastructure, services **needed for CAE**



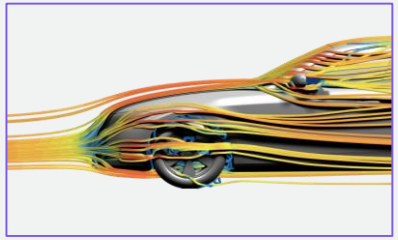
Formula 1 Redesigns Car for Closer Racing and More Exciting Fan Experience by Using AWS HPC Solutions

Reference: https://aws.amazon.com/solutions/case-studies/formula-1-graviton2/

# Automotive customers use engineering simulation extensively

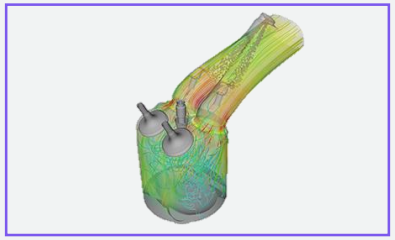


Crash[1]

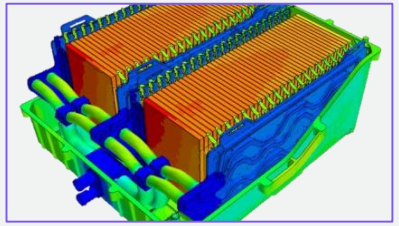


Aerodynamics[2]

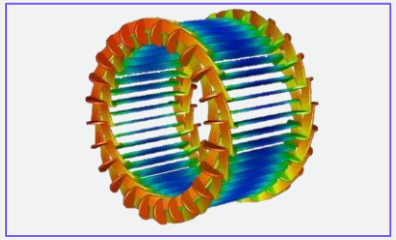
Thermal/Cooling[2]



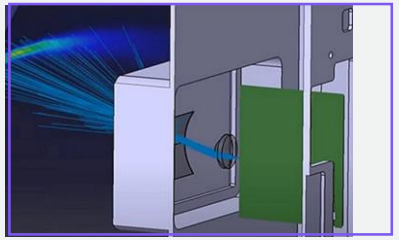
Engine[4]



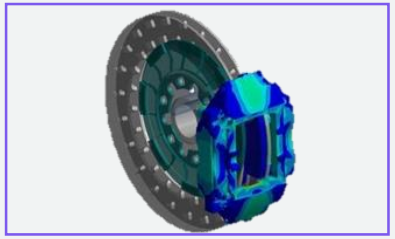
Battery[2]



Electric Motor[3]



Sensors & Electronics[3]

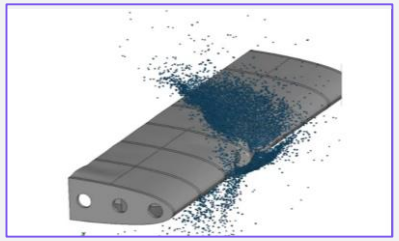


Body & Chassis[3]

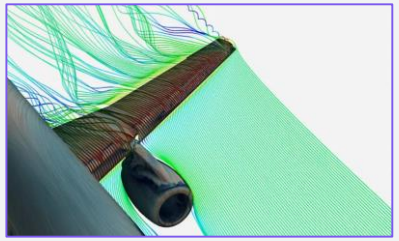
Images from AWS Partners:

1. www.altair.com
2. www.plm.automation.siemens.com
3. www.ansys.com
4. www.convergecfd.com

# Aerospace customers use engineering simulation extensively



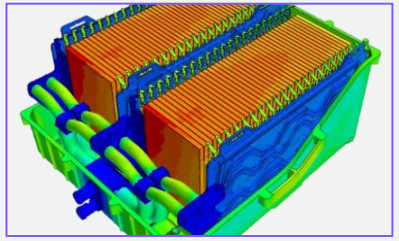
Impact[1]



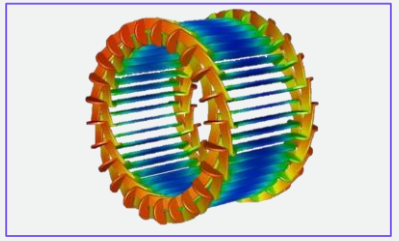
Aerodynamics[1]

Thermal/Cooling[2]

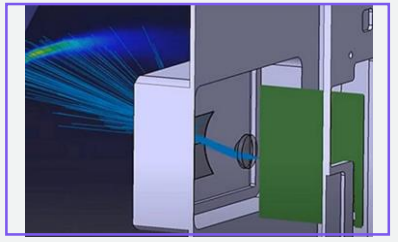
Engine[3]



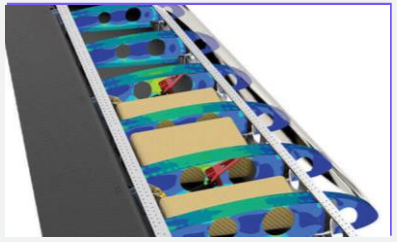
Battery[2]



Electric Motor[1]



Sensors & Electronics[1]

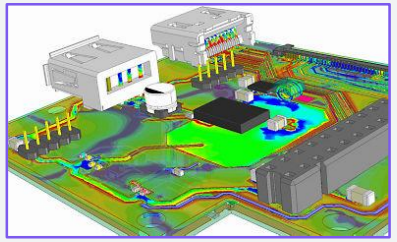


Aero Structures[3]

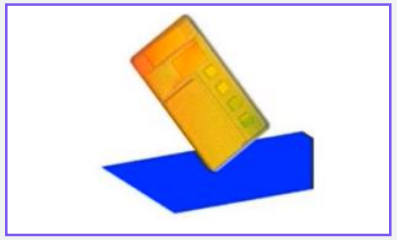
Images from AWS Partners:

1. www.ansys.com
2. www.plm.automation.siemens.com
3. www.altair.com

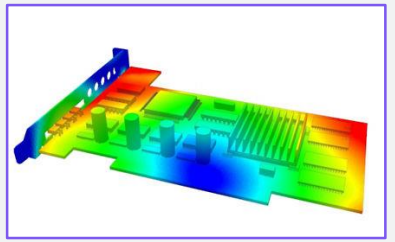
# High Tech customers use engineering simulation extensively



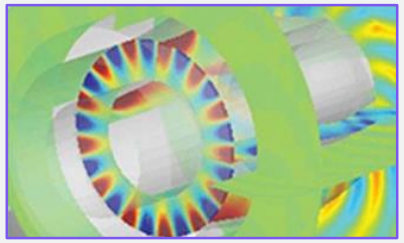
Chip, Package, System SI, PI[3]



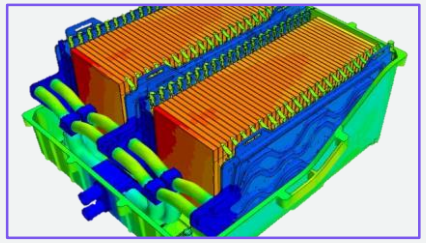
Structural Reliability[2]



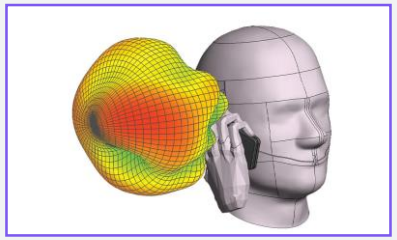
Thermal/Cooling[3]



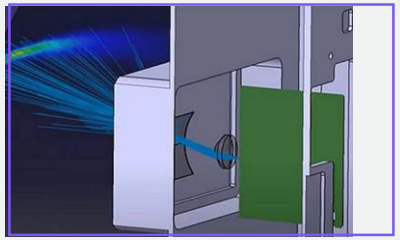
Acoustics[4]



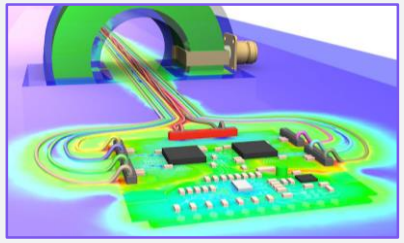
Battery[2]



Antennas[1]



Sensors[3]



EMI, EMC[3]

Images from AWS Partners:

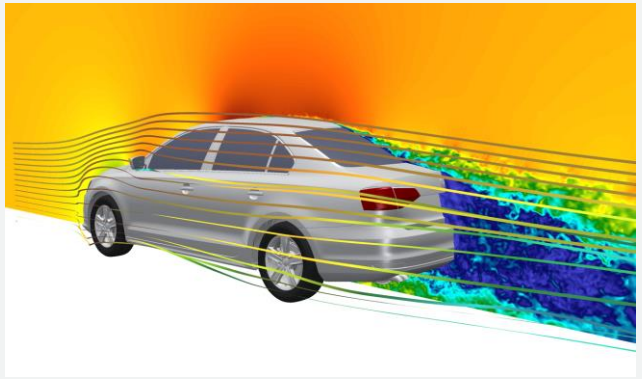
1. www.altair.com
2. www.plm.automation.siemens.com
3. www.ansys.com
4. www.hexagon.com

# Engineering Simulation is done with partner apps

| Example apps | Fluid Simulation | Structural Simulation | Electromagnetics Simulation |
|---|---|---|---|
| Method Name<br><br>**Software Provider** | Computational Fluid Dynamics (CFD) | Finite Element Analysis/Method (FEA/FEM) | Finite Element Analysis/method (FEA/FEM) |
| **Altair** | AcuSolve, uFX | Radioss, Optistruct | Feko |
| **Ansys** | Fluent, CFX | Mechanical, LS-Dyna | Maxwell, HFSS |
| **Dassault Systems** | PowerFLOW | Abaqus | CST |
| **ESI** | Ace+ | PamCrash | Prosivic |
| **Hexagon** | Cradle CFD | Nastran | |
| **Siemens** | Star-CCM+ | Simcenter Nastran | Simcenter LF EM |
| **Others** | Converge | | |

# Engineering Simulation workloads are –

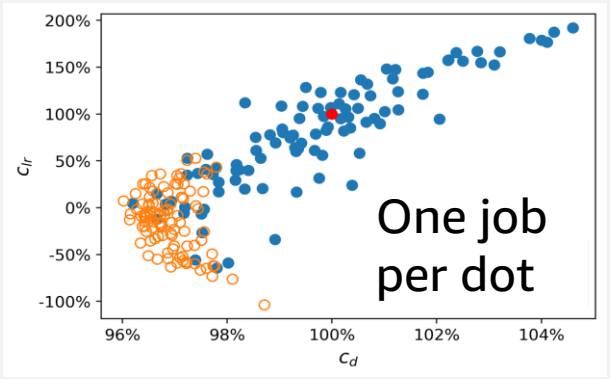
## Large



e.g. One engineering simulation job can run on

**1000 cores** for **hours**

## Numerous

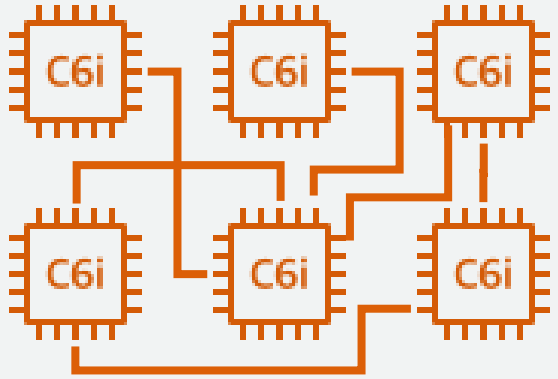



Designing one product needs

**100s** of types of simulation

**100s** of jobs per sim. type

## Tightly Coupled




If a single core fails, the entire job fails

Images from case study: https://aws.amazon.com/partners/success/volkswagen-ag-altair/

# Why Cloud
## for Engineering Simulation

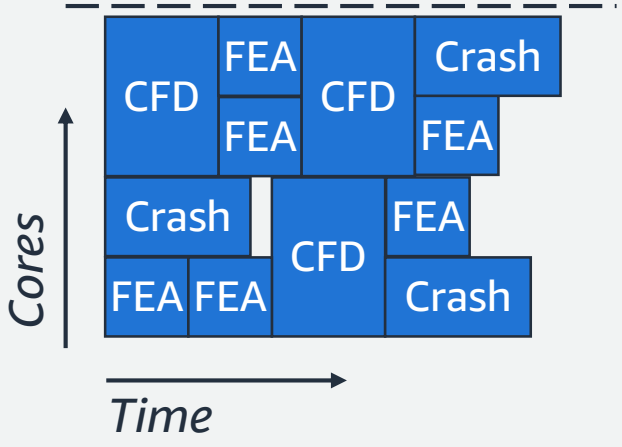
# HPC in the cloud has many benefits over HPC on-premise

| | |
|---|---|
| **Massive Capacity** | No waiting in long job queues; Higher productivity |
| **Elasticity** | Business agility |
| **Pay Per Use** | OpEx instead of CapEx; Lower TCO |
| **Latest Processors** | Get best return on your ISV software licenses |
| **Disaster Resilience** | Avert business disruption |
| **Global Presence** | Enable your global team |
| **Sustainability** | Cloud is greener than on premises clusters |
| **Economy of Scale** | Lower TCO (Total Cost of Ownership) |

# Massive capacity of the cloud unlocks user productivity

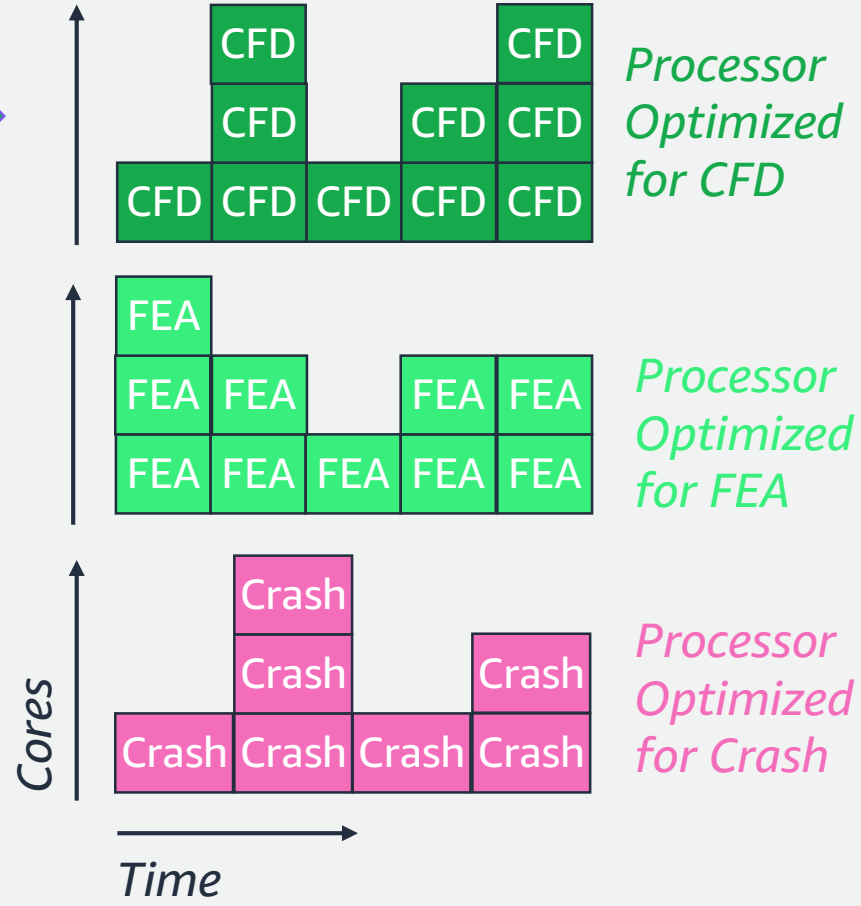
# Elasticity of the cloud provides business agility

- Limited capacity
- Same processor for all applications



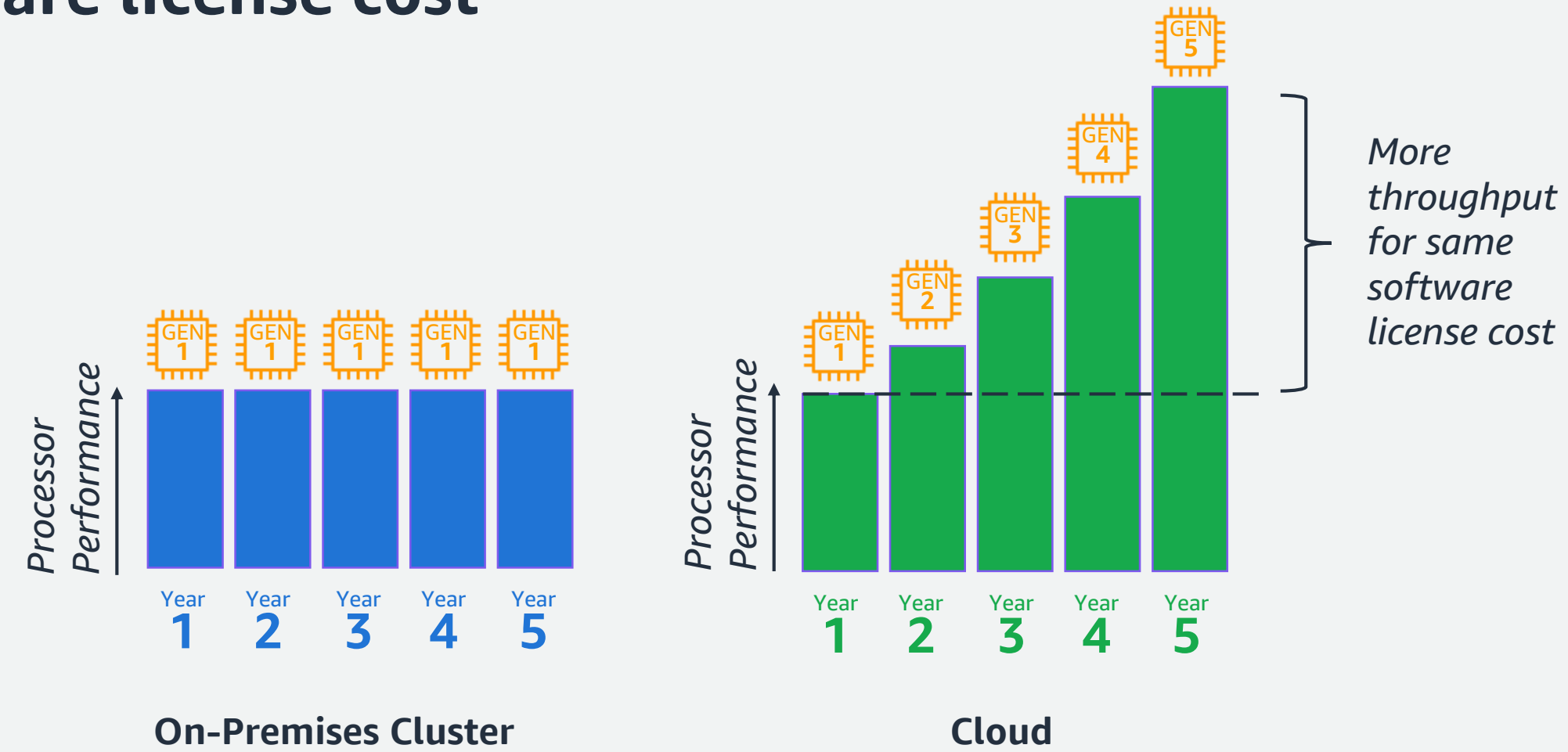

**On-Premises Cluster**

- Flexible capacity
- Optimum processor for each application




**Cloud**

# Latest processors on the cloud provide best ROI for software license cost



# The cloud enables your teams across the globe

**Worldwide**

- **Same infrastructure**
- **Same processes**
- **Same benefits**

**Manage all global deployment centrally**

# The cloud offers carbon footprint reduction opportunity

AWS can lower the carbon footprint of average on-premises data center workloads by nearly 80% today and up to 96% once AWS is powered with 100% renewable energy


**Europe**
Up to 5 times more energy efficient




**US**
3.6 times more energy efficient

**Asia Pacific**
5 times more energy efficient

Find all the reports on aws.amazon.com/sustainability/resources/


=

# Faster Product Development

*"For every $1 spent on HPC, businesses see $507 in incremental revenues and $47 in incremental profit." **

*** Hyperion ROI Study**
(http://www.hyperionresearch.com/roi-with-hpc/)

# AWS Services
## for Engineering Simulation

aws HPC

- ML for CAE
- Hybridization
- Visualization
- Orchestration
- **Compute**
- Storage

| | Cascade Lake | Ice Lake | Sapphire Rapids | EPYC Rome | EPYC Milan | Graviton 2 | Graviton 3 | Graviton 3E |
|---|---|---|---|---|---|---|---|---|
| **HPC Optimized** | | hpc6id.32xl | | hpc5a.48xl | hpc6a.48xl | | | hpc7g.16xl (Coming Soon) |
| Processor | | 64 Cores | | 96 Cores | 96 Cores | | | 64 Cores |
| Memory | | 16 GB/Core | | 4 GB/Core | 4 GB/Core | | | 2 GB/Core |
| Network | | 200 Gbps | | 25 Gbps | 100 Gbps | | | 200 Gbps |
| Disk | | 16 TB | | | | | | |
| **Compute Optimized** | c5n.18xl | c6i.32xl c6id.32xl | | c5a.24xl c5ad.24xl | c6a.48xl | c6gn.16xl | c7g.16xl | c7gn.16xl |
| Processor | 36 Cores | 64 Cores | | 48 Cores | 96 Cores | 64 Cores | 64 Cores | 64 Cores |
| Memory | 5.3 GB/Core | 4 GB/Core | | 4 GB/Core | 4 GB/Core | 2 GB/Core | 2 GB/Core | 2 GB/Core |
| Network | 100 Gbps | 50 Gbps | | 20 Gbps | 50 Gbps | 100 Gbps | 30 Gbps | 200 Gbps |
| Disk | | 7.6 TB | | 3.8 TB | | | | |
| **Memory Optimized** | r5n.24xl r5dn.24xl | r6i.32xl r6id.32xl | r7iz.32xl | r5a.24xl r5ad.24xl | r6a.48xl | r6g.16xl r6gd.16xl | | |
| Processor | 48 Cores | 64 Cores | 64 Cores | 48 Cores | 96 Cores | 64 Cores | | |
| Memory | 16 GB/Core | 16 GB/Core | 16 GB/Core | 16 GB/Core | 16 GB/Core | 8 GB/Core | | |
| Network | 100 Gbps | 50 Gbps | 50 Gbps | 20 Gbps | 50 Gbps | 25 Gbps | | |
| Disk | 3.6 TB | 7.6 TB | | 3.6 TB | | 3.8 TB | | |
| **General Purpose** | m5n.24xl m5dn.24xl | m6i.32xl m6id.32xl | | m5a.24xl m5ad.24xl | m6a.48xl | m6g.16xl m6gd.16xl | | |
| Processor | 48 Cores | 64 Cores | | 48 Cores | 96 Cores | 64 Cores | | |
| Memory | 8 GB/Core | 8 GB/Core | | 8 GB/Core | 8 GB/Core | 4 GB/Core | | |
| Network | 100 Gbps | 50 Gbps | | 20 Gbps | 50 Gbps | 25 Gbps | | |
| Disk | 3.6 TB | 7.6 TB | | 3.6 TB | | 3.8 TB | | |


| GPU Accelerated | p4d.24xl | p4de.24xl | p3dn.24xl | g5.48xl | g4dn.12xl | g4dn.metal |
|---|---|---|---|---|---|---|
| GPU Type | Nvdia A100 | Nvdia A100 | Nvdia V100 | Nvidia A10 | Nvidia T4 | Nvidia T4 |
| GPUs | 8 GPUs | 8 GPUs | 8 GPUs | 8 GPUs | 4 GPUs | 8 GPUs |
| GPU Memory | 40 GB/GPU | 80 GB/GPU | 32 GB/GPU | 24 GB/GPU | 16 GB/GPU | 16 GB/GPU |
| Processor Type | Intel CascadeLk | Intel CascadeLk | Intel Broadwell | AMD EpycRome | Intel CascadeLk | Intel CascadeLk |
| Processor | 48 Cores | 48 Cores | 48 Cores | 96 Cores | 24 Cores | 24 Cores |
| Memory | 24 GB/Core | 24 GB/Core | 16 GB/Core | 4 GB/Core | 8 GB/Core | 8 GB/Core |
| Network | 400 Gbps | 400 Gbps | 100 Gbps | 100 Gbps | 50 Gbps | 100 Gbps |
| GPU Network | 600 GBps | 600 GBps | Nvlink | Gbps | Gbps | Gbps |
| Disk | 8 TB | 8 TB | 1.8 TB | 7.6 TB | 0.9 TB | 1.8 TB |


# Dedicated HPC Line of Instances


**hpc5a**

AMD Epyc Rome
96 core
4 GB/core
25 Gbps

**hpc6a**

AMD Epyc Milan
96 core
4 GB/core
100 Gbps

**Coming Soon**

Coming Soon

**hpc6id**

Intel Icelake
64 core
16 GB/core
200 Gbps
16 TB Nvme Disk

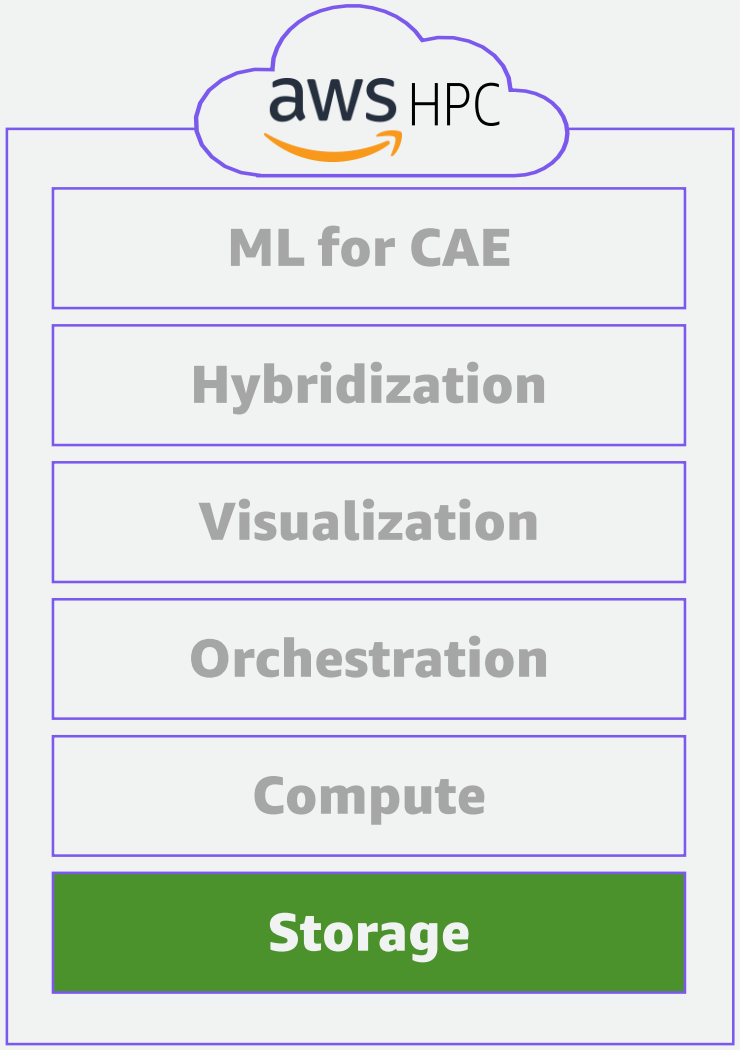
**hpc7g**

AWS Graviton 3

# Hpc6a


- First publicly available HPC focused instance
- 3x better price-performance
- Available in US-Ohio, Gov-Cloud, EU-Stockholm, JP-Tokyo (not GA), AU-Sydney (not GA)

**Technical Specifications:** AMD 3rd Gen EPYC Milan processors, 96 cores, up to 3.6GHz frequency, and 384GB of RAM. Elastic Fabric Adapter (EFA) enabled by default at 100 Gbps





## Amazon FSx for Lustre

**Fully managed shared storage built on the world's most popular high-performance file system.**

## Amazon S3

**Object storage built to retrieve any amount of data from anywhere.**

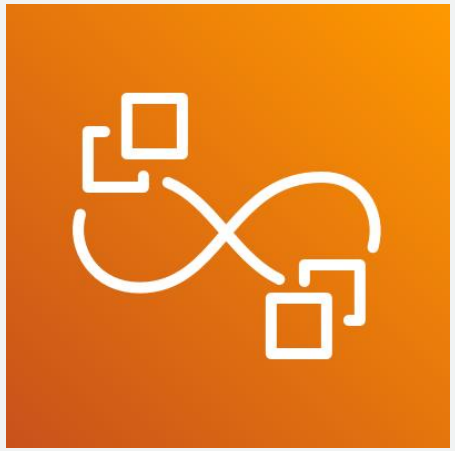
## Amazon Elastic Block Store (EBS)

**Easy to use, high performance block storage at any scale.**

## Amazon Elastic File System

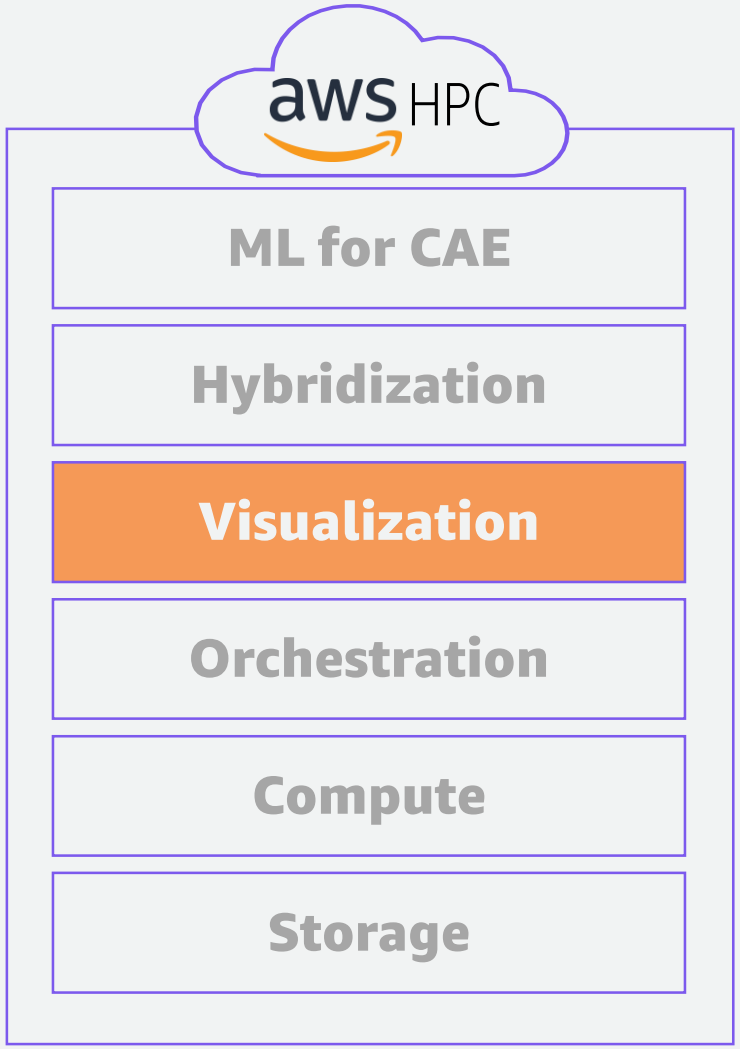
**Simple, serverless, set-and-forget, elastic file system.**


## AWS ParallelCluster

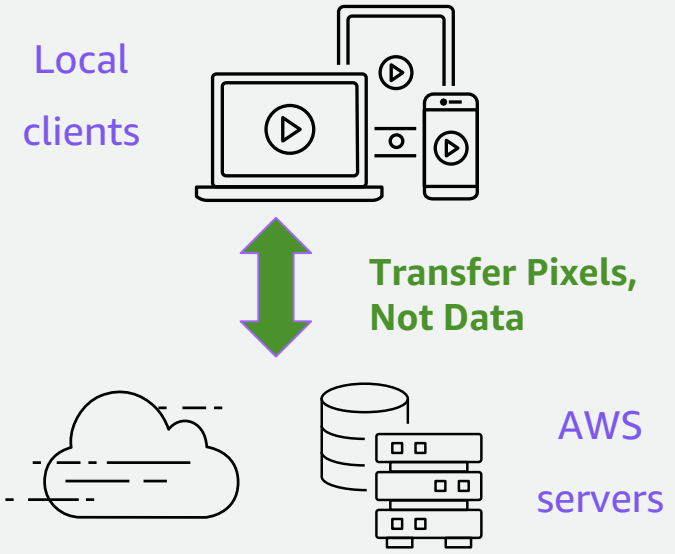


Simplifies deployment of HPC in the cloud, including integrating with popular HPC scheduler SLURM

Integrated with AWS Batch, Amazon FSx for Lustre and Elastic Fabric Adapter




## AWS NICE DCV




Users can access, manipulate, and share business-critical information, regardless of their location, over LAN or WAN networks

# Thank you!

Art Sedighi, Ph.D. (Dr. S.)
asedig@amazon.com