

# THE CONFLUENCE OF AI AND HIGH-PERFORMANCE COMPUTING

Sachin Nagpal

# WHAT IS HPC?

*"High-Performance Computing," or HPC, is the application of "supercomputers" to computational problems that are either too large for standard computers or would take too long.*

**- NICS**

*High-performance computing (HPC) is the use of super computers and parallel processing techniques for solving complex computational problems.*

**- Techopedia**

*The term high performance computing (HPC) refers to any computational activity requiring more than a single computer to execute a task.*

**- HPC Wales**



# IS HPC DEFINED BY INFRASTRUCTURE?

COMPUTE



MEMORY/STORAGE



FABRIC



SOFTWARE



# ... OR BY APPLICATION DOMAIN?

PHYSICS



LIFE SCIENCES



WEATHER & CLIMATE



MANUFACTURING

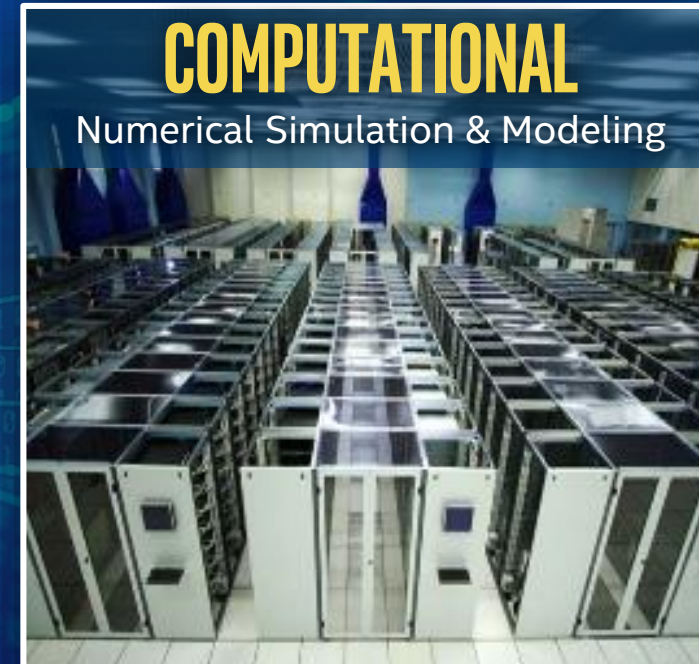
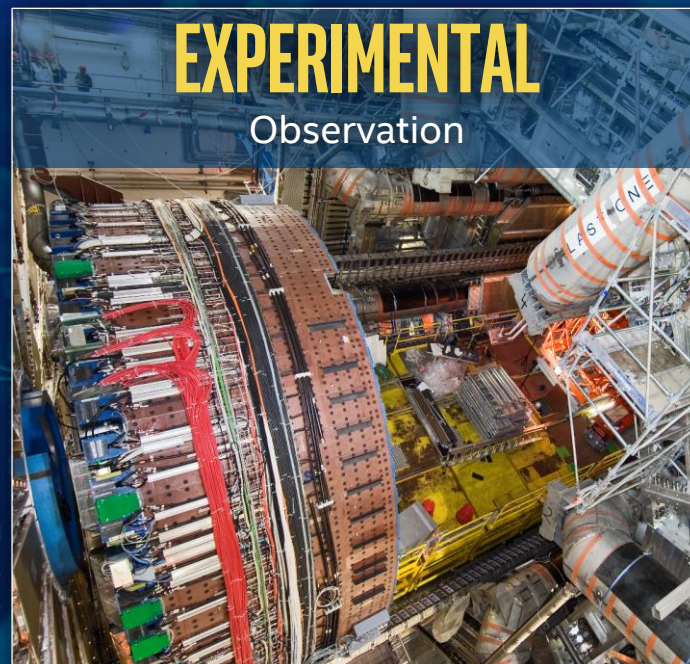


HPC: An **activity** characterized by the workload's *intent, nature, and response to scale*



# HPC ACROSS THE DOMAINS OF SCIENCE & ENGINEERING

**THEORETICAL**  
Mathematical Model

$$\frac{1}{r} \frac{\partial}{\partial \theta} \left( \frac{\partial u_r}{\partial \theta} + \frac{u_\phi}{r} \frac{\partial u_r}{\partial \phi} \right) + \frac{1}{r^2 \sin(\phi)^2} \frac{\partial}{\partial \theta^2} \left( \sin(\phi) \frac{\partial u_r}{\partial \theta} \right) - 2 \frac{u_r + \frac{\partial u_\phi}{\partial \phi} + u_\phi}{r^2}$$
$$\frac{\partial u_\theta}{\partial \theta} + \frac{u_\phi}{r} \frac{\partial u_\theta}{\partial \phi} + \frac{u_r u_\theta + u_\theta u_\phi \cot(\phi)}{r} = -\frac{1}{r \sin(\phi)} \frac{\partial p}{\partial \theta} + \rho g_\theta$$
$$\frac{1}{\sin(\phi)^2} \frac{\partial^2 u_\phi}{\partial \theta^2} + \frac{1}{r^2 \sin(\phi)} \frac{\partial}{\partial \phi} \left( \sin(\phi) \frac{\partial u_\theta}{\partial \phi} \right) + \frac{2 \frac{\partial u_r}{\partial \theta} + 2 \cos(\phi)}{r^2 \sin(\phi)}$$
$$\frac{\partial u_\phi}{\partial \theta} + \frac{u_\phi}{r} \frac{\partial u_\phi}{\partial \phi} + \frac{u_r u_\phi - u_\theta^2 \cot(\phi)}{r} = -\frac{1}{r} \frac{\partial p}{\partial \phi} + \rho g_\phi$$
$$\frac{1}{\sin(\phi)^2} \frac{\partial^2 u_\phi}{\partial \theta^2} + \frac{1}{r^2 \sin(\phi)} \frac{\partial}{\partial \phi} \left( \sin(\phi) \frac{\partial u_\phi}{\partial \theta} \right) + \frac{2}{r^2} \frac{\partial u_r}{\partial \phi} - \frac{u_\phi}{r^2}$$


**DATA ANALYTICS**

**VISUALIZATION**

Computational & experimental images: CERN



# HPC IS EVOLVING, EXPANDING...



**SCALE**  
EXASCALE

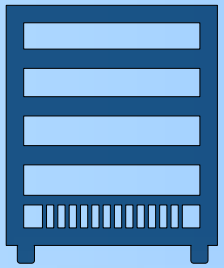


**SCOPE**  
ANALYTICS AND AI

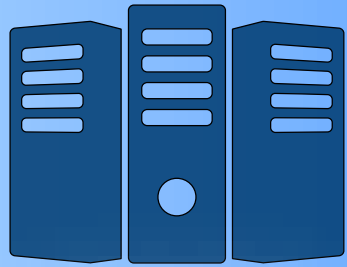


**DELIVERY**  
HPC IN THE CLOUD

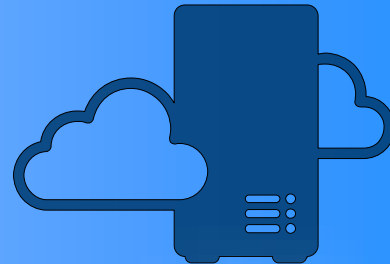
# THE NEXT BIG WAVE OF COMPUTING



MAINFRAMES



STANDARDS-  
BASED SERVERS



CLOUD  
COMPUTING

- ✓ DATA DELUGE
- ✓ COMPUTE BREAKTHROUGH
- ✓ INNOVATION SURGE

**ARTIFICIAL  
INTELLIGENCE**

AI COMPUTE CYCLES WILL GROW **12X** BY 2020



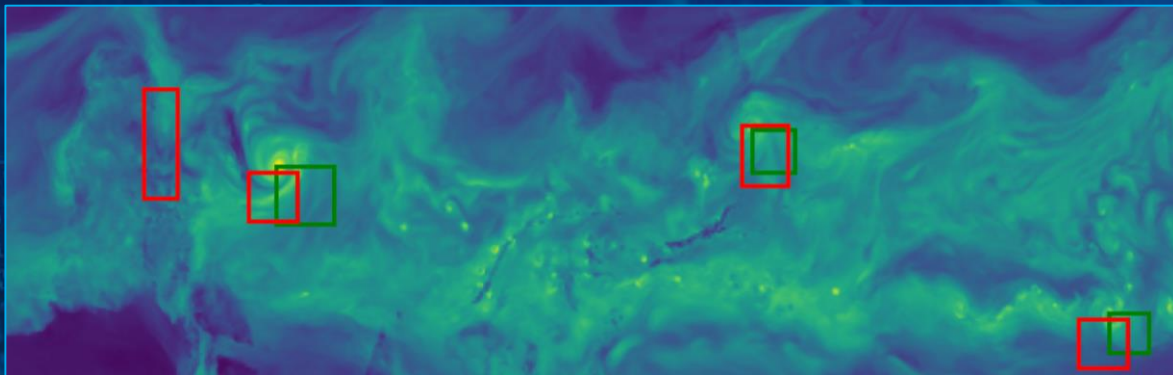
# IS AI AN HPC WORKLOAD?



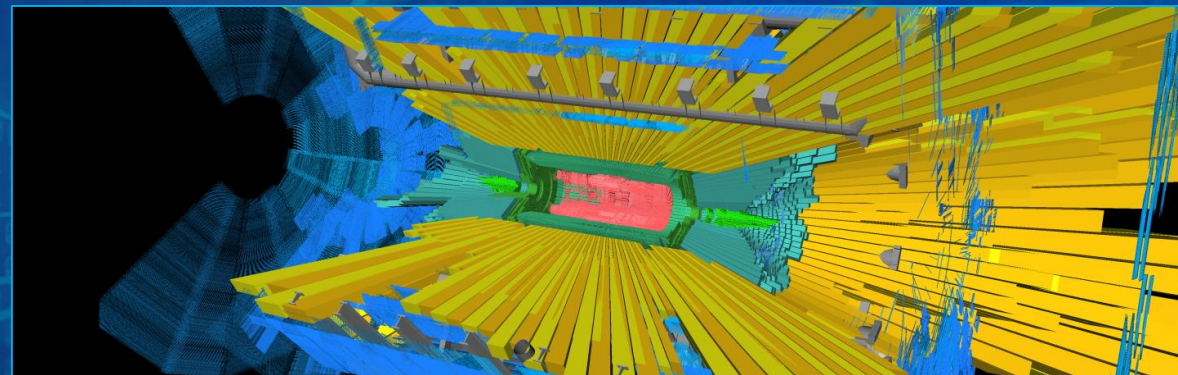


# ARTIFICIAL INTELLIGENCE: AN HPC WORKLOAD & HPC TOOL

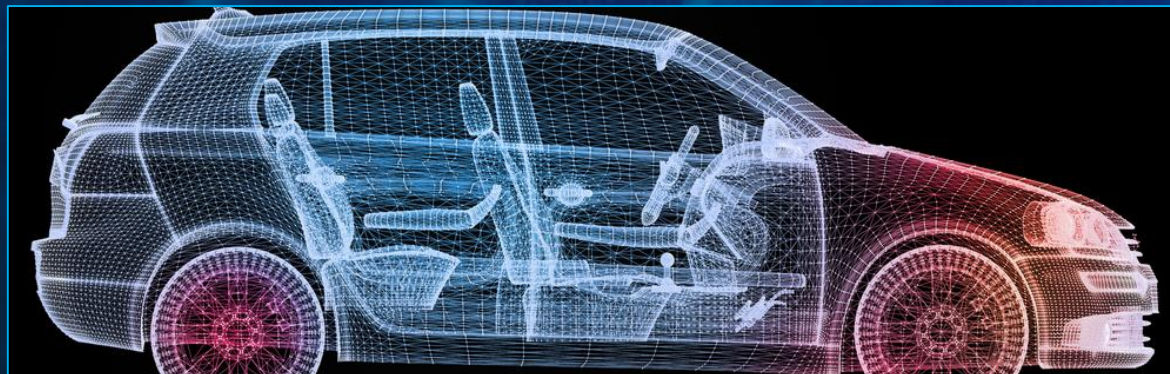
## CLIMATE



## PHYSICS



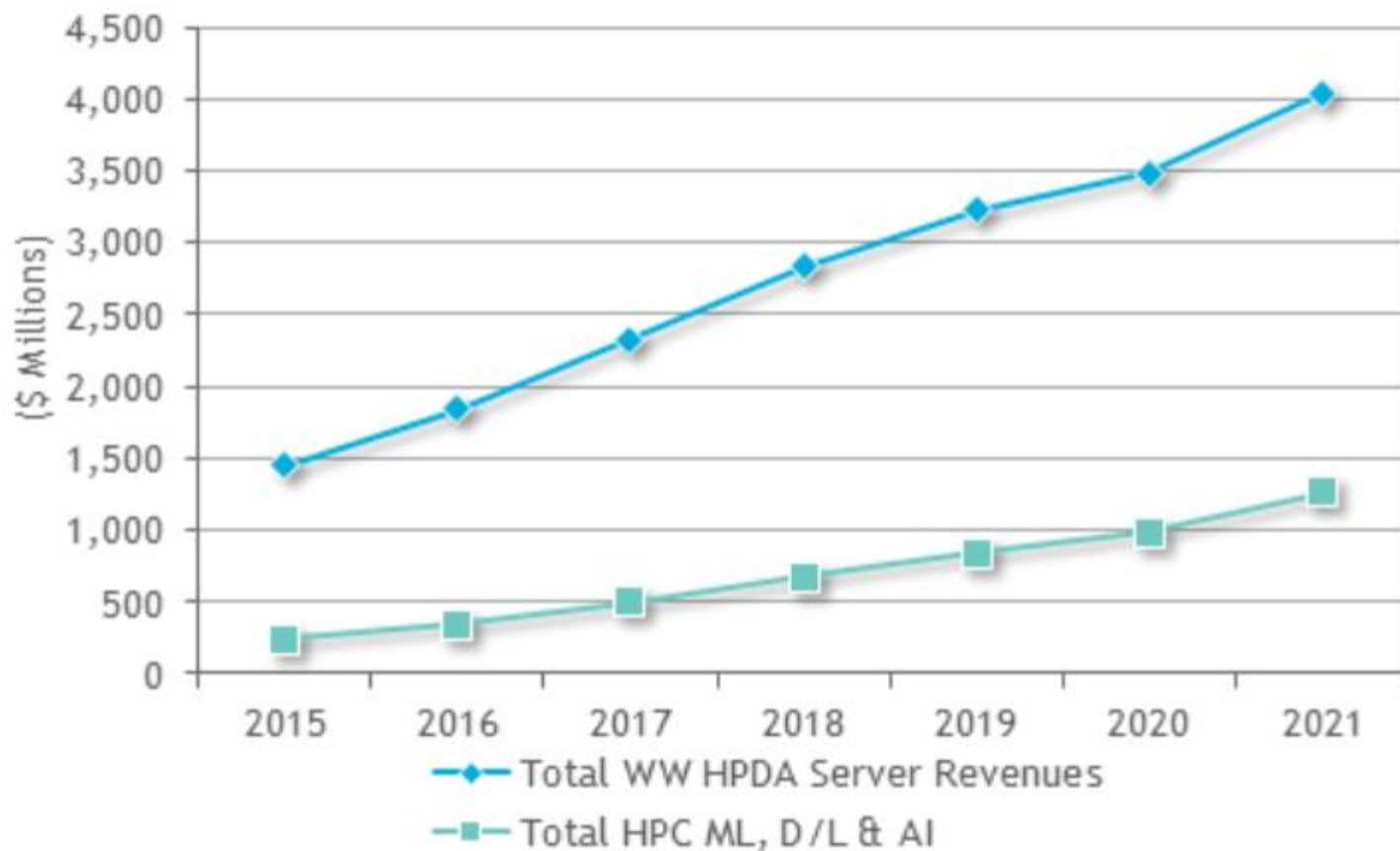
## AUTONOMOUS DRIVING





# HIGH-PERFORMANCE DATA ANALYTICS AND AI IN HPC: ON THE RISE

## Worldwide Server-Based AI Revenues



Source: Hyperion Research, 2017

HPC customer trends for analytics:

- HPDA server revenue growing 17% annual growth (2016-2021) to \$4B in 2021
- \$1.1B will be first-time HPC adopters
- ML/DL subset of HPDA will grow even faster – at 26% annually

Overall HPC server growth projected at 5.8% annually



# THREE PILLARS OF HIGH PERFORMANCE COMPUTING

## SIMULATION & MODELING

Model Drives Data



## DATA ANALYTICS

Data Drives Insight



## ARTIFICIAL INTELLIGENCE

Model Inferred from Data



## VISUALIZATION



## COMMON, HIGH-PERFORMANCE DATA STORE

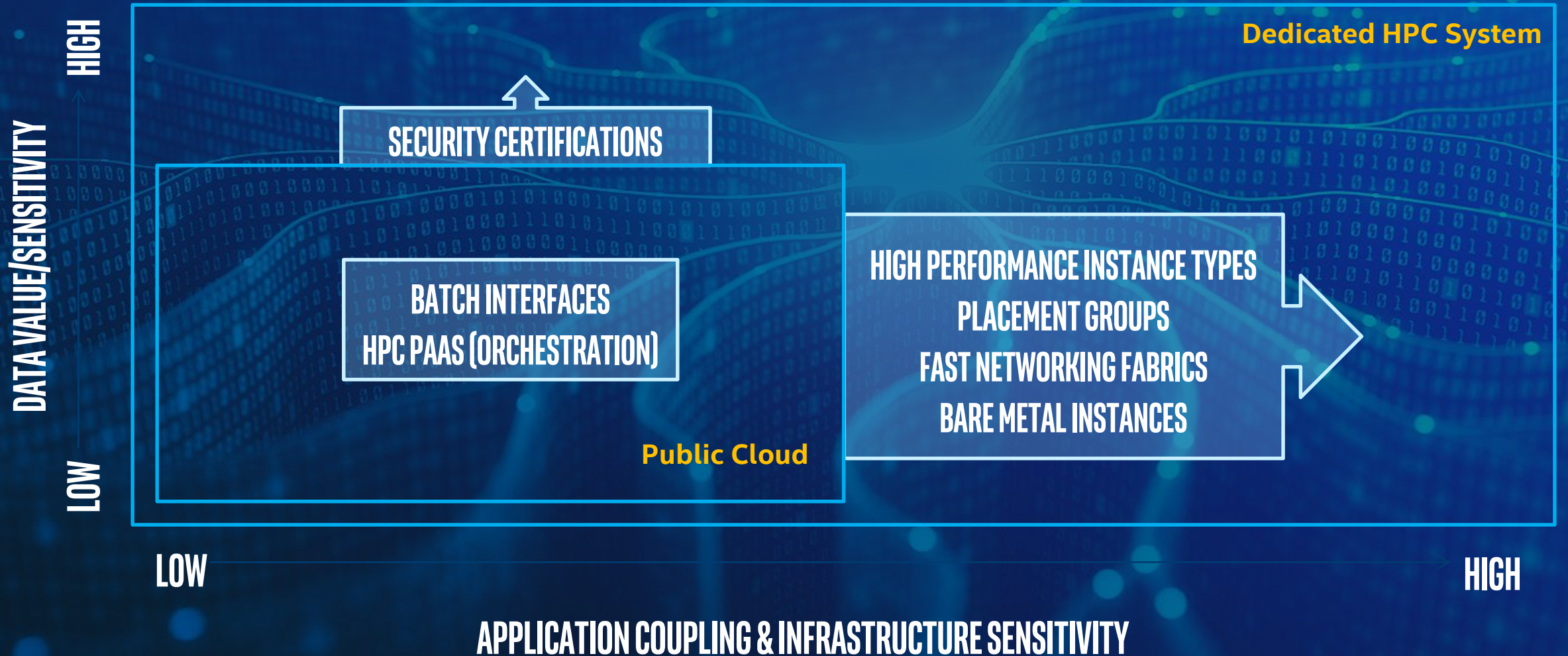


# HPC AND CLOUD: NEW DELIVERY





# CLOUD'S EXPANDING HPC FRONTIER





# WHY CONSIDER THE CLOUD FOR HPC?



**R&D COLLABORATION**



**MANAGE DEMAND SURGES**



**EASY MAINTENANCE**



**CAPITAL/  
INVESTMENT**



**ACCESS TO SCALE**



**UPGRADING CURRENT  
CAPABILITIES**



# 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® Platinum 8168 processor

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



# Intel® Xeon® Scalable processors in Azure

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








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

## Ideal for compute-intensive workloads

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



# INTEL IS YOUR PARTNER AS HPC EVOLVES & EXPANDS



**SCALE**  
EXASCALE



**SCOPE**  
ANALYTICS AND AI



**DELIVERY**  
HPC IN THE CLOUD

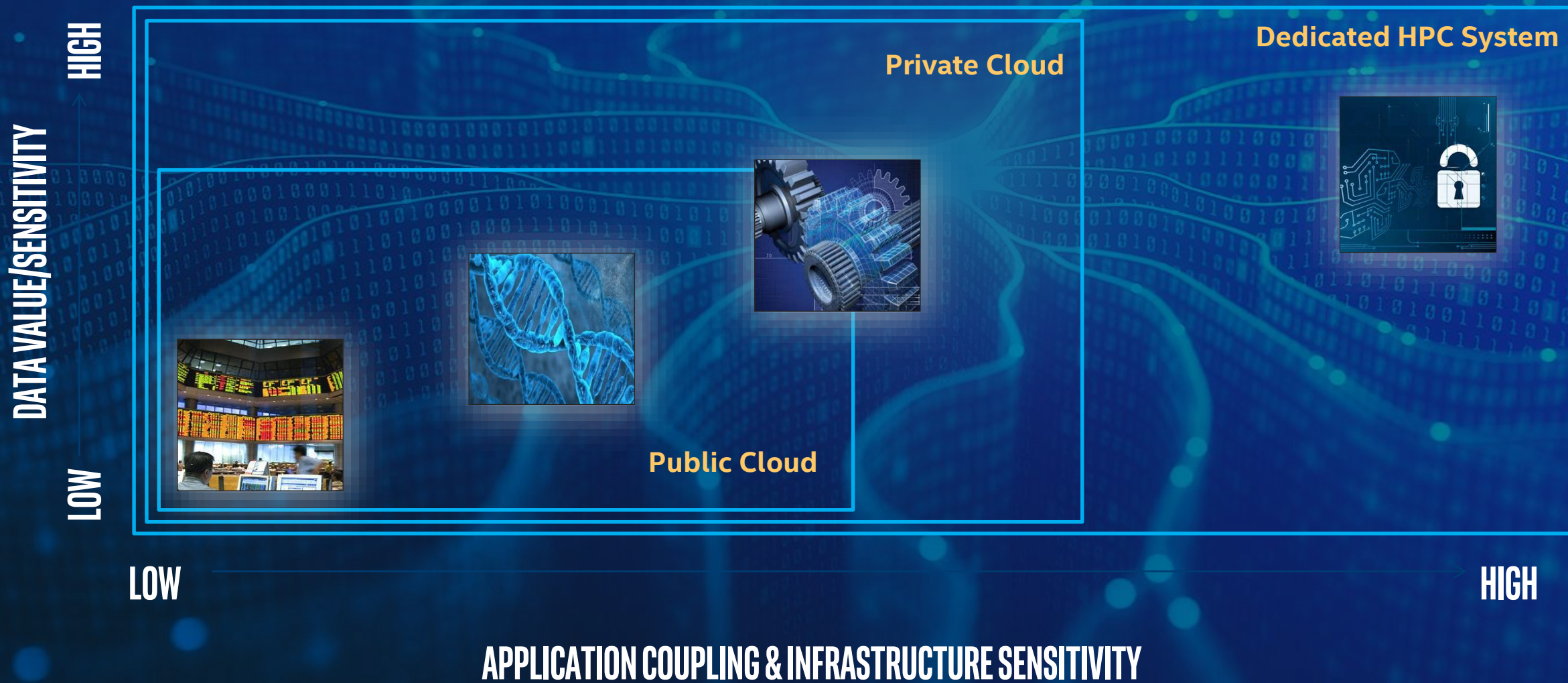




experience  
what's inside™

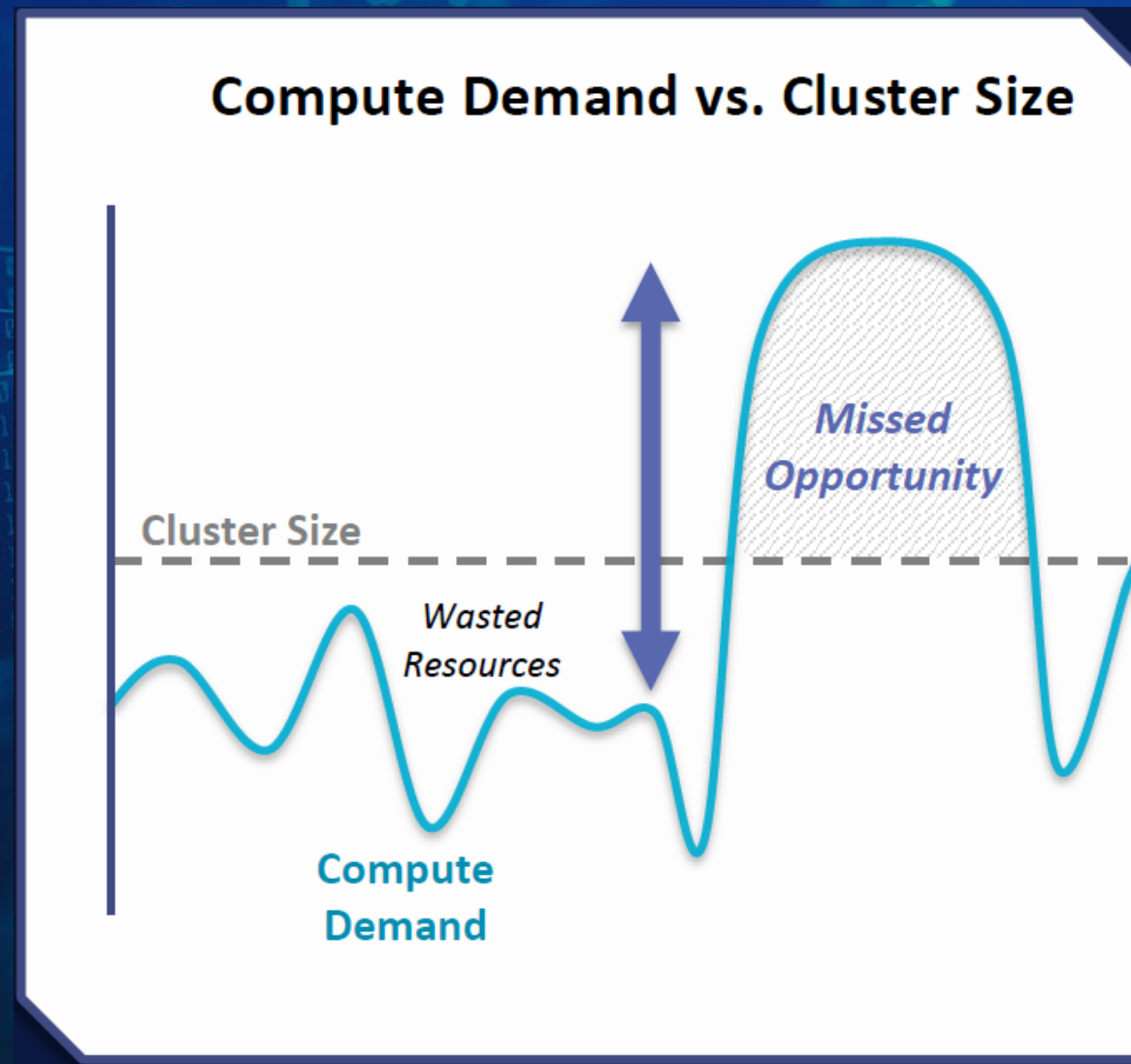


# EXAMPLE HPC WORKLOAD FIT FOR THE CLOUD





# CHALLENGES FOR EXISTING USERS





# CHALLENGES FOR NEW USERS

**300,000**

Approximate number of  
manufacturers in the United States

**95%**

Of which are categorized as small  
or medium (1-500 employees)

**200%**

More jobs are provided by small and  
medium manufacturers than large ones

**98%**

Of all products will be developed  
and manufactured digitally by 2020

**94%**

Of all small and medium  
manufacturers **have not yet adopted  
high-performance digital manufacturing**

Top barriers to adoption:

- Awareness
- Defensible ROI
- Business risk
- Access to technology and expertise



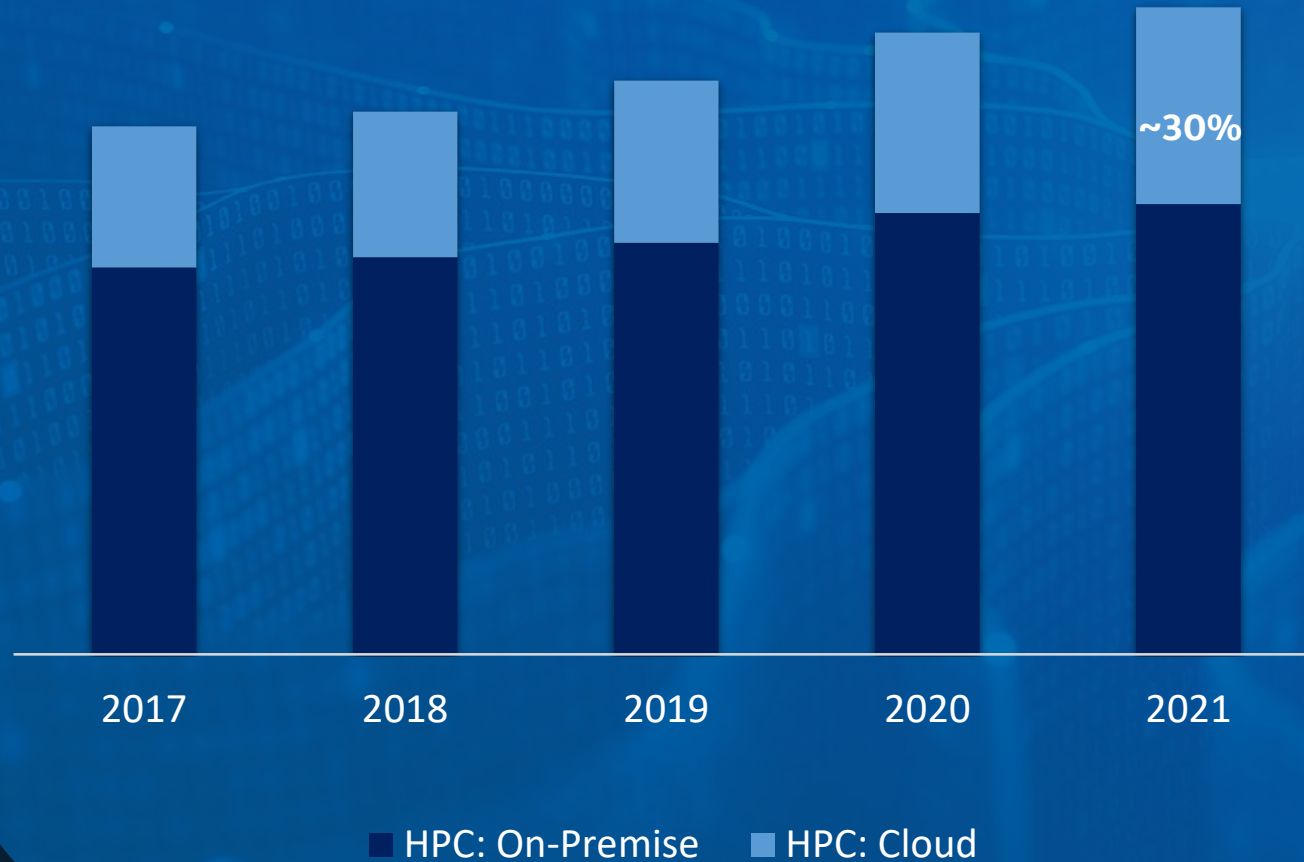
**HPC IS CHANGING...**

**...BUT WHAT IS HPC?**



# HPC IN PUBLIC CLOUD: GROWING AND POISED FOR ACCELERATION

HPC by Deployment Type



Industrial HPC customers' near-term budget trends:

- 20% growth for public cloud
- Over 2x the growth in HPC server and technical computing desktop spending