The HPC Ecosystem at AWS

HPC and the Cloud? Surely you must be joking.

Brian W Barrett
Principal Engineer, HPC Engineering, AWS
HPC in AWS Examples
Tightly-coupled HPC – weather

![WRF 2.5k CONUS Benchmark](chart.png)

**WRF 2.5k CONUS Benchmark**

Instance type: c4.8xlarge
HyperThreading: off
HPC in aerospace

Boom leverages Rescale and AWS to enable supersonic travel

- Simulated vortex lift with 200M cell models on 512+ cores
- Increased simulation throughput: 100 jobs in parallel with 6x speedup per job → 600x speedup
- Eliminated IT overhead, including server capital costs & in-house IT and software teams
- Elastic HPC capacity and pay-as-you-go AWS clusters allow business agility & ability to scale

“Rescale’s ScaleX cloud platform is a game-changer for engineering. It gives Boom computing resources comparable to building a large on-premise HPC center. Rescale lets us move fast with minimal capital spending and resources overhead.”

- Josh Krall
- CTO & Co-Founder
1.1M vCPUs for Machine Learning

A group of researchers from Clemson University achieved a remarkable milestone while studying topic modeling, an important component of machine learning associated with natural language processing, breaking the record for creating the largest high-performance cluster in the cloud by using more than 1,100,000 vCPUs on Amazon EC2 Spot Instances running in a single AWS region.
What Customers Want
Customer Asks

• Elasticity
• Time to completion
• Flexibility
• TCO/ROI
Cluster Load

Ideal
Cluster Load

Ideal

Reality
Review: C5 Instances – “Compute”

- Custom Intel Xeon Scalable processor (Skylake) @ 3.0 GHz
  - Turbo up to 3.5 ghz
- Supports AVX512
- C-state controls

<table>
<thead>
<tr>
<th>Model</th>
<th>Cores</th>
<th>Memory (GiB)</th>
<th>Network Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>c5.large</td>
<td>1 (2 vCPU)</td>
<td>4</td>
<td>Up to 10Gbps</td>
</tr>
<tr>
<td>c5.xlarge</td>
<td>2 (4 vCPU)</td>
<td>8</td>
<td>Up to 10Gbps</td>
</tr>
<tr>
<td>c5.2xlarge</td>
<td>4 (8 vCPU)</td>
<td>16</td>
<td>Up to 10Gbps</td>
</tr>
<tr>
<td>c5.4xlarge</td>
<td>8 (16 vCPU)</td>
<td>32</td>
<td>Up to 10Gbps</td>
</tr>
<tr>
<td>c5.9xlarge</td>
<td>18 (36 vCPU)</td>
<td>72</td>
<td>10Gbps</td>
</tr>
<tr>
<td>c5.18.xlarge</td>
<td>36 (72 vCPU)</td>
<td>144</td>
<td>25Gbps</td>
</tr>
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</table>
We Confess... We Like Ethernet..
But Ethernet?
But Ethernet?
Ok, so Latency?

- We can add bandwidth; it’ll cost money, but it’s technically easy
- Latency is harder...

EC2 Placement Group Latency

Round Trip Latency (µs)

- p50
- p99

CC2  C3  C4  M4  C5  2018
# AWS compute instance types

<table>
<thead>
<tr>
<th>General Purpose</th>
<th>Compute Optimized</th>
<th>Storage and I/O Optimized</th>
<th>Memory Optimized</th>
<th>GPU Graphics</th>
<th>GPU and FPGA Compute</th>
</tr>
</thead>
<tbody>
<tr>
<td>T2</td>
<td>C5</td>
<td>I3</td>
<td>X1</td>
<td>P3</td>
<td>P2</td>
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<tr>
<td>M5</td>
<td>C4</td>
<td>H1</td>
<td></td>
<td>P2</td>
<td>P2</td>
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<tr>
<td>M4</td>
<td></td>
<td>D2</td>
<td>R4</td>
<td>H1</td>
<td>H1</td>
</tr>
</tbody>
</table>
AWS Storage is a Platform

Amazon EFS
Amazon EBS
Amazon EC2 Instance Store
Amazon S3 / S3-IA
Amazon Glacier

File
Block
Object

Data Transfer

Internet/VPN
AWS Direct Connect
Amazon CloudFront
S3 Transfer Acceleration
ISV Connectors
Storage Gateway
AWS Snowball
Amazon Kinesis Firehose
So About that Custom Hardware?
Slightly Sillier Example...

Ruggedized case
“8.5G impact”

80 TB
10 GE network

E-ink shipping label

Rain- and dust-resistant
Tamper-resistant case and electronics
All data encrypted end-to-end
What You Think AWS Looks Like

Hardware

Software

Amazon Linux

cc2.8xlarge

Instance Storage
EBS Volumes
VPC Networking
What AWS Looks Like Today

Software
Nitro Hypervisor

Hardware
EBS Volumes

c5.18xlarge

Enhanced Networking

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Or if you prefer not to have a hypervisor
Where we’re innovating
FPGA Ecosystem

- Building an ecosystem important
- FPGA instance type, 8 FPGAs per instance
  - 16 nm Xilinx UltraScale Plus FPGA
  - 64 GiB DDR4 ECC protected memory, with a dedicated PCIe x16 connection.
  - Each FPGA contains approximately 2.5 million logic elements and approximately 6,800 Digital Signal Processing (DSP) engines.
- Reusable Amazon FPGA (AFI) to build marketplace of FPGA options
- Developer AMI to build your own
  - prepackaged tool development environment
  - scripts and tools for simulating your FPGA design, compiling code, and building and registering your AFI.
Thank you!

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