Noise in the Clouds: Influence of Network Performance Variability on Application Scalability

*Now at Sapienza University of Rome, Italy*
# HPC in the cloud

<table>
<thead>
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</thead>
<tbody>
<tr>
<td>AWS</td>
<td>2x18C Intel Xeon Platinum @ 3GHz</td>
<td>100 Gb/s</td>
<td>Fat Tree</td>
<td>SRD</td>
</tr>
<tr>
<td>Azure</td>
<td>2x22C Intel Xeon Platinum @ 2.7GHz</td>
<td>100-200 Gb/s</td>
<td>Non-blocking Fat Tree</td>
<td>InfiniBand</td>
</tr>
<tr>
<td>GCP</td>
<td>2x15C Intel Cascade Lake @ 3.1GHz</td>
<td>100 Gb/s</td>
<td>3:1 blocking Fat Tree</td>
<td>TCP/IP + Intel QuickData</td>
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<tr>
<td>Oracle</td>
<td>2x18C Intel Xeon Gold @ 3GHz</td>
<td>100 Gb/s</td>
<td>Non-blocking Fat Tree</td>
<td>RoCEv2</td>
</tr>
<tr>
<td>Daint</td>
<td>2x18C Intel Xeon E5-2695 v4 @2.1GHz</td>
<td>82 Gb/s</td>
<td>Cray Aries (Dragonfly)</td>
<td>FMA</td>
</tr>
<tr>
<td>Alps</td>
<td>2x64C AMD EPYC 7742 @ 2.25GHz</td>
<td>100 Gb/s</td>
<td>HPE Cray Slingshot (Dragonfly)</td>
<td>RoCEv2</td>
</tr>
<tr>
<td>DEEP-EST</td>
<td>2x12C Intel Xeon Gold @3.2GHz</td>
<td>100 Gb/s</td>
<td>Mellanox Infiniband</td>
<td>InfiniBand</td>
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**Target**

Compare **network performance** of cloud HPC vs on-premise HPC

Analyze **network noise** of cloud HPC vs on-premise HPC and its impact **at scale**
Network Performance
Bandwidth and latency

![Graph showing bandwidth and latency comparison for various services including AWS, GCP, Alps, DEEP-EST, Azure, Oracle, and Daint. The x-axis represents message size ranging from 1B to 16MiB, while the y-axis shows bandwidth in Gb/s. The graph illustrates how different services perform under varying message sizes.]
HPC vs. normal instances

- AWS
  - Bandwidth (Gb/s)
  - Message Size: 1B, 256B, 64KiB, 16MiB
  - RTT (µs)

- Azure
  - Bandwidth (Gb/s)
  - Message Size: 1B, 256B, 64KiB, 16MiB
  - RTT (µs)

- GCP
  - Bandwidth (Gb/s)
  - Message Size: 1B, 256B, 64KiB, 16MiB
  - RTT (µs)

- Oracle
  - Bandwidth (Gb/s)
  - Message Size: 1B, 256B, 64KiB, 16MiB
  - RTT (µs)
Network Noise
Bandwidth noise

Cloud systems are more affected by bandwidth noise than premise systems.
Noise impact at scale
Noise
Methodology

Get network performance measurements...  
...and OS and network noise measurements...

...and simulate performance at scale
Simulation validation (16 nodes)
Bandwidth noise can increase the runtime by 50% even when running at small scale (4 nodes)
Impact of bandwidth noise on monetary cost

Dummy application: 8192x8192 matrix multiplication followed by 512MiB allreduce (20% of time spent in communication)

Network noise impacts the monetary cost, even for applications not dominated by communication.
Conclusions

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... or [spcl.ethz.ch](https://spcl.ethz.ch)

https://github.com/DanieleDeSensi/cloud_noise
https://github.com/DanieleDeSensi/cloud_noise_data