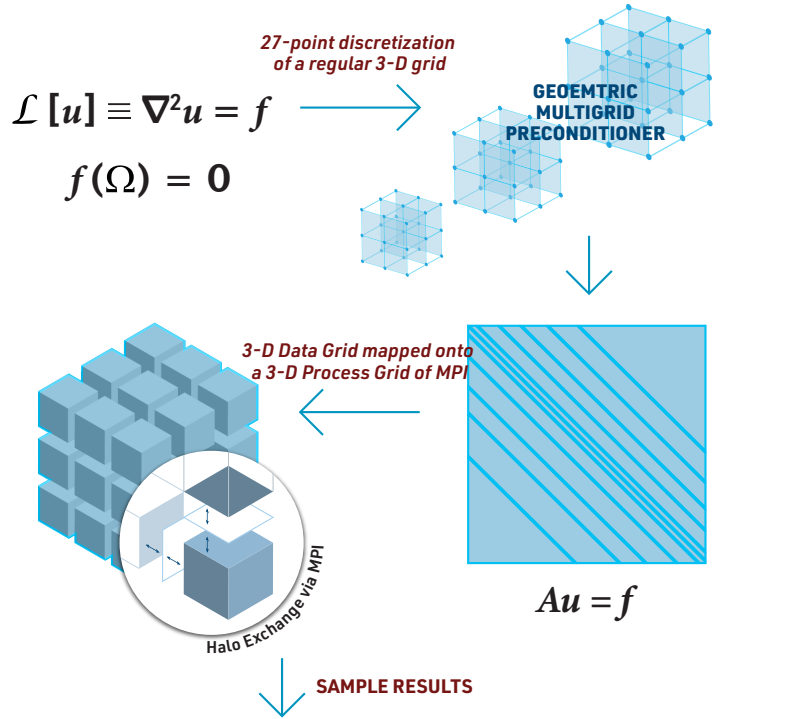


HPCG

NOVEMBER 2019 HPCG TOP 5		SITE	COUNTRY	R _{MAX} PFLOP/S	HPCG PFLOP/S
1	Summit	DOE/SC/ORNL	USA	143.5	2.93
2	Sierra	DOE/NNSA/LLNL	USA	94.6	1.80
3	Trinity	DOE/NNSA/LANL/SNL	USA	20.2	0.54
4	ACBI	AIST	Japan	16.9	0.51
5	Piz Daint	CSCS	Switzerland	21.2	0.50

The HPC Conjugate Gradient (HPCG) benchmark uses a preconditioned conjugate gradient (PCG) algorithm to measure the performance of HPC platforms with respect to frequently observed, yet challenging, patterns of execution, memory access, and global communication.

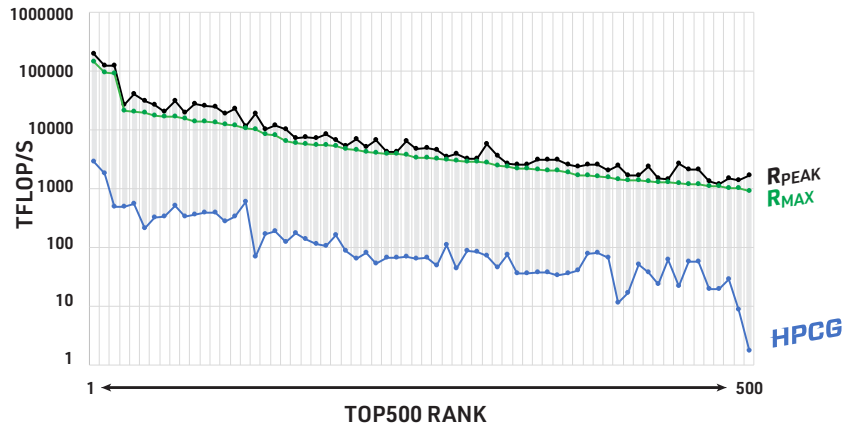
The PCG implementation uses a regular 27-point stencil discretization in 3 dimensions of an elliptic partial differential equation (PDE) with zero Dirichlet boundary condition. The 3-D domain is scaled to fill a 3-D virtual process grid of all available MPI process ranks. The CG iteration includes a local and symmetric Gauss-Seidel preconditioner, which computes a forward and a back solve with a triangular matrix. All of these features combined allow HPCG to deliver a more accurate performance metric for modern HPC hardware architectures.



PRECONDITIONED CONJUGATE GRADIENT SOLVER

```

p0 ← x0, r0 ← b - Ap0
for i = 1, 2, to max_iterations do
  zi ← M-1ri-1
  if i = 1 then
    pi ← zi
    αi ← dot_prod(ri-1, zi)
  else
    αi ← dot_prod(ri-1, zi)
    βi ← αi/αi-1
    pi ← βipii-1 + zi
  end if
  αi ← dot_prod(ri-1, zi) / dot_prod(pi, Api)
  xi+1 ← xi + αipi
  ri ← ri-1 - αiApi
  if ||ri||2 < tolerance then
    STOP
  end if
end for
  
```



FIND OUT MORE AT
<http://www.hpcg-benchmark.org/>



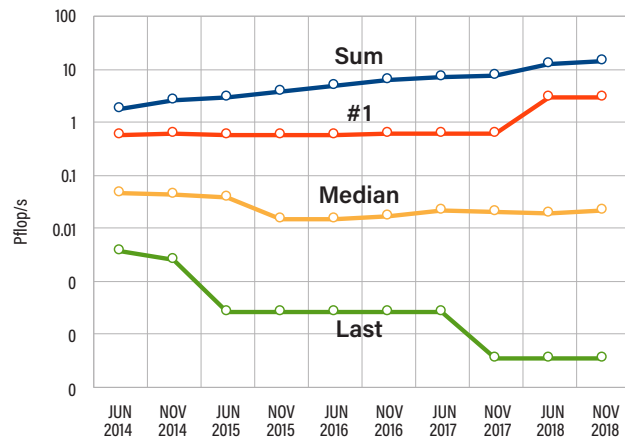
HPCG



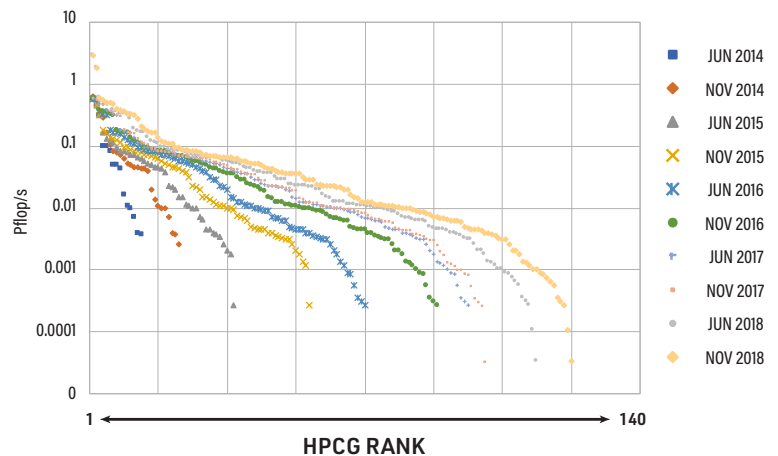
FIND OUT MORE AT

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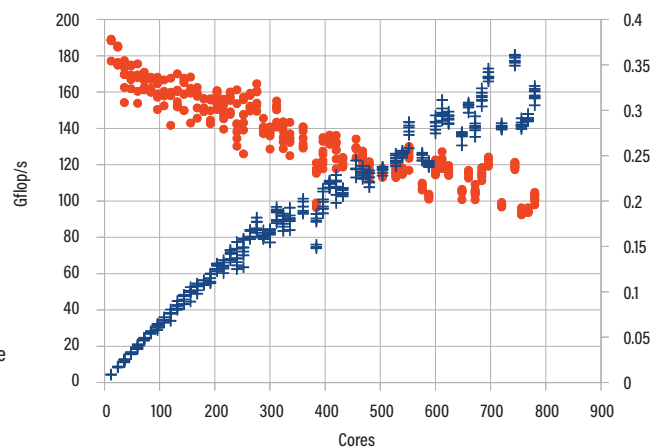
The chart to the right shows various performance statistics from the past HPCG result lists. The sum of performance indicates steady growth of results accumulated on the list. The median and smallest values decrease as HPCG list increases the number of systems on the list, thus expanding the range of recorded values. The #1 entry experienced a large increase in June 2018 with the introduction of Summit, nearly reaching 3 Pflop/s.



The chart to the right shows all performance results from the past HPCG result lists. Different lists are represented by different colors. The number of entries on the lists keeps increasing and reached 130 in 2018.



The chart to the right shows scaling performance results of the reference HPCG code on 780-core cluster with 180 InfiniBand interconnect. The scaling is 160 linear (blue marks) with constant per-core performance (red marks) for 140 small core counts (below about 200 cores). Beyond that point, the scaling 120 slowly deteriorates to reveal hardware's deficiency for codes that 100 HPCG was designed to represent.



+ Gflop/s
● Gflop/s per core