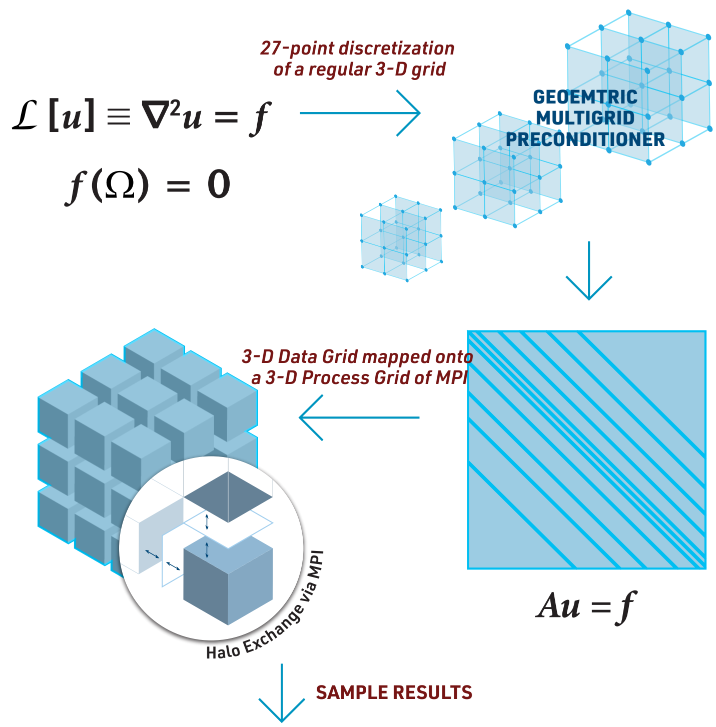
HPCG

NOVEMBER 2018 TOP 5

		SITE	COUNTRY	RMAX 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	**K computer**	RIKEN	Japan	10.5	0.60
4	**Trinity**	DOE/NNSA/LANL/SNL	USA	20.2	0.54
5	**ACBI**	AIST	Japan	16.9	0.51

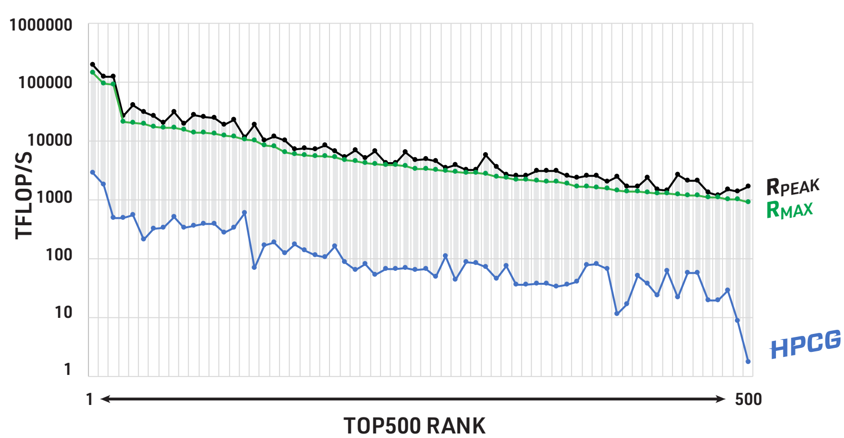
The HPC Conjugate Gradient (HPCG) benchmark uses a preconditioned conjugate gradient (PCG) algorithm to measure the performance of HPC platforms with respect to frequently observed, yet challenging, patterns of execution, memory access, and global communication.

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

$p_0 \leftarrow x_0,\ r_0 \leftarrow b - Ap_0$
for $i = 1, 2,$ to max_iterations **do**
  $z_i \leftarrow M^{-1} r_{i-1}$
  if $i = 1$ **then**
    $p_i \leftarrow z_i$
    $\alpha_i \leftarrow \text{dot\_prod}(r_{i-1}, z_i)$
  else
    $\alpha_i \leftarrow \text{dot\_prod}(r_{i-1}, z_i)$
    $\beta_i \leftarrow \alpha_i / \alpha_{i-1}$
    $p_i \leftarrow \beta_i p_{i-1} + z_i$
  end if
  $\alpha_i \leftarrow \text{dot\_prod}(r_{i-1}, z_i) / \text{dot\_prod}(p_i, Ap_i)$
  $x_{i+1} \leftarrow x_i + \alpha_i p_i$
  $r_i \leftarrow r_{i-1} - \alpha_i Ap_i$
  if $\|r_i\|_2 <$ tolerance **then**
    STOP
  end if
end for



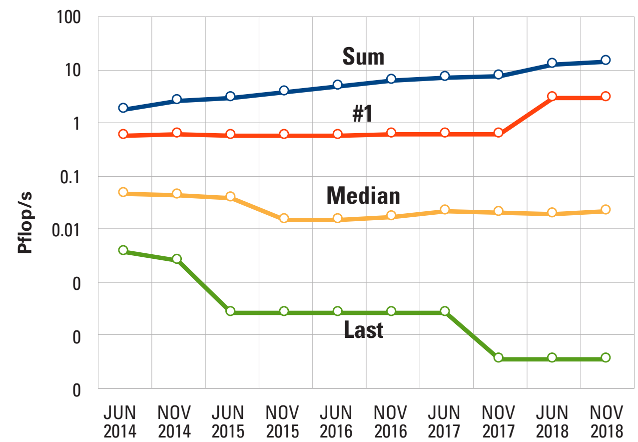
FIND OUT MORE AT
http://www.hpcg-benchmark.org/

SPONSORED BY

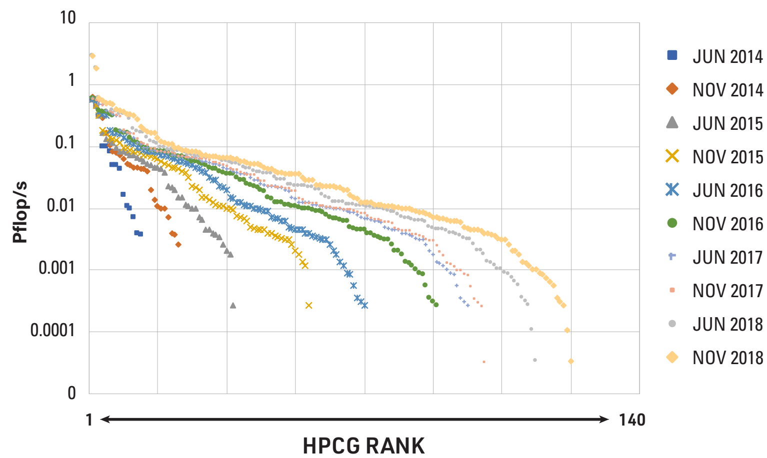
HPCG

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

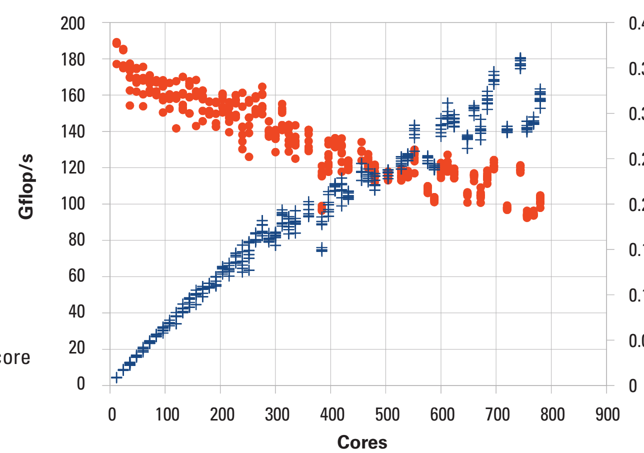
The chart to the right shows various performance statistics from the past HPCG result lists. The sum of performance indicates steady growth of results accumulated on the list. The median and smallest values decrease as HPCG list increases the number of systems on the list, thus expanding the range of 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.



ICL INNOVATIVE COMPUTING LABORATORY

THE UNIVERSITY OF TENNESSEE KNOXVILLE

Sandia National Laboratories

SPONSORED BY

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration