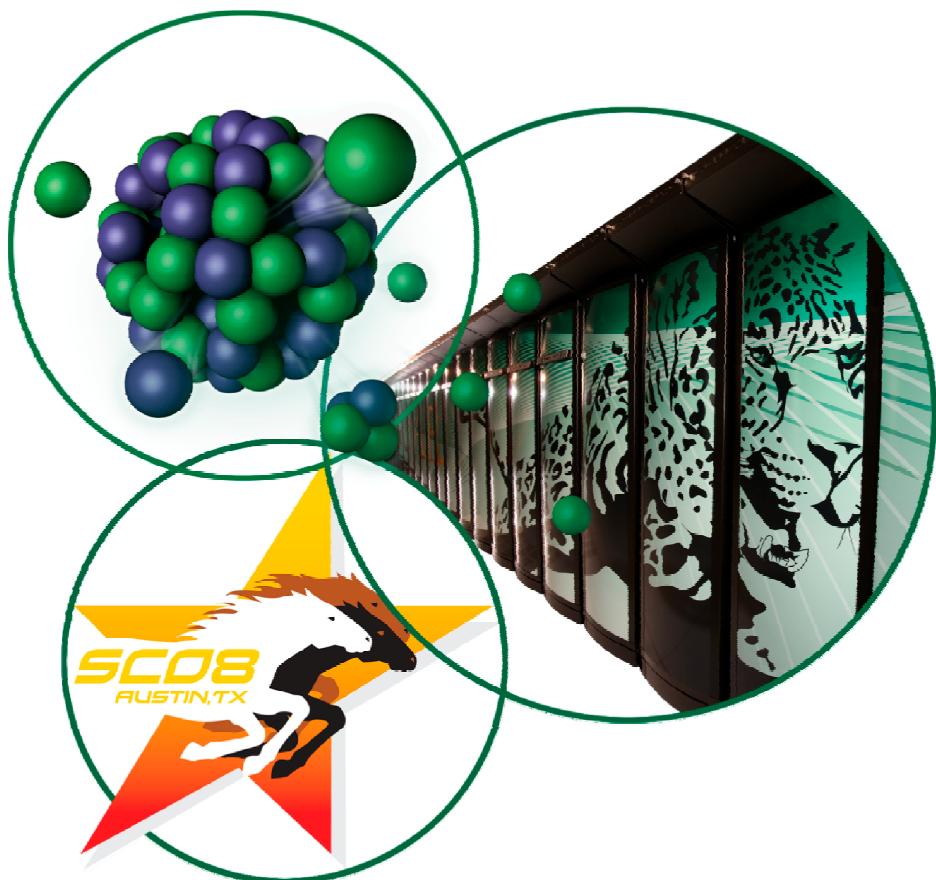


# The HPC Challenge (HPCC) Benchmark Suite



Presented by

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# HPCC: Components



## 1. HPL (High Performance LINPACK)

$$Ax=b$$

Name	Kernel	Bytes/iter	FLOPS/iter
Copy	$a(i) = b(i)$	16	0
Scale	$a(i) = q * b(i)$	16	1
Sum	$a(i) = b(i) + c(i)$	24	1
Triad	$a(i) = b(i) + q * c(i)$	24	2

## 2. STREAM

## 3. PTRANS

$$A \leftarrow A^T + B$$

## 4. RandomAccess



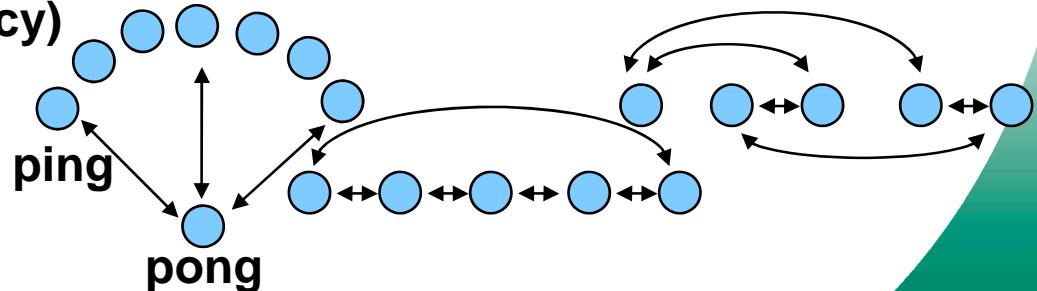
## 5. FFT

$$z_k = \sum_j x_j \exp(-2\pi i j k/n)$$

## 6. Matrix-matrix multiply

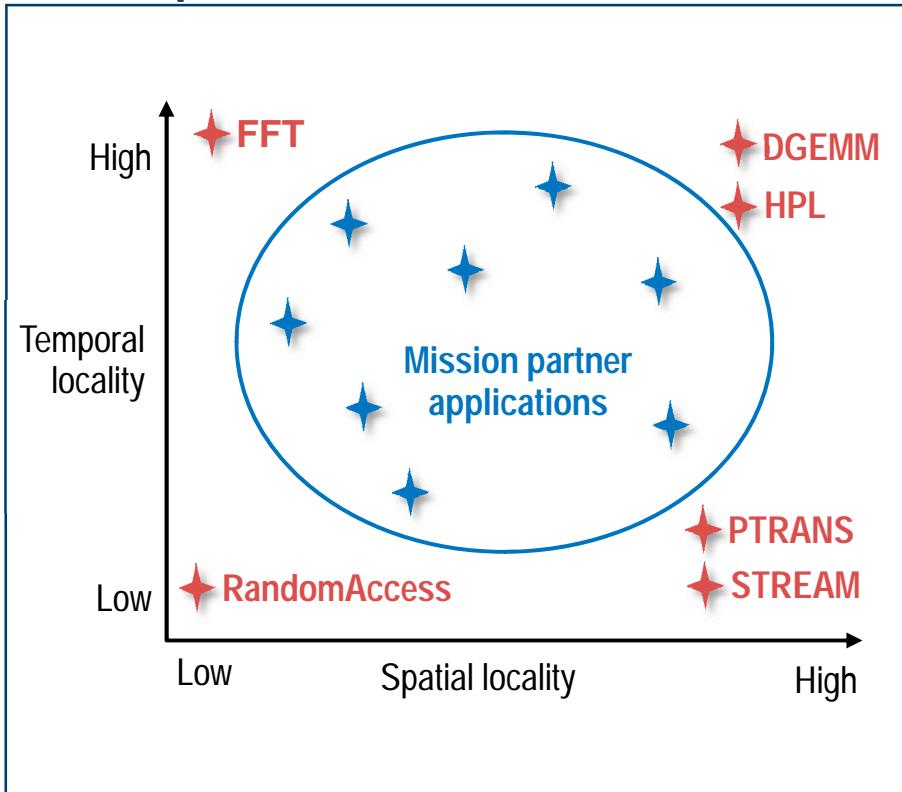
$$C \leftarrow s * C + t * A * B$$

## 7. b\_eff (effective bandwidth/latency)

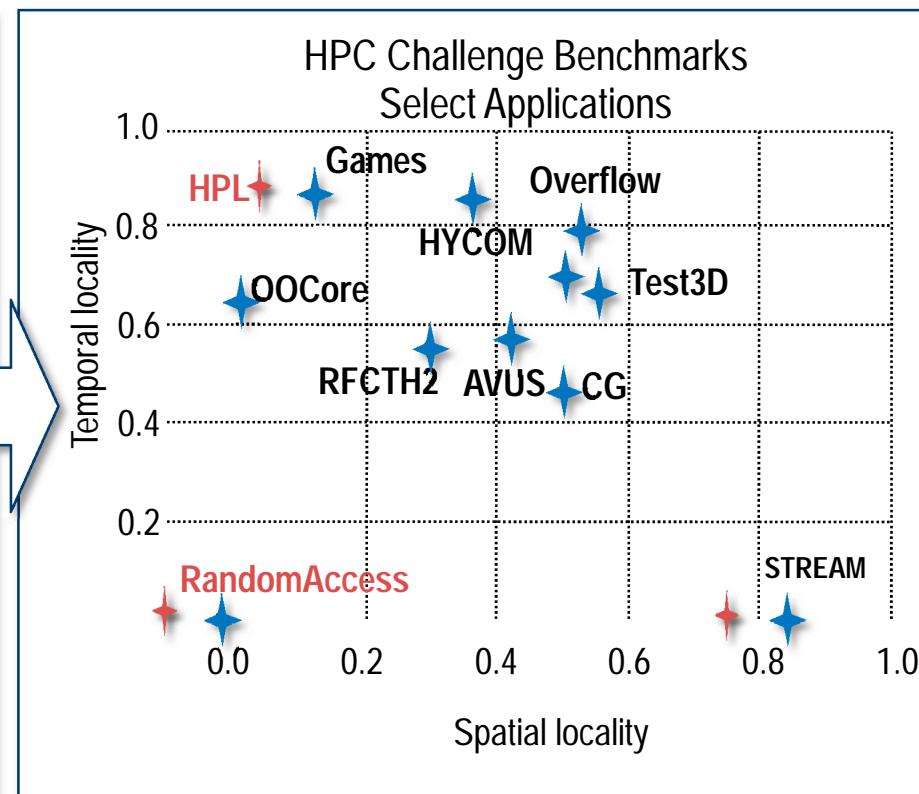


# HPCC: Motivation and measurement

## Concept



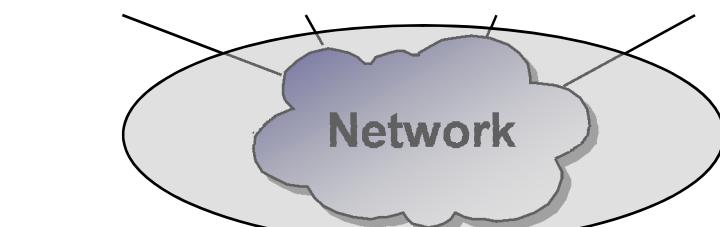
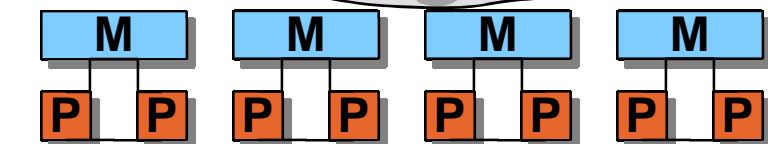
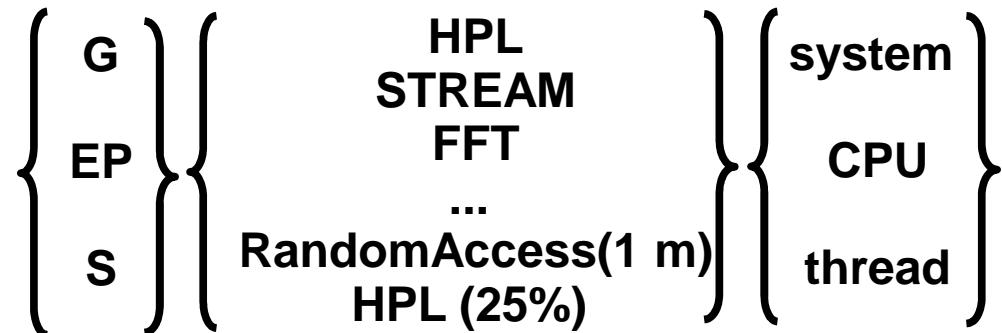
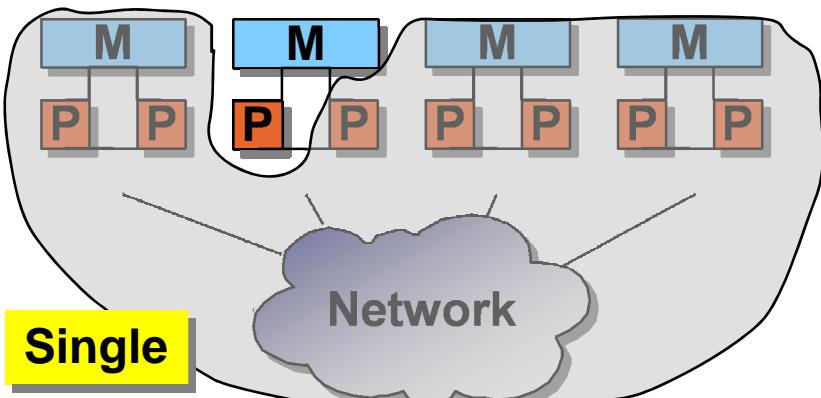
## Measurement



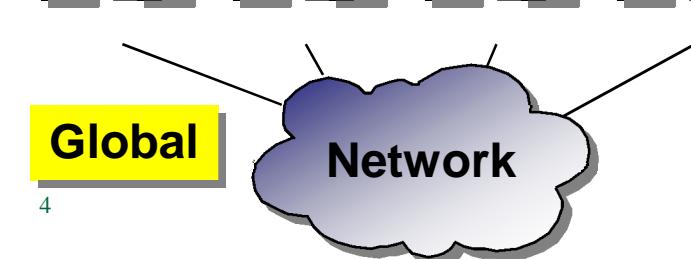
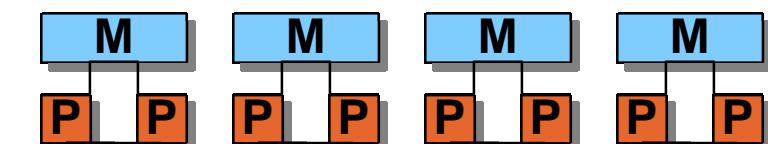
**Spatial and temporal data locality**  
here is for one node/processor  
- i.e., locally or "in the small"

Generated by PMaC @ SDSC

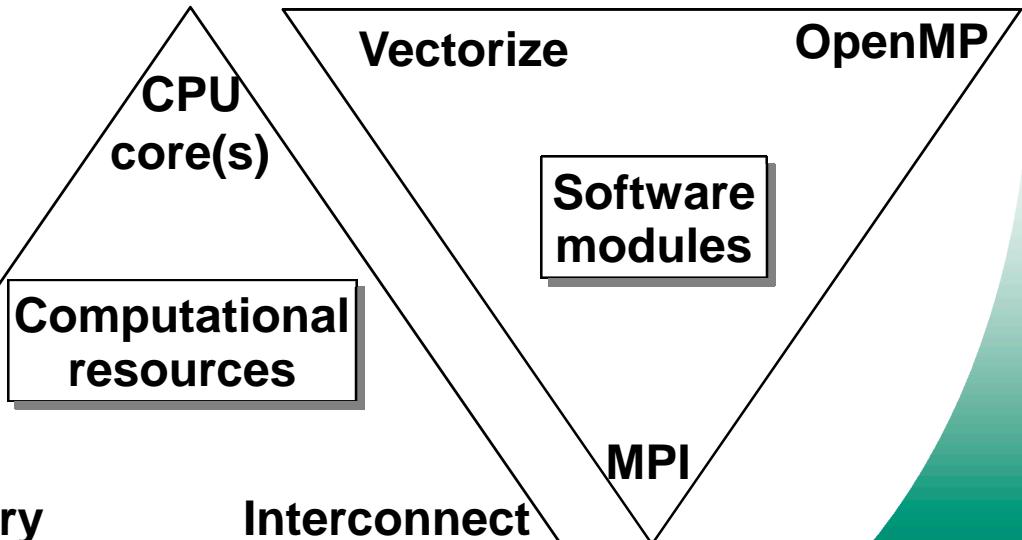
# HPCC: Scope and naming conventions



Embarrassingly Parallel



Global



# HPCC: Hardware probes

HPCS program has developed a new suite of benchmarks (HPC Challenge)

Each benchmark focuses on a different part of the memory hierarchy

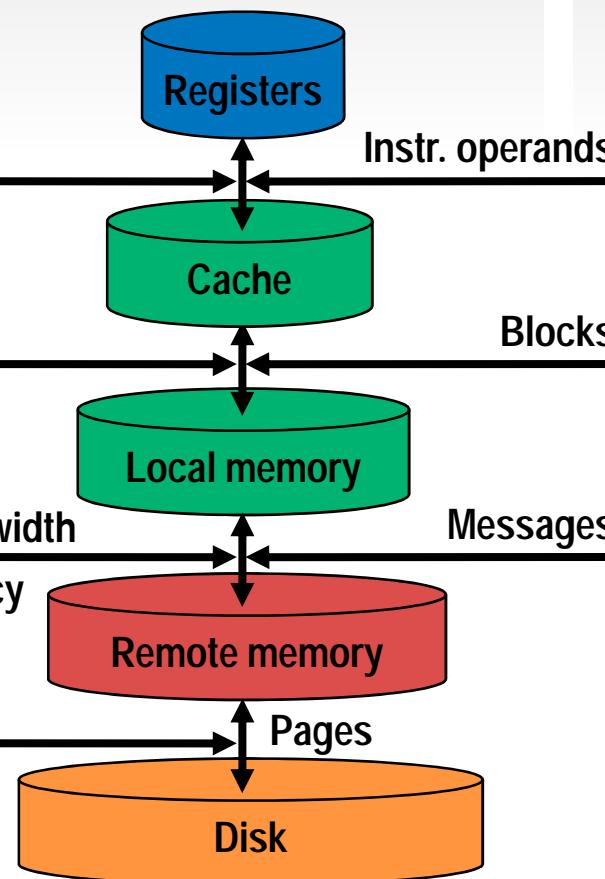
HPCS program performance targets will flatten the memory hierarchy, improve real application performance, and make programming easier

Top500: solves a system ( $Ax = b$ )

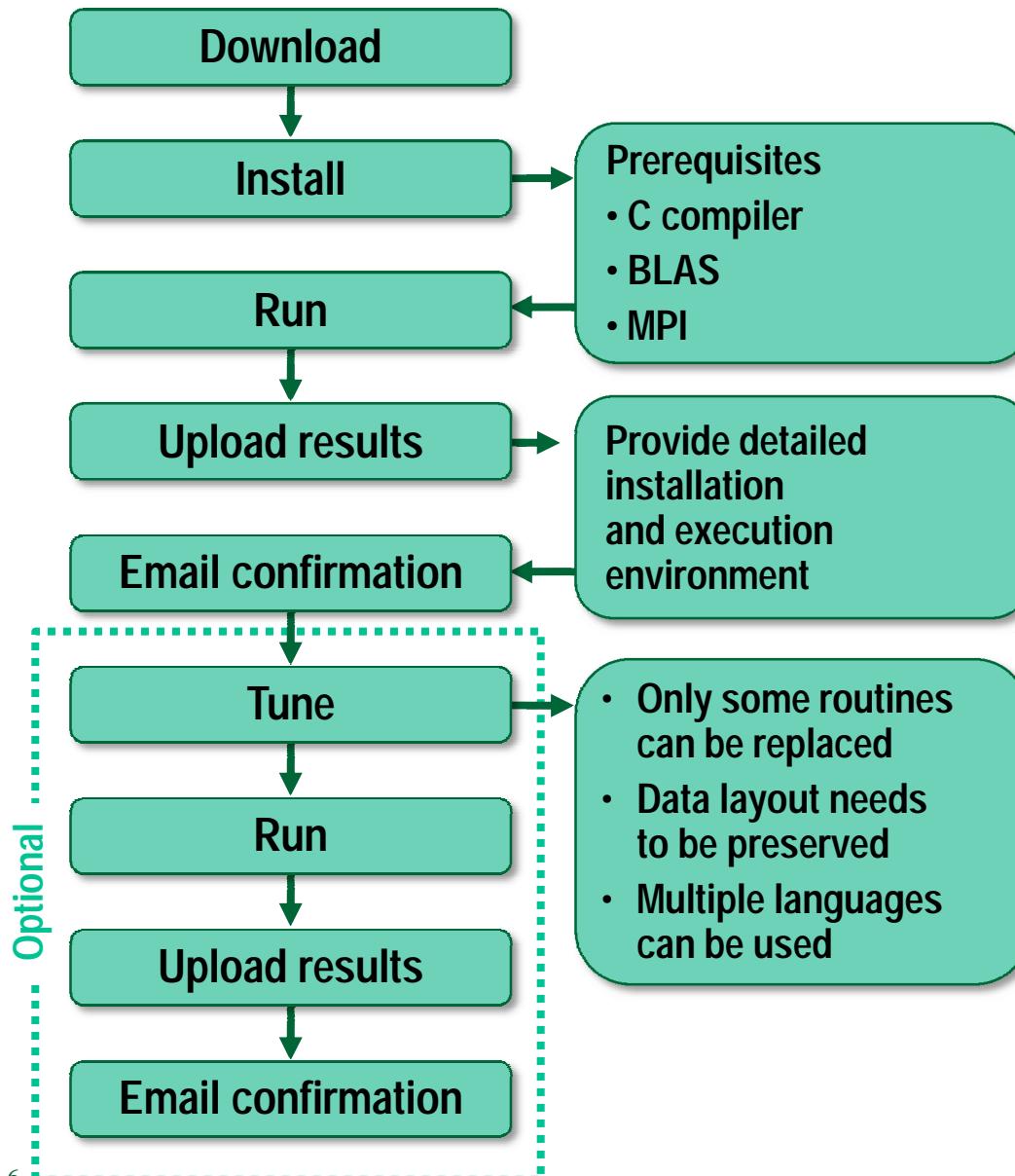
STREAM: vector operations ( $A = B + s \times C$ )

FFT: 1D fast Fourier transform [ $Z = FFT(X)$ ]

RandomAccess: Random updates [ $T(i) = XOR(T(i), r)$ ]



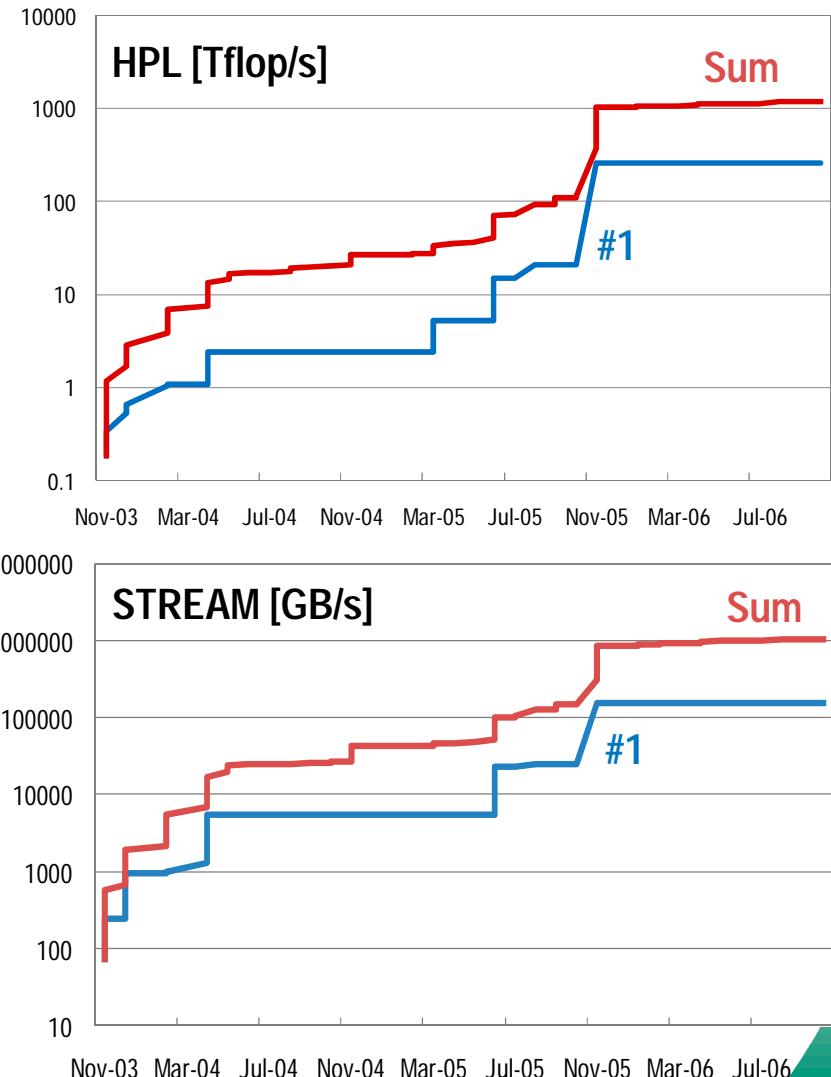
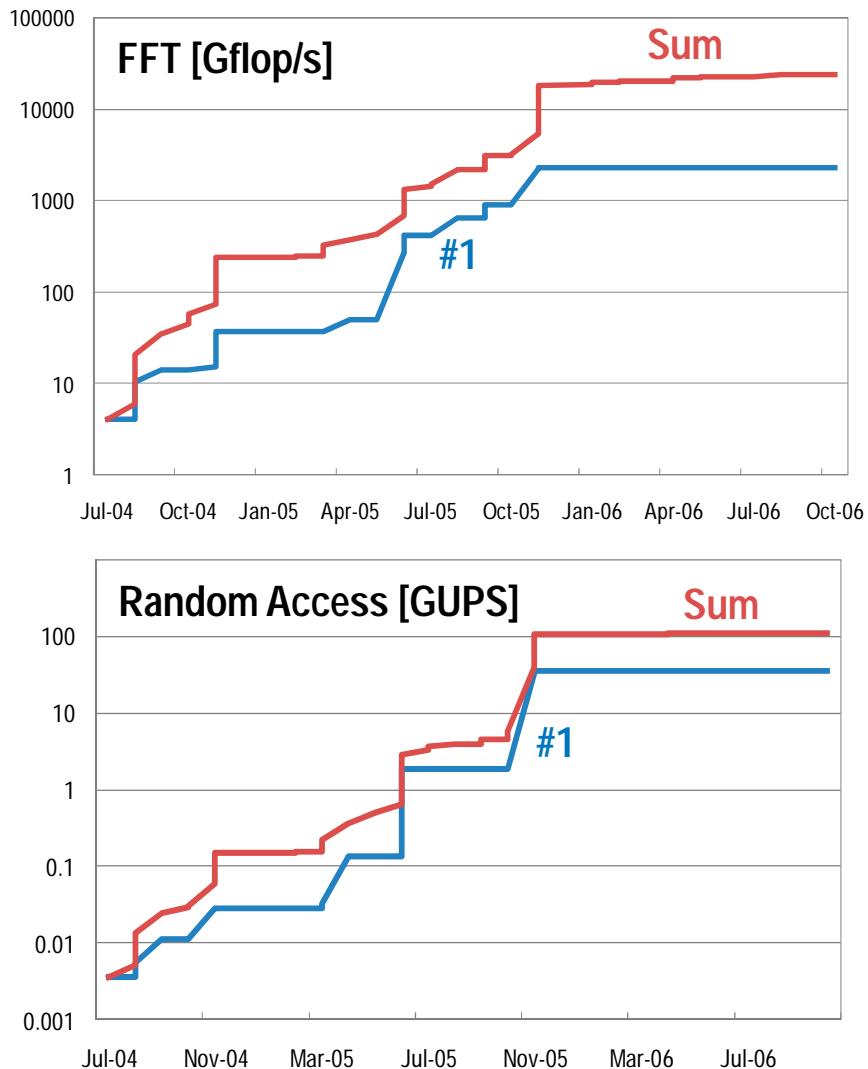
# HPCC: Official submission process



Results are immediately available on the Web site:

- Interactive HTML
- XML
- MS Excel
- Kiviat charts (radar plots)

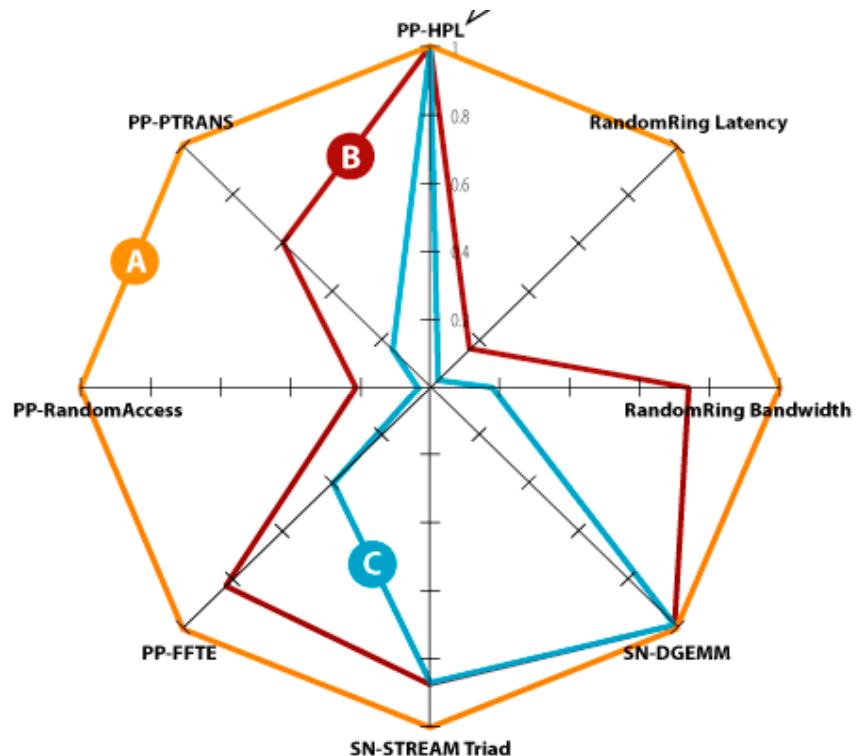
# HPCC: Submissions over time



# HPCC: Comparing three interconnects

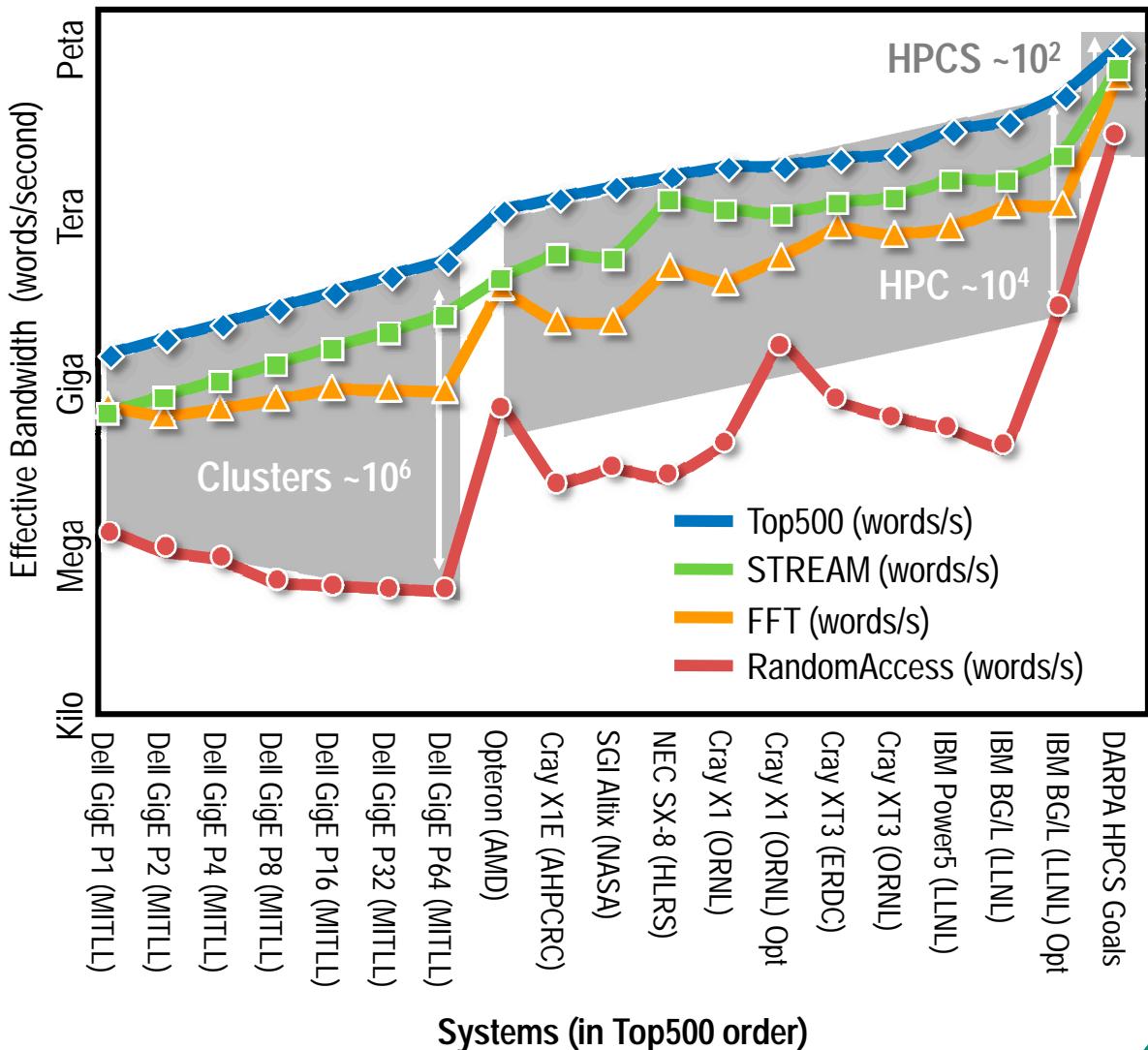
- 3 AMD Opteron clusters
  - Clock: 2.2 GHz
  - 64-processor cluster
- Interconnect types
  - A. Vendor
  - B. Commodity
  - C. GigE
  - G-HPL
  - Matrix-matrix multiply
- Cannot be differentiated based on
  - G-HPL
  - Matrix-matrix multiply
- Available on HPCC Web site
  - <http://icl.cs.utk.edu/hpcc/>

Kiviat chart (radar plot)



# HPCC: Analysis of sample results

- All results in words/second
- Highlights memory hierarchy
- Clusters
  - Hierarchy steepens
- HPC systems
  - Hierarchy constant
- HPCS goals
  - Hierarchy flattens
  - Easier to program



# HPCC: Augmenting June TOP500

Rank	Name	Rmax	Data provided by HPCC database						
			HPL	PTRANS	STREAM	FFT	GUPS	Lat.	b/w
1	BG/L	280.6	259.2	4665.9	160	2311	35.47	5.92	0.16
2	BGW (*)	91.3	83.9	171.5	50	1235	21.61	4.70	0.16
3	ASC Purple	75.8	57.9	553.0	44	842	1.03	5.11	3.22
4	Columbia (*)	51.9	46.8	91.3	21	230	0.25	4.23	1.39
5	Tera-10	42.9							
6	Thunderbird	38.3							
7	Fire x4600	38.18							
8	BlueGene eServer	37.33							
9	Red Storm	36.2	33.0	1813.1	44	118	1.02	7.97	1.15
10	Earth Simulator	35.9							

# Contact

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