



pMatlab Takes the HPCchallenge

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Motivation

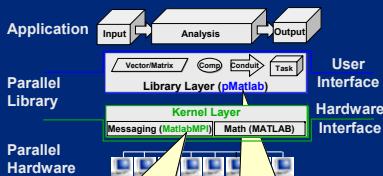
- The DARPA HPCs program has created the HPCchallenge benchmark suite in an effort to redefine how we measure productivity in the HPC domain
- MATLAB® is the primary high level language used within the signal processing community; increasingly used for
 - large system simulations
 - processing data in the field
- pMatlab implements global array semantics in MATLAB
 - Global array semantics allow indexing and general element access for distributed data
- Implementing the HPCchallenge benchmarks using pMatlab allows a unique opportunity to explore the merits of pMatlab with respect to high performance embedded computing

Goals

- Implement and analyze the performance of HPCchallenge benchmarks using pMatlab
- Optimize and add functionality to the pMatlab toolbox
- Compare traditional C/MPI with MATLAB using global array semantics. Measurements of productivity include:
 - Maximum problem size: Largest problem that can be solved or fit into memory
 - Execution performance: Run-time performance of the benchmark
 - Code size: Software lines of code (SLOC) required to implement the benchmark

pMatlab

pMatlab Software Architecture

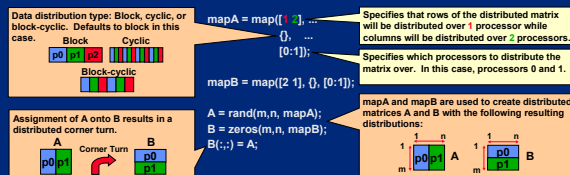


- Can build a parallel library with a few messaging primitives
- MatlabMPI provides this messaging capability:

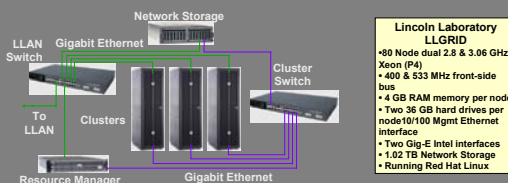

```
MPI_Send(dst, comm, tag, X);
MPI_Recv(source, comm, tag);
```
- Can build applications with a few parallel structures and functions
- pMatlab provides parallel arrays and functions


```
X = ones(n, mapX);
Y = zeros(m, mapY);
Y(i, :) = Zt(X);
```

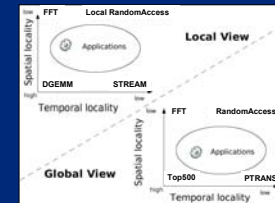
pMatlab Goal: Maps and Distributed Matrices



Benchmark Platform



HPCchallenge



HPCchallenge Relevance to HPEC

- Four key benchmarks have significant relevance to HPEC
 - FFT: Distributed corner turn and FFTs important in multi-sensor signal processing
 - RandomAccess: Random data accesses typical of "post detection" operations
 - Top500: Matrix-matrix multiplies typical of multi-element beamforming
 - STREAM: Distributed vector operations common to signal processing
- Multiple implementations
 - C/Fortran, C/Fortran+MPI, MATLAB, pMatlab

Conclusions

Benchmark Results Summary

- Memory scalability comparable to C/MPI on nearly all of HPCchallenge (for 128 CPUs). Allows MATLAB users to work on much larger problems.
- Execution performance comparable to C/MPI on nearly all of HPCchallenge (for 128 CPUs). Allows MATLAB users run their programs much faster.
- Code size much smaller. Allows MATLAB users to write programs much faster than C/MPI
- pMatlab allows MATLAB users to effectively exploit parallel computing, and can achieve performance comparable to C/MPI.

HPCchallenge Benchmark Results: C/MPI vs. pMatlab

	Maximum Problem Size	Execution Performance	Code Size: C/MPI to pMatlab ratio
Random Access	Comparable (128x)	Comparable	6x
Top500	pMatlab (86x), C/MPI (83x)	pMatlab (3x), C/MPI (35x)	66x
FFT	Comparable (128x)	Comparable (55x)	35x
STREAM	Comparable (128x)	Comparable (128x)	8x

This work is sponsored by Defense Advanced Research Projects Administration, under Air Force Contract F19628-00-C-0002. Opinions, interpretations, conclusions and recommendations are those of the author and are not necessarily endorsed by the United States Government.

