Benefits of Kernel-assisted Approaches on Scientific Applications: An Analysis Using LIMIC2 and CMA in MVAPICH2

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MVAPICH User Group (**MUG**) meeting

August, 26th 2013

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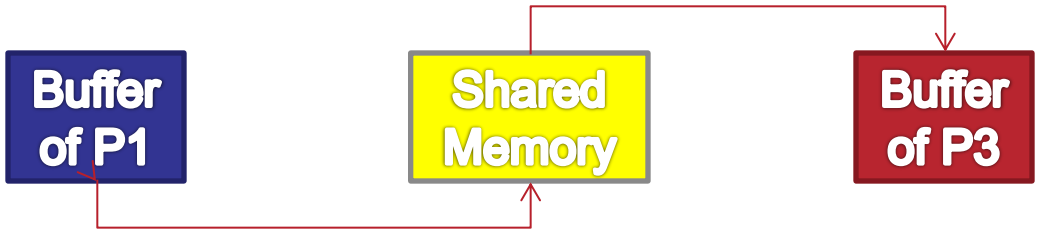
Why do we need LiMIC or CMA ?

- MPI is the de facto standard for writing parallel applications
- More and more cores inside nodes, it raises the importance/impact of intra-node communications.
- Most of MPI librairies use shared memory but…

Shared Memory



- Involved two memory copy operations
- Pro: portable solution, low latency
- Con: cache pollution for large messages, memory bandwidth and CPU cycle waste

LiMIC

- Linux Kernel Module for MPI Intra-Node Communication
- Need to be loaded
- Provides a kernel-assisted direct copy between MPI processes
- Simple interface.
- Used at TACC on Lonestar and Stampede

“Issues” with LiMIC

- Kernel crash: By passing an invalid LiMIC buffer identifier that will try to access a non-existing address space
- Security issue: it is possible to access the memory of all processes in the machine

CMA

- Introduced with Kernel 3.2
- Similar to LiMIC, but without the “issues”
- Support added in Mvapich2 1.9
- Two system calls:
  - process_vm_readv(): transfers data from the remote process to the local process.
  - process_vm_writv(): transfers data from the local process to the remote process.

Experimental setup

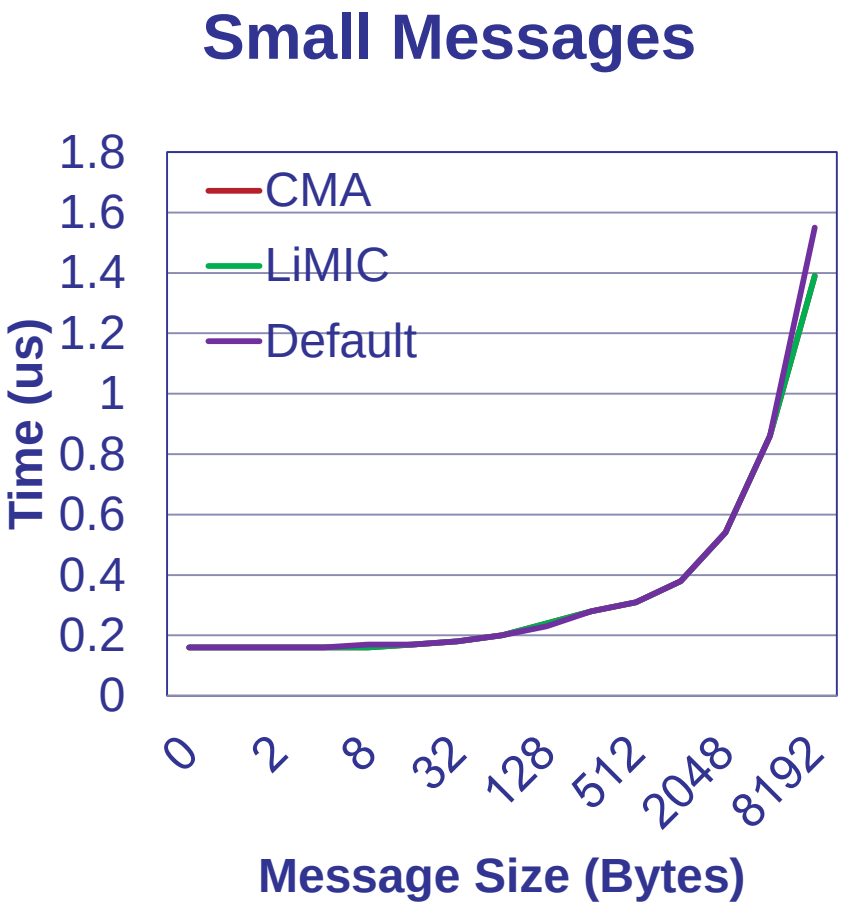
TACC Stampede Nodes :

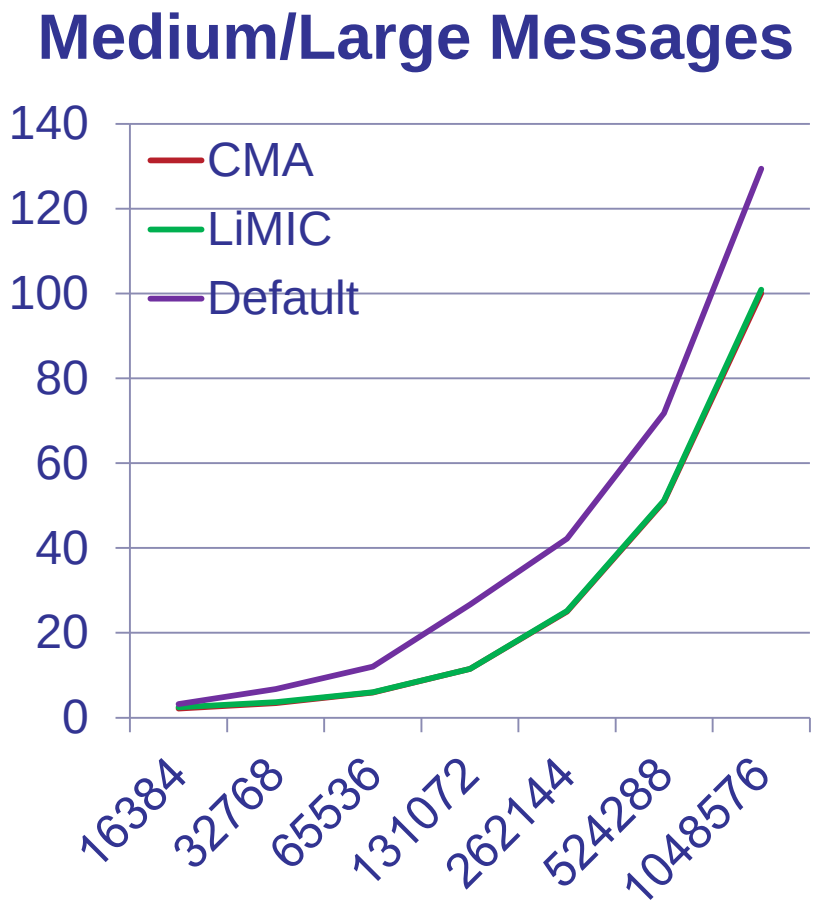
- Dual-socket 8-core Intel Sandy Bridge with Turbo (latency/Bandwidth) + Quad-socket 8-core Intel SB (Collective, NAS)
- CentOS
- Compiler: Intel 13.1.0

3 different builds of MVAPICH2 (Default, LiMIC, CMA)

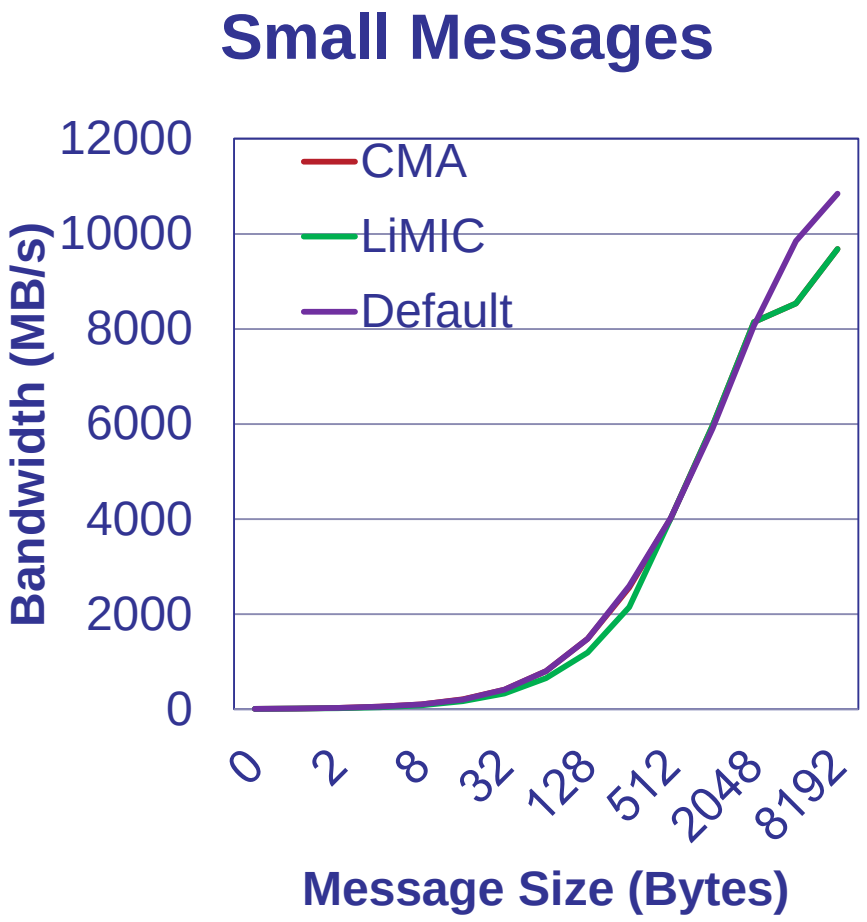
Benchmarks: OSU Benchmarks, NAS Class-D

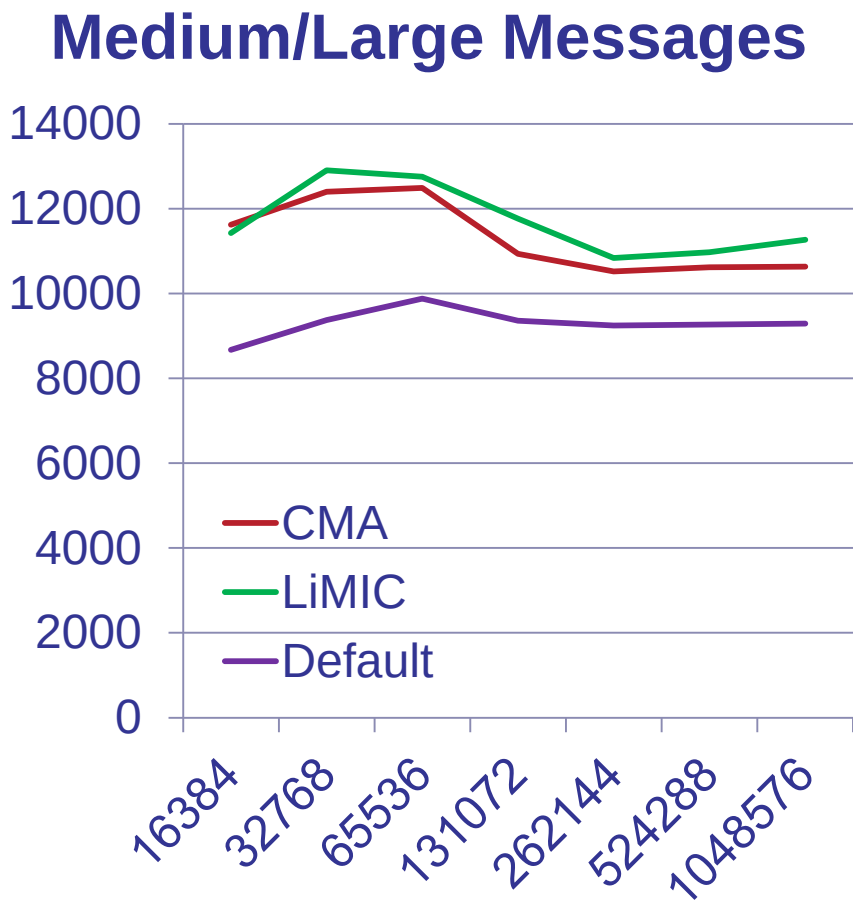
Latency Intra-socket



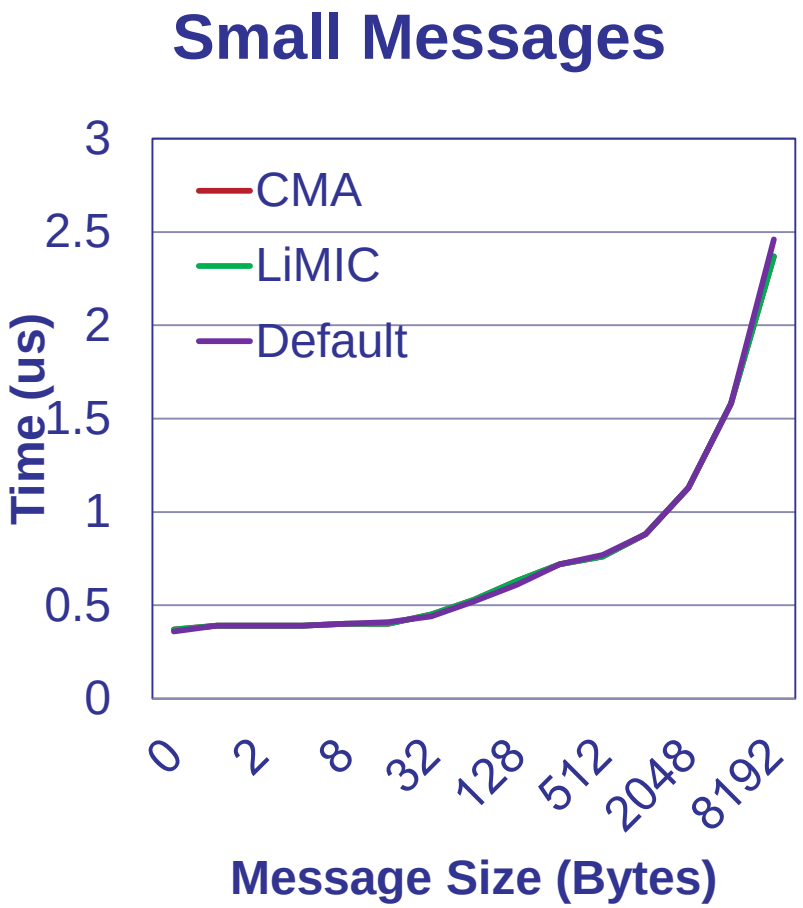


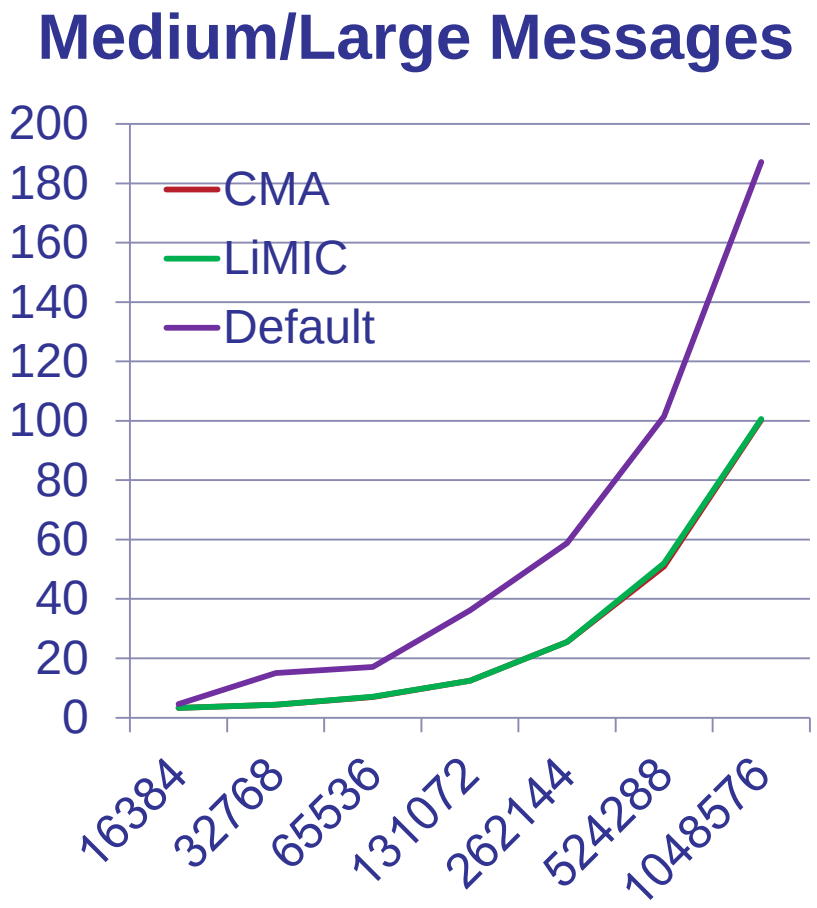
Bandwidth Intra-socket





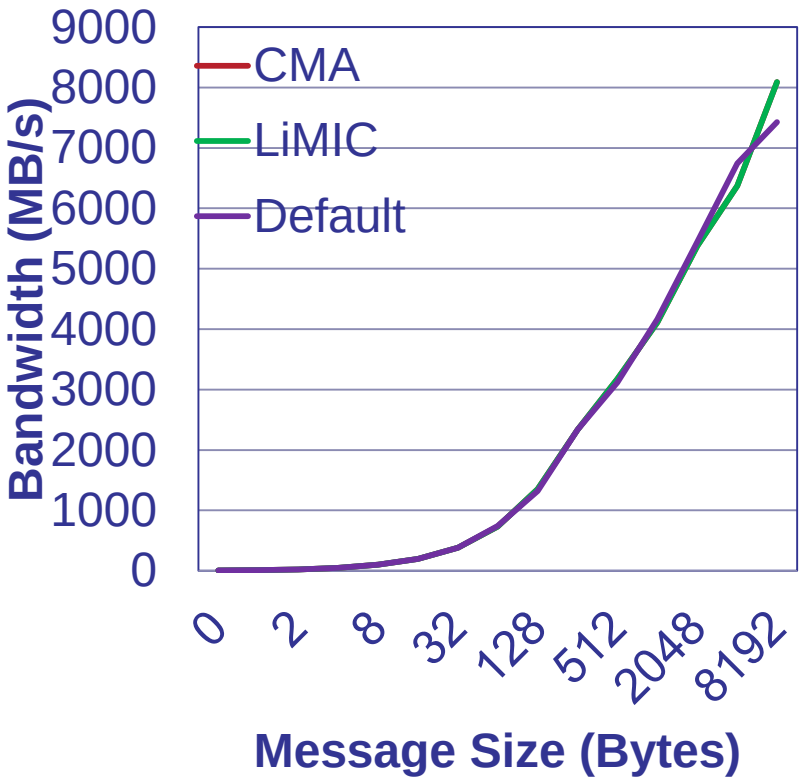
Latency Inter-socket



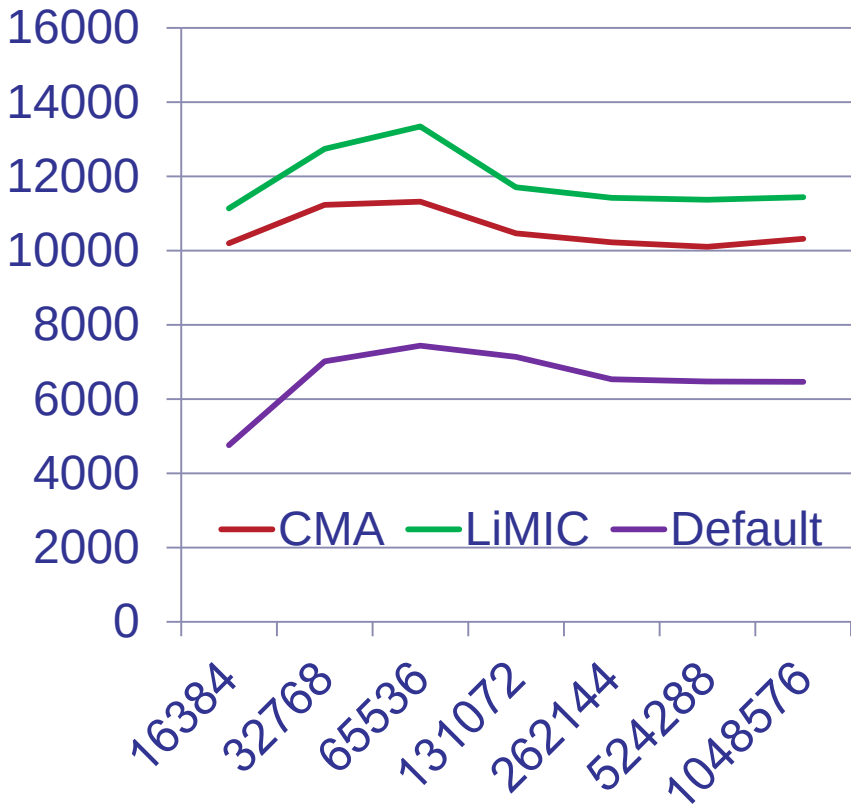


Bandwidth Inter-socket

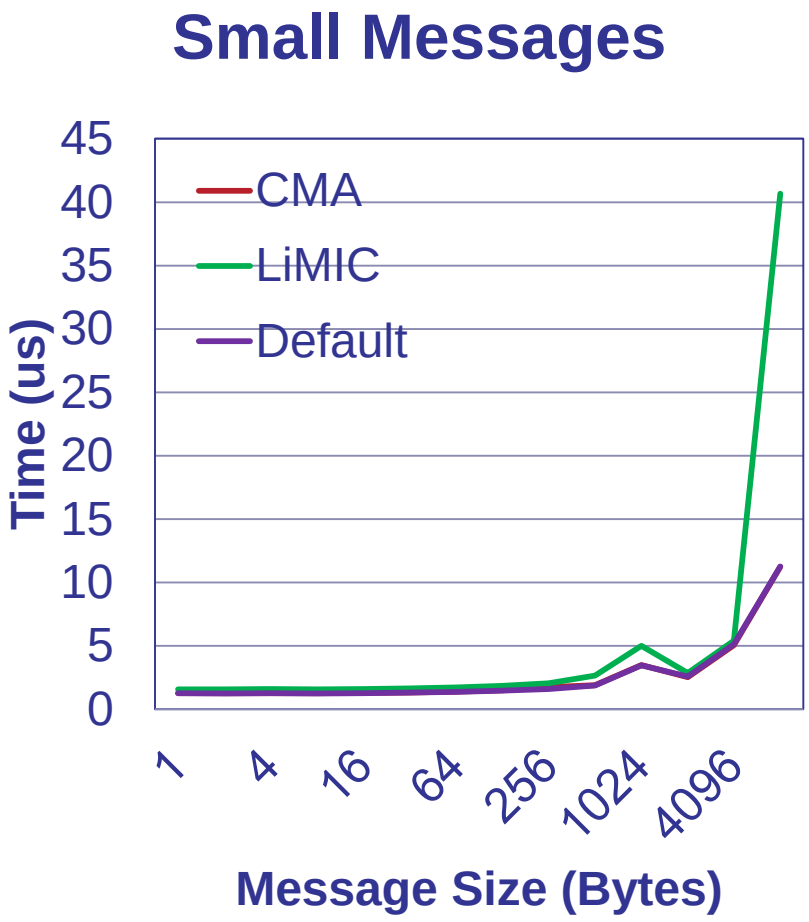
Small Messages

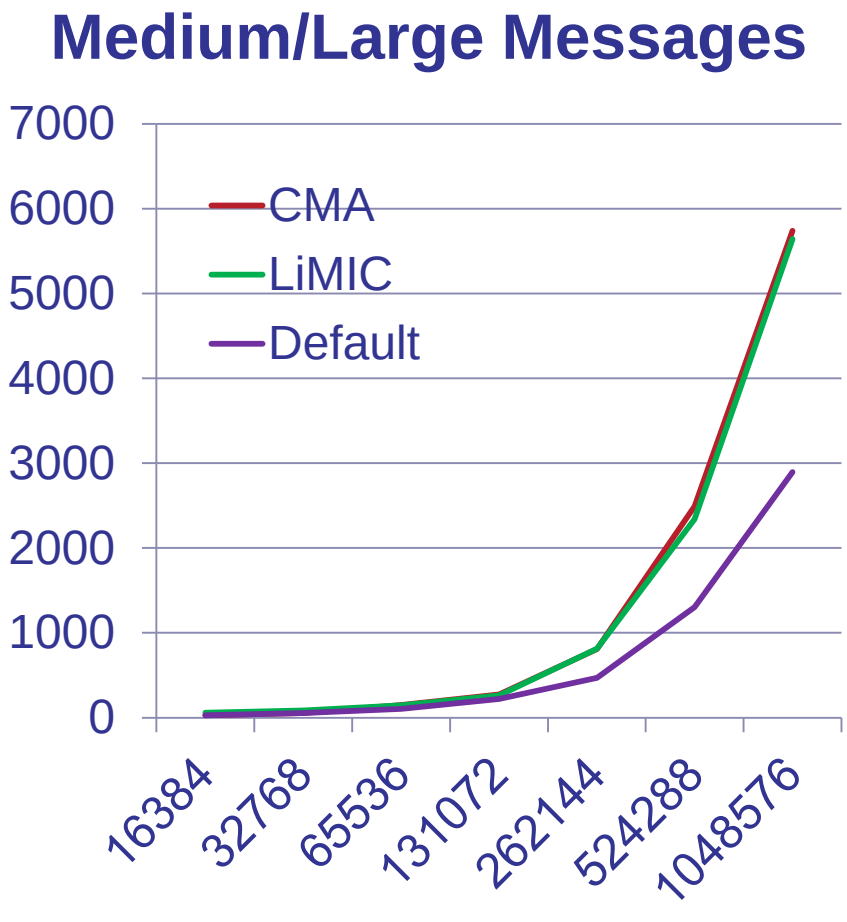


Medium/Large Messages

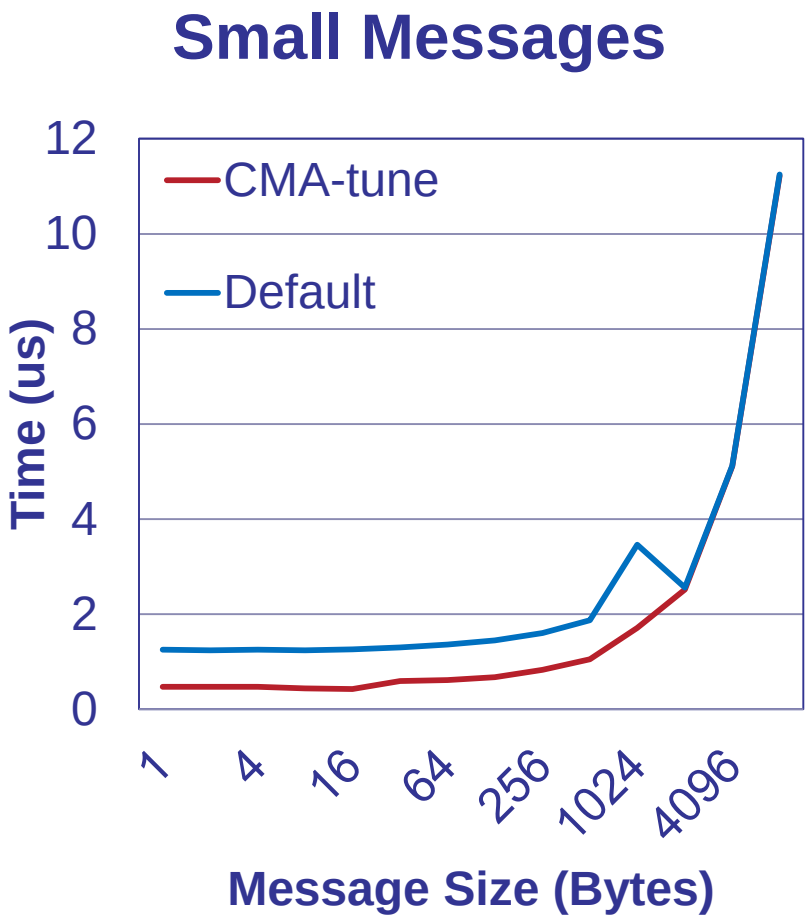


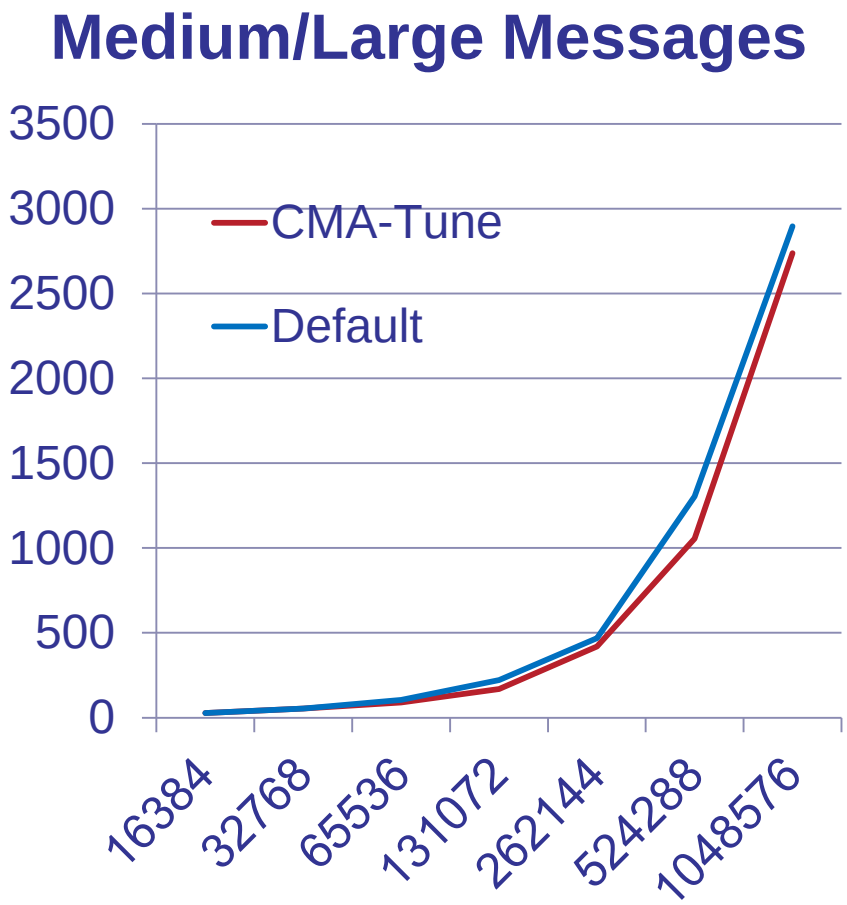
Gather: Impact of Tuning



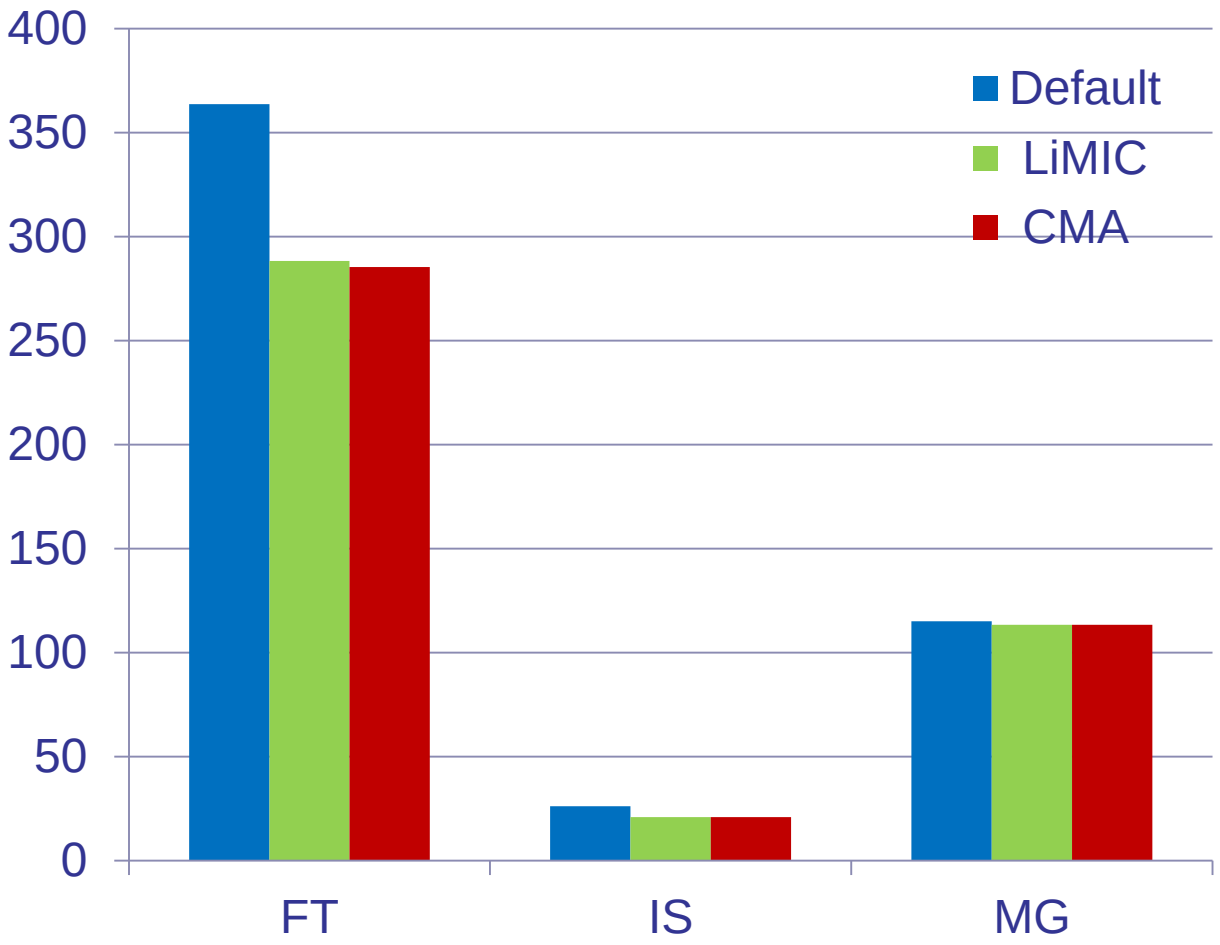


Gather: Impact of Tuning





NAS Class D



FT: discrete 3D fast Fourier Transform, all-to-all communication

IS: Integer Sort, random memory access

MG: Multi-Grid on a sequence of meshes, long- and short-distance communication memory intensive

Done on large mem node (1TB) with 32 cores

Conclusion

- CMA and LiMIC bring significant throughput improvement to MPI communication
- Which one should I use ?
  - On “old” system: LiMIC
  - On “new” system: CMA

Thank you !

For more information:
www.tacc.utexas.edu