Parallel Profiling using IPM on Rosa

Rosa Introduction Course

Scientific Computing Group

03 July 2009

References

- IPM website (D. Skinner, K. Fuelberger, N. Wright)
  - http://www.nersc.gov/nusers/resources/software/tools/ipm.php
  - http://ipm-hpc.sourceforge.net

- CSCS website
  - **User Entry Point >**
    - **Software and Programming Environment >**
      - **Debugging and Performance Analysis > Performance > IPM**

- module help ipm

IPM Features

- IPM is a profiling tool for MPI codes which :
  - Might work with your application when other tools don't
  - Is portable (CRAY, IBM, etc...), easy to use and Open Source
  - Provides a high-level performance summary of
    - MPI communication (time, # of calls, size, patterns)
    - Physical memory usage per compute node
    - Hardware performance counters (PAPI)
  - Is scalable, minimizes the impact on the running code, maintains a small memory footprint.
- IPM does not :
    - Support I/O (should be available soon),
    - Support function profiling,
    - Support OpenMP or PGAS languages.

Using IPM regions

- Instrument your code
  - ➔ CALL MPI_Pcontrol (1, “Region_1\0”)
  - ➔ ...
  - ➔ CALL MPI_Pcontrol (-1, “Region_1\0”)
  - Separate IPM output generated for each defined region
  - Non consecutive regions will be aggregated if same name used
  - Non MPI code blocks can be defined

Using IPM

- Profiling your code with IPM involves the following steps :
  - Load the IPM module
    - → module load ipm
    - Using the CRAY wrappers (ftn, cc, CC) will automatically link your MPI code with the ipm library : no need to modify your compilation line, the wrapper will do it !
  - Relink your code (No need to recompile !)
    - → ftn -o test.exe test.f90
    - → Set PAPI counter group if needed : export IPM_HPM=2
  - Execute the resultant executable by submitting your PBS job as usual
    - → aprun -n 128 test.exe
  - Visualize the results with the ipm_parse perl script
    - → ipm_parse –help
    - → ipm_parse –html username.12334535.324523.0
      - can be done on your workstation !

How to use IPM : basics

Upon completion you get

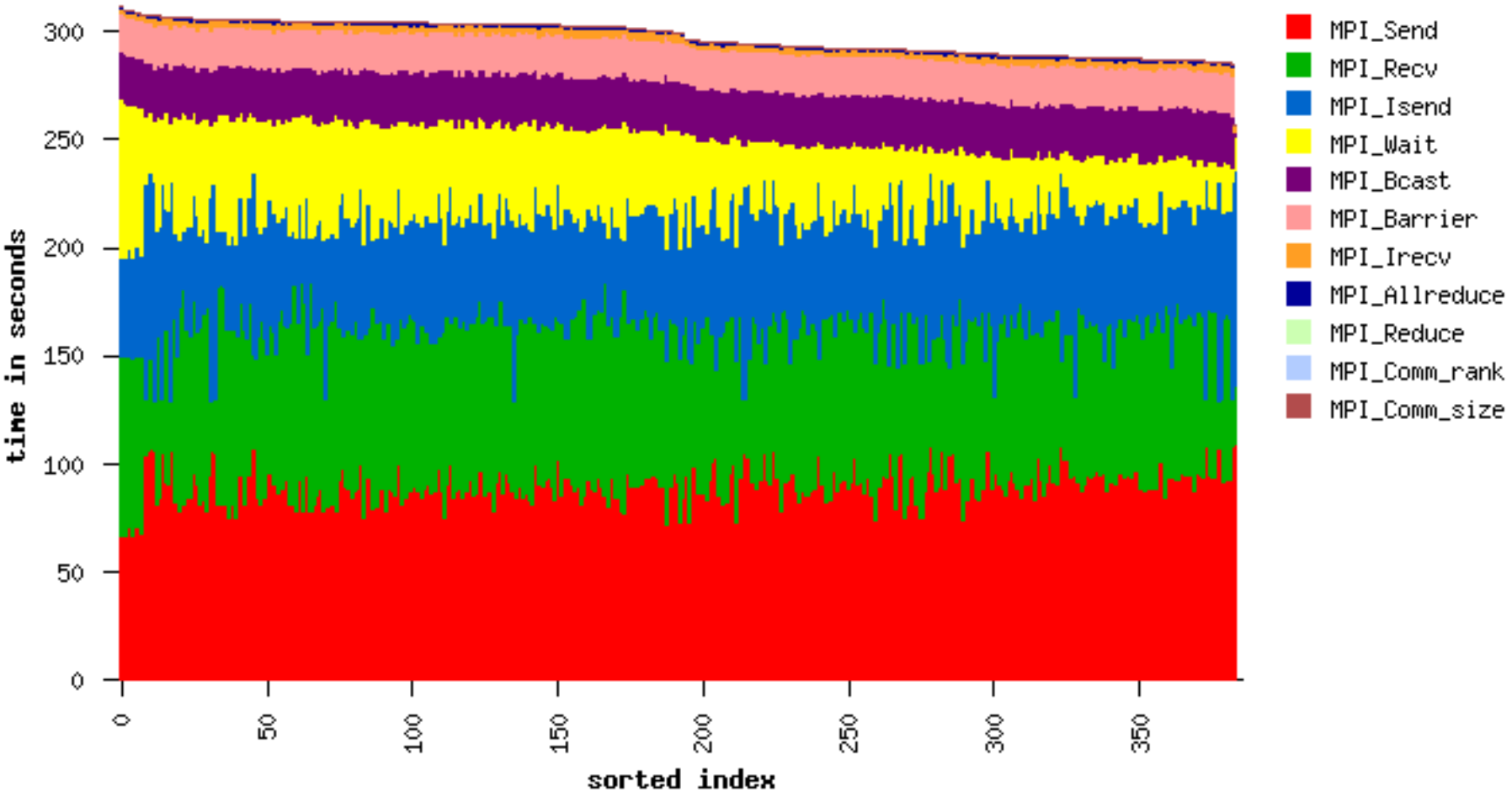
```
##IPMv0.85###########################################################################
#
# command : ../exe/pmemd -O -c inpcrd -o res (completed)
# host    : s05405                          mpi_tasks : 64 on 4 nodes
# start   : 02/22/05/10:03:55               wallclock : 24.278400 sec
# stop    : 02/22/05/10:04:17               %comm     : 32.43
# gbytes  : 2.57604e+00 total               gflop/sec : 2.04615e+00 total
#
###########################################################################
```

Maybe that’s enough.
If so you’re done.
Have a nice day.

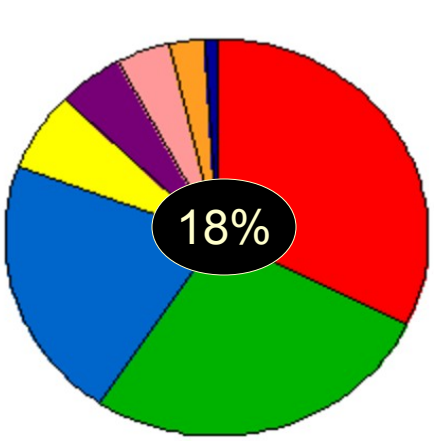
Want more detail? IPM_REPORT=full

```
# PM_CYC                3.00519e+11   4.69561e+09   4.50223e+09   5.83342e+09
# PM_FPU0_CMPL          2.45263e+10   3.83223e+08    3.3396e+08   5.12702e+08
# PM_FPU1_CMPL          1.48426e+10   2.31916e+08   1.90704e+08    2.8053e+08
# PM_FPU_FMA            1.03083e+10   1.61067e+08   1.36815e+08   1.96841e+08
# PM_INST_CMPL          3.33597e+11   5.21245e+09   4.33725e+09   6.44214e+09
# PM_LD_CMPL            1.03239e+11   1.61311e+09   1.29033e+09   1.84128e+09
# PM_ST_CMPL            7.19365e+10   1.12401e+09   8.77684e+08   1.29017e+09
# PM_TLB_MISS           1.67892e+08   2.62332e+06   1.16104e+06   2.36664e+07
#
#                            [time]       [calls]        <%mpi>      <%wall>
# MPI_Bcast                 352.365          2816         69.93        22.68
# MPI_Waitany                81.0002       185729         16.08         5.21
# MPI_Allreduce              38.6718         5184          7.68         2.49
# MPI_Allgatherv             14.7468          448          2.93         0.95
# MPI_Isend                  12.9071       185729          2.56         0.83
# MPI_Gatherv                2.06443          128          0.41         0.13
# MPI_Irecv                    1.349       185729          0.27         0.09
# MPI_Waitall                0.606749         8064          0.12         0.04
# MPI_Gather                0.0942596          192          0.02         0.01
##############################################################################
```

Example IPM_parse output (demo...)

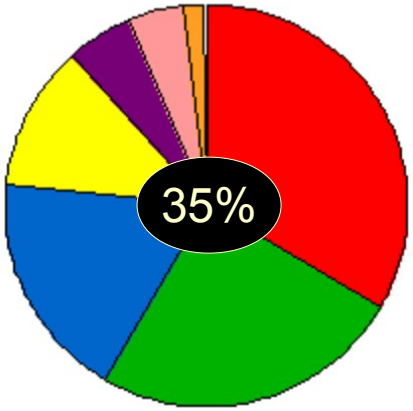


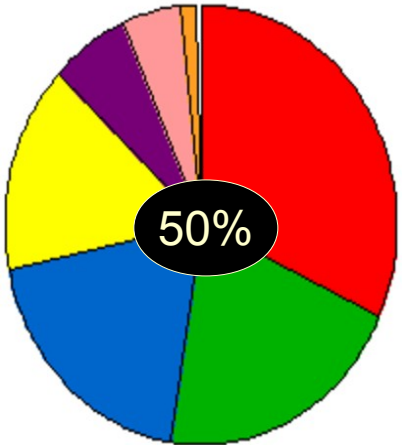
ECHAM5 / XT5 : % of MPI Time



T106
032cores

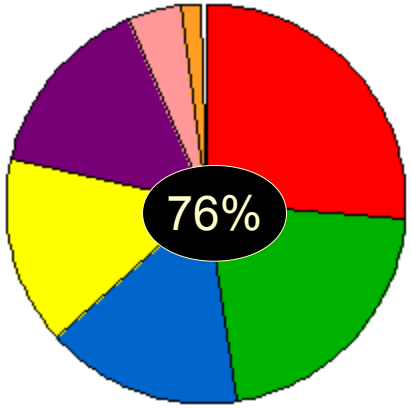
T106
064cores



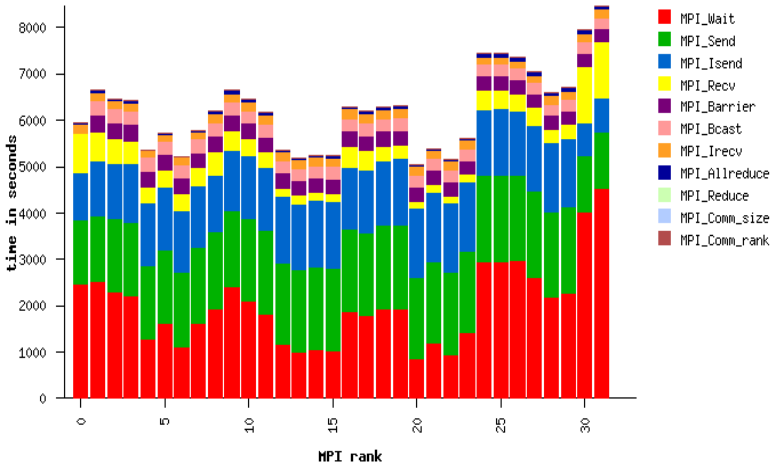


T106
128cores

T106
512cores



ECHAM5 / XT5 : Communication balance by MPI rank



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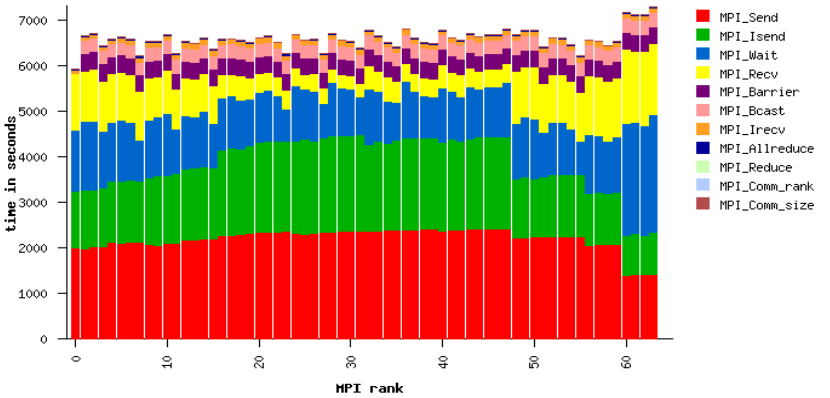

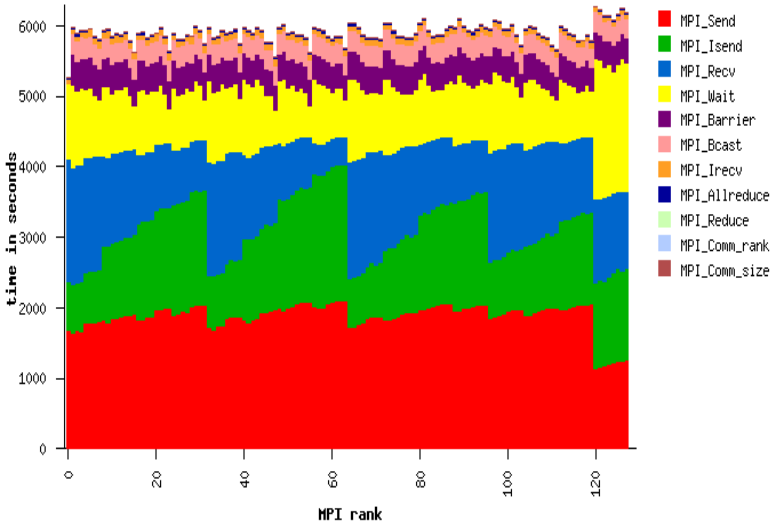

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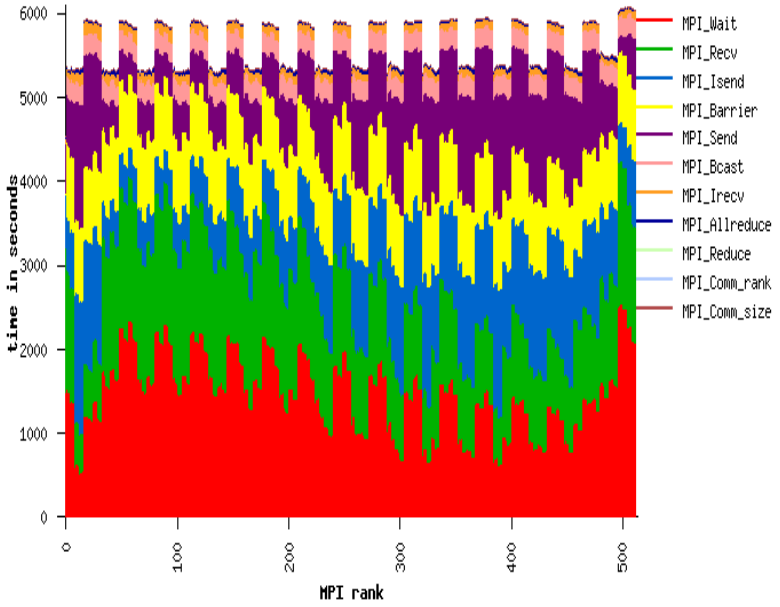

CSCS CRAY XT5

- **Rosa is a 20 cabinet Cray XT5 system :**
  - **1844 compute nodes + 20 I/O nodes**
  - **8cores per cnode => 14 752 compute cores @ 2.4 GHz Shanghai**
  - **16 GBytes of memory per cnode => 29 TB**
  - **9.6 GB/s interconnect bandwidth**

\ PER	core	socket	node	blade	cabinet	rosa (19 SIO nodes Excluded)
core	-	4	8	32	768	14752
socket	-	-	2	8	192	3688
node	-	-	-	4	96	1844
blade	-	-	-	-	24	461
cabinet	-	-	-	-	-	19
MEMORY (GB)	2	8	16	64	1536	29504

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# stop    : 02/22/05/10:04:17               %comm     : 32.43
# gbytes  : 2.57604e+00 total               gflop/sec : 2.04615e+00 total
#
#                           [total]         <avg>           min           max
# wallclock                  1373.67       21.4636       21.1087       24.2784
# user                        936.95       14.6398         12.68          20.3
# system                       227.7       3.55781          1.51             5
# mpi                         503.853        7.8727        4.2293       9.13725
# %comm                                      32.4268         17.42        41.407
# gflop/sec                  2.04614     0.0319709       0.02724       0.04041
# gbytes                     2.57604     0.0402507     0.0399284     0.0408173
# gbytes_tx                 0.665125     0.0103926   1.09673e-05     0.0368981
# gbyte_rx                  0.659763     0.0103088   9.83477e-07     0.0417372
#
```

To extend IPM into a PAT, one needs…

① More documentation
- On its general usage/features
- Available tools and analysis

② More post-processing tool development
- Has not been a priority

③ IO and user-written code profiling
- Some headway made on IO front

④ Additional visualization options
- Developing new tools/software
- Using existing software (CUBE, Walrus)

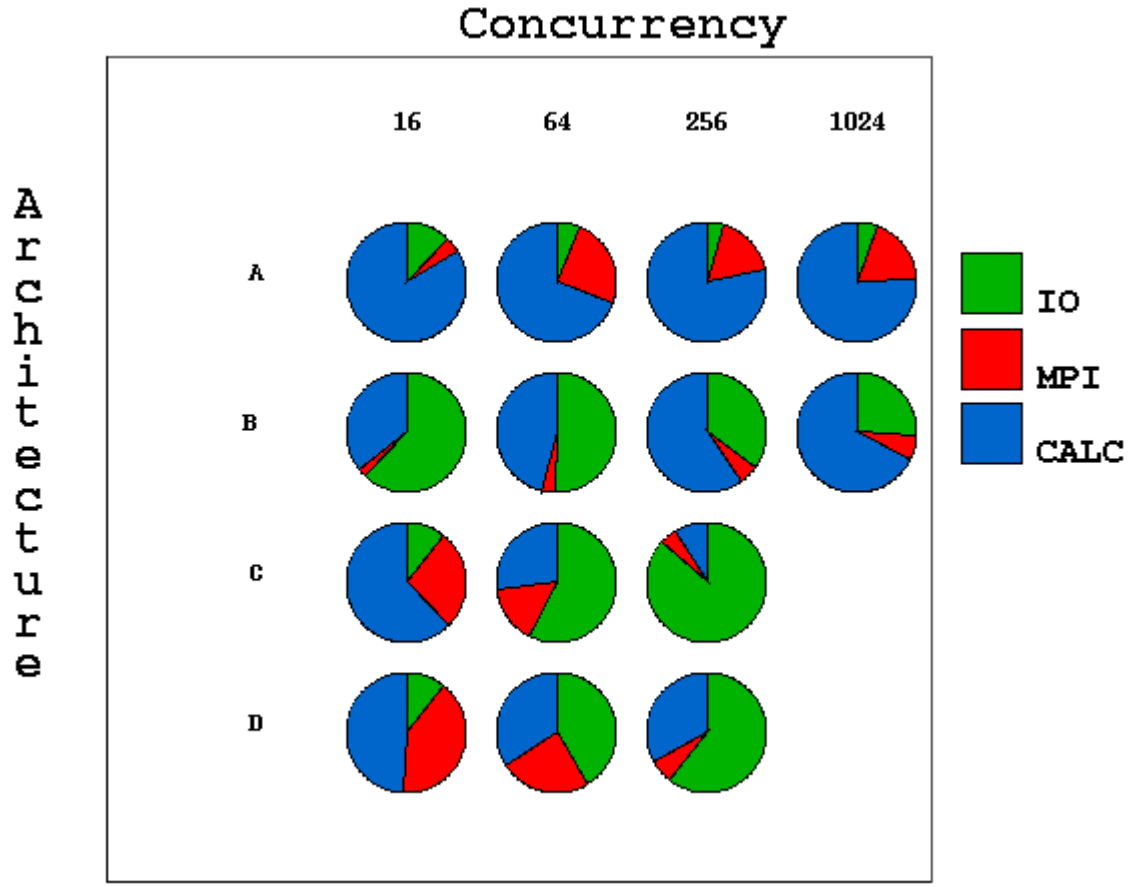
⑤ Additional parallelization paradigms
- No OpenMP or PGAS support currently

IPM: Methodology

- MPI_Init()
  - Initialize monitoring environment, allocate memory
- For each MPI call
  - Compute hash **key** from
    - Type of call (send/recv/bcast/...)
    - Buffer size (in bytes)
    - Communication partner rank
  - Store / update **value** in hash table with timing data
    - Number of calls,
    - minimum duration, maximum duration, summed time
- MPI_Finalize()
  - Aggregate, report to stdout, write XML log

Portability: Profoundly Interesting

A high level description of the
performance of a well known cosmology code on four well known architectures.



IPM: XML log files

- There's a lot more information in the logfile than you get to stdout. A logfile is written that has the hash table, switch traffic, memory usage, executable information, ...
- Parallelism in writing of the log (when possible)
- The IPM logs are durable performance profiles serving
  - HPC center production needs: https://www.nersc.gov/nusers/status/llsum/ http://www.sdsc.edu/user_services/top/ipm/
  - HPC research: ipm_parse renders txt and html http://www.nersc.gov/projects/ipm/ex3/
  - your own XML consuming entity, feed, or process