

PMlib講習会後半 実習編

PMlibのインストールとテスト

- ゲスト無線LANの使用について(別資料)
- PMlibパッケージの入手方法
- テストシステムへのログイン
- PMlibのインストール
- exampleプログラムの実行

PMlibパッケージの入手方法

- (公式な)PMlibパッケージ公開リポジトリ
 - <http://avr-aics-riken.github.io/PMlib/>
- PMlib開発用共有リポジトリ
 - <http://github.com/avr-aics-riken/PMlib/>
- **本日は**以下のリポジトリからPMlib最新開発版を使用する
 - <https://github.com/mikami3heart/PMlib/>
 - Webブラウザで右上の clone or download ボタンから Download ZIP
 - ファイル名 : PMlib-master.zip
- インストールに関する資料
 - <https://github.com/mikami3heart/PMlib-tutorials/>
 - 本資料(スライド) ファイル名 : Tutorial-slide2-installation.pdf
 - 利用手引き説明書 ファイル名 : PMlib-5.0-user-manual.pdf
 - 参考スクリプトファイル名 : scripts.K.tar.gz

京コンピュータでの実習

PMlibのインストール

PMlibのインストール 京コンピュータ(1)

- 本日はログインノードでPMlibをインストールする。
 - アプリケーションは計算ノードで実行される。
 - (インストールはログインノードでも計算ノードでも可能)
- WebブラウザでダウンロードしたPMlib-master.zipを使う
 - このファイルを京コンピュータログインノードへ転送する
 - (本日京コンピュータ以外のシステムをリモート利用して実習参加の方は、各環境にあわせて以下読み替えて下さい)

公式版PMlibのインストール 京コンピュー(2)

- 京コンピュータの適当なディレクトリにパッケージを転送する

```
myPC$ ssh ログイン名@k.aics.riken.jp ls -go
myPC$ ssh ログイン名@k.aics.riken.jp mkdir -p pmlib/tar_balls
myPC$ scp avr*PMlib*.tar.gz ログイン名@k.aics.riken.jp:pmlib/tar_balls
```

- 京コンピュータへログインし、パッケージを展開する

```
myPC$ ssh ログイン名@k.aics.riken.jp

K$ ls pmlib/tar_balls/avr*PMlib*.tar.gz
K$ cd pmlib
K$ tar -zxf tar_balls/avr*PMlib*.tar.gz
K$ ln -s avr*PMlib* PMlib
K$ ls -go
lrwxrwxrwx 1 28 2015-08-24 PMlib -> avr-aics-riken-PMlib-ced9279
drwxr-xr-x 9 4096 2015-08-24 avr-aics-riken-PMlib-ced9279
drwxr-xr-x 2 4096 2015-08-24 tar_balls
```

開発版PMlibのインストール 京コンピュータ(2)

- 京コンピュータの適当なディレクトリにパッケージを転送する

```
myPC$ ssh ログイン名@k.aics.riken.jp ls -go
myPC$ ssh ログイン名@k.aics.riken.jp mkdir -p pmlib/tar_balls
myPC$ scp PMlib-master.zip ログイン名@k.aics.riken.jp:pmlib/tar_balls
```

- 京コンピュータへログインし、パッケージを展開する

```
myPC$ ssh ログイン名@k.aics.riken.jp

K$ hostname
fe01p02
K$ ls pmlib/tar_balls/PMlib-master.zip
K$ cd pmlib
K$ unzip tar_balls/PMlib-master.zip
K$ ln -s PMlib-master PMlib
K$ ls -go
lrwxrwxrwx 1 12 2016-06-21 15:15 PMlib -> PMlib-master
drwxr-xr-x 10 4096 2016-06-21 15:13 PMlib-master
drwxr-xr-x 2 4096 2016-06-21 15:11 tar_balls
```

PMlibのインストール 京コンピュータ(3)

- ログインノード上で以下のコマンドで MPI版をmake する。

```
K$ INSTALL_DIR=${HOME}/pmlib/install_dir
K$ SRC_DIR=${HOME}/pmlib/PMlib
K$ BUILD_DIR=${SRC_DIR}/BUILD_DIR
K$ cd $BUILD_DIR; if [ $? != 0 ] ; then echo '@@@ Directory error @@@'; exit; fi
K$
K$ CFLAGS="-std=c99 -Kopenmp,fast -Ntl_notrt -w"
K$ FCFLAGS="-Ccpp -Kopenmp,fast -Ntl_notrt -w -Knootmsg"
K$ CXXFLAGS="-Kopenmp,fast -Ntl_notrt -w"
K$
K$ ../configure CXX=mpiFCCpx CC=mpifccpx FC=mpifrtpx \
  CXXFLAGS="${CXXFLAGS}" CFLAGS="${CFLAGS}" FCFLAGS="${FCFLAGS}" \
  --with-comp=FJ --host=sparc64-unknown-linux-gnu \
  --with-papi=yes --with-example=yes --prefix=${INSTALL_DIR}
K$ make
K$ make install
```

- あるいは

```
K$ ./x.make-pmlib-K.sh
```


PMlibのインストール 京コンピュータ(4)

- インストール時の標準出力メッセージ例

```
K$ ./x.make-pmlib-K.sh
+ ../configure CXX=mpiFCCpx CC=mpifccpx FC=mpifrtpx ...
-----
Running PMlib Configure Script
-----
checking for a BSD-compatible install... /usr/bin/install -c
...
-----
Finished Running PMlib Configure Script
-----
+ make
make all-recursive
make[1]: ディレクトリ `${HOME}/pmlib/PMlib/BUILD_DIR' に入ります
... (かなりメッセージが表示されますが、無害なものです)
make[1]: ディレクトリ `${HOME}/pmlib/PMlib/BUILD_DIR' から出ます
+ make install
...
make[1]: ディレクトリ `${HOME}/pmlib/PMlib/BUILD_DIR' から出ます
```

PMlibのインストール 京コンピュータ(5)

- exampleプログラムがmakeされた事を確認する

```
K$ cd PMlib/BUILD_DIR/example
```

```
K$ ls -go test?/test?
```

```
-rwxr-xr-x 1 4455942 2016-06-21 23:00 test1/test1
```

```
-rwxr-xr-x 1 4456240 2016-06-21 23:00 test2/test2
```

```
-rwxr-xr-x 1 4460921 2016-06-21 23:00 test3/test3
```

```
-rwxr-xr-x 1 4459978 2016-06-21 23:00 test4/test4
```

```
-rwxr-xr-x 1 4460921 2016-06-21 23:00 test5/test5
```

```
K$ file test?/test?
```

```
test1/test1: ELF 64-bit MSB executable, SPARC V9, total store ordering, version 1 (SYSV), dynamically linked (uses shared libs), for GNU/Linux 2.6.12, not stripped
```

```
test2/test2: ELF 64-bit MSB executable, SPARC V9, total store ordering, version 1 (SYSV), dynamically linked (uses shared libs), for GNU/Linux 2.6.12, not stripped
```

```
test3/test3: ELF 64-bit MSB executable, SPARC V9, total store ordering, version 1 (SYSV), dynamically linked (uses shared libs), for GNU/Linux 2.6.12, not stripped
```

```
test4/test4: ELF 64-bit MSB executable, SPARC V9, total store ordering, version 1 (SYSV), dynamically linked (uses shared libs), for GNU/Linux 2.6.12, not stripped
```

```
test5/test5: ELF 64-bit MSB executable, SPARC V9, total store ordering, version 1 (SYSV), dynamically linked (uses shared libs), for GNU/Linux 2.6.12, not stripped
```

京コンピュータでの実習 例題プログラムの対話的実行

example/に含まれる例題プログラム

- 以下の例題プログラムが含まれる
 - test1: C++主プログラムからのPMlib呼び出し
 - test2: C++とCの混合プログラムでPMlibの呼び出し(C++から)
 - test3: プロセスgroupを明示的に生成するプログラムからの呼び出し
 - test4: fortranプログラムからのPMlibの呼び出し
 - test5: MPI_Comm_splitでコミュニケータを分割したプログラムに対してプロセスを自動group化してレポート出力
- PMlibライブラリと例題プログラムは同じconfigureオプションでmakeされる
 - configureオプションの詳細は INSTALLファイル又は利用説明書を参照
- MPIプログラムとしてテスト可能なのは
 - test1, test2, test3, test4, test5
 - コンパイル時のマクロ `_PM_WITHOUT_MPI_` 未定義(-U)で自動生成
- シリアルプログラムとしてテスト可能なのは
 - test1, test2, test4
 - コンパイル時のマクロ `_PM_WITHOUT_MPI_` 定義(-D)で自動生成

PMlib例題プログラムの対話的実行 京コンピュータ

- 京の計算資源は大変込み合っているため、各自で計算ノード1台のみを利用する対話的ジョブを起動し、以降の実習を進める
- makeされたexample/test1プログラムを計算ノード上で対話的実行

```
K$ pjsub --interact --rsc-list "elapse=01:00:00" --rsc-list "node=1" --mpi "proc=2"
[INFO] PJM 0000 pjsub Job 2955440 submitted.
[INFO] PJM 0081 ....connected.
[INFO] PJM 0082 pjsub Interactive job 2955440 started.
Env_base: K-1.2.0-18
```

```
K$ hostname
g05-040
K$ pwd
${HOME}/pmlib/PMlib/BUILD_DIR/example
K$ source /work/system/Env_base
K$ /opt/FJSVXosPA/bin/xospastop
K$ export OMP_NUM_THREADS=4 NPROCS=2
K$ mpiexec -n ${NPROCS} ./test1/test1
```

PMlib例題プログラムのバッチ実行 京コンピュータ

- 前ページと同じジョブをバッチジョブとして投入実行する例
- #PJM --stgin-basedir のパス名は各自修正する

```
K$ cat x.run-test1.sh
#!/bin/bash
#PJM -N MYTEST1
#PJM --rsc-list "elapse=1:00:00"
#PJM --rsc-list "node=1"
#PJM --mpi "proc=2"
#PJM -j
#PJM -S
# stage io files
#PJM --stg-transfiles all
#PJM --mpi "use-rankdir"
#PJM --stgin-basedir "/home/ra000004/a03155/pmlib/PMlib/BUILD_DIR/example"
#PJM --stgin "rank=* test1/test1 %r:./test1"
source /work/system/Env_base
/opt/FJSVXosPA/bin/xospastop
export OMP_NUM_THREADS=4 NPROCS=2
mpiexec -n ${NPROCS} ./test1

K$ pjsub x.run-test1.sh
```

京コンピュータ: test1の実行結果例

基本レポート: 環境変数 HWPC_CHOOSERの指定なし → 計算量自己申告モード

PMLib Basic Report -----

Timing Statistics Report from PMLib version 5.0.4

Linked PMLib supports: MPI, OpenMP, HWPC, no-OTF

Host name : g05-040

Date : 2016/06/22 : 01:27:48

Mrs. Kobe

Parallel Mode: Hybrid (2 processes x 4 threads)

The environment variable HWPC_CHOOSER is not provided. No HWPC report.

Total execution time = 2.008230e+00 [sec]

Total time of measured sections = 2.000537e+00 [sec]

Exclusive sections statistics per process and total job.

Inclusive sections are marked with (*)

Section Label	call	accumulated time[sec]					[user defined counter values]		
		avr	avr[%]	sdv	avr/call		avr	sdv	speed
Second section(*) :	1	1.736e+00	86.80	8.58e-03	1.736e+00		2.800e+10	0.00e+00	16.12 Gflops(*)
Subsection Y :	3	7.010e-01	35.04	1.05e-03	2.337e-01		1.200e+10	0.00e+00	17.12 Gflops
Subsection X :	3	6.988e-01	34.93	7.66e-04	2.329e-01		4.800e+10	0.00e+00	68.69 GB/sec
First section :	1	2.311e-01	11.55	6.98e-04	2.311e-01		4.000e+09	0.00e+00	17.31 Gflops
Sections per process		9.321e-01		-Exclusive CALC sections-			1.600e+10		17.17 Gflops
Sections per process		6.988e-01		-Exclusive COMM sections-			4.800e+10		68.69 GB/sec
Sections total job		9.321e-01		-Exclusive CALC sections-			3.200e+10		34.33 Gflops
Sections total job		6.988e-01		-Exclusive COMM sections-			9.600e+10		37.38 GB/sec

京コンピュータ: test1の実行結果例

詳細レポート: 各測定区間毎に全MPIランクのレポート

```
# PMLib Process Report --- Elapsed time for individual MPI ranks -----
```

```
Label Subsection Y
```

Header	ID	:	call	time[s]	time[%]	t_wait[s]	t[s]/call	counter	speed
Rank	0	:	3	7.017e-01	35.1	0.000e+00	2.339e-01	1.200e+10	1.710e+10 Flops
Rank	1	:	3	7.002e-01	35.0	1.488e-03	2.334e-01	1.200e+10	1.714e+10 Flops

```
Label Subsection X
```

Header	ID	:	call	time[s]	time[%]	t_wait[s]	t[s]/call	counter	speed
Rank	0	:	3	6.993e-01	35.0	0.000e+00	2.331e-01	4.800e+10	6.864e+10 B/sec
Rank	1	:	3	6.983e-01	34.9	1.083e-03	2.328e-01	4.800e+10	6.874e+10 B/sec

```
Label First section
```

Header	ID	:	call	time[s]	time[%]	t_wait[s]	t[s]/call	counter	speed
Rank	0	:	1	2.306e-01	11.5	9.871e-04	2.306e-01	4.000e+09	1.734e+10 Flops
Rank	1	:	1	2.316e-01	11.6	0.000e+00	2.316e-01	4.000e+09	1.727e+10 Flops

京コンピュータ: test2の実行結果例

基本レポート: 環境変数 HWPC_CHOOSERの指定がないため計算量自己申告モードだが、計算量を引数で与えていない(あるいは0と指定)している。

```
# PMLib Basic Report -----
```

```
Timing Statistics Report from PMLib version 5.0.4
```

```
Linked PMLib supports: MPI, OpenMP, HWPC, no-OTF
```

```
Host name : g05-040
```

```
Date      : 2016/06/22 : 01:31:43
```

```
Mr. Bean
```

```
Parallel Mode: Hybrid (2 processes x 4 threads)
```

```
The environment variable HWPC_CHOOSER is not provided. No HWPC report.
```

```
Total execution time          = 9.388940e-01 [sec]
```

```
Total time of measured sections = 9.348356e-01 [sec]
```

```
Exclusive sections statistics per process and total job.
```

```
Inclusive sections are marked with (*)
```

Section	call	accumulated time[sec]				[user defined counter values]			
Label		avr	avr[%]	sdv	avr/call	avr	sdv	speed	
First location :	1	6.967e-01	74.53	3.25e-03	6.967e-01	0.000e+00	0.00e+00	0.00	Mflops
Second location :	1	2.349e-01	25.13	9.45e-04	2.349e-01	0.000e+00	0.00e+00	0.00	Mflops
Sections per process		9.317e-01	-Exclusive CALC sections-			0.000e+00			0.00 Mflops
Sections total job		9.317e-01	-Exclusive CALC sections-			0.000e+00			0.00 Mflops

京コンピュータ: test2の実行結果例

詳細レポート: 各測定区間毎に全MPIランクのレポート

```
# PMLib Process Report --- Elapsed time for individual MPI ranks -----
```

Label First location

Header	ID	:	call	time[s]	time[%]	t_wait[s]	t[s]/call	counter	speed
Rank	0	:	1	6.990e-01	74.8	0.000e+00	6.990e-01	0.000e+00	0.000e+00 Flops
Rank	1	:	1	6.944e-01	74.3	4.600e-03	6.944e-01	0.000e+00	0.000e+00 Flops

Label Second location

Header	ID	:	call	time[s]	time[%]	t_wait[s]	t[s]/call	counter	speed
Rank	0	:	1	2.356e-01	25.2	0.000e+00	2.356e-01	0.000e+00	0.000e+00 Flops
Rank	1	:	1	2.343e-01	25.1	1.336e-03	2.343e-01	0.000e+00	0.000e+00 Flops

京コンピュータ: test3の実行結果例

基本レポート、詳細レポートの他、プロセスグループ毎の詳細レポートを出力

```
# PMLib Basic Report ----- (省略)
# PMLib Process Report --- Elapsed time for individual MPI ranks ----- (省略)

# PMLib Process Group [ 1] Elapsed time for individual MPI ranks -----

Label 2nd section
Header ID :      call   time[s] time[%]  t_wait[s]  t[s]/call   counter    speed
Rank    0 :          1  5.128e-01  60.8  0.000e+00  5.128e-01  0.000e+00  0.000e+00 Flops
Label 1st section
Header ID :      call   time[s] time[%]  t_wait[s]  t[s]/call   counter    speed
Rank    0 :          1  2.333e-01  27.6  0.000e+00  2.333e-01  0.000e+00  0.000e+00 Flops

# PMLib Process Group [ 2] Elapsed time for individual MPI ranks -----

Label 2ndModified STREAM TRIAD, num_threads=4, array size= 50000000
Function      Rate (MB/s)   Avg time      Min time      Max time
Triad:    35941.1650        0.0558        0.0334        0.0914
section
Header ID :      call   time[s] time[%]  t_wait[s]  t[s]/call   counter    speed
Rank    1 :          1  6.976e-01  82.7  0.000e+00  6.976e-01  0.000e+00  0.000e+00 Flops
Label 1st section
Header ID :      call   time[s] time[%]  t_wait[s]  t[s]/call   counter    speed
Rank    1 :          1  2.326e-01  27.6  0.000e+00  2.326e-01  0.000e+00  0.000e+00 Flops
```

京コンピュータ: test4の実行結果例

基本レポート、詳細レポートを出力

PMLib Basic Report -----

Timing Statistics Report from PMLib version 5.0.4
Linked PMLib supports: MPI, OpenMP, HWPC, no-OTF
Host name : g05-040
Date : 2016/06/22 : 01:39:46
Fortran API
Parallel Mode: Hybrid (2 processes x 4 threads)
The environment variable HWPC_CHOOSER is not provided. No HWPC report.

Total execution time = 1.318232e+01 [sec]
Total time of measured sections = 1.306007e+01 [sec]

Exclusive sections statistics per process and total job.
Inclusive sections are marked with (*)

Section Label	call	accumulated time[sec]				[user defined counter values]			
		avr	avr[%]	sdv	avr/call	avr	sdv	speed	
Second section(*) :	1	1.282e+01	98.17	1.57e-01	1.282e+01	1.200e+10	0.00e+00	935.95	Mflops(*)
Subsection X :	3	5.733e+00	43.90	1.02e-01	1.911e+00	2.400e+10	0.00e+00	4.19	GB/sec
Subsection Y :	3	5.703e+00	43.67	7.93e-02	1.901e+00	6.000e+09	0.00e+00	1.05	Gflops
First section :	1	1.464e-03	0.01	4.21e-06	1.464e-03	4.000e+06	0.00e+00	2.73	Gflops
Sections per process		5.705e+00	-Exclusive CALC sections-			6.004e+09		1.05	Gflops
Sections per process		5.733e+00	-Exclusive COMM sections-			2.400e+10		4.19	GB/sec
Sections total job		5.705e+00	-Exclusive CALC sections-			1.201e+10		2.10	Gflops
Sections total job		5.733e+00	-Exclusive COMM sections-			4.800e+10		8.37	GB/sec

PMLib Process Report --- Elapsed time for individual MPI ranks ----- (省略)

京コンピュータ: test5の実行結果例

基本+詳細+MPI_Comm_splitでコミュニケータを分割したプロセス毎のレポート

```
# PMLib Basic Report ----- (省略)
# PMLib Process Report --- Elapsed time for individual MPI ranks ----- (省略)

# PMLib Process Group [ 0] Elapsed time for individual MPI ranks -----

Label section-2
Header ID :      call   time[s] time[%]  t_wait[s]  t[s]/call   counter    speed
Rank    0 :          1  6.957e-01 114.0  0.000e+00  6.957e-01  0.000e+00  0.000e+00 Flops
Label section-1
Header ID :      call   time[s] time[%]  t_wait[s]  t[s]/call   counter    speed
Rank    0 :          1  3.541e-03   0.6  0.000e+00  3.541e-03  0.000e+00  0.000e+00 Flops

# PMLib Process Group [ 1] Elapsed time for individual MPI ranks -----

Label section-2
Header ID :      call   time[s] time[%]  t_wait[s]  t[s]/call   counter    speed
Rank    1 :          1  5.110e-01  83.7  0.000e+00  5.110e-01  0.000e+00  0.000e+00 Flops
Label section-1
Header ID :      call   time[s] time[%]  t_wait[s]  t[s]/call   counter    speed
Rank    1 :          1  1.822e-03   0.3  0.000e+00  1.822e-03  0.000e+00  0.000e+00 Flops
```

HWPCを利用した計算量の自動測定

- 環境変数HWPC_CHOOSERにFLOPSを指定

```
K$ cat x.run-test1.sh
#!/bin/bash
#PJM -N MYTEST1
#PJM --rsc-list "elapse=1:00:00"
#PJM --rsc-list "node=1"
#PJM --mpi "proc=2"
#PJM -j
#PJM -S
# stage io files
#PJM --stg-transfiles all
#PJM --mpi "use-rankdir"
#PJM --stgin-basedir "/home/ra000004/a03155/pmlib/PMlib/BUILD_DIR/example"
#PJM --stgin "rank=* test1/test1 %r:./test1"
source /work/system/Env_base
/opt/FJSVXosPA/bin/xospastop
export OMP_NUM_THREADS=4 NPROCS=2
export HWPC_CHOOSER=FLOPS
mpiexec -n ${NPROCS} ./test1

K$ pjsub x.run-test1.sh
```

京Test1 : HWPC_CHOOSERにFLOPSを指定

基本レポート: 計算量の自動測定

PMLib Basic Report -----

Timing Statistics Report from PMLib version 5.0.4
Linked PMLib supports: MPI, OpenMP, HWPC, no-OTF
Host name : g05-040
Date : 2016/06/22 : 01:53:20
Mrs. Kobe
Parallel Mode: Hybrid (2 processes x 4 threads)
The environment variable HWPC_CHOOSER=FLOPS is provided.

Total execution time = 2.005677e+00 [sec]
Total time of measured sections = 1.996694e+00 [sec]

Exclusive sections statistics per process and total job.
Inclusive sections are marked with (*)

Section	call	accumulated time[sec]				[hardware counter byte counts]		
Label		avr	avr[%]	sdv	avr/call	avr	sdv	speed
-----+								
Second section(*) :	1	1.733e+00	86.77	9.56e-03	1.733e+00	4.603e+09	7.07e-01	2.66 Gflops(*)
Subsection X :	3	6.975e-01	34.94	1.18e-03	2.325e-01	1.438e+10	2.12e+00	20.61 Gflops
Subsection Y :	3	6.962e-01	34.87	1.60e-03	2.321e-01	1.381e+10	2.12e+00	19.83 Gflops
First section :	1	2.309e-01	11.56	1.50e-05	2.309e-01	4.090e+09	4.77e-07	17.71 Gflops
-----+								
Sections per process		1.625e+00	-Exclusive CALC sections-			3.228e+10		19.87 Gflops
-----+								
Sections total job		1.625e+00	-Exclusive CALC sections-			6.455e+10		39.73 Gflops

京Test1 : HWPC_CHOOSERにFLOPSを指定

詳細レポート(計算量の自動測定): プロセス毎の詳細レポート、HWPCレポート

```
# PMLib Process Report --- Elapsed time for individual MPI ranks -----
```

```
Label Subsection X
```

Header	ID	:	call	time[s]	time[%]	t_wait[s]	t[s]/call	counter	speed
Rank	0	:	3	6.984e-01	35.0	0.000e+00	2.328e-01	1.438e+10	2.059e+10 Flops (HWPC)
Rank	1	:	3	6.967e-01	34.9	1.675e-03	2.322e-01	1.438e+10	2.064e+10 Flops (HWPC)

```
Label Subsection Y
```

Header	ID	:	call	time[s]	time[%]	t_wait[s]	t[s]/call	counter	speed
Rank	0	:	3	6.974e-01	34.9	0.000e+00	2.325e-01	1.381e+10	1.980e+10 Flops (HWPC)
Rank	1	:	3	6.951e-01	34.8	2.259e-03	2.317e-01	1.381e+10	1.986e+10 Flops (HWPC)

```
Label First section
```

Header	ID	:	call	time[s]	time[%]	t_wait[s]	t[s]/call	counter	speed
Rank	0	:	1	2.309e-01	11.6	2.122e-05	2.309e-01	4.090e+09	1.771e+10 Flops (HWPC)
Rank	1	:	1	2.309e-01	11.6	0.000e+00	2.309e-01	4.090e+09	1.771e+10 Flops (HWPC)

```
# PMLib hardware performance counter (HWPC) Report -----
```

```
Label Subsection X
```

Header	ID	:	FP_OPS	[Flops]
Rank	0	:	1.438e+10	2.059e+10
Rank	1	:	1.438e+10	2.064e+10

```
Label Subsection Y
```

Header	ID	:	FP_OPS	[Flops]
Rank	0	:	1.381e+10	1.980e+10
Rank	1	:	1.381e+10	1.986e+10

```
Label First section
```

Header	ID	:	FP_OPS	[Flops]
Rank	0	:	4.090e+09	1.771e+10
Rank	1	:	4.090e+09	1.771e+10

京Test1 : HWPCレポートの記号

printDetail()関数へのlegend引数指定で表示(表示項目はシステム毎に異なる)

Detected CPU architecture:

Sun

Fujitsu SPARC64 VIIIfx

The available PMLib HWPC events for this CPU are shown below.

The values for each process as the sum of threads.

HWPC events legend:

FP_OPS: floating point operations

VEC_INS: vector instructions

FMA_INS: Fused Multiply-and-Add instructions

LD_INS: memory load instructions

SR_INS: memory store instructions

L1_TCM: level 1 cache miss

L2_TCM: level 2 cache miss (by demand and by prefetch)

L2_WB_DM: level 2 cache miss by demand with writeback request

L2_WB_PF: level 2 cache miss by prefetch with writeback request

TOT_CYC: total cycles

MEM_SCY: Cycles Stalled Waiting for memory accesses

STL_ICY: Cycles with no instruction issue

TOT_INS: total instructions

FP_INS: floating point instructions

Derived statistics:

[GFlops]: floating point operations per nano seconds (10^{-9})

[Mem GB/s]: memory bandwidth in load+store GB/s

[L1\$ %]: Level 1 cache hit percentage

[LL\$ %]: Last Level cache hit percentage

京Test2 : HWPC_CHOOSERにFLOPSを指定

基本レポート: 計算量の自動測定

PMLib Basic Report -----

Timing Statistics Report from PMLib version 5.0.4
Linked PMLib supports: MPI, OpenMP, HWPC, no-OTF
Host name : g05-040
Date : 2016/06/22 : 01:56:47
Mr. Bean
Parallel Mode: Hybrid (2 processes x 4 threads)
The environment variable HWPC_CHOOSER=FLOPS is provided.

Total execution time = 9.402618e-01 [sec]
Total time of measured sections = 9.368410e-01 [sec]

Exclusive sections statistics per process and total job.
Inclusive sections are marked with (*)

Section Label	call	accumulated time[sec]				[hardware counter byte counts]			
		avr	avr[%]	sdv	avr/call	avr	sdv	speed	
First location :	1	7.002e-01	74.74	1.35e-03	7.002e-01	1.216e+10	0.00e+00	17.36	Gflops
Second location :	1	2.327e-01	24.84	1.10e-03	2.327e-01	4.033e+09	0.00e+00	17.33	Gflops
Sections per process		9.329e-01	-Exclusive CALC sections-			1.619e+10		17.35	Gflops
Sections total job		9.329e-01	-Exclusive CALC sections-			3.238e+10		34.71	Gflops

京Test1 : HWPC_CHOOSERにBANDWIDTHを指定

PMLib Basic Report -----

Timing Statistics Report from PMLib version 5.0.4

Linked PMLib supports: MPI, OpenMP, HWPC, no-OTF

Host name : g05-040

Date : 2016/06/22 : 01:58:50

Mrs. Kobe

Parallel Mode: Hybrid (2 processes x 4 threads)

The environment variable HWPC_CHOOSER=BANDWIDTH is provided.

Total execution time = 2.009118e+00 [sec]

Total time of measured sections = 2.000287e+00 [sec]

Exclusive sections statistics per process and total job.

Inclusive sections are marked with (*)

Section Label	call	accumulated time[sec]					[hardware counter flop counts]		
		avr	avr[%]	sdv	avr/call		avr	sdv	speed
Second section(*) :	1	1.736e+00	86.78	9.59e-03	1.736e+00		5.274e+09	6.38e+07	3.04 GB/sec(*)
Subsection Y :	3	6.998e-01	34.98	1.21e-03	2.333e-01		1.588e+10	2.72e+08	22.69 GB/sec
Subsection X :	3	6.963e-01	34.81	9.91e-04	2.321e-01		1.561e+10	1.90e+08	22.42 GB/sec
First section :	1	2.313e-01	11.57	1.34e-04	2.313e-01		4.797e+09	2.57e+08	20.74 GB/sec
Sections per process		1.627e+00	-Exclusive COMM sections-				3.629e+10		22.30 GB/sec
Sections total job		1.627e+00	-Exclusive COMM sections-				7.258e+10		44.59 GB/sec

京Test1 : HWPC_CHOOSERにBANDWIDTHを指定

PMLib Process Report --- Elapsed time for individual MPI ranks -----

Label Subsection Y

Header	ID	:	call	time[s]	time[%]	t_wait[s]	t[s]/call	counter	speed
Rank	0	:	3	7.007e-01	35.0	0.000e+00	2.336e-01	1.607e+10	2.294e+10 B/sec (HWPC)
Rank	1	:	3	6.989e-01	34.9	1.718e-03	2.330e-01	1.569e+10	2.245e+10 B/sec (HWPC)

Label Subsection X

Header	ID	:	call	time[s]	time[%]	t_wait[s]	t[s]/call	counter	speed
Rank	0	:	3	6.970e-01	34.8	0.000e+00	2.323e-01	1.574e+10	2.259e+10 B/sec (HWPC)
Rank	1	:	3	6.956e-01	34.8	1.402e-03	2.319e-01	1.548e+10	2.225e+10 B/sec (HWPC)

Label First section

Header	ID	:	call	time[s]	time[%]	t_wait[s]	t[s]/call	counter	speed
Rank	0	:	1	2.312e-01	11.6	1.888e-04	2.312e-01	4.616e+09	1.996e+10 B/sec (HWPC)
Rank	1	:	1	2.314e-01	11.6	0.000e+00	2.314e-01	4.978e+09	2.151e+10 B/sec (HWPC)

PMLib hardware performance counter (HWPC) Report -----

Label Subsection Y

Header	ID	:	L2_TCM	L2_WB_DM	L2_WB_PF	[HW B/s]
Rank	0	:	1.226e+08	6.057e+03	2.921e+06	2.294e+10
Rank	1	:	1.197e+08	6.342e+03	2.837e+06	2.245e+10

Label Subsection X

Header	ID	:	L2_TCM	L2_WB_DM	L2_WB_PF	[HW B/s]
Rank	0	:	1.191e+08	1.137e+04	3.844e+06	2.259e+10
Rank	1	:	1.175e+08	7.926e+03	3.359e+06	2.225e+10

Label First section

Header	ID	:	L2_TCM	L2_WB_DM	L2_WB_PF	[HW B/s]
Rank	0	:	3.487e+07	6.986e+03	1.179e+06	1.996e+10
Rank	1	:	3.851e+07	8.730e+02	3.850e+05	2.151e+10

京Test1 : HWPC_CHOOSERにCYCLEを指定

```
# PMLib hardware performance counter (HWPC) Report -----  
Label Subsection Y  
Header ID : TOT_CYC TOT_INS LD_INS SR_INS  
Rank 0 : 5.953e+09 1.267e+10 6.036e+09 1.051e+08  
Rank 1 : 5.907e+09 1.267e+10 6.036e+09 1.051e+08  
Label Subsection X  
Header ID : TOT_CYC TOT_INS LD_INS SR_INS  
Rank 0 : 6.063e+09 1.292e+10 6.046e+09 1.351e+08  
Rank 1 : 6.025e+09 1.292e+10 6.046e+09 1.351e+08  
Label First section  
Header ID : TOT_CYC TOT_INS LD_INS SR_INS  
Rank 0 : 1.862e+09 3.997e+09 2.003e+09 8.019e+06  
Rank 1 : 1.863e+09 3.997e+09 2.003e+09 8.018e+06
```

京Test1 : HWPC_CHOOSERにCACHEを指定

```
# PMLib hardware performance counter (HWPC) Report -----
```

```
Label Subsection Y
```

```
Header ID :      L1_TCM      L2_TCM
```

```
Rank    0 :  2.460e+08  1.224e+08
```

```
Rank    1 :  2.460e+08  1.177e+08
```

```
Label Subsection X
```

```
Header ID :      L1_TCM      L2_TCM
```

```
Rank    0 :  2.470e+08  1.253e+08
```

```
Rank    1 :  2.470e+08  1.160e+08
```

```
Label First section
```

```
Header ID :      L1_TCM      L2_TCM
```

```
Rank    0 :  8.113e+07  3.683e+07
```

```
Rank    1 :  8.113e+07  3.781e+07
```

Intel Xeonクラスタでの実習 PMlibのインストール

PMlibのインストール Intel 環境

- 京コンピュータと同様の手順だが、configureのオプションが異なる。
- 以下の例はIntelコンパイラ、Intel MPIの組み合わせでmakeする場合

```
$ cat x.make-intel-impi.sh
#!/bin/bash
module load intel impi papi/intel # moduleコマンドについては次ページを参照
SRC_DIR=${HOME}/pmlib/PMlib
cd ${SRC_DIR}; if [ $? != 0 ]; then echo '*** Directory error ***'; exit; fi
autoreconf -i # 初回のみ autoreconf の実行が必要な場合がある。

cd ${SRC_DIR}/BUILD_DIR; if [ $? != 0 ]; then echo '*** Directory error ***'; exit; fi
CFLAGS="-std=c99 -openmp"
FCFLAGS="-fpp -openmp "
CXXFLAGS="-openmp "
INSTALL_DIR=${HOME}/pmlib/install_develop

../configure \
  CXX=mpiicpc CC=mpiicc FC=mpiifort \
  CFLAGS="${CFLAGS}" CXXFLAGS="${CXXFLAGS}" FCFLAGS="${FCFLAGS}" \
  --with-comp=INTEL --with-mpi=${I_MPI_ROOT} \
  --with-papi=${PAPI_DIR} --with-example=yes -prefix=${INSTALL_DIR}

make
make install

$ ./x.make-intel-impi.sh
```


PMlibのインストール Intel 環境

- 前ページの例で第2行目のmoduleコマンド

```
module load intel impi papi/intel
```

- は以下のコマンド群と同様な効果がある。もしmoduleコマンドが設定されていない場合は、Intelコンパイラ、Intel MPI、PAPIの実際のディレクトリパスを確認の上、この行を以下のコマンド群に書き換えてmakeする。

```
# module load intel
INTEL_DIR=/usr/local/intel/composer_xe_2013
source ${INTEL_DIR}/bin/compilervars.sh intel64

# module load impi
export I_MPI_ROOT=/usr/local/intel/impi/4.1.0.024
source ${I_MPI_ROOT}/bin64/mpivars.sh
export I_MPI_F90=ifort
export I_MPI_F77=ifort
export I_MPI_CC=icc
export I_MPI_CXX=icpc

# module load papi/intel
PAPI_ROOT=/usr/local/papi/papi-5.3.2/intel
PAPI_DIR=${PAPI_ROOT}
export LD_FLAGS="-L${PAPI_ROOT}/lib -lpapi -lpmf"
export INCLUDES="-I${PAPI_ROOT}/include"
export LD_LIBRARY_PATH=${PAPI_ROOT}/lib:${LD_LIBRARY_PATH}
```

PMlibのインストール GNU 環境

- 京コンピュータと同様の手順だが、configureのオプションが異なる。
- 以下の例はGNUコンパイラ、OpenMPIの組み合わせでmakeする場合

```
$ cat x.make-gnu-openmpi.sh
#!/bin/bash
module load openmpi/gnu papi/gnu # moduleコマンドについては次ページを参照
SRC_DIR=${HOME}/pmlib/PMlib
cd ${SRC_DIR}; if [ $? != 0 ]; then echo '*** Directory error ***'; exit; fi
autoreconf -i # 初回のみ autoreconf の実行が必要な場合がある。

cd ${SRC_DIR}/BUILD_DIR; if [ $? != 0 ]; then echo '*** Directory error ***'; exit; fi
CFLAGS="-O3 -fopenmp "
FCFLAGS="-cpp -O3 -fopenmp "
CXXFLAGS="-O3 -fopenmp "
INSTALL_DIR=${HOME}/pmlib/install_gnu

../configure \
  CXX=mpicxx CC=mpicc FC=mpif90 \
  CFLAGS="${CFLAGS}" CXXFLAGS="${CXXFLAGS}" FCFLAGS="${FCFLAGS}" \
  --with-comp=GNU --with-mpi=${MPI_DIR} \
  --with-papi=${PAPI_DIR} --with-example=yes -prefix=${INSTALL_DIR}

make
make install

$ ./x.make-gnu-openmpi.sh
```

PMlibのインストール GNU 環境

- 前ページの例でmoduleコマンドの行

```
module load openmpi/gnu papi/gnu
```

- は以下のコマンド群と同じ効果である。もしmoduleコマンドが設定されていない場合は、OpenMPIやPAPIの実際のディレクトリパスを確認の上、この行をコマンド群に書き換えてmakeする。

```
export FC=gfortran
export CC=gcc
export CXX=g++
export HYDRA_BOOTSTRAP=ssh
export HYDRA_BOOTSTRAP_EXEC=/usr/bin/ssh
OPENMPI_DIR=/usr/local/openmpi/openmpi-1.8.7-gnu
PAPI_ROOT=/usr/local/papi/papi-5.3.2/gnu
LDFLAGS="-L${PAPI_ROOT}/lib -lpapi -lpfm"
INCLUDES="-I${PAPI_ROOT}/include"
```

```
export PATH=${OPENMPI_DIR}/bin:${PAPI_ROOT}/bin:${PATH}
export LD_LIBRARY_PATH=${OPENMPI_DIR}/lib:${PAPI_ROOT}/lib:${LD_LIBRARY_PATH}
MPI_DIR=${OPENMPI_DIR}
PAPI_DIR=${PAPI_ROOT}
```

Intel Xeonクラスタでの実習
例題プログラムの実行
(以降の出力例はPMlib-4.0の場合)

PMlib例題プログラムの実行 Intel Xeon

- makeされたexample/test[1-5]プログラムを計算ノード上で実行する
- バッチジョブを投入・実行する。
- 下の例はtest1プログラムでの例(test2-test5も同様)
 - 環境変数 HWPC_CHOOSERの指定がないため計算量自己申告モード

```
#!/bin/bash
#BSUB -J PMLIB-EXAMPLE-INTEL
#BSUB -o PMLIB-EXAMPLE-INTEL-%J
#BSUB -n 4
#BSUB -R "span[ptile=1]"
#BSUB -x
module load intel impi papi/intel pmlib/intel

BUILD_DIR=${HOME}/pmlib/PMlib/BUILD_DIR
WKDIR=/media/dali/data1/mikami/check_pmlib
cd $WKDIR; if [ $? != 0 ] ; then echo '@@@ Directory error @@@'; exit; fi

NPROCS=4
export OMP_NUM_THREADS=8
mpirun -np ${NPROCS} ${BUILD_DIR}/example/test1/test1
```

Intel Xeon : test1の実行結果例

基本レポート: 環境変数 HWPC_CHOOSERの指定なし

→経過時間と自己申告計算量(関数への引数で明示的に与えた式・値を評価)

```
# PMLib Basic Report -----
```

Timing Statistics Report from PMLib version 4.1.4

Linked PMLib supports: MPI, OpenMP, HWPC

Host name : vsp20

Date : 2015/10/27 : 16:23:50

Mr. Bean

Parallel Mode: Hybrid (4 processes x 8 threads)

The environment variable HWPC_CHOOSER is not provided. No HWPC report.

Total execution time = 2.614012e-01 [sec]

Total time of measured sections = 2.590960e-01 [sec]

Exclusive Sections statistics per process and total job.

Section Label	call	accumulated time[sec]				[flop counts or byte counts]			
		avr	avr[%]	sdv	avr/call	avr	sdv	speed	
First location :	3	1.569e-01	00.56	5.38e-04	5.230e-02	0.000e+00	0.00e+00	0.00	Mflops
Third location :	1	5.111e-02	19.73	1.41e-04	5.111e-02	1.601e+10	0.00e+00	313.23	GB/sec
Second location :	1	5.109e-02	19.72	1.14e-04	5.109e-02	4.000e+09	0.00e+00	78.29	Gflops

Sections per process		2.080e-01				4.000e+09		19.23	Gflops
Sections per process		5.111e-02				1.601e+10		313.23	GB/sec

Sections total job		2.080e-01				1.600e+10		76.93	Gflops
Sections total job		5.111e-02				6.403e+10		1.25	TB/sec

Intel Xeon : test1の実行結果例

詳細レポート:環境変数 HWPC_CHOOSERを設定しないで実行した場合の例

```
# PMlib Process Report --- Elapsed time for individual MPI ranks -----
```

Label First location

Header	ID	:	call	time[s]	time[%]	t_wait[s]	t[s]/call	flop msg	speed
Rank	0	:	3	1.572e-01	60.7	2.363e-04	5.241e-02	0.000e+00	0.000e+00 Flops
Rank	1	:	3	1.563e-01	60.3	1.139e-03	5.211e-02	0.000e+00	0.000e+00 Flops
Rank	2	:	3	1.575e-01	60.8	0.000e+00	5.249e-02	0.000e+00	0.000e+00 Flops
Rank	3	:	3	1.566e-01	60.4	8.991e-04	5.219e-02	0.000e+00	0.000e+00 Flops

Label Third location

Header	ID	:	call	time[s]	time[%]	t_wait[s]	t[s]/call	flop msg	speed
Rank	0	:	1	5.104e-02	19.7	2.699e-04	5.104e-02	1.601e+10	3.136e+11 Bytes/sec
Rank	1	:	1	5.107e-02	19.7	2.420e-04	5.107e-02	1.601e+10	3.134e+11 Bytes/sec
Rank	2	:	1	5.131e-02	19.8	0.000e+00	5.131e-02	1.601e+10	3.120e+11 Bytes/sec
Rank	3	:	1	5.100e-02	19.7	3.159e-04	5.100e-02	1.601e+10	3.139e+11 Bytes/sec

Label Second location

Header	ID	:	call	time[s]	time[%]	t_wait[s]	t[s]/call	flop msg	speed
Rank	0	:	1	5.105e-02	19.7	2.139e-04	5.105e-02	4.000e+09	7.836e+10 Flops
Rank	1	:	1	5.104e-02	19.7	2.170e-04	5.104e-02	4.000e+09	7.836e+10 Flops
Rank	2	:	1	5.126e-02	19.8	0.000e+00	5.126e-02	4.000e+09	7.803e+10 Flops
Rank	3	:	1	5.102e-02	19.7	2.460e-04	5.102e-02	4.000e+09	7.841e+10 Flops

Intel Xeon : test2の実行結果例

基本レポート: 環境変数 HWPC_CHOOSERの指定がないため計算量自己申告モード
自己申告モードで計算量を引数で与えないと0と解釈され、時間情報だけが評価される

```
# PMLib Basic Report -----
```

Timing Statistics Report from PMLib version 4.1.4

Linked PMLib supports: MPI, OpenMP, HWPC

Host name : vsp21

Date : 2015/10/27 : 19:59:20

Mr. Bean

Parallel Mode: Hybrid (4 processes x 8 threads)

The environment variable HWPC_CHOOSER is not provided. No HWPC report.

Total execution time = 2.094159e-01 [sec]

Total time of measured sections = 2.076831e-01 [sec]

Exclusive Sections statistics per process and total job.

Section	call	accumulated time[sec]				[flop counts or byte counts]			
Label		avr	avr[%]	sdv	avr/call	avr	sdv	speed	
First location :	1	1.567e-01	75.45	4.12e-04	1.567e-01	0.000e+00	0.00e+00	0.00	Mflops
Second location :	1	5.099e-02	24.55	1.65e-04	5.099e-02	0.000e+00	0.00e+00	0.00	Mflops

Sections per process		2.077e-01				0.000e+00		0.00	Mflops

Sections total job		2.077e-01				0.000e+00		0.00	Mflops

Intel Xeon : test2の実行結果例

詳細レポート:各測定区間毎に全MPIランクのレポート

```
# PMLib Process Report --- Elapsed time for individual MPI ranks -----
```

Label First location

Header	ID	:	call	time[s]	time[%]	t_wait[s]	t[s]/call	flops/msg	speed
Rank	0	:	1	1.565e-01	75.4	7.432e-04	1.565e-01	0.000e+00	0.000e+00 Flops
Rank	1	:	1	1.566e-01	75.4	6.323e-04	1.566e-01	0.000e+00	0.000e+00 Flops
Rank	2	:	1	1.563e-01	75.3	9.592e-04	1.563e-01	0.000e+00	0.000e+00 Flops
Rank	3	:	1	1.573e-01	75.7	0.000e+00	1.573e-01	0.000e+00	0.000e+00 Flops

Label Second location

Header	ID	:	call	time[s]	time[%]	t_wait[s]	t[s]/call	flops/msg	speed
Rank	0	:	1	5.082e-02	24.5	3.271e-04	5.082e-02	0.000e+00	0.000e+00 Flops
Rank	1	:	1	5.087e-02	24.5	2.720e-04	5.087e-02	0.000e+00	0.000e+00 Flops
Rank	2	:	1	5.111e-02	24.6	3.505e-05	5.111e-02	0.000e+00	0.000e+00 Flops
Rank	3	:	1	5.114e-02	24.6	0.000e+00	5.114e-02	0.000e+00	0.000e+00 Flops

Intel Xeon : test3の実行結果例

基本レポート、詳細レポートの他、プロセスグループ毎の詳細レポートを出力

```
# PMLib Basic Report ----- (省略)
# PMLib Process Report --- Elapsed time for individual MPI ranks ----- (省略)

# PMLib Process Group [    1] Elapsed time for individual MPI ranks -----

Label 2nd section
Header ID :      call   time[s] time[%]  t_wait[s]  t[s]/call   floplmsg    speed
Rank   0 :        1  2.043e-01  68.5  4.163e-04  2.043e-01  0.000e+00  0.000e+00 Flops
Rank   1 :        1  2.048e-01  68.7  0.000e+00  2.048e-01  0.000e+00  0.000e+00 Flops
Label 1st section
Header ID :      call   time[s] time[%]  t_wait[s]  t[s]/call   floplmsg    speed
Rank   0 :        1  5.444e-02  18.3  0.000e+00  5.444e-02  0.000e+00  0.000e+00 Flops
Rank   1 :        1  5.247e-02  17.6  1.966e-03  5.247e-02  0.000e+00  0.000e+00 Flops

# PMLib Process Group [    2] Elapsed time for individual MPI ranks -----

Label 2nd section
Header ID :      call   time[s] time[%]  t_wait[s]  t[s]/call   floplmsg    speed
Rank   2 :        1  2.514e-01  84.3  6.453e-02  2.514e-01  0.000e+00  0.000e+00 Flops
Rank   3 :        1  3.160e-01 106.0  0.000e+00  3.160e-01  0.000e+00  0.000e+00 Flops
Label 1st section
Header ID :      call   time[s] time[%]  t_wait[s]  t[s]/call   floplmsg    speed
Rank   2 :        1  5.500e-02  18.4  0.000e+00  5.500e-02  0.000e+00  0.000e+00 Flops
Rank   3 :        1  5.409e-02  18.1  9.141e-04  5.409e-02  0.000e+00  0.000e+00 Flops
```

Intel Xeon : test4の実行結果例

FortranプログラムからのPMLib利用。
基本レポート(詳細レポート、HWPCレポートも同様)

```
# PMLib Basic Report -----
```

Timing Statistics Report from PMLib version 4.1.4

Linked PMLib supports: MPI, OpenMP, HWPC

Host name : vsp21

Date : 2015/10/27 : 19:59:26

user

Parallel Mode: Hybrid (4 processes x 8 threads)

The environment variable HWPC_CHOOSER is not provided. No HWPC report.

Total execution time = 2.325020e-01 [sec]

Total time of measured sections = 2.335144e-01 [sec]

Exclusive Sections statistics per process and total job.

Section	call	accumulated time[sec]				[flop counts or byte counts]			
Label		avr	avr[%]	sdv	avr/call	avr	sdv	speed	
2-submtxm :	3	2.311e-01	98.98	6.63e-03	7.704e-02	0.000e+00	0.00e+00	0.00 MB/sec	
1-subinit :	1	2.391e-03	1.02	3.47e-05	2.391e-03	0.000e+00	0.00e+00	0.00 MB/sec	
-----+-----+-----+-----+-----+-----+-----+-----+-----+-----									
Sections per process		2.335e-01				0.000e+00		0.00 MB/sec	
-----+-----+-----+-----+-----+-----+-----+-----+-----+-----									
Sections total job		2.335e-01				0.000e+00		0.00 MB/sec	

Intel Xeon : test5の実行結果例

基本レポート、詳細レポート、+PMlibが内部でグループ化したプロセス毎のレポート

```
# PMlib Basic Report ----- (省略)
# PMlib Process Report --- Elapsed time for individual MPI ranks ----- (省略)

# PMlib Process Group [    0] Elapsed time for individual MPI ranks -----

Label  section-2
Header ID :      call   time[s] time[%]  t_wait[s]  t[s]/call   floplmsg    speed
Rank    0 :        1  2.507e-01  109.8  0.000e+00  2.507e-01  0.000e+00  0.000e+00 Flops
Rank    1 :        1  2.501e-01  109.5  6.680e-04  2.501e-01  0.000e+00  0.000e+00 Flops
Label  section-1
Header ID :      call   time[s] time[%]  t_wait[s]  t[s]/call   floplmsg    speed
Rank    0 :        1  1.833e-03    0.8  9.060e-06  1.833e-03  0.000e+00  0.000e+00 Flops
Rank    1 :        1  1.842e-03    0.8  0.000e+00  1.842e-03  0.000e+00  0.000e+00 Flops

# PMlib Process Group [    1] Elapsed time for individual MPI ranks -----

Label  section-2
Header ID :      call   time[s] time[%]  t_wait[s]  t[s]/call   floplmsg    speed
Rank    2 :        1  2.030e-01   88.9  0.000e+00  2.030e-01  0.000e+00  0.000e+00 Flops
Rank    3 :        1  2.022e-01   88.5  7.873e-04  2.022e-01  0.000e+00  0.000e+00 Flops
Label  section-1
Header ID :      call   time[s] time[%]  t_wait[s]  t[s]/call   floplmsg    speed
Rank    2 :        1  1.950e-03    0.9  0.000e+00  1.950e-03  0.000e+00  0.000e+00 Flops
Rank    3 :        1  1.821e-03    0.8  1.287e-04  1.821e-03  0.000e+00  0.000e+00 Flops
```

HWPCを利用した計算量の自動測定 Intel Xeon

- test1のバッチジョブ実行例
- 計算量の自動測定モード(環境変数 HWPC_CHOOSERで指定)

```
#!/bin/bash
#BSUB -J PMLIB-EXAMPLE-INTEL
#BSUB -o PMLIB-EXAMPLE-INTEL-%J
#BSUB -n 4
#BSUB -R "span[ptile=1]"
#BSUB -x
module load intel impi papi/intel pmlib/intel

BUILD_DIR=${HOME}/pmlib/PMlib/BUILD_DIR
WKDIR=/media/dali/data1/mikami/check_pmlib
cd $WKDIR; if [ $? != 0 ] ; then echo '@@@ Directory error @@@'; exit; fi

NPROCS=4
export OMP_NUM_THREADS=8
export HWPC_CHOOSER=FLOPS
mpirun -np ${NPROCS} ${BUILD_DIR}/example/test1/test1
```

Intel Xeon Test1 : HWPC_CHOOSERにFLOPSを指定

基本レポート: 計算量の自動測定

PMLib Basic Report -----

Timing Statistics Report from PMLib version 4.1.4

Linked PMLib supports: MPI, OpenMP, HWPC

Host name : vsp21

Date : 2015/10/27 : 19:59:31

Mr. Bean

Parallel Mode: Hybrid (4 processes x 8 threads)

The environment variable HWPC_CHOOSER=FLOPS is provided.

Total execution time = 2.612011e-01 [sec]

Total time of measured sections = 2.590463e-01 [sec]

Exclusive Sections statistics per process and total job.

Section Label	call	accumulated time[sec]					[flop counts or byte counts]			
		avr	avr[%]	sdv	avr/call		avr	sdv	speed	
First location :	3	1.569e-01	50.58	3.83e-04	5.231e-02		1.438e+10	4.92e+06	91.62	Gflops
Second location :	1	5.107e-02	19.71	1.01e-05	5.107e-02		4.753e+09	1.72e+05	93.08	Gflops
Third location :	1	5.106e-02	19.71	8.14e-06	5.106e-02		4.753e+09	2.75e+05	93.10	Gflops
Sections per process		2.590e-01					2.388e+10		92.20	Gflops
Sections total job		2.590e-01					9.553e+10		368.79	Gflops

Intel Xeon Test1 : HWPC_CHOOSERにFLOPSを指定

詳細レポート(計算量の自動測定):プロセス毎の詳細レポート

PMLib Process Report --- Elapsed time for individual MPI ranks -----

Label First location

Header	ID	:	call	time[s]	time[%]	t_wait[s]	t[s]/call	flop msg	speed	
Rank	0	:	3	1.569e-01	60.6	3.917e-04	5.228e-02	1.438e+10	9.167e+10	Flops (HWPC)
Rank	1	:	3	1.572e-01	60.7	0.000e+00	5.241e-02	1.438e+10	9.145e+10	Flops (HWPC)
Rank	2	:	3	1.572e-01	60.7	6.914e-05	5.239e-02	1.438e+10	9.148e+10	Flops (HWPC)
Rank	3	:	3	1.564e-01	60.4	8.388e-04	5.214e-02	1.437e+10	9.187e+10	Flops (HWPC)

Label Second location

Header	ID	:	call	time[s]	time[%]	t_wait[s]	t[s]/call	flop msg	speed	
Rank	0	:	1	5.107e-02	19.7	2.861e-06	5.107e-02	4.753e+09	9.306e+10	Flops (HWPC)
Rank	1	:	1	5.106e-02	19.7	1.383e-05	5.106e-02	4.753e+09	9.309e+10	Flops (HWPC)
Rank	2	:	1	5.106e-02	19.7	2.193e-05	5.106e-02	4.753e+09	9.310e+10	Flops (HWPC)
Rank	3	:	1	5.108e-02	19.7	0.000e+00	5.108e-02	4.753e+09	9.306e+10	Flops (HWPC)

Label Third location

Header	ID	:	call	time[s]	time[%]	t_wait[s]	t[s]/call	flop msg	speed	
Rank	0	:	1	5.105e-02	19.7	1.407e-05	5.105e-02	4.753e+09	9.310e+10	Flops (HWPC)
Rank	1	:	1	5.107e-02	19.7	0.000e+00	5.107e-02	4.754e+09	9.309e+10	Flops (HWPC)
Rank	2	:	1	5.105e-02	19.7	1.597e-05	5.105e-02	4.753e+09	9.311e+10	Flops (HWPC)
Rank	3	:	1	5.106e-02	19.7	2.146e-06	5.106e-02	4.753e+09	9.308e+10	Flops (HWPC)

Intel Xeon Test1 : HWPC_CHOOSERにFLOPSを指定

詳細レポート(計算量の自動測定):HWPCレポート

```
# PMLib hardware performance counter (HWPC) Report -----  
Label First location  
Header ID :      SP_OPS      DP_OPS      [Flops]  
Rank   0 :  1.438e+10  4.400e+01  9.167e+10  
Rank   1 :  1.438e+10  2.900e+01  9.145e+10  
Rank   2 :  1.438e+10  2.800e+01  9.148e+10  
Rank   3 :  1.437e+10  2.800e+01  9.187e+10  
Label Second location  
Header ID :      SP_OPS      DP_OPS      [Flops]  
Rank   0 :  4.753e+09  8.000e+00  9.306e+10  
Rank   1 :  4.753e+09  1.000e+01  9.309e+10  
Rank   2 :  4.753e+09  1.200e+01  9.310e+10  
Rank   3 :  4.753e+09  1.100e+01  9.306e+10  
Label Third location  
Header ID :      SP_OPS      DP_OPS      [Flops]  
Rank   0 :  4.753e+09  1.100e+01  9.310e+10  
Rank   1 :  4.754e+09  1.400e+01  9.309e+10  
Rank   2 :  4.753e+09  1.200e+01  9.311e+10  
Rank   3 :  4.753e+09  9.000e+00  9.308e+10
```


Intel Xeon : HWPCレポートの記号

printDetail()関数へのlegend引数指定で表示(表示項目はシステム毎に異なる)

Detected CPU architecture:

GenuineIntel

Intel(R) Xeon(R) CPU E5-2670 0 @ 2.60GHz

The available PMLib HWPC events for this CPU are shown below.

The values for each process as the sum of threads.

HWPC events legend:

FP_OPS: floating point operations

SP_OPS: single precision floating point operations

DP_OPS: double precision floating point operations

VEC_SP: single precision vector floating point operations

VEC_DP: double precision vector floating point operations

LD_INS: memory load instructions

SR_INS: memory store instructions

L1_HIT: level 1 cache hit

L2_HIT: level 2 cache hit

L3_HIT: level 3 cache hit

HIT_LFB cache line fill buffer hit

L1_TCM: level 1 cache miss

L2_TCM: level 2 cache miss

L3_TCM: level 3 cache miss by demand

OFFCORE: demand and prefetch request cache miss

TOT_CYC: total cycles

TOT_INS: total instructions

FP_INS: floating point instructions

Derived statistics:

[GFlops]: floating point operations per nano seconds (10^{-9})

[Mem GB/s]: memory bandwidth in load+store GB/s

[L1\$ %]: Level 1 cache hit percentage

[LL\$ %]: Last Level cache hit percentage

Intel Xeon Test2 : HWPC_CHOOSERにFLOPSを指定

基本レポート: 計算量の自動測定

PMLib Basic Report -----

Timing Statistics Report from PMLib version 4.1.4

Linked PMLib supports: MPI, OpenMP, HWPC

Host name : vsp21

Date : 2015/10/27 : 19:59:34

Mr. Bean

Parallel Mode: Hybrid (4 processes x 8 threads)

The environment variable HWPC_CHOOSER=FLOPS is provided.

Total execution time = 2.097340e-01 [sec]

Total time of measured sections = 2.073585e-01 [sec]

Exclusive Sections statistics per process and total job.

Section Label	call	accumulated time[sec]				[flop counts or byte counts]			
		avr	avr[%]	sdv	avr/call	avr	sdv	speed	
First location :	1	1.563e-01	75.36	5.31e-04	1.563e-01	1.436e+10	1.76e+07	91.91	Gflops
Second location :	1	5.110e-02	24.64	6.58e-05	5.110e-02	4.756e+09	3.41e+05	93.07	Gflops
Sections per process		2.074e-01				1.912e+10		92.20	Gflops
Sections total job		2.074e-01				7.647e+10		368.78	Gflops

Intel Xeon Test1 : HWPC_CHOOSERにBANDWIDTHを指定

PMLib Basic Report -----
(部分的に表示)

Section Label	call	accumulated time[sec]				[flop counts or byte counts]			
		avr	avr[%]	sdv	avr/call	avr	sdv	speed	
First location :	3	1.565e-01	60.50	4.86e-04	5.216e-02	3.683e+10	3.53e+07	235.32	GB/sec
Second location :	1	5.109e-02	19.75	2.36e-05	5.109e-02	1.229e+10	8.38e+05	240.65	GB/sec
Third location :	1	5.109e-02	19.75	4.35e-05	5.109e-02	1.229e+10	4.76e+05	240.63	GB/sec
Sections per process		2.587e-01				6.141e+10		237.42	GB/sec
Sections total job		2.587e-01				2.457e+11		949.69	GB/sec

PMLib Process Report --- Elapsed time for individual MPI ranks -----
(部分的に表示)

Label First location

Header	ID	:	call	time[s]	time[%]	t_wait[s]	t[s]/call	flop msg	speed
Rank	0	:	3	1.560e-01	60.3	1.176e-03	5.199e-02	3.686e+10	2.364e+11 Bytes/s (HWPC)
Rank	1	:	3	1.564e-01	60.5	7.520e-04	5.213e-02	3.685e+10	2.356e+11 Bytes/s (HWPC)
Rank	2	:	3	1.571e-01	60.8	0.000e+00	5.238e-02	3.679e+10	2.341e+11 Bytes/s (HWPC)
Rank	3	:	3	1.565e-01	60.5	6.628e-04	5.216e-02	3.681e+10	2.352e+11 Bytes/s (HWPC)

PMLib hardware performance counter (HWPC) Report -----
(部分的に表示)

Label First location

Header	ID :	LD_INS	SR_INS	L1_HIT	HIT_LFB	L2_DRD_REQ	L2_DRD_HIT	L2_PF_MISS	L2_RFO_MIS	[HW B/s]
Rank	0 :	3.103e+09	9.339e+06	2.540e+09	5.501e+08	3.200e+08	1.844e+08	4.403e+08	3.217e+04	2.364e+11
Rank	1 :	3.103e+09	9.296e+06	2.539e+09	5.503e+08	3.202e+08	1.844e+08	4.399e+08	3.257e+04	2.356e+11
Rank	2 :	3.097e+09	8.414e+06	2.535e+09	5.489e+08	3.204e+08	1.847e+08	4.390e+08	3.122e+04	2.341e+11
Rank	3 :	3.097e+09	8.443e+06	2.534e+09	5.499e+08	3.203e+08	1.845e+08	4.393e+08	3.111e+04	2.352e+11

本日はお疲れさまでした