PAC 2017

Chao Gao

December 4, 2017

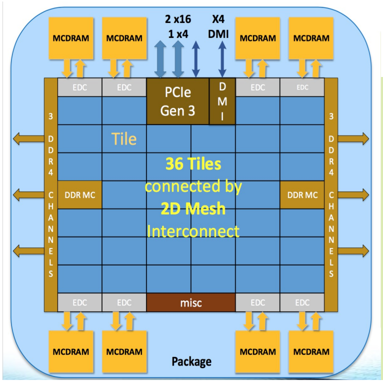
Overview

what is the PAC?

Parallel Application Challenge.

KNL

KNL(Knights Landing): 2nd Generation Intel Xeon Phi Processor.



Chip: 36 Tiles interconnected by **2D Mesh**
Tile: 2 Cores + 2 VPU/core + 1 MB L2

Memory: MCDRAM: 16 GB on-package; High BW
DDR4: 6 channels @ 2400 up to 384GB
IO: 36 lanes PCIe Gen3. 4 lanes of DMI for chipset
Node: 1-Socket only
Fabric: Omni-Path on-package (not shown)

Vector Peak Perf: 3+TF DP and 6+TF SP Flops
Scalar Perf: ~3x over Knights Corner
Streams Triad (GB/s): MCDRAM : 400+; DDR: 90+

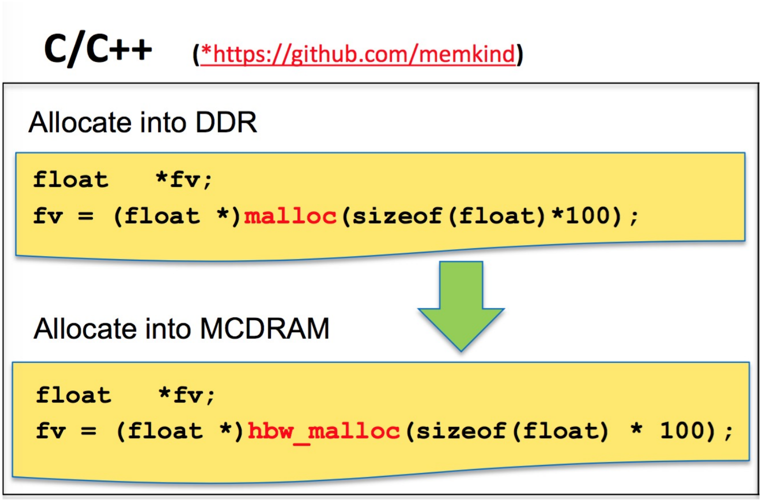
How fast

We want to make the program run fast, so we parallelize it.

Two big item.

- Data. How to get the data fast?
- Task. How to accomplish the task fast?

Based on specific hardware



C/C++ (*https://github.com/memkind)

Allocate into DDR

```
float   *fv;
fv = (float *)malloc(sizeof(float)*100);
```

Allocate into MCDRAM

```
float   *fv;
fv = (float *)hbw_malloc(sizeof(float) * 100);
```

Using cache gracefully

Fetch the data fits in the cache size. Reduce the cache miss rate.

```
for(j = 0; j < 100; j++)
    for(i = 0; i < 5000; i++)
        x[i][j] = 2 * x[i][j];
```

```
for(i = 0; i < 5000; i++)
    for(j = 0; j < 100; j++)
        x[i][j] = 2 * x[i][j];
```

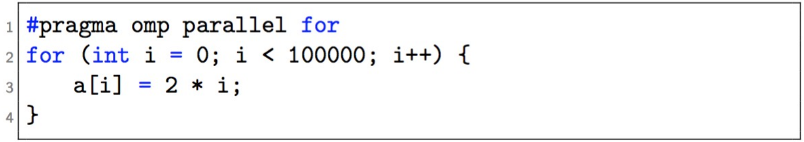
Vectorization

Vectorization is a special case of automatic parallelization, where a computer program is converted from a scalar implementation to a vector implementation, which processes one operation on multiple pairs of operands at once. That is SIMD(Single Instruction Multiple Data).

```
#pragma simd
for (i=0; i<n; i++)
    c[i] = a[i] + b[i];
```

OpenMP

OpenMP is an application programming interface(API) that supports multi-platform shared memory multiprocessing programming in C, C++ and Fortran.



```
#pragma omp parallel for
for (int i = 0; i < 100000; i++) {
    a[i] = 2 * i;
}
```

Data dependency causes problems

```
#pragma omp parallel for
for (int i = 2; i < 10; i++) {
    factorial[i] = factorial[i-1];
}
```

```
#pragma omp parallel for num_threads(2)
for (int i = 2; i < 10; i++) {
    factorial[i] = factorial[i-4];
}
```

MPI

MPI: Message Passing Interface. Data is moved from the address space of one process to that of another process through cooperative operations on each process. Mostly used in clusters of distributed memory.

When using MPI, we should partition the data manually, and have to manage how processes communicate, and have to deal with the scynchronization problem.

MPI

```
#include "mpi.h"
int main(int argc, char *argv[]) {
   int myid, numprocs;
   MPI_Init( &argc, &argv );
   MPI_Comm_rank( MPI_COMM_WORLD, &myid );
   MPI_Comm_size( MPI_COMM_WORLD, &numprocs );
   printf("I am %d of %d\n", myid, numprocs );
   MPI_Finalize();
}
```

- MPI_Comm_size: number of processes
- MPI_Comm_rank: get current process ID

SPMD

I have to know who am I.

```c
int main(int argc, char *argv[]) {
    int numprocs, myid, source; MPI_Status status;
    char message[100];
    MPI_Init(&argc, &argv);
    MPI_Comm_rank(MPI_COMM_WORLD, &myid);
    MPI_Comm_size(MPI_COMM_WORLD, &numprocs);
    if(myid!=0) {
        strcpy(message, "Hello World!");
        MPI_Send(message,strlen(message)+1, MPI_CHAR,
            0,99, MPI_COMM_WORLD);
    } else {/* myid == 0 */
    for (source = 1; source < numprocs; source++) {
        MPI_Recv(message, 100, MPI_CHAR, source, 99,
            MPI_COMM_WORLD, &status);
        printf("%s\n", message); }
}
```

Algorithm

Of course, algorithm-level optimization is significant.

- Parameter tuning
- Just use a more powerful algorithm.

应用驱动·生态共建
2017 THE 13th HPC CHINA
全国高性能计算学术年会
National Annual Conference on High Performance Computing
签到处
2017年10月19-21日 中国·合肥
PARATERA
应用驱动
生态共建
2017 THE 13th HPC CHINA
全国高性能计算学术年会
主会场
←

PAC
第五届"英特尔杯"
2017全国并行应用挑战赛颁奖晚宴
The 5th "Intel Cup" Parallel Application Challenge–PAC2017
智引天下 算出精彩
指导单位：中国计算机学会高性能计算专业委员会
主办单位：教育部高等学校计算机类专业教学指导委员会
英特尔（中国）有限公司
承办单位：北京并行科技股份有限公司
支持单位：国家超级计算广州中心
中科院计算技术研究所、中科院计算机网络信息中心
电子商务与电子支付国家工程实验室
百度云
机械工业出版社华章分社
intel
PARATERA 并行
国家超级计算广州中心
Lenovo
Sugon

Come on

Parallel Application Challenge(PAC)

Asia Supercomputer Community Student Supercomputer Challenge(ASC)

The End