LLVM-based Software for Guided Parallelization with OpenMP

Manuel Arenaz
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● Why Parallware?
● ORNL & Appentra
● Parallware Trainer (DEMO)
● Conclusions
Software modernization through parallelization with MPI+X
High-level programming: $X = \text{OpenMP or OpenACC}$

**WHY DEVELOPING PARALLANWARE?**

**PARALLEL PROGRAMMING IS HARD!**
Currently a manual process
Can we make it easier?
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ORNL & APPENTRA

COLLABORATION ON TOOLS INNOVATION

Fernanda Foertter

Oscar Hernandez

ORNL Industrial Partnership Program, project CSC193: “Porting Parallware Tools to Large HPC Installations including Titan” (2015-2016)

Jacobo Lobeiras, Manuel Arenaz, Oscar Hernández: Experiences in extending parallware to support OpenACC. WACCPD@SC 2015: 4:1-4:12
This research used resources of the Oak Ridge Leadership Computing Facility, which is a DOE Office of Science User Facility supported under Contract DE-AC05-00OR22725.
ORNL & APPENTRA

**TRAINING**

- Newcomers
- Learning
- Microbenchmarks

Work on specification of new tools for productive HPC training

```
#include math.h

void coulomb(double* vec, int size, // List of charged part

double** mat, int rows, int cols, // Output matrix

double x0, double y0, double 20 // Initial point

double x1, double y1 // Final point

const double PI = 3.14159265358979323846264338327950288419716939937510

double double; // Vector

for(int k = 0; k < size; k++)
{
    for(int j = 0; j < size; j++)
    {
        double dx = vec[k] - vec[j];
        double dy = vec[k] - vec[j];
        double charge = dx * dx + dy * dy;
        double dist = sqrt(dx + dy); // Distance
        mat[i][j] = mat[i][j] / (4 * PI * e0); // Energy
    }
}
```
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Interactive Tool for HPC Training

“Tell me, I will forget,
Show me, I may remember,
Involve me, I will understand.” - Confucius

EXPERIENTIAL LEARNING

- Higher productivity in HPC training
- “Learn by Doing” & “Student-Centric”
Interactive Tool for HPC Training

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**MICROBENCHMARKS**

- Mandelbrot
- Sparse Matrix - Vector product
- Laplace computations
- PGI compiler OpenMP & OpenACC
Interactive Tool for HPC Training

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TECHNICAL FEATURES

- Interactive real-time editor GUI
- Assisted code parallelization using OpenMP & OpenACC
- Programming language C
- Detailed report of the parallelism discovered in the code
- Support for multiple compilers

“Take-away your work”
(based on make & ssh)
OUTLINE

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Conclusions
CONCLUSIONS

● Present Parallware Trainer at SC16 Emerging Technologies Showcase
  ○ Tuesday, Wednesday, Thursday 9:00 AM - 17:30 PM, Room 155-B
  ○ Also booth talks at DoE, OpenMP and OpenACC

● Parallware Trainer Early Access Program:
  ○ Invitation to participate (we need feedback)
  ○ Contact me <manuel.arenaz@appentra.com>

● Continue ORNL & Appentra collaboration:
  ○ Prototype of Parallware Assistant for HPC developers
  ○ Search other innovative tools based on Parallware
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