



Performance Counter Exercises

OpenPOWER Tutorial, SC19, Denver

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Outline

Introduction

Ascent

PMU Hands-On

Connect to Ascent

Task Setup

Task Organization

PMU Hands-On Description

Ascent

- Supercomputer used for exercises: **Ascent**
- Ascent: Training machine for Summit; same node design
 - 18 nodes
 - IBM POWER9 + NVIDIA Tesla V100
 - POWER9: 2 sockets, each 22 cores
 - Tesla V100: 6 GPUs per node
 - CPU ↔ GPU, GPU ↔ GPU: connections via NVLink
- This tutorial: Make use of all of this!

PMU Hands-On

Overview

- Measure various counters with PAPI
- Characterize Jacobi application...
- ... in context of POWER9 architecture.
- But first: Getting to Ascent

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Connect to Ascent

Ascent Setup

URL to follow along <http://bit.ly/sc19-op-material>

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- 1 Login** to Ascent with `ssh user@login1.ascent.olcf.ornl.gov`
 - Sign up at <http://bit.ly/sc19-op-signup> for **TRN003** project
 - Get your login credentials via mail

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- 2 Bootstrap** our account
 - Call `source /gpfs/wolf/trn003/world-shared/bootstrap.sh`
 - This sets up scripts and loads the latest course material in your home directory

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3 Re-login with SSH forwarding

- We are using Jupyter Notebooks for tasks!
- During login, a message is printed to forward SSH ports with your personal port
Your personal SSH port forwarding command (for Jupyter Notebooks):
`ssh -L 8888:localhost:12345 aherten@login1.ascent.olcf.ornl.gov`
- Windows: Configure PuTTY (/...) to forward remote port 12345 to your local port 8888

See also: `man instructions` on Ascent

Task Organization

Part 1

- Three hands-ons exercises
 - Task 1 Performance Counters (*PMU*)
 - Task 2 Performance Optimization
 - Task 3 GPU and Multi-GPU programming
- Each exercise in own folder

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- All use Jupyter Notebooks to guide through flow of tasks → interactive computing with comments and visualization
- **Not able to use Jupyter Notebook?** Backup: Download converted Jupyter Notebook (HTML, PDF) and follow along analogously. Notebook has instructions for you as well!
→ Interactive Notebooks strongly recommended!

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→ **Interactive Notebooks strongly recommended!**
- **Always:** Instructors there to help you!

Task Setup

1 Start Jupyter Lab server

```
jupyter lab
```

2 Visit printed URL, click to open Notebook

Copy/paste this URL into your browser when you connect for first time, to login with token:
`localhost:8888/?token=13dabbec6216514124ea3fef196b1622494b023b520e6e30`

3 Navigate to folder of exercise, i.e. to SC19-Tutorial/2-Performance_Counters/Handson

4 Hack away!

5 Switch to next task? Navigate to next Notebook!

Task Organization

Part 2

- Tasks have Makefiles to steer compilation but also to submit to batch system
- Batch system: IBM Spectrum LSF, with combination of `bsub` and `jsrun`
 - Shortcut submission command prepared in environment variable `$SC19_SUBMIT_CMD`
 - Use it with `eval $SC19_SUBMIT_CMD ls`
 - Study and adapt it with `echo $SC19_SUBMIT_CMD`
 - Usually, tasks have functionality to hide batch system interaction: `make run`
- Editing: Directly in Jupyter, or via text editors on Ascent, like `vim`
- Solutions always given in separate directories. You decide when/if to look at them!

PMU Hands-On Description

PMU Hands-On Descriptions

Task 1 Measure cycles and instructions needed for Jacobi solver

Task 2 Measure loads and stores

- A Normal loads and stores

- B More loads and stores

- C Compute bandwidth

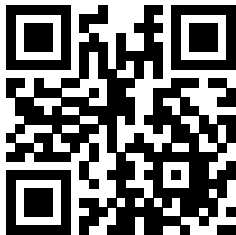
Task E1 Measure floating point operations; determine Arithmetic Intensity

Task E2 Extend range

Solutions

Solutions are shown in a dedicated Jupyter Notebook.
You decide when to look at them!

Please submit evaluation!



bit.ly/sc19-eval

Appendix

References: Images, Graphics I

- [1] Oak Ridge National Lab. *Oak Ridge Launches Summit Supercomputer*. URL: <https://ornl.gov/news/ornl-launches-summit-supercomputer>.