हाइपीसी
HiPC

Aligning communication pattern of FFT with Dragonfly topology

Anando Gopal Chatterjee

17th December, 2018

Indian Institute of Technology Kanpour, India

Table of contents

Introduction

FFT

- Fast Fourier Transform is an important tool for image and signal processing, radio astronomy, fluid flows and many other branches of science and technology.
- We have develloped an FFT library, named FFTK, which has been scaled upto 1,96,608 cores of Shaheen, a Cray XC40 supercomputer, in KAUST, Saudi Arabia [1].
- For 1D FFTs we use FFTW [2].
- Present clusters have millions of cores, 2D pencil decomposition is typically used [3]

[1] Chatterjee *et al.*, JPDC 2018
[2] Frigo *et al.*, Proceedings of IEEE, 2005
[3] Pekurovsky, SIAM Journal of Scientific Computing, 2012

FFT Algorithm

Forward Fourier transform is given by the following equation.

$$\hat{f}(\mathbf{k}) = \sum_{k_x, k_y, k_z} f(x, y, z) \exp(-ik_x x) \exp(-ik_y y) \exp(-ik_z z) \tag{1}$$

The beauty of this sum is that k_x, k_y, and k_z can be summed independent of each other.

FFT Algorithm

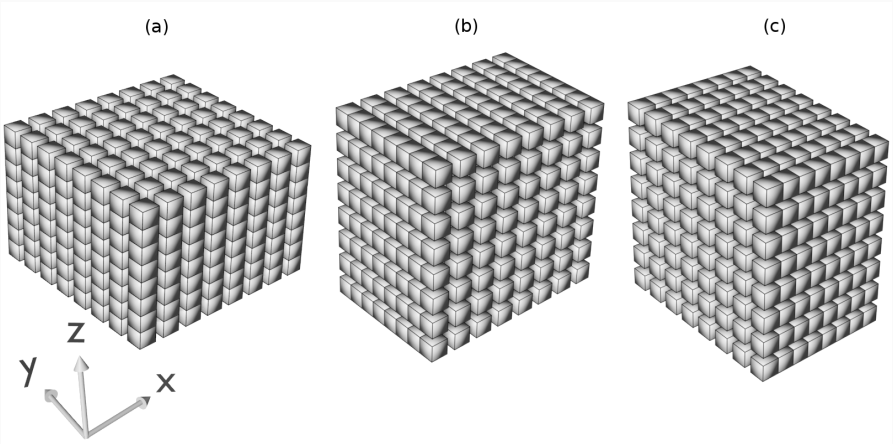


Figure 1: Three stages of FFT

- FFT along Z axis
- Communicate Z pencils to Y pencils.
- FFT along Y axis
- Communicate Y pencils to X pencils.
- FFT along X axis

Topology

Topology

- Shaheen is a Cray-XC40 supercomputer
- It is fabricated using Dragonfly topology.
- This is a hierarchical topology.

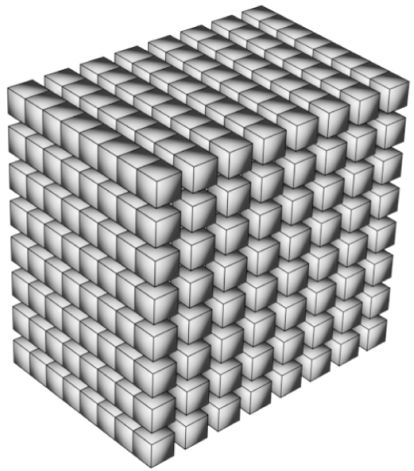
Topology

- Animaion

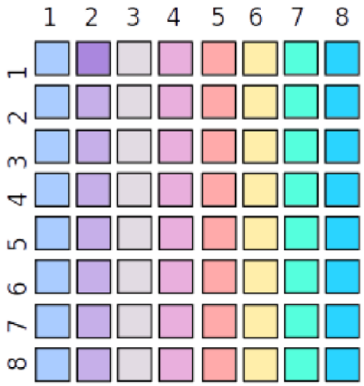
Allocation Policy

Allocation policy

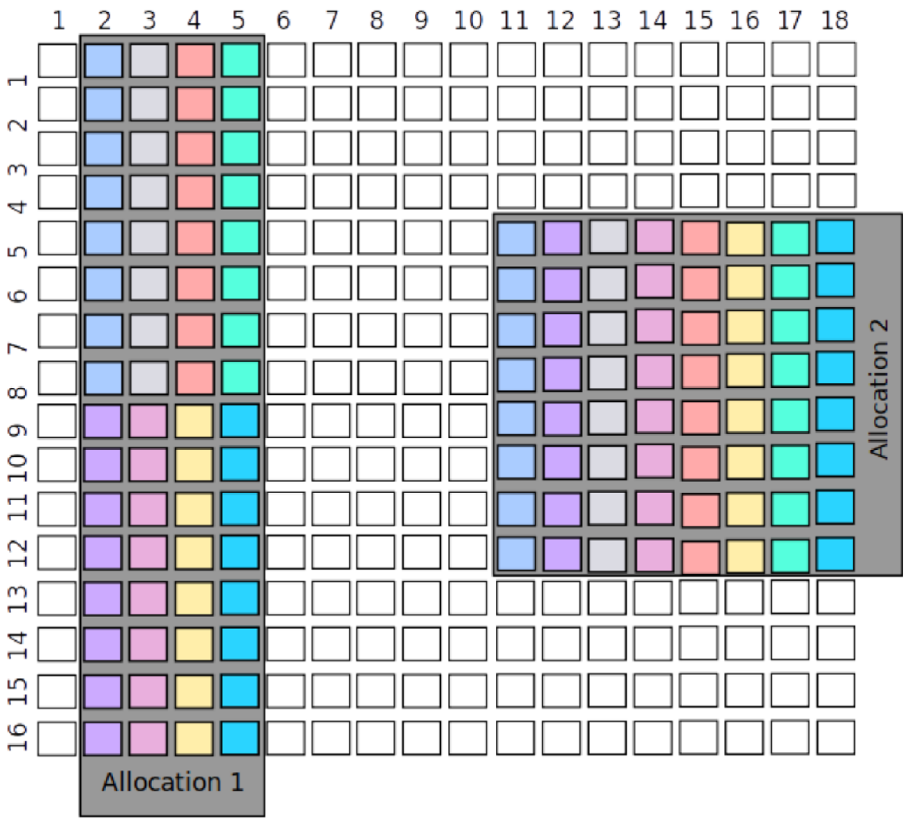
(a)



(b)



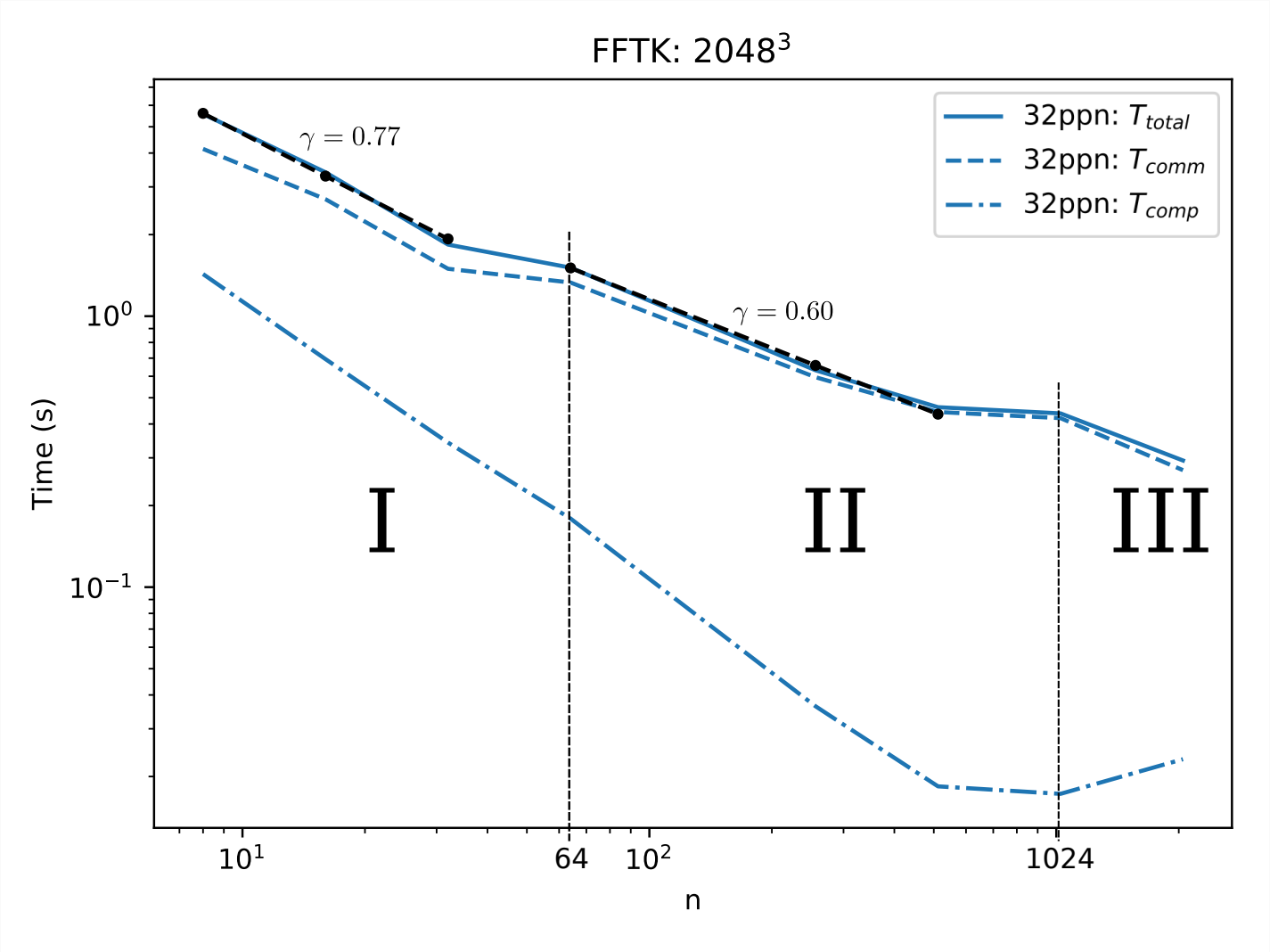
(c)



Scaling and Conclusion

Scaling and Conclusion

$$T = Cp^{-\gamma} \tag{2}$$



A Tool

NID Marker

Collaborators

Dr. Samar Aseeri
Prof. Mahendra K. Verma
Prof. David E. Keyes

Dr. Bilel Hadri
Andrew Winfer

Collaborators

Thank You
Q/A