Introduction and Motivation

- Tomographic image reconstruction and data analysis is a compute-intensive process
  - Reconstruction of a 3D image from 12 GB 2D projections dataset can take 22 hours with 24 cores machine
  - Computation times can significantly increase with different analysis algorithm, input size and # of iteration
- Current detectors and cameras have high data acquisition rates and can generate large volumes of data
  - Data acquisition rates are expected to increase several orders of magnitude
- Current software and tools are insufficient
  - Low performance with software packages (MatLab, IDL)
  - High maintenance cost with custom software (MPI, OpenMP, GPGPU)

Goals

- Easing the implementation of tomographic data analysis and image reconstruction code
  - MapReduce-like processing structure
  - Iterative execution
- Efficient parallel and distributed computation
  - Scalability, high performance execution
- Data-centric processing
  - Awareness of data organization

Parallel Image Reconstruction

Per-Slice Parallelization

- Per-slice parallelization
  - Computational complexity of each slice might be high
  - Limited # slices or Level of parallelization
- In-slice parallelization
  - Ray-level parallelization
  - Require additional communication btw slices
  - Modification on the reconstruction algorithm

In-Slice Parallelization

- Iteration 1
  - Local and global reduction functions
  - Data analysis code
  - Reduction object represents intermediate state of exec.
  - No sorting, shuffling and grouping operations

Preliminary Results

- Per-slice parallelization with ART: 74MB, 780 Slices
- 90-98% scalability efficiency between 2-390 cores
- 87% scalability efficiency for 780 cores

Future Direction

- In-slice parallelization
- More advanced algorithms: Neighbor communication
- Near real-time data analysis and image reconstruction
- Providing tool as Software as a Service (SaaS)