Parallel implementation of Time-Domain airborne SAR focusing

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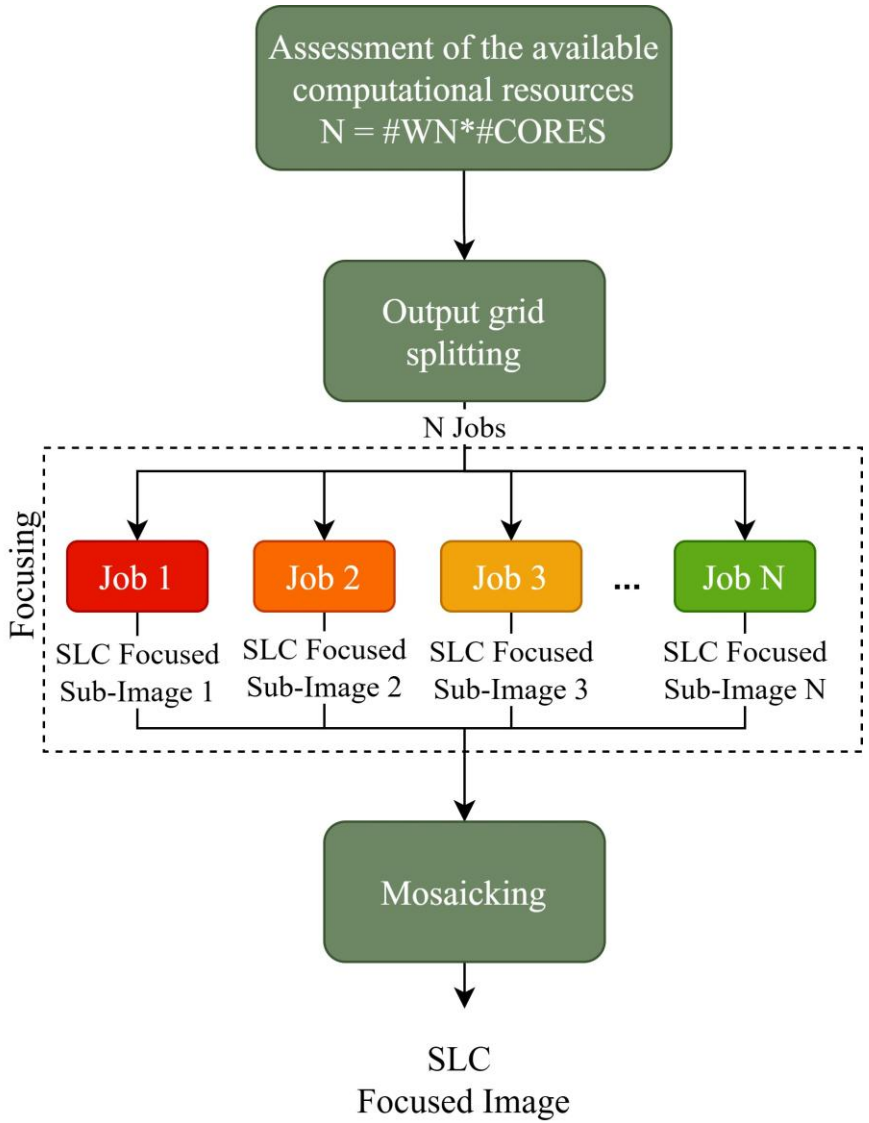
ITINERIS Contributions to IT Platform

The IREA-CNR Information Technology (IT) platform. Source: Esposito et al., 2024. On the Capabilities of the IREA-CNR Airborne SAR Infrastructure.

- The Information Technology (IT) platform is located at IREA-CNR laboratories in Naples.
- High-performance cluster: 22 nodes, each with dual AMD EPYC 7513 CPUs (32 cores per CPU), optimized for multi-node and multi-thread parallel processing.
- Large capacity and speed: each node features 2 TB RAM and 192 TB RAW storage using 12 × 16TB 7K SAS 12Gbps disks, interconnected by dual 25 Gb/s networks.
- Runs on openSUSE 15.4, tailored for efficient management and processing of SAR datasets.
- Optimized for parallel programming: supports efficient multi-node and multi-thread computing for large-scale SAR data processing.
- The ITINERIS project enabled the expansion of the IT platform with **5 new computing nodes**: 5 HPE servers equipped with a total of 20 × Xeon Gold 6418H CPUs, 480 cores, 20 TB RAM, 1/25/100 Gbps network connectivity, 2 × Nvidia L40 48 GB GPUs, and 538 TB of data storage, significantly boosting multi-core processing capacity.

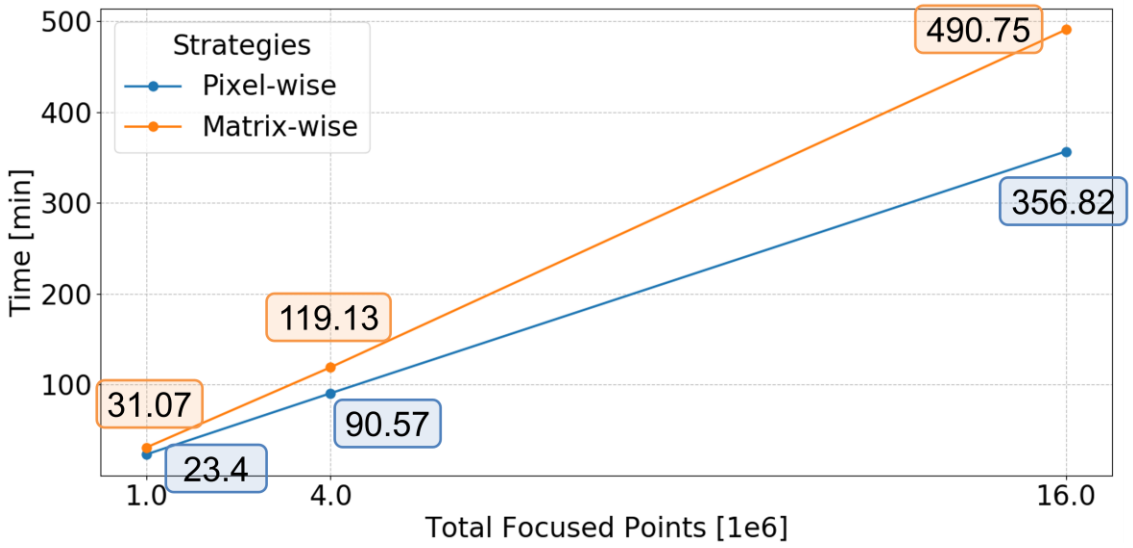
Parallel Implementation of TD SAR Focusing Procedure



- **Assessment of computational resources:** the number of jobs is calculated by multiplying the worker nodes (WNs) by the available cores (CORES).
- **Output grid splitting and focusing:** the output grid is divided into equal non-overlapping parts, each assigned to a core with necessary data to avoid memory overload. Two approaches:
  - **Pixel-Wise –** each target is focused separately in a unique processing step. The portion/image is fully focused once all targets have been processed.
  - **Matrix-Wise –** all targets on the output grid are partially focused simultaneously. The portion/image is fully focused once all the elements in the synthetic aperture have been processed.
- **Focused data mosaicking:** the adjacent focused portions are directly assembled into the final SLC image without further merging steps.

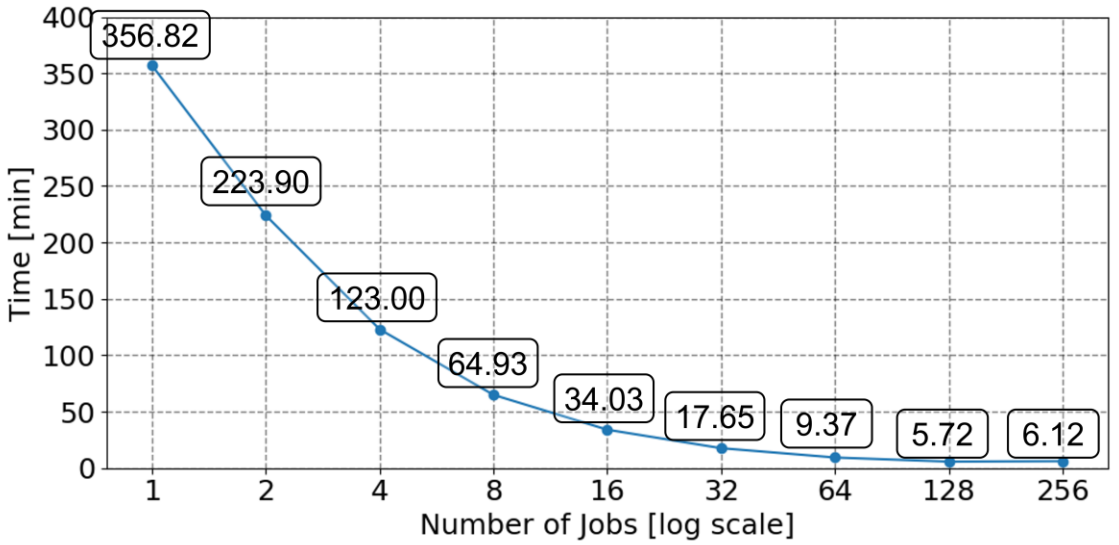
Results, Conclusions and Future Work

Pixel-Wise vs Matrix-Wise



- The pixel-wise strategy outperforms the matrix-wise approach in terms of computing time.
- Processing time scaled nearly linearly with the number of focused points.

Parallel Processing Procedure



- Improves computing efficiency: processing times were reduced by factors ranging from 1.6 to nearly 60.
- Excessively increasing the number of jobs can lead to performance degradation due to job management overhead.

Current Developments:

- Migration of the parallel implementation to a GPU-based architecture.

THANKS!

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