TOGA NETWORKS

High Performance Computing Lab

ISRAEL

Looking for **Consortiums for** HORIZON-CL5-2022-D3-03-04

Integrated Wind Farm Control

Role: **Work Package Leader**

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Focus of the HPC team

- Teams with multidisciplinary skills From application level down to silicon
  - System & Network Architecture
  - OS Kernel, Firmware, Drivers expertise

- Enabling disruptive innovation:
  - LibfastMesh(Optimized framework for unstructured mesh)
  - Container Direct (Was 1st in the world with DPDK&RDMA native performance)
  - Hyper Burst Buffer for HPC storage acceleration integrated in Huawei Hyper MPI (Order of magnitude speedup compared to baseline)
  - UCG: Collective operations for UCX (up to 90% improvement of performance)
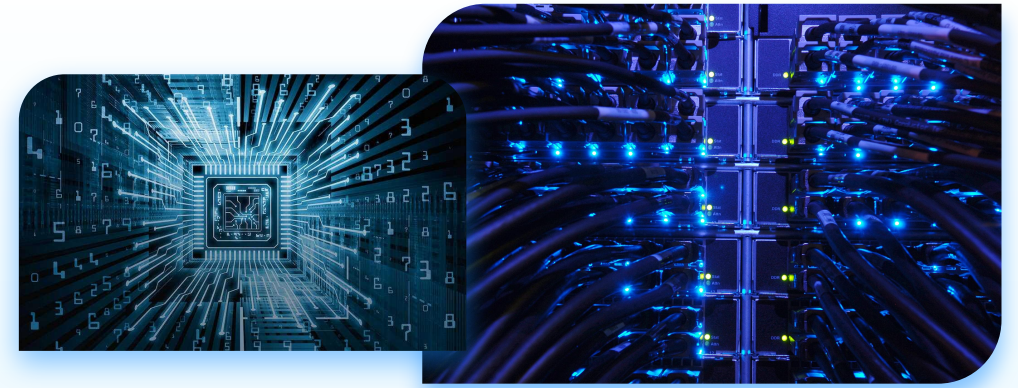
- Weather forecast
- Numerical weather prediction (NWP)
- Climate, marine environment, marine protected area
- Global warming simulation
- Offshore wind energy
- Emergency management and security simulation
- Computational Fluid Dynamics (CFD)
- Real time HPC-AI for model improvements (CFD, weather for improved efficiency, reduced costs)
- Pollutant managements: noise reduction, combustion, ...
- Civil aircraft performance optimization for environmental footprint reduction (high lift)

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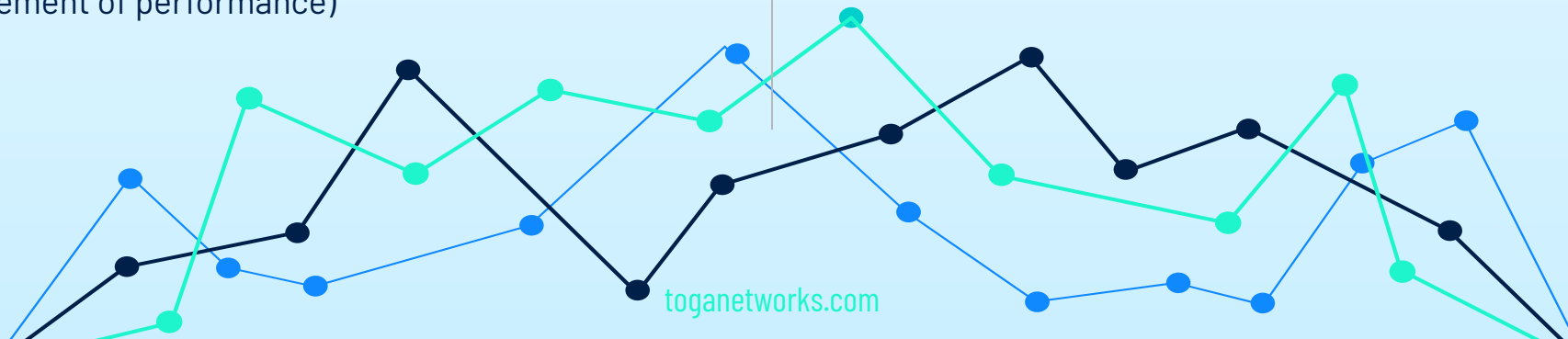
Previous/Current Work of HPC Lab

The LibFastMesh Framework

◆ Objective: develop optimized CFD framework to accelerate OpenFOAM legacy solvers
◆ Explicit compressible flows
◆ Special focus on memory-bandwidth and scalability
◆ New framework that serves as PoC for optimizing OpenFOAM

➔ State-of-the-art optimizations
  ◆ Novel Hamiltonian path cell ordering for unstructured grids
  ◆ Efficient data structures minimizing memory-bandwidth
  ◆ Utilize advanced MPI functionality (neighborhood, RMA)
  ◆ More than 3x speedup over OpenFOAM

Enabling high performance parallel I/O with ADIOS2 for WRF

➔ I/O performance improvements of adding the ADIOS2 data management library to WRF
➔ New library speeds up normal writes to PFS and adds a multitude of new features such as:
  ◆ Node-local burst buffer write support
  ◆ High performance Compression
  ◆ Possible two-way data coupling,
  ◆ In-situ analysis

➔ Tests results in this work indicate between one and two orders of magnitude improvement in perceived write time at scale when using the new ADIOS2 I/O backend
➔ A sample weather forecasting pipeline using theADIOS2 SST engine was shown to decrease the total time to solution by half compared to the legacy PnetCDF method at scale.

PUBLICATIONS

Paper: "A Novel Framework for Unstructured Finite-Volume Methods with Optimized Hamiltonian Path Cell Ordering and Parallel Efficiency" (AIAA Scitech2022)
By Solal A. T. Amouyal, Max Shkatrut, Alex Margolin, Valerio D'Alessandro , Matteo Falone
Paper: "Remote Programmability Model for SmartNICs in HPC Workloads" (OpenSHMEM Workshop 2021) By Morad Horany, Alex Margolin
Paper: "High Performance Parallel I/O and In-Situ Analysis in the WRF Model with ADIOS2" By Michael Laufer, Erick Fredj

HPC Lab's Potential Contribution

HORIZON-CL5-2022-D3-03-04 Integrated Wind Farm Control

We Propose:

1) Using live data (measurements, weather data, ...) to feed a model that could give as fast as possible (now-cast) the necessary weather conditions in the near future to allow for operators to make as optimized decisions as possible. For such a project, we would focus on the optimization of currently available WRF models to allow for such outcome, in terms of simulation and in-situ analysis of the data.

2) A new concept based on 3D WRF modeling: an array of several simulated "Virtual" meteorological towers (VTM). The VTM is extremely cost-effective for determining wind vector profiles, atmospheric stability, and turbulence properties, all of which are crucial parameters used by the wind energy industry for design applications during extreme weather events (in situ processing) and (real-time) operating procedures critical for decision makers

3) Connecting live data from offshore models to predict weather/ocean interactions and thus improve power generation. Real time reaction to constantly maintain high power generation as weather changes, Big data management / Weather prediction / Real time use of local measurement. Combination of HPC cluster with big data center to obtain better reaction / control in a very short amount of time

THANK YOU

HORIZON-CL5-2022-D3-03-04 Integrated Wind Farm Control:

Role of HPC Lab: *Work Package Leader*

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