MAX-PLANCK-GESELLSCHAFT

ASYNCHRONICITY

THE CHALLENGE OF FINE-GRAINED PARALLELISM

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October 26, 2016

Max-Planck-Institut
für Meteorologie

INVITATION NOT TO BE IN TIME

NOT FOR THE FAINT HEARTED

- Climate modeling requires a lot of computing time for tuning models without scientific output.
- Very difficult to run large ensembles.
- New machines get build up and tested for some time before getting into production.
- Let's join this (needs adventures scientist, courageous computing center director, and non-dogmatic vendor) ...

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Thanks to Thomas Schulthess,CSCS, and Cray: 100 member historical ensemble, 67 member 1%CO2, 5000 years pi-control, and 3000 years 4xCO2 and a new tuned (Mauritsen, Roeckner, Haak, . . .) HighRes model. A large number of PhD students working on the results.

SETTING THE STAGE

WHAT IS DRIVING NEW DEVELOPMENTS?

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Consequence: more and more, fine grained parallelism is required to achieve the necessary performance to answer scientific questions posed.

OBJECTIVES

Key points to consider are

- to keep all critical hardware resources concurrently in use,
- to minimize or hide the response time for remote access and service requests,
- to reduce contributions of parallel resources and task scheduling not used for computational work itself, and
- to minimize resource access conflicts.

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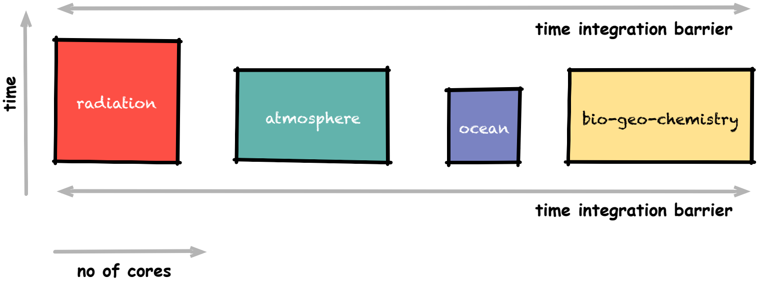
ALGORITHMS

The solution framework proposed consists of the

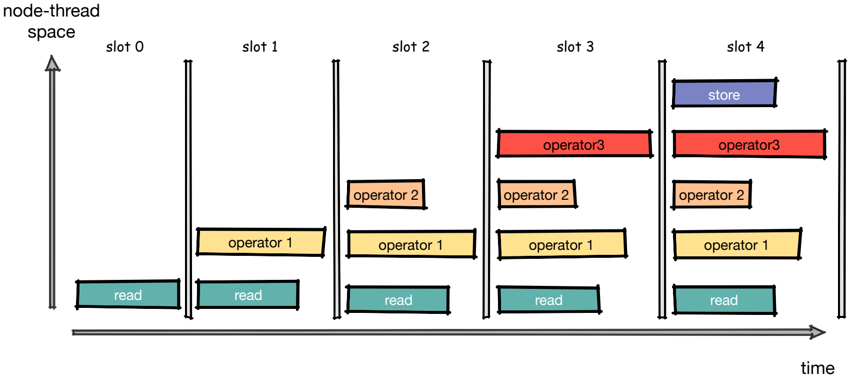
- functional description of processing algorithms, and
- a direct acyclic graph representation (DAG) of processing (to be used for optimization and parallelization).

PROCESSES COMPACTION

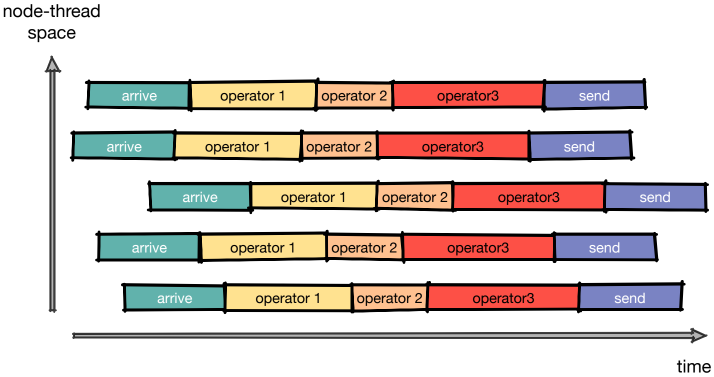
COARSE-GRAINED ASYNCHRONOUS PROCESSES



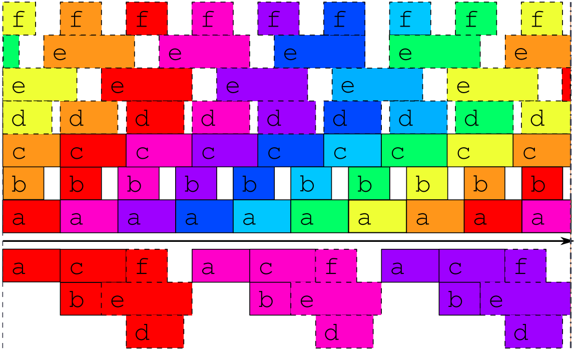
HOW A VECTOR PIPELINING PROCESSING MODEL WORKS



MOVING TO A DAG BASED PROCESSING MODEL



DAG BASED META-SCHEDULING



cylc, Hilary Oliver, NIWA

FUTURE

DEVELOPMENT ACTIVITIES

- Development of a DAG based worker/broker toolkit with arithmetic operators as first test and later add cdo
  Hermes, Florian Rathgeber and Tiago Quintino (ECMWF)
- Refactoring of cdo by moving to C++ and disentangling command line and operator handling
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WHAT NEXT?

- Get a working prototype of post-processing tools and scheduling
- Using meta-scheduling for applicable problems
- Rethink the time operator splitting of the model physics to allow for a more functional, concurrent usable representation of processes — or resolve those explictly …
- Development and application of model developer friendly Domain Specific Languages (DSL)

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ADDITIONAL CONSTRAINTS

UNKNOWNS

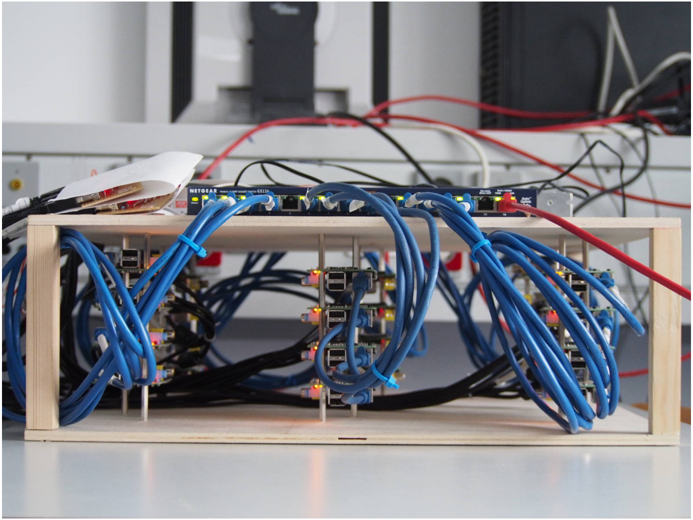
There are two more aspects contributing to effective system usage. Power consumption and the system's reliability.

Who does not have application specific checkpoint/restart?

The influence of this parameters on future development are not in the primary scope of this considerations, but are supposed to have a strong impact on solutions.

PERHAPS . . .

LATEST HARDWARE DEPLOYMENT



Courtesy by Miriam, 7a

SYSTEM CHARACTERISTICS

- 24 nodes with Broadcom BCM2835 SoC (700 MHz ARM 1176JZF-S, VideoCore IV GPU)
- Non-blocking fat tree high speed network IEEE 802.3u (100BASE-TX) via USB-2 Bus (aggregated 273.6 MB/s)
- NFSv4 network filesystem, SLURM, GCC, mpich
- Linux Debian jessie (Kernel 4.4)

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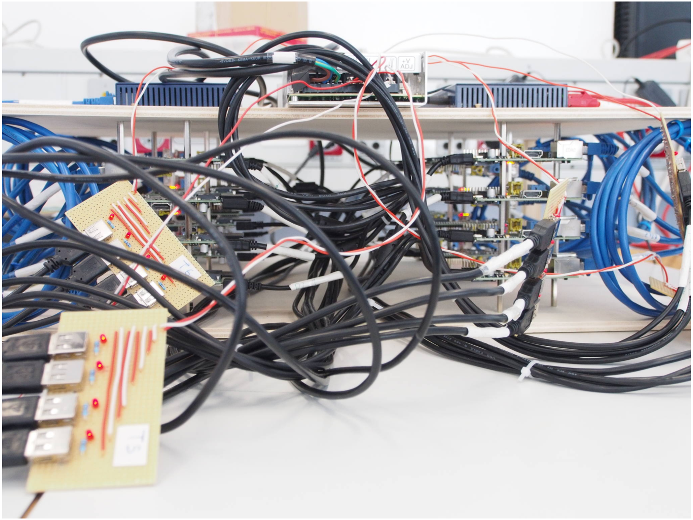
Successfully run echam 4.6 T31L19 (CVS version 6.00, 2000-09-19 08:26:58 (Git: da9d477) , no code changes) using the full system.

ENERGY CONSUMPTION 100 W



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