Parallel Flow Simulator(flow_mpi)

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Once upon a time . . .

When do you think parallel development started in OPM?

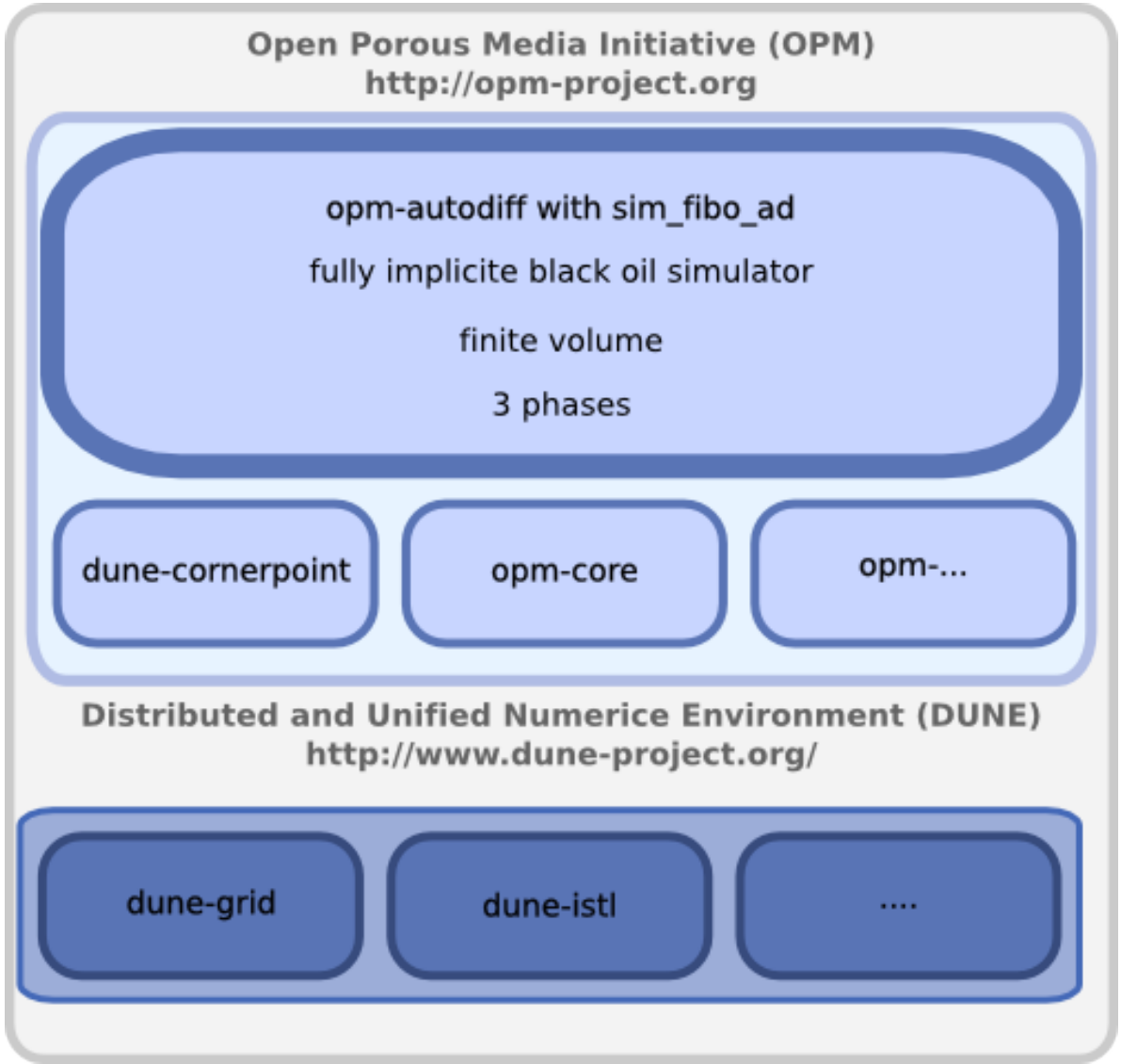
It started in 2009

commit 8d50358cc, and 5dc6e0e33
Author: Atgeirr Flø Rasmussen
Date: Fri Sep 11 12:56:51 2009 +0000
. . . We will need them to set up the paralell index set, though. We test with some partitioning on, we do however provoke an error now upon run.

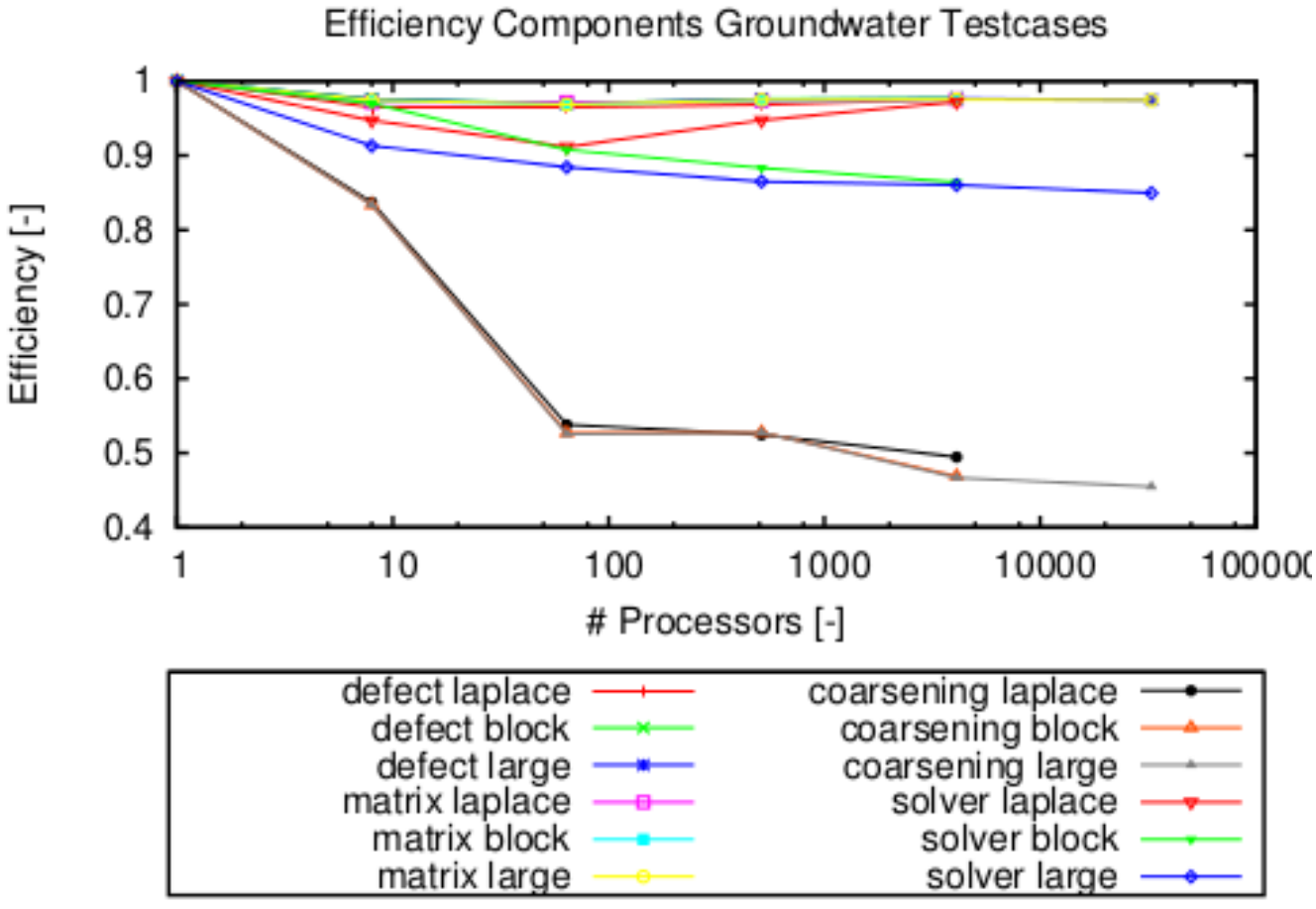
@joakim-hove

There were even (kind of) tests in OPM back then!
commit 1cf52111ce2b
Made parsolver_test not fail for MPI-disabled builds. Instead, it does nothing.

My starting point 2013 (sim_fibo_ad)

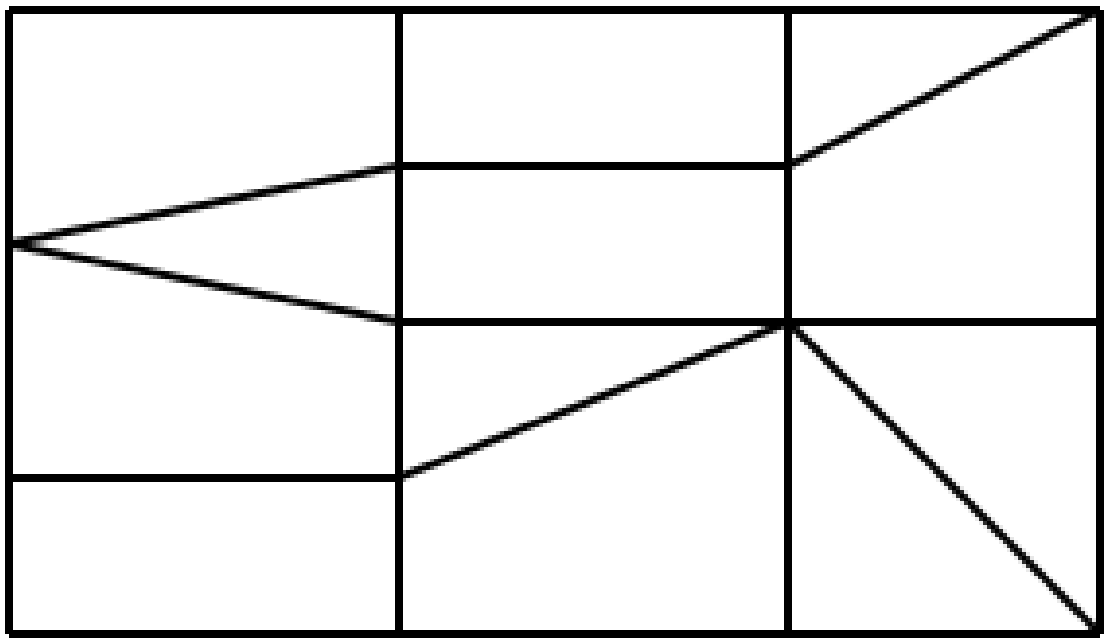


DUNE is Parallel

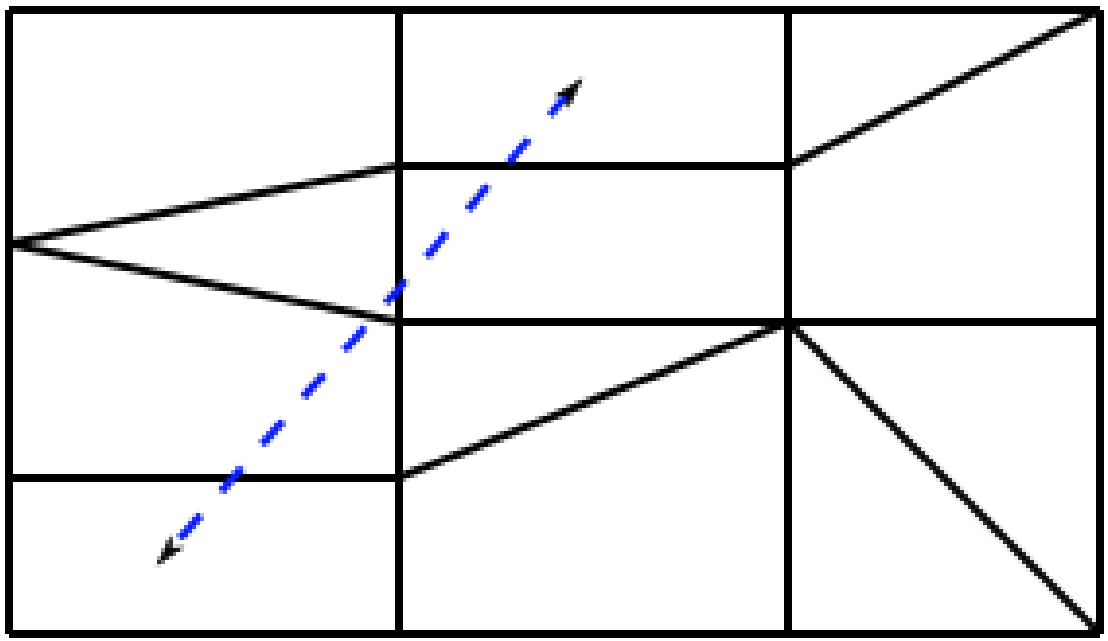


Tests von Prof. Ippisch (TU Clausthal) auf JUGENE.

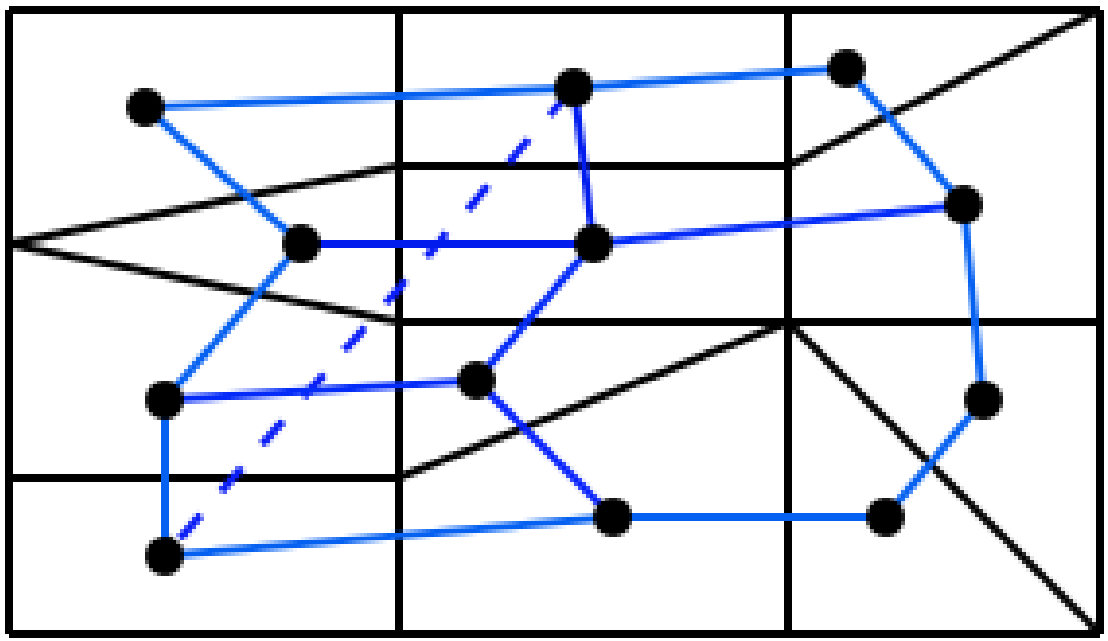
Finite Volumes on CpGrid



Wells lead to influences from distant cells



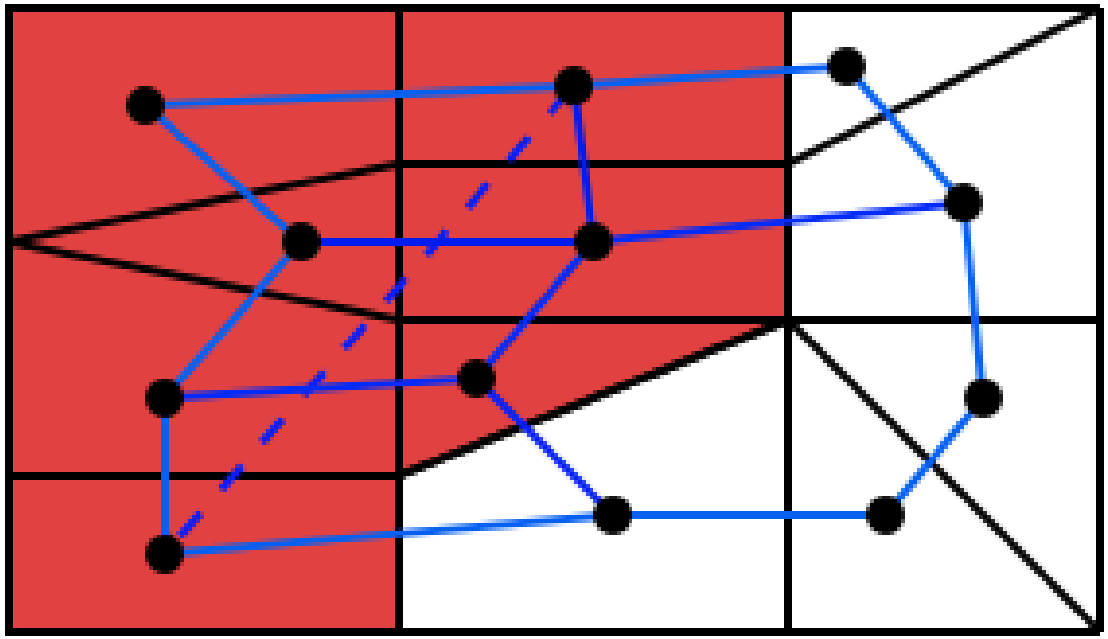
Graph of influences



Keep well influences together with Loadbalancer

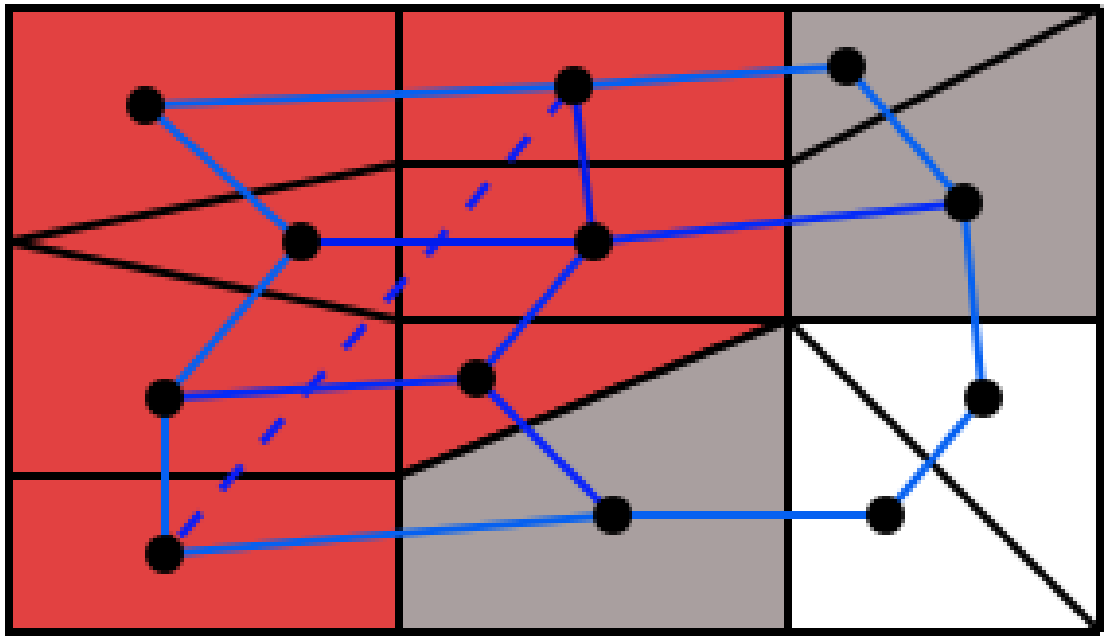
Graph with transmissibilities as weights. Highest weights for the edges representing connections between cells perforated by a well.

Non-overlapping decomposition



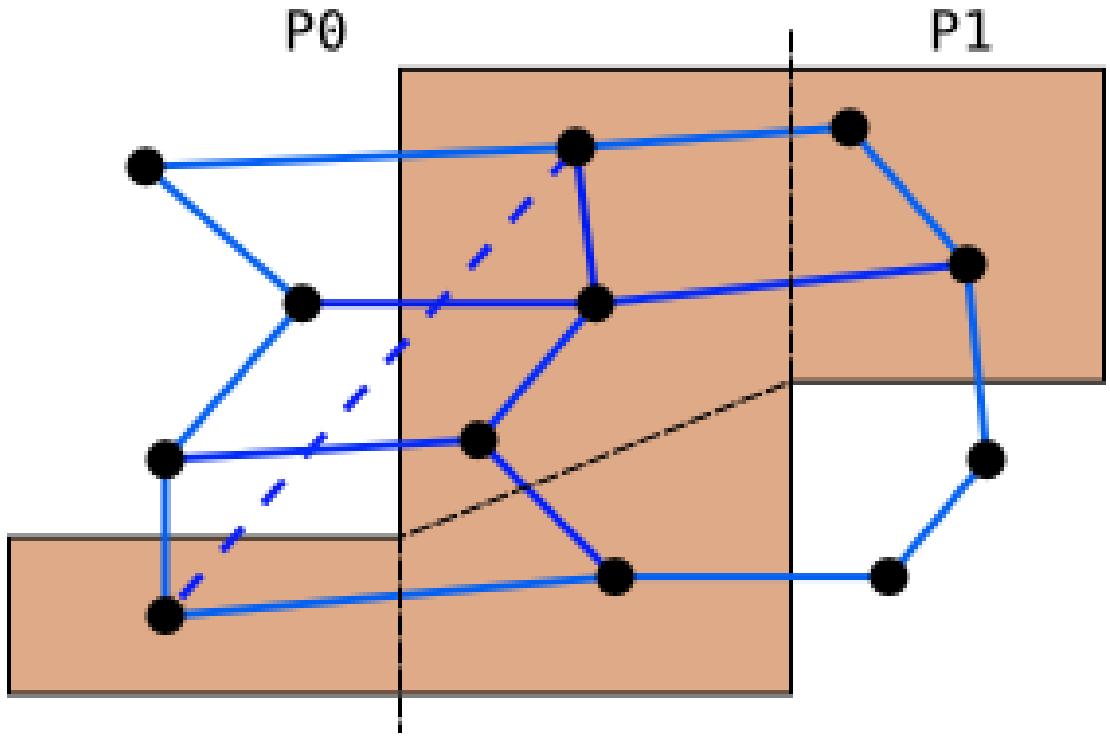
Each well contained in one partition. Process wants to calculate correct results in red cells...

Ghost layer to compute correct results

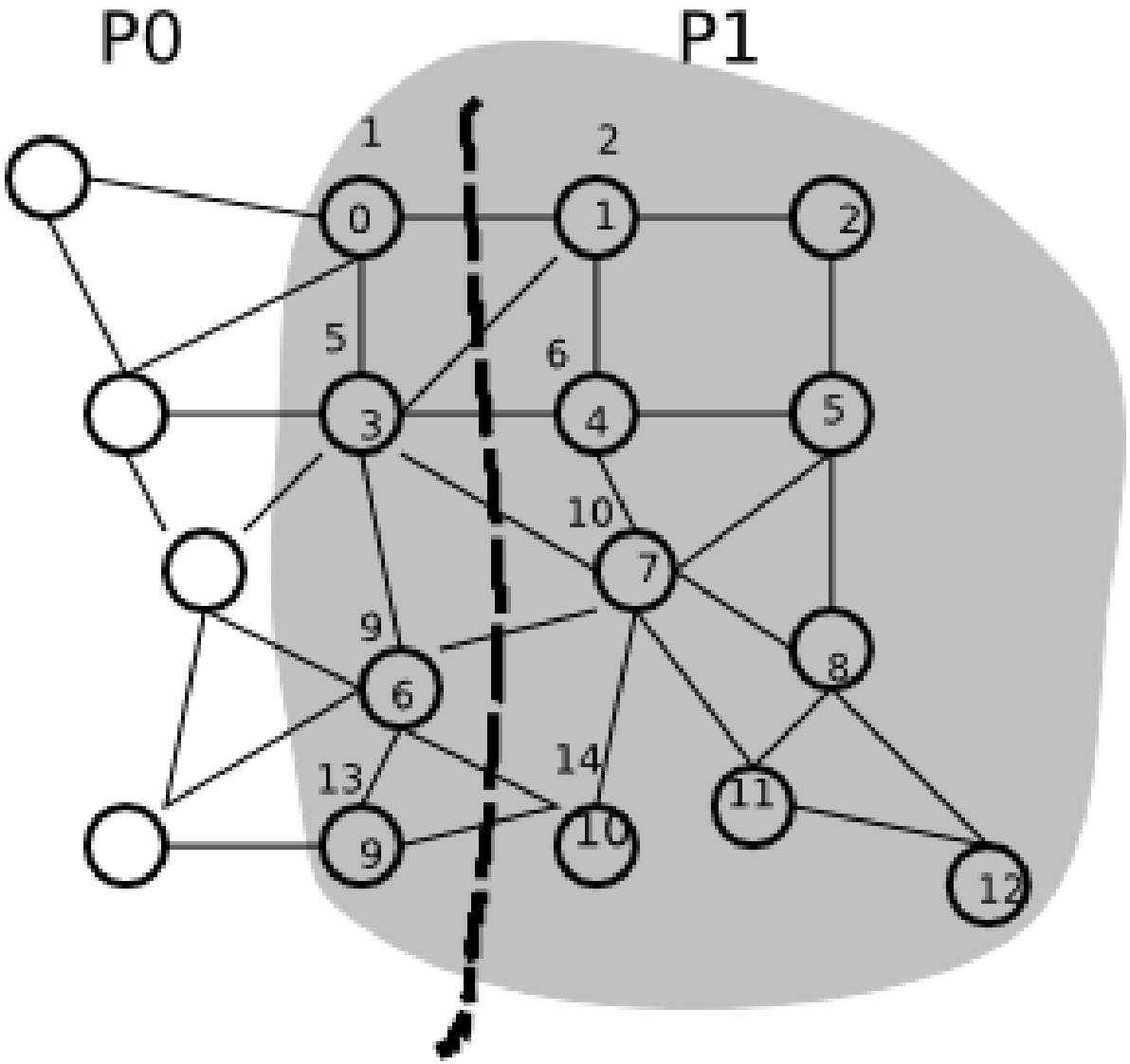


. . . and needs a layer of ghost cells (grey) for this.

Use communication for correct ghost values



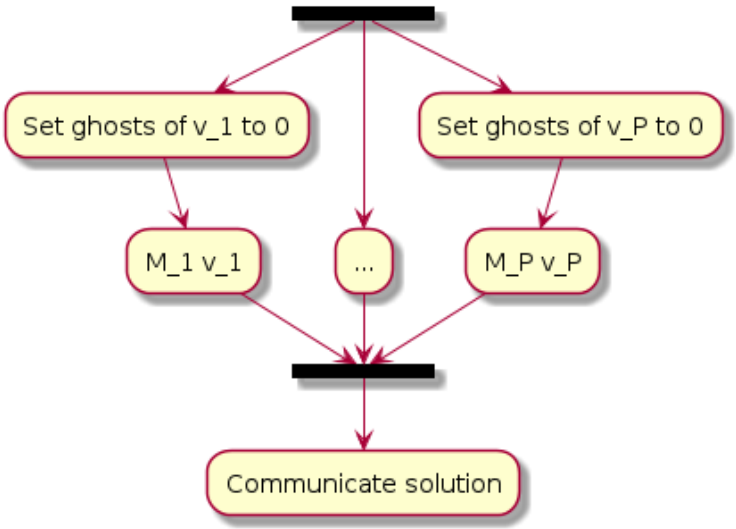
Global / Local Numbering



DO NOT USE GLOBAL DATA!!!!

The process only sees its local partion!!!
One exception: One can use the global Parser/EclipseState, but it might not scale

Hybrid Smoothers



- Each process knows the correct values of the global vector v
- After communication the result is consistent.

Parallelization Agnostic Solvers I

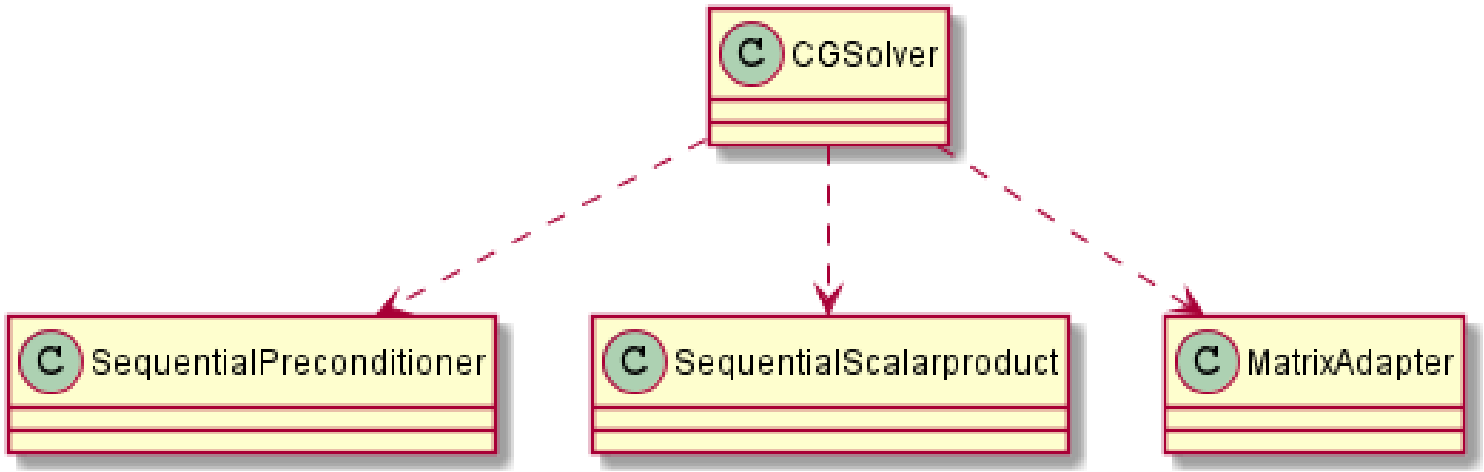


Figure: A Sequential Conjugate Gradient Solver

Parallelization Agnostic Solvers II

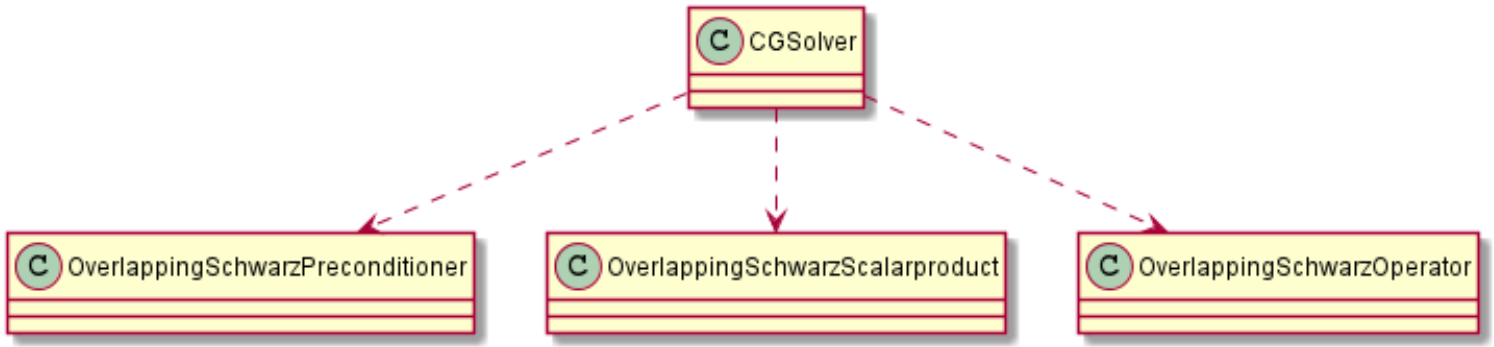
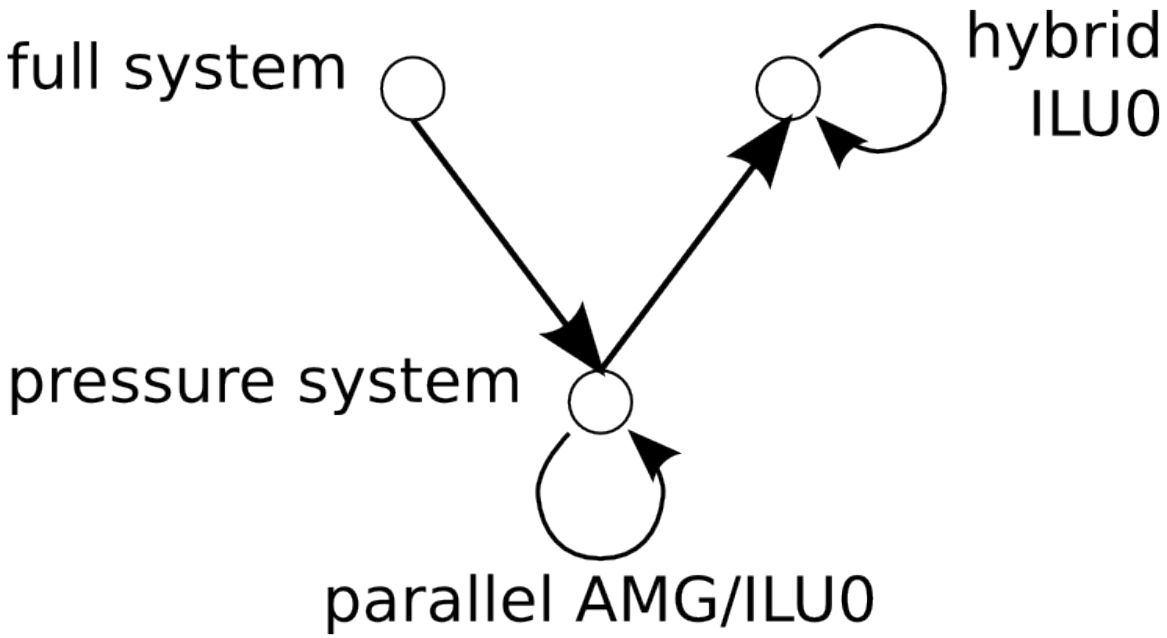


Figure: A Parallel Conjugate Gradient Solver

Parallel Blackoil with CPR Preconditioner

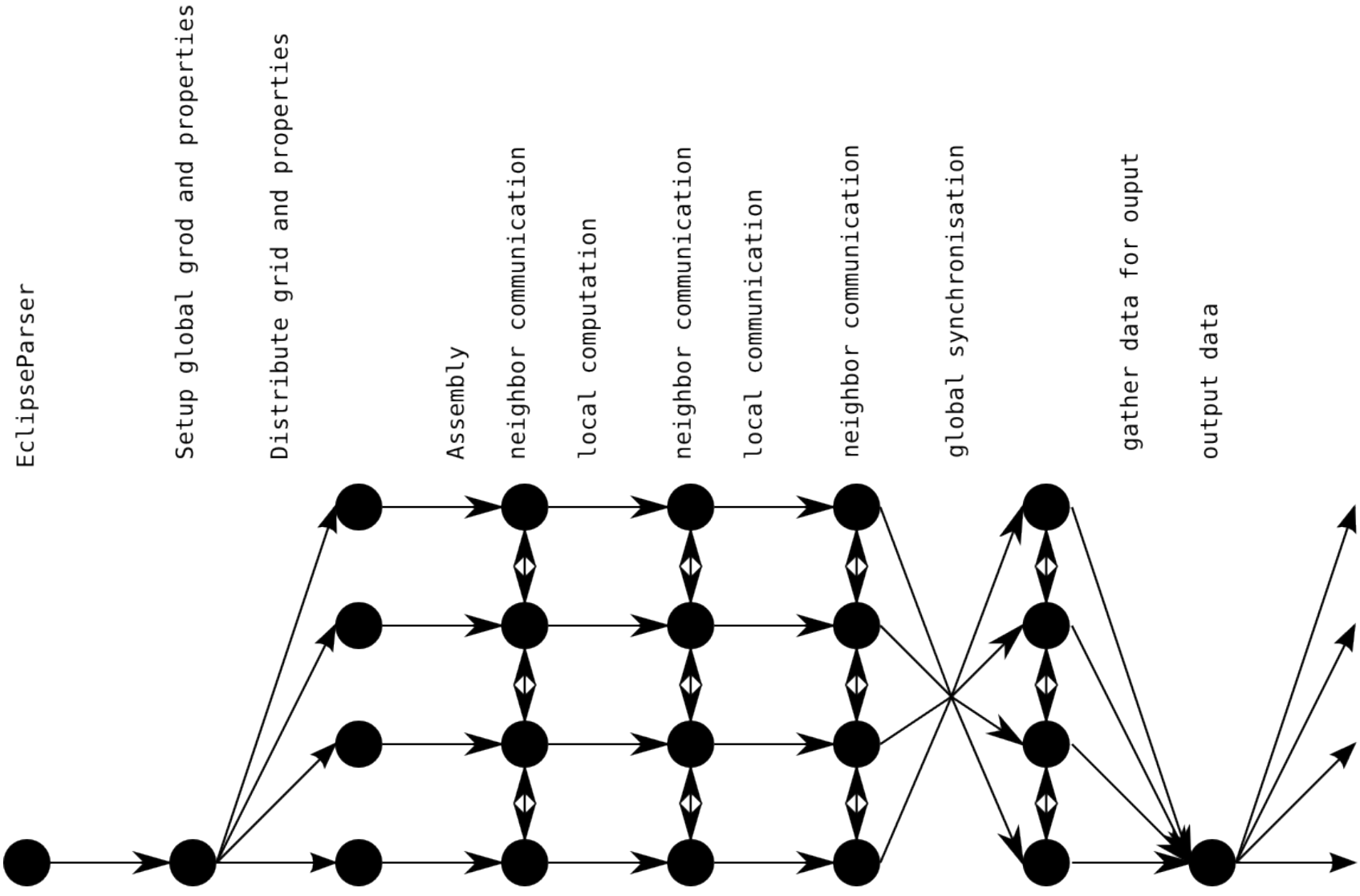


- Each well has to be contained in the partition of one process.
- Use parallel versions of convergence tests in nonlinear solver and adaptive time stepping.

Parallel Simulator Properties

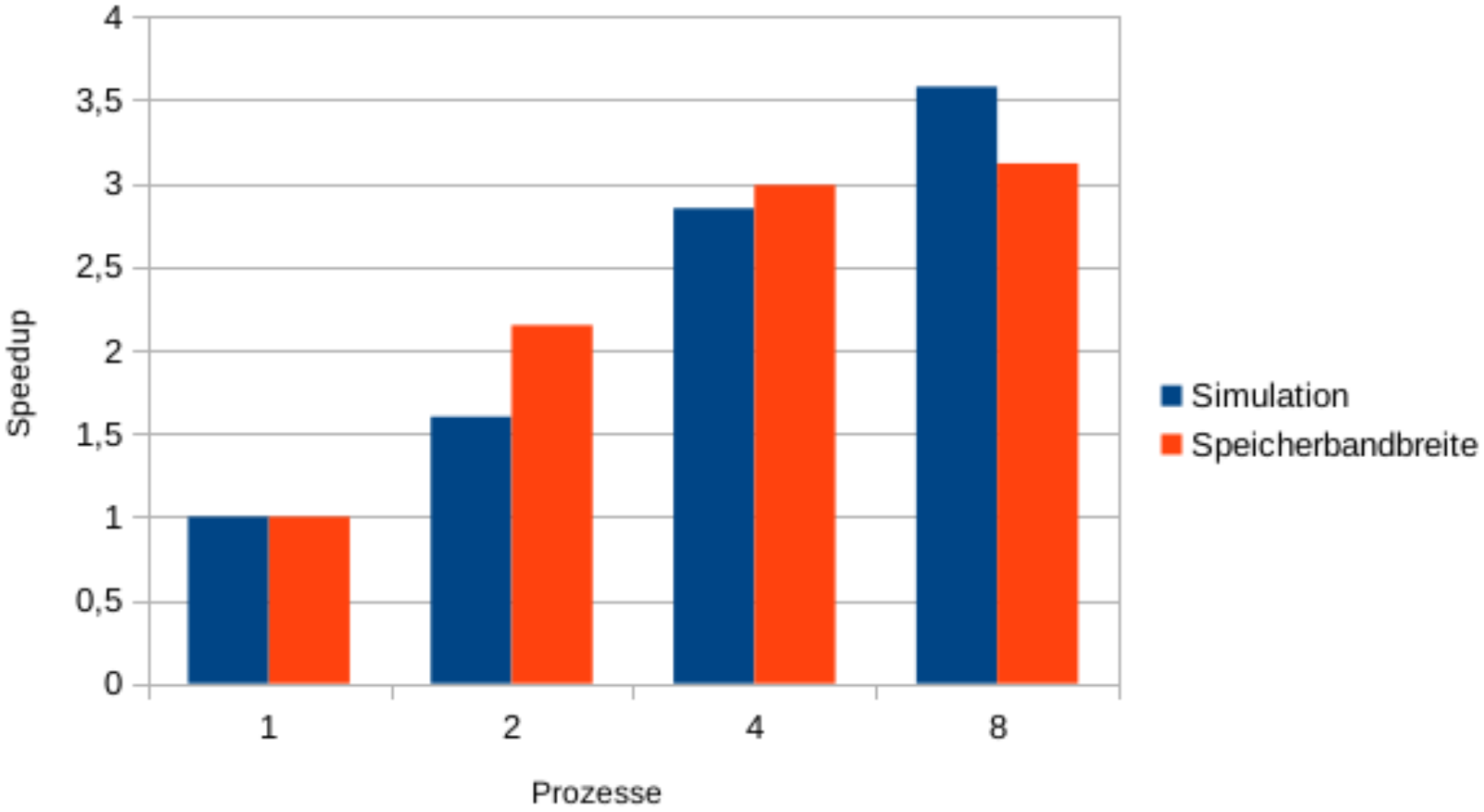
- Created from eclipse file.
- Uses CPGrid's scatterData to distribute

Parallel work flow



Scalability Norne

1 Intel(R) Xeon(R) CPU E5-2620 v3 @2.40GHz (6 cores/12 threads)



Parallel Norne Results

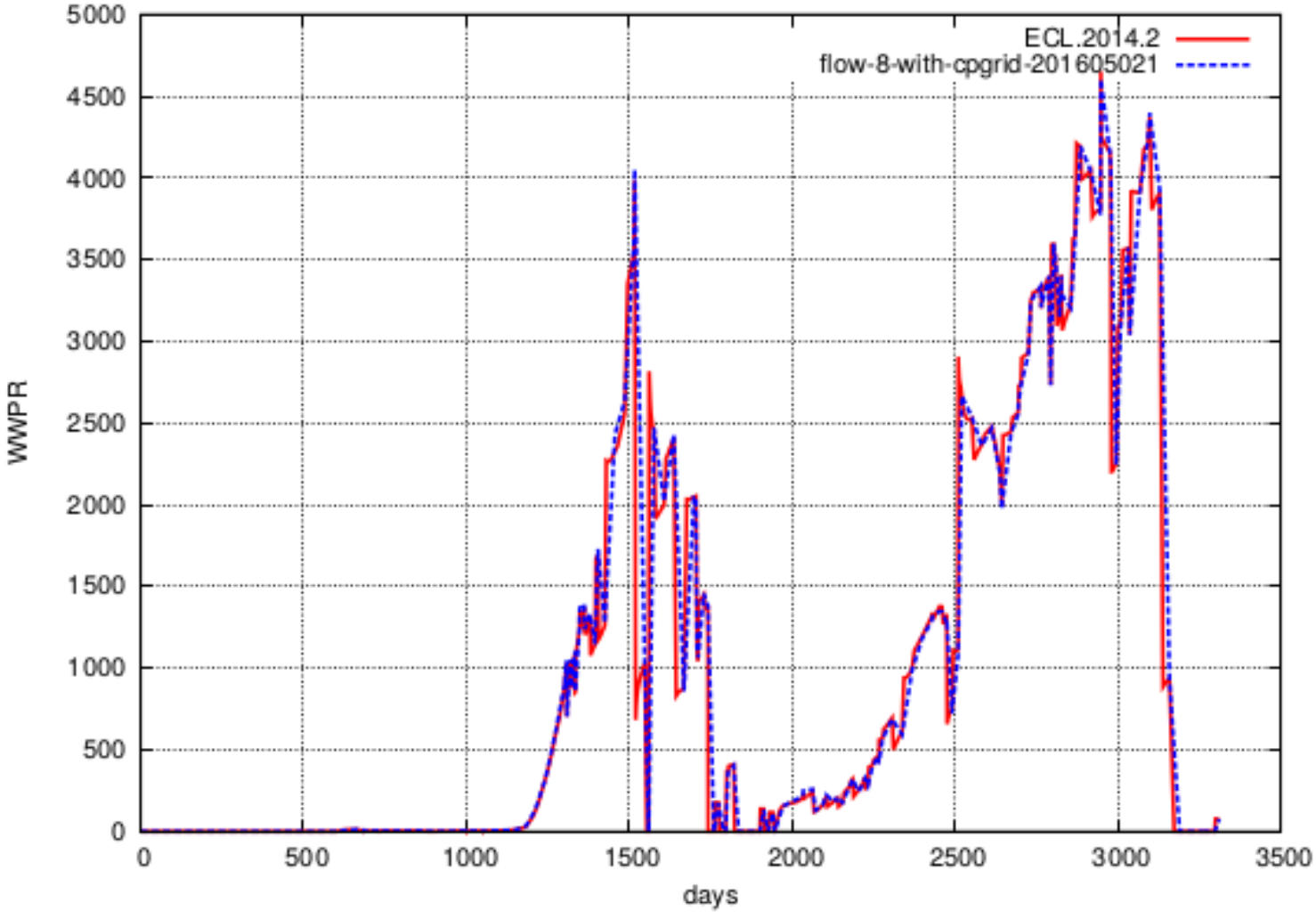


Figure 20: WWPR of well **B-3H**.

CPGrid with wrong face tags

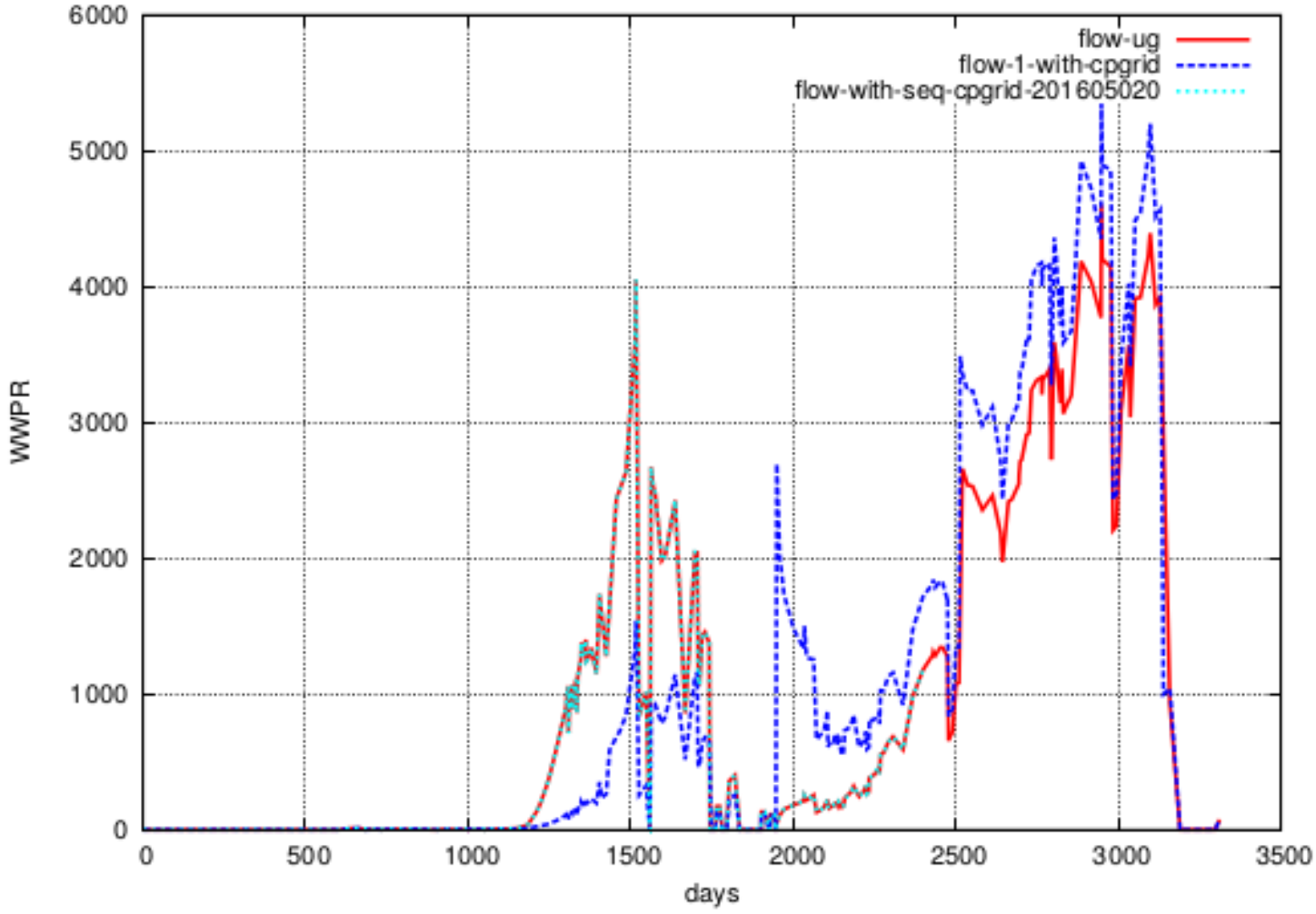


Figure 20: WWPR of well **B-3H**.

(Silently adding/using new properties

Without distribution these properties will be added to the wrong cells and phases.

Beware of global/region reduction

If they cross the process border, they need to be parallelization aware:

- max
- min
- scalar product / norm
- ...

Outlook / Summary

Using DUNE (grid/ISTL) in the early time was a wise decision as allowed parallelizing flow in an affordable and scalable manner later on.

But keep in mind that global assumptions are dangerous now!!!

Contact / Contact

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