Erlangen Regional Computing Center

UNIVERSITÄT GREIFSWALD
Wissen lockt. Seit 1456

FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG

Winter term 2020/2021

Parallel Programming with OpenMP and MPI

Dr. Georg Hager
Erlangen Regional Computing Center (RRZE) at Friedrich-Alexander-Universität Erlangen-Nürnberg
Institute of Physics, Universität Greifswald

Assignment 2 discussion

High Performance Computing

Assignment 2, Task 1

"Slow computing"

- Assume that a system (2) executes all code a factor of μ slower than a reference system (1):

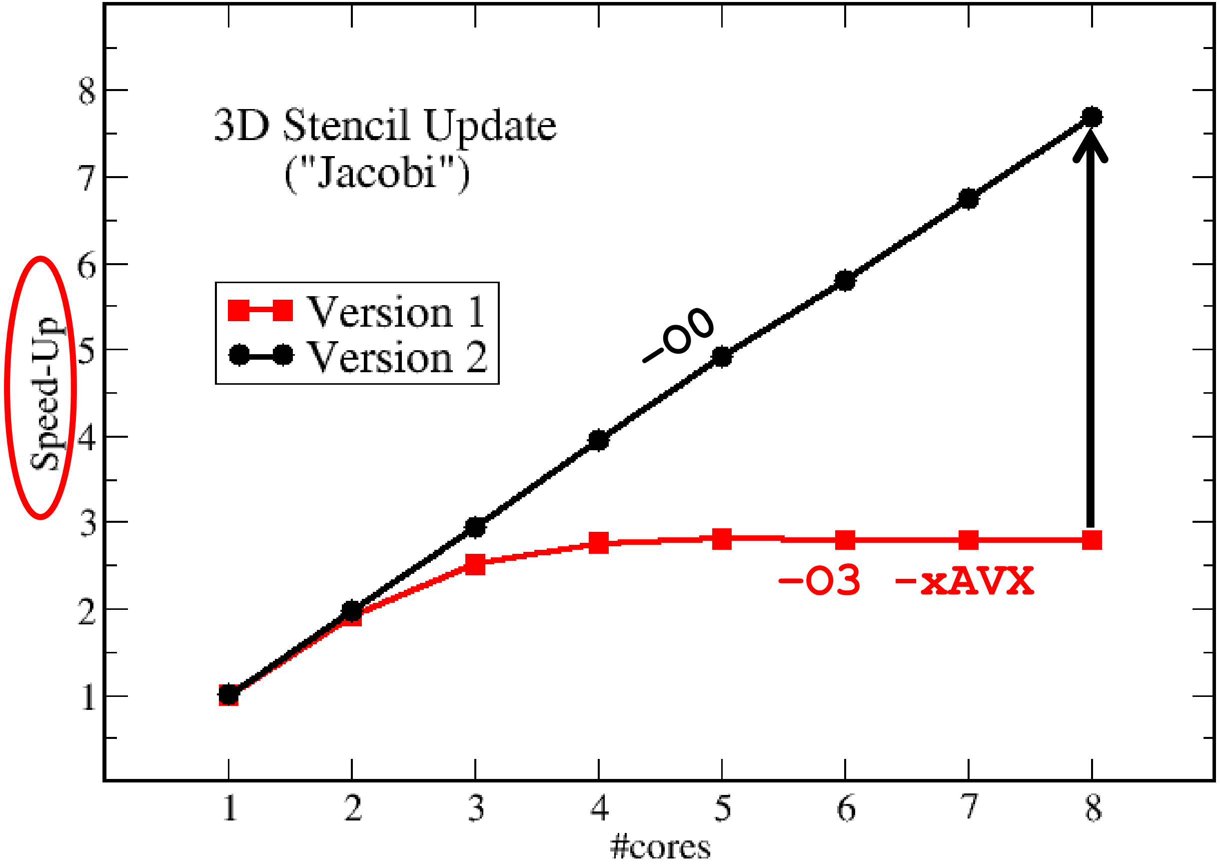
$$S_\mu(N) = \frac{\mu}{\mu s + \frac{\mu(1-s)}{N} + kN} = \frac{1}{s + \frac{1-s}{N} + kN/\mu}$$

→ $\mu > 1$ implies better speedup at same N

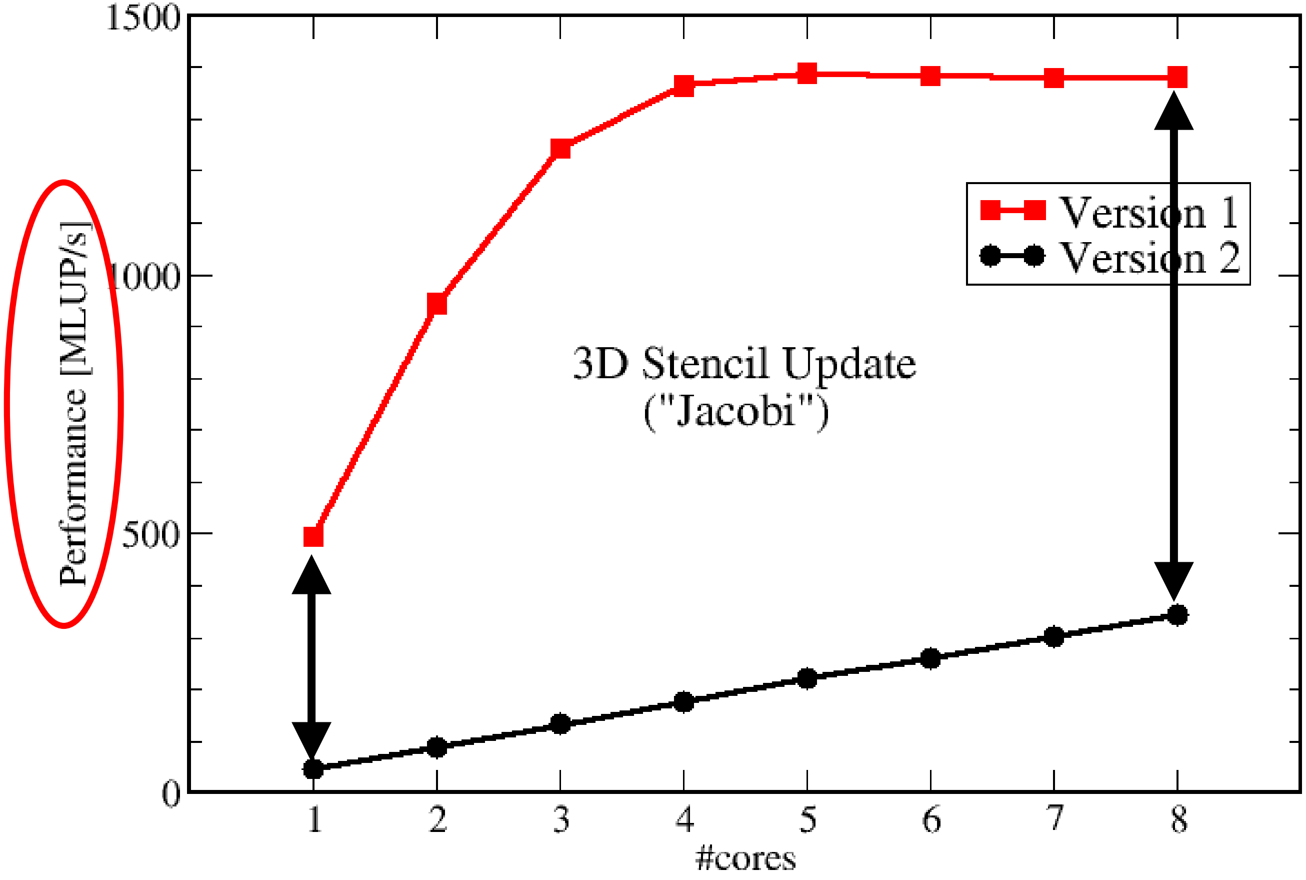
→ "A machine with slow CPUs scales better"

Corollary: A slow code scales better, too! :-/

Assignment 2, Task 1



Assignment 2, Task 1



Assignment 2, Task 2

- Parallel loop with overhead of $T_o = 2000\ \text{cy}$:

```
#pragma omp parallel for
for(i=0; i<n; ++i)
  a[i] = a[i] + s * c[i];
```

- Machine: 8 cores, 3 GHz, $P_{peak} = 192\ \text{Gflop/s}$, $b_s = 40\ \text{Gbyte/s}$
- Execution time

$$T_{exec} = \frac{24 \times n\ \text{byte}}{b_s} + T_o \rightarrow \text{Performance } P = \frac{2 \times n\ \text{flops}}{T_{exec}} = \frac{2n\ \text{flops}}{\frac{24n\ \text{byte}}{b_S} + T_o}$$

- Asymptotic performance: $P_a = \frac{b_s}{12\ \text{byte/flop}}$
- Condition: $P(n) = \frac{1}{2} P_a$

Assignment 2, Task 2

- Solve for n:

$$n = \frac{b_s T_o}{24 \text{ byte}} = 1111$$

- → n is linear in the overhead time and the memory bandwidth