Effective Parallel Code Generation Through Auto-Sequentialisation

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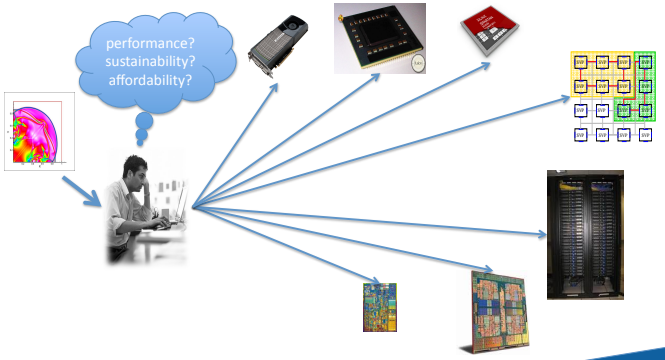
Stephan Herhut, Carl Joslin, Jing Guo, Dan Rolls,
Clemens Grelck, Raphael Poss, Mike Lankamp,
Chris Jesshope, Sven-Bodo Scholz

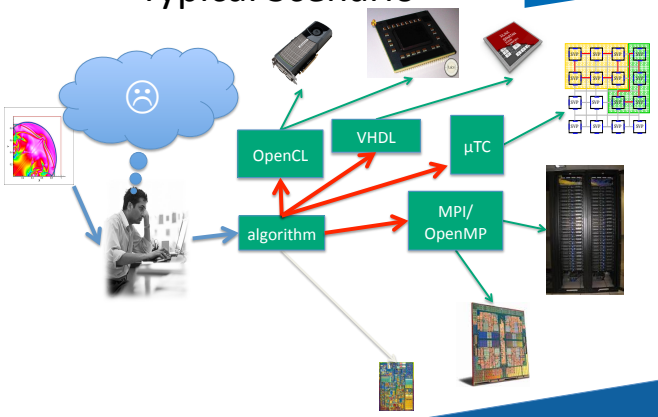
ADVANCE

apple core

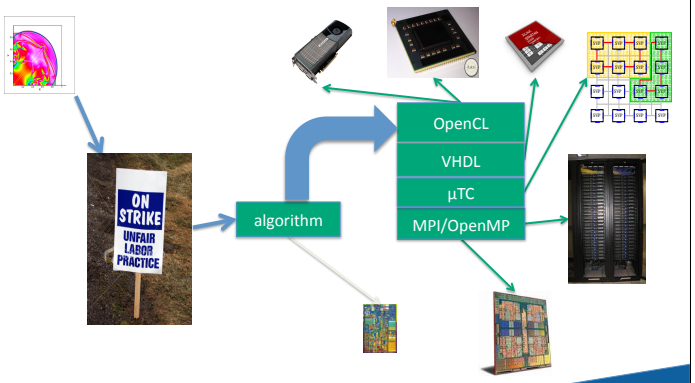
The Multicore Challenge



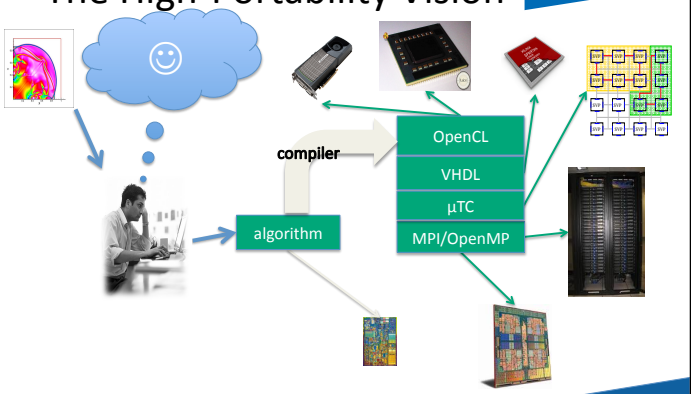
Typical Scenario



Tomorrow's Scenario



The High-Portability Vision



The Parallelism Myth

sequential program parallel code

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Sequentialisation Challenge

concurrent program

parallel code

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The Parallelism Challenge

concurrent program

we start here!

sequential program parallel code

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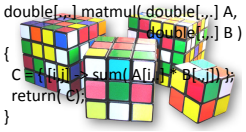
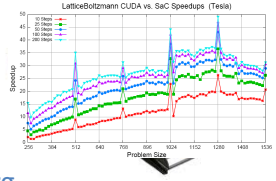
What is SaC ?

```
double[.,.] matmul( double[.,.] A,
                    double[.,.] B )
{
  C = { [i,j] -> sum( A[i,.] * B[.,j] ) };
  return( C);
}
```



```
a = [1,2,3,4];
b = modarray( a, [0], 42);
stdout = print( a, stdout);
stdout = print( b, stdout);
```



www.sac-home.org

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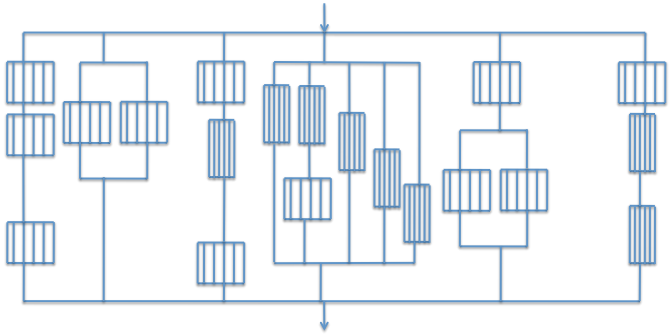
Sequentialisation Challenge



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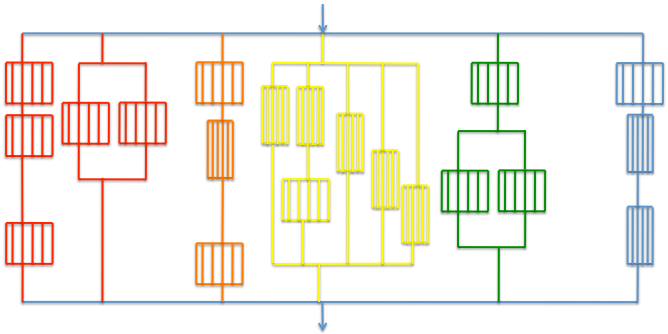
Sequentialisation for SMP



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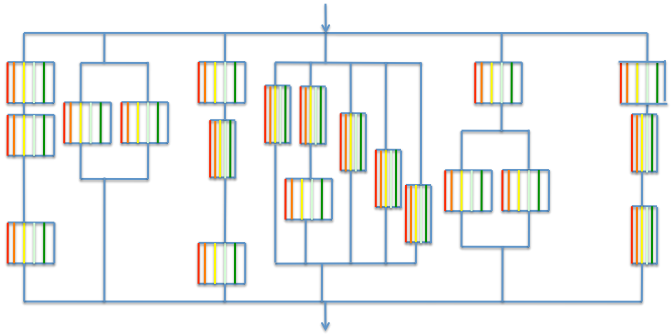
Sequentialisation for GPUs



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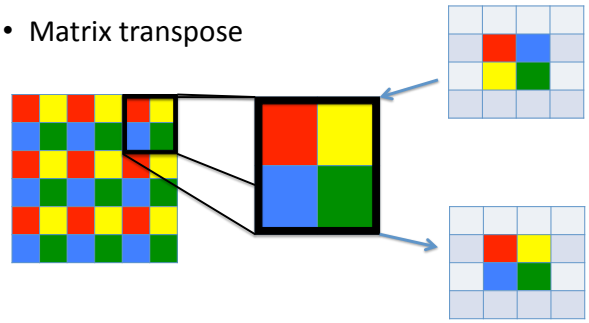
The Memory Abyss

- Matrix transpose



un-coalesced read => bad!!

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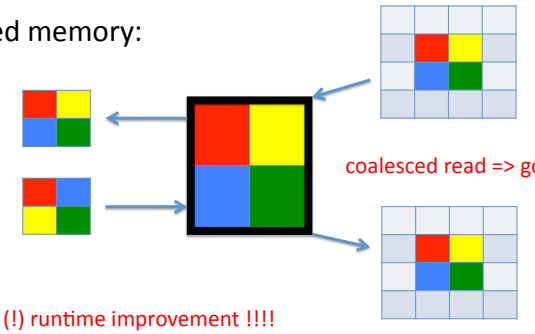
Shared Memory To The Rescue!

shared memory:



coalesced read => good!!

6-fold (!) runtime improvement !!!!
knowledge about hw-sequentialisation is key!

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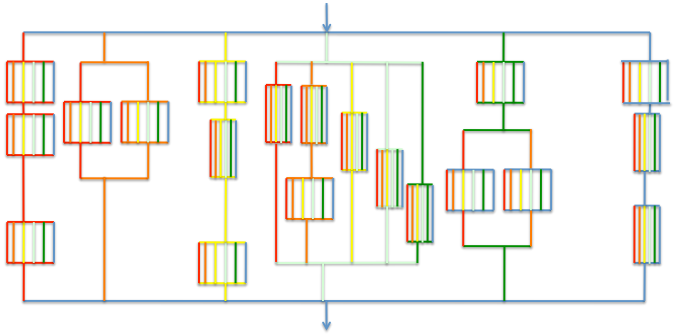
Microgrid == Nivana ?!



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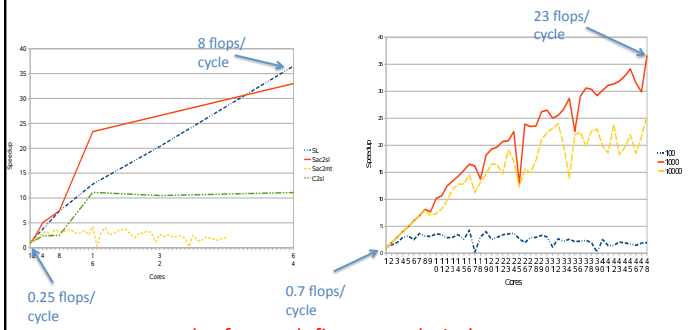
Stencil Computations



scales for much finer granularity!
much better energy efficiency!

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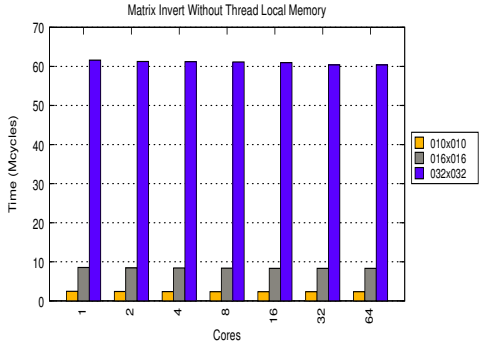
The Memory Strikes Back I



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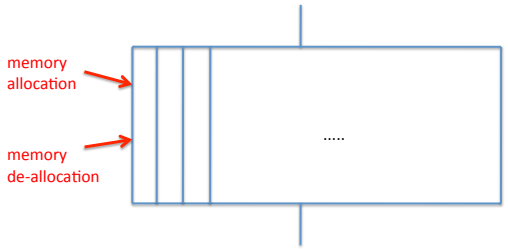
What is happening?



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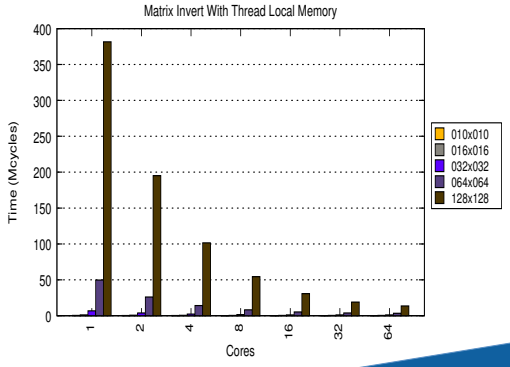
HW to the Rescue: Thread-Local Memory



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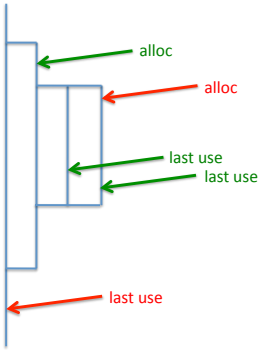
Moving to Task Parallelism



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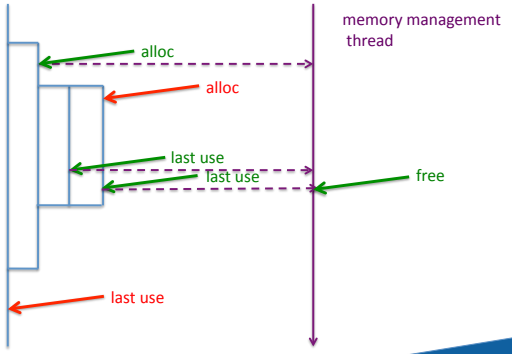
Asynchronous Reference Counting



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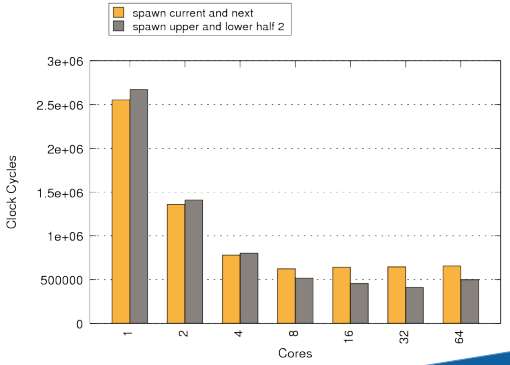
Naive fib(12) !



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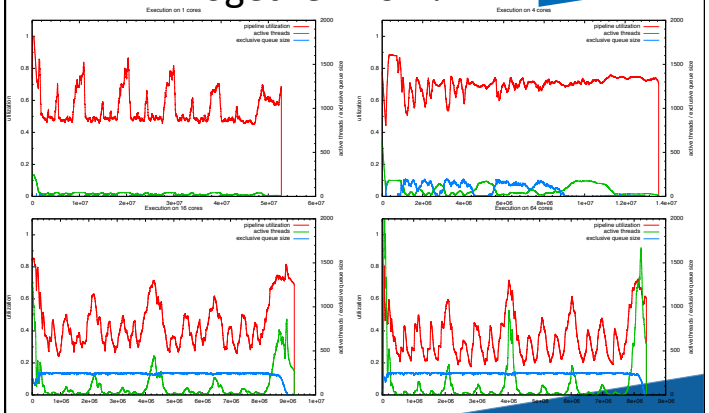
All Together Now!



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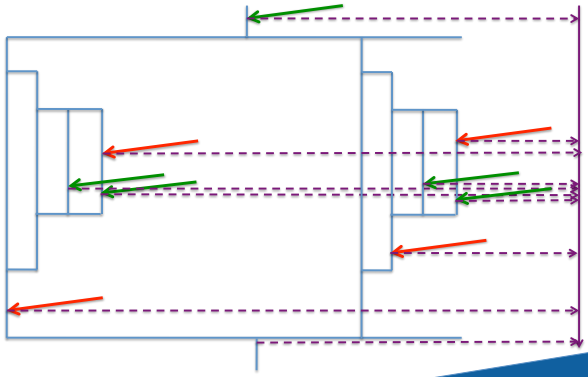
Memory, Again!



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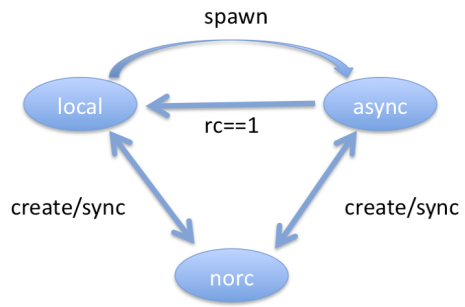
Multi-Modal RC:



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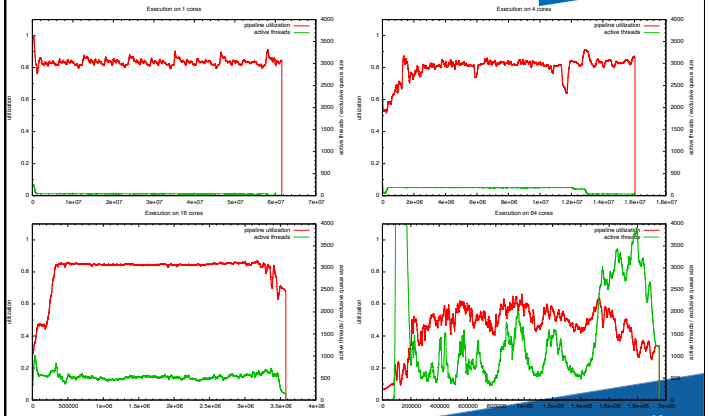
new runtimes:



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Memory Management and Many Cores

today:

tomorrow:

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Conclusions

- There is no one-fits-all parallelisation!
- The more parallel it gets the more attention memory organisation requires!
- Sequentialisation and memory organisation go hand in hand!

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