Self-Configuration and Self-Optimization Algorithmic Skeletons using Events

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Taken from http://www.extremetech.com/extreme/146967-stanford-breaks-million-core-supercomputing-barrier2

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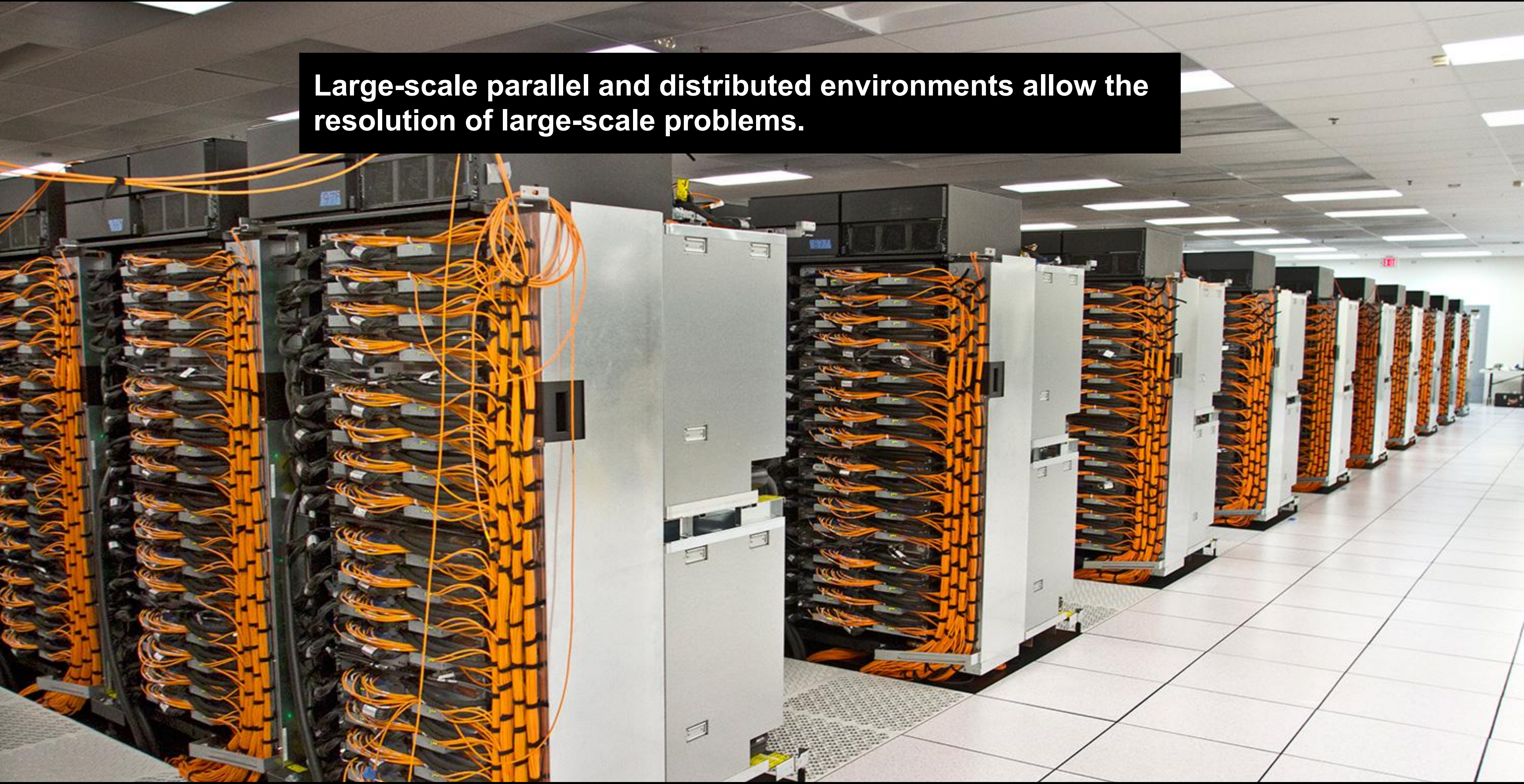

Large-scale parallel and distributed environments allow the resolution of large-scale problems.

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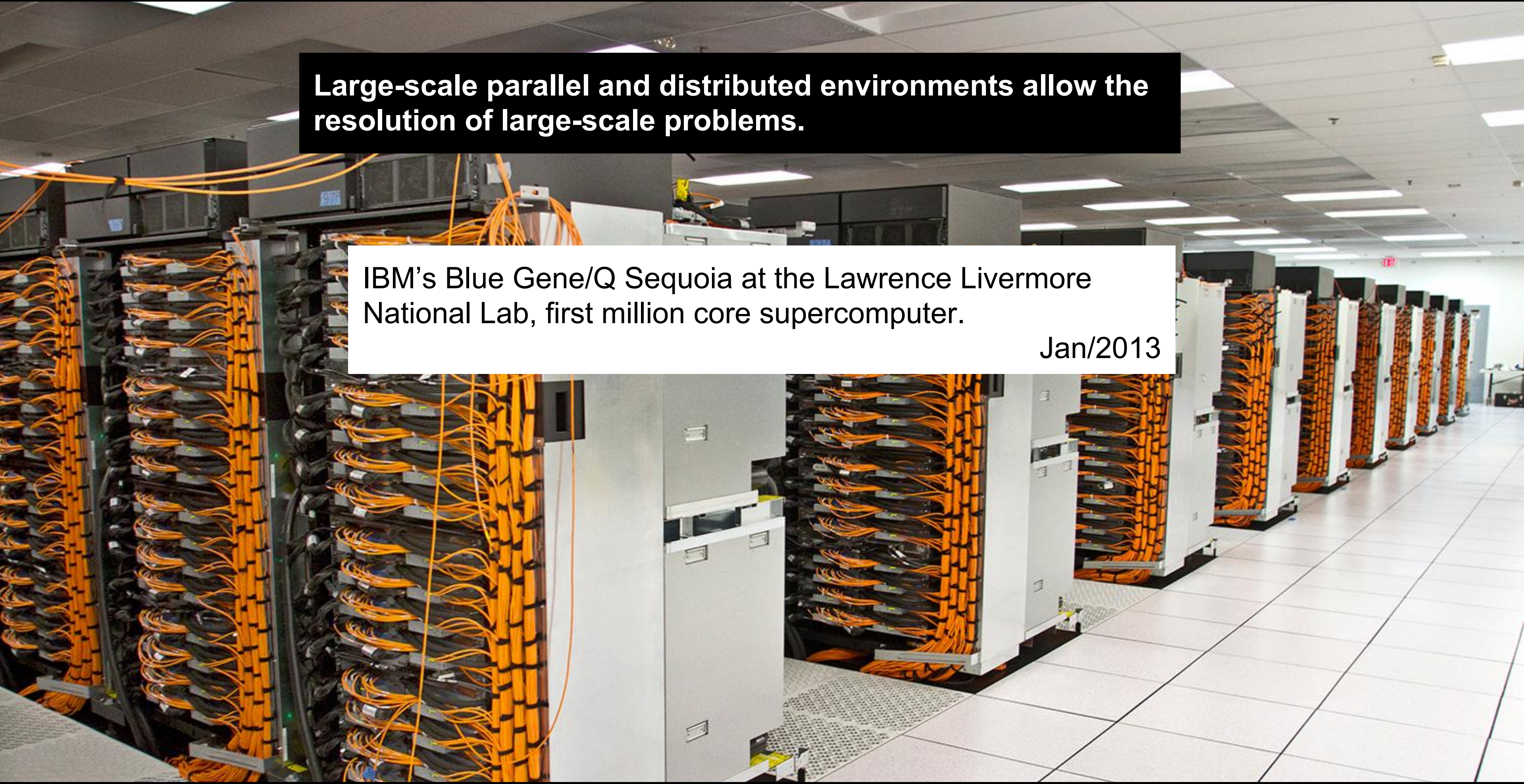

IBM’s Blue Gene/Q Sequoia at the Lawrence Livermore National Lab, first million core supercomputer.

Jan/2013

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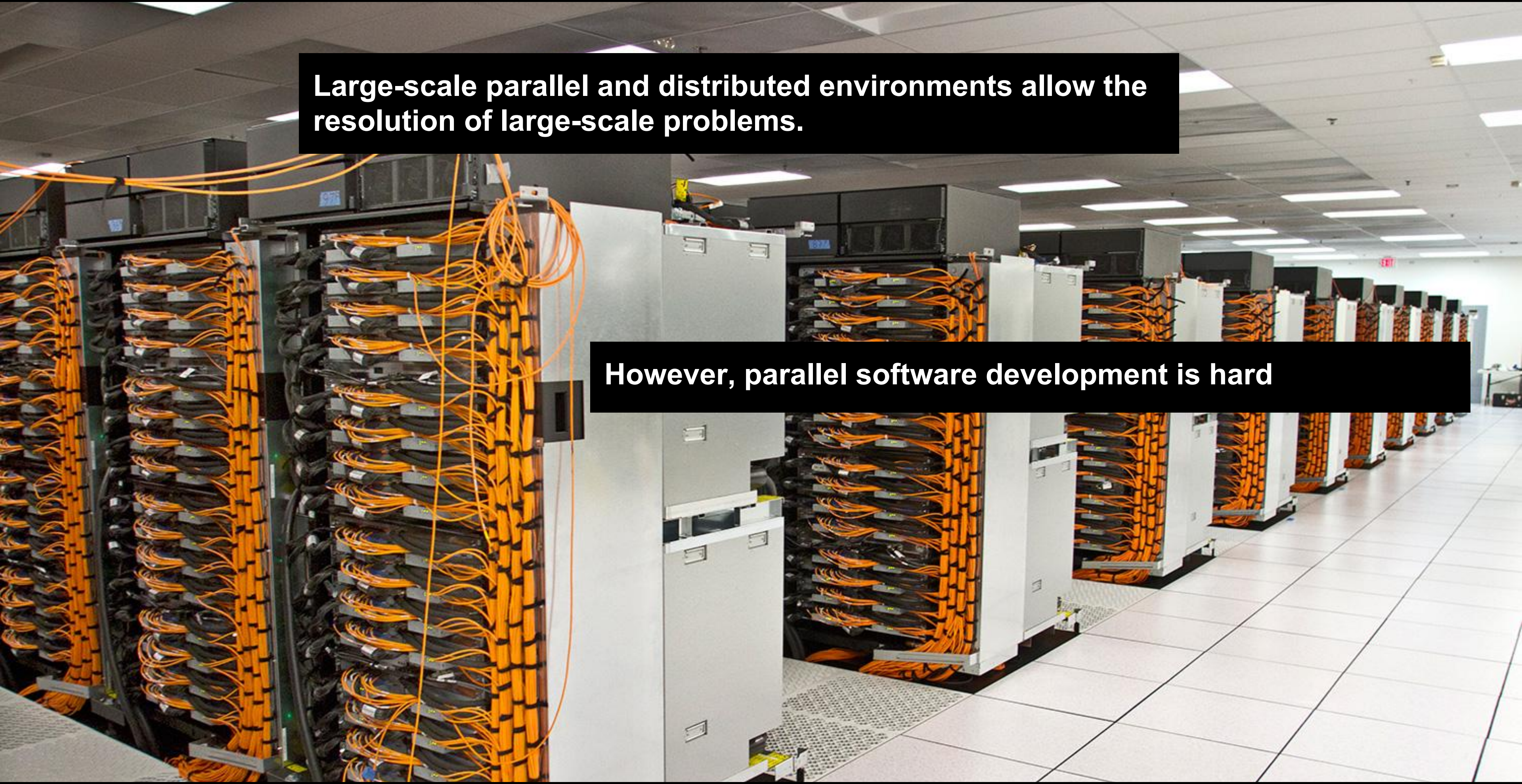

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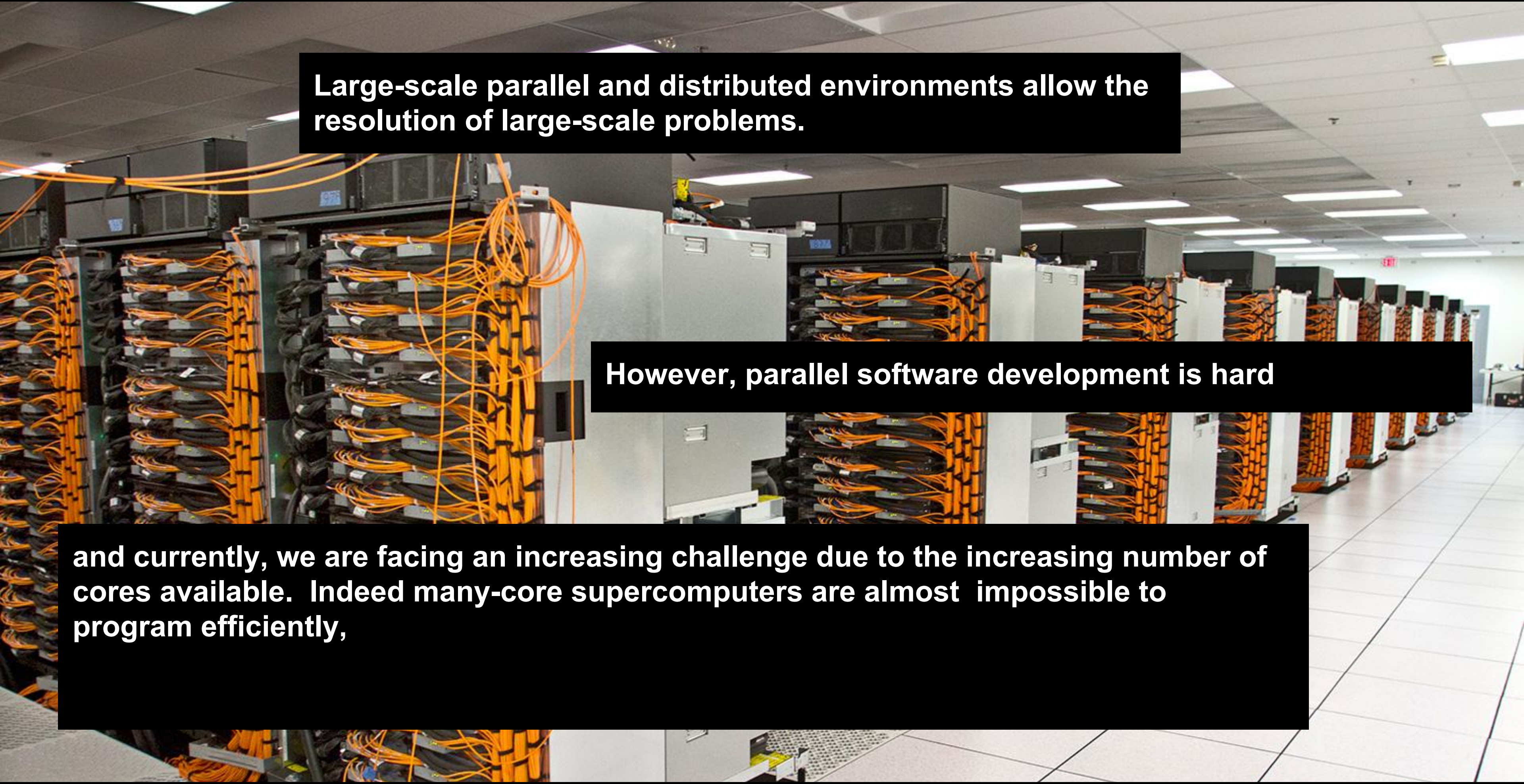
However, parallel software development is hard



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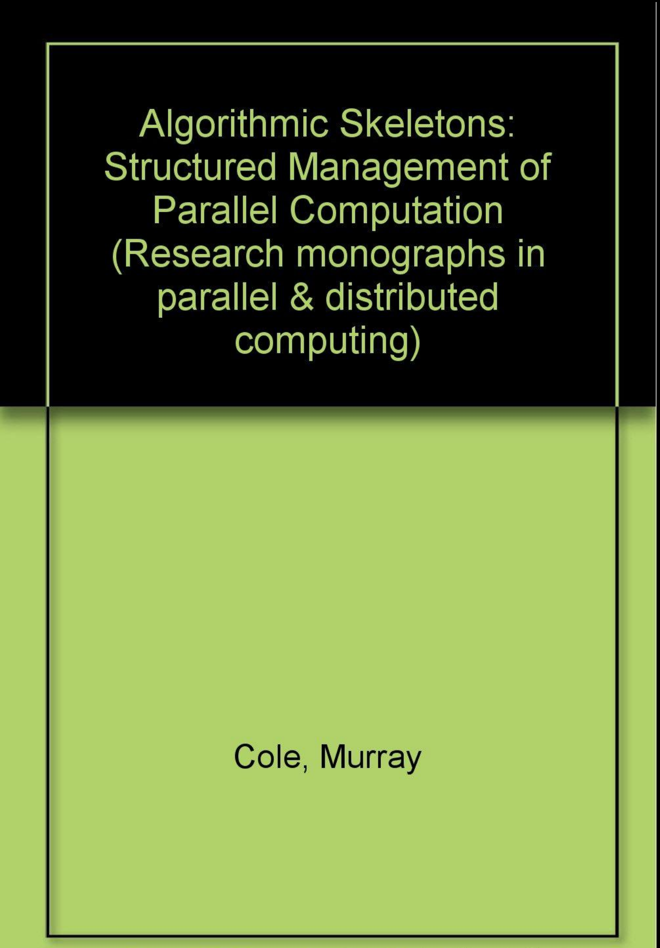
COLE '89



Note: This is not the actual book cover

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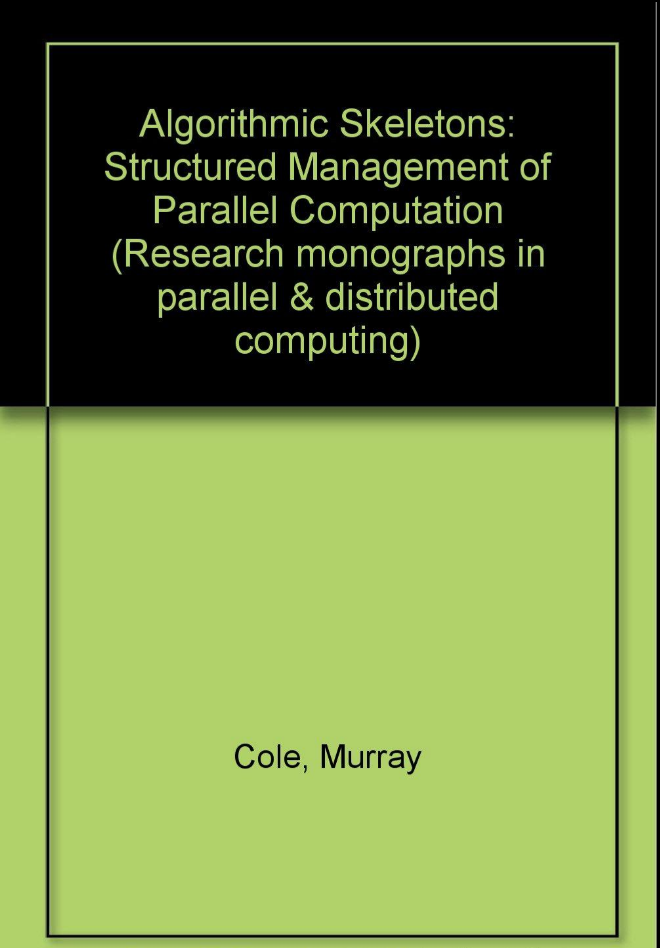

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Map Reduce

Master - Slave

Divide & Conquer

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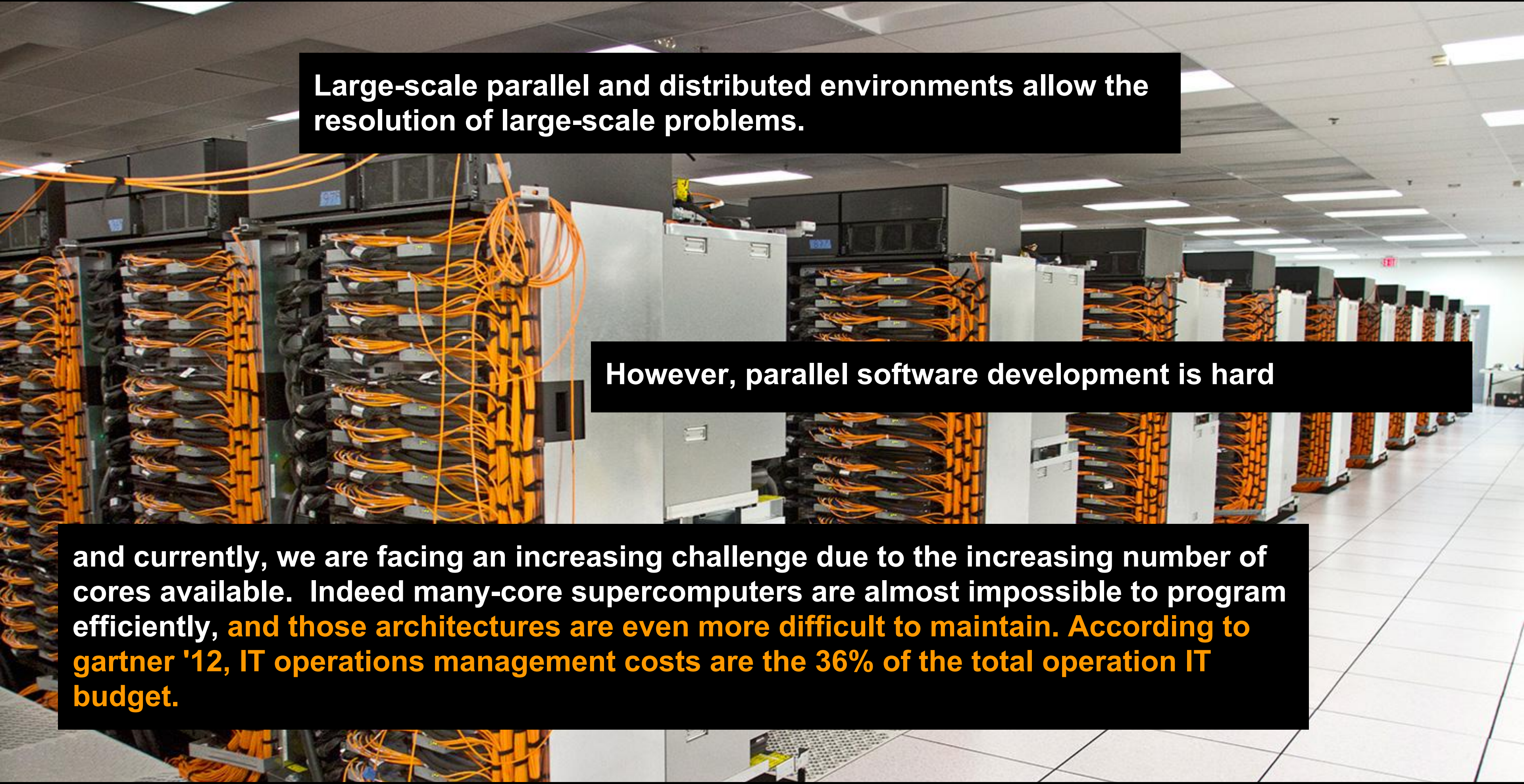
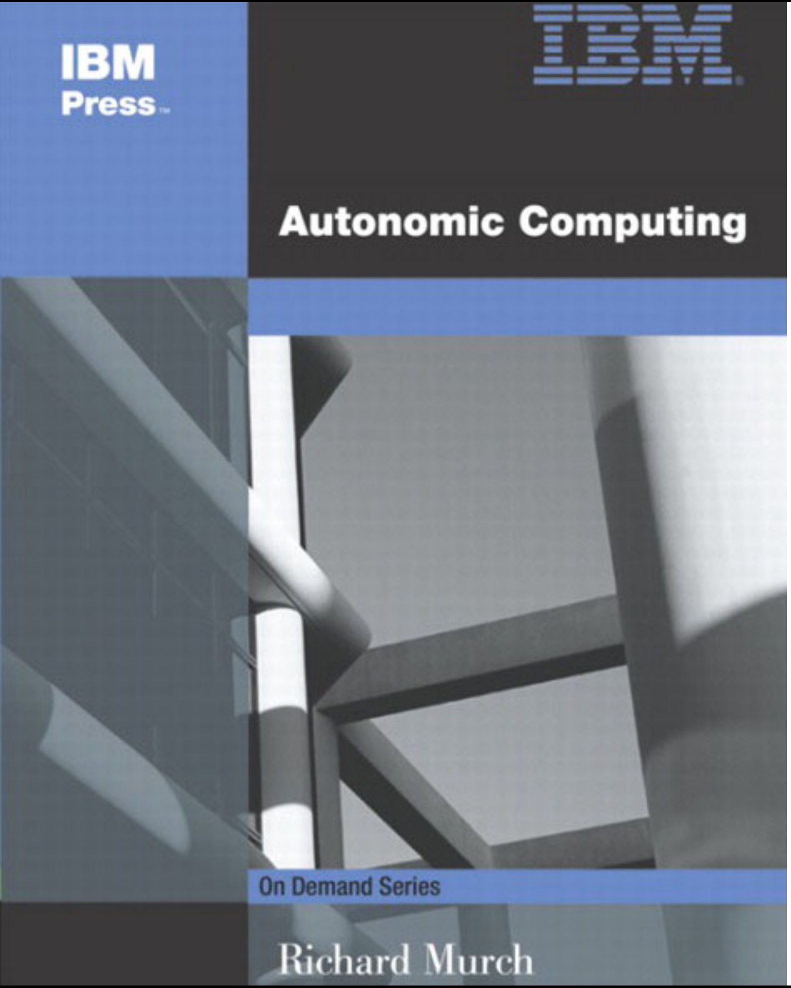


Large-scale parallel and distributed environments allow the resolution of large-scale problems.

However, parallel software development is hard

and currently, we are facing an increasing challenge due to the increasing number of cores available. Indeed many-core supercomputers are almost impossible to program efficiently, and those architectures are even more difficult to maintain. According to gartner '12, IT operations management costs are the 36% of the total operation IT budget.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Optimizing
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Protecting

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Self-Configuration and Self-Optimization Algorithmic Skeletons using Events

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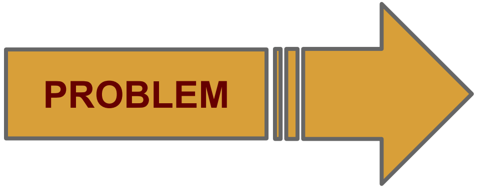

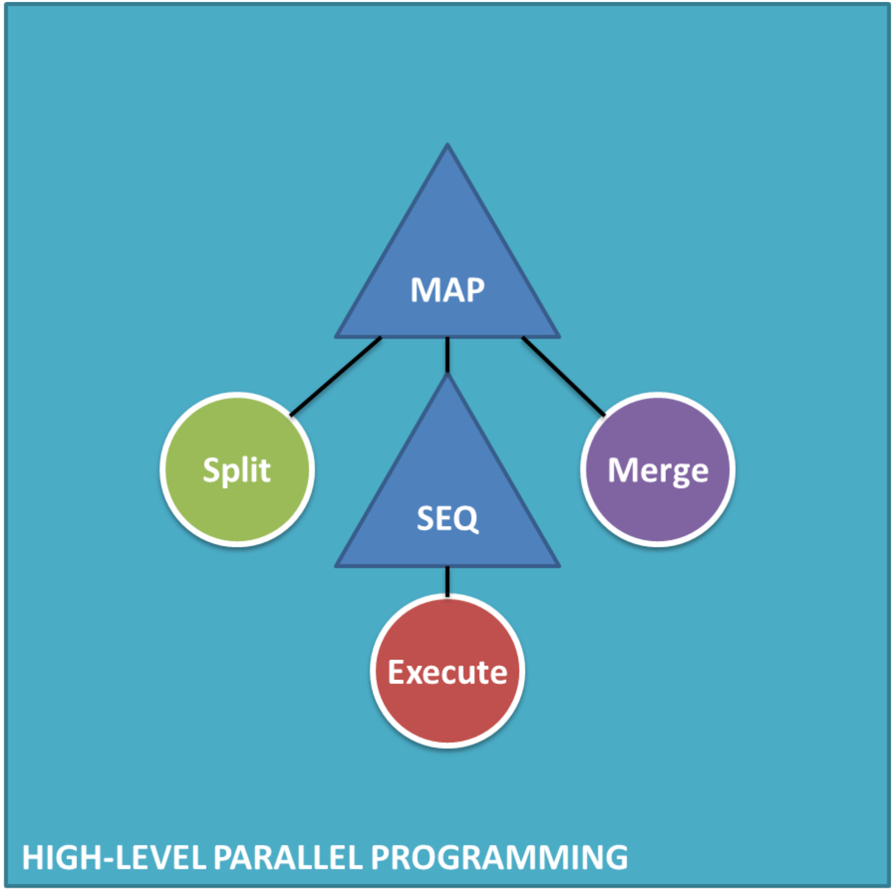

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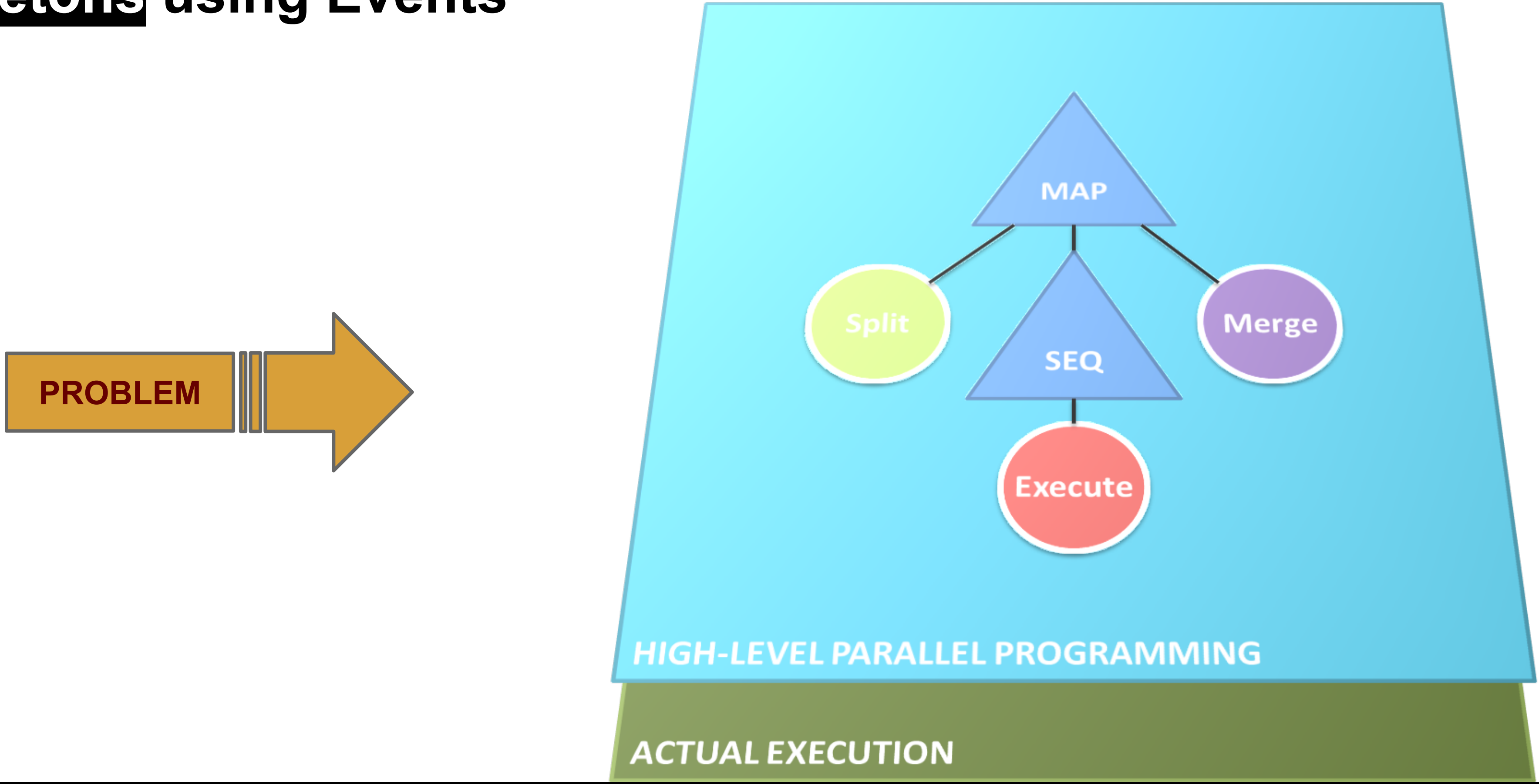

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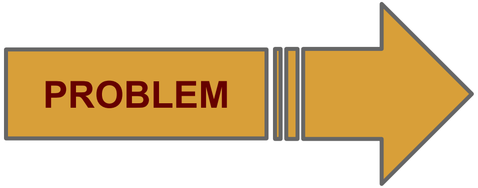

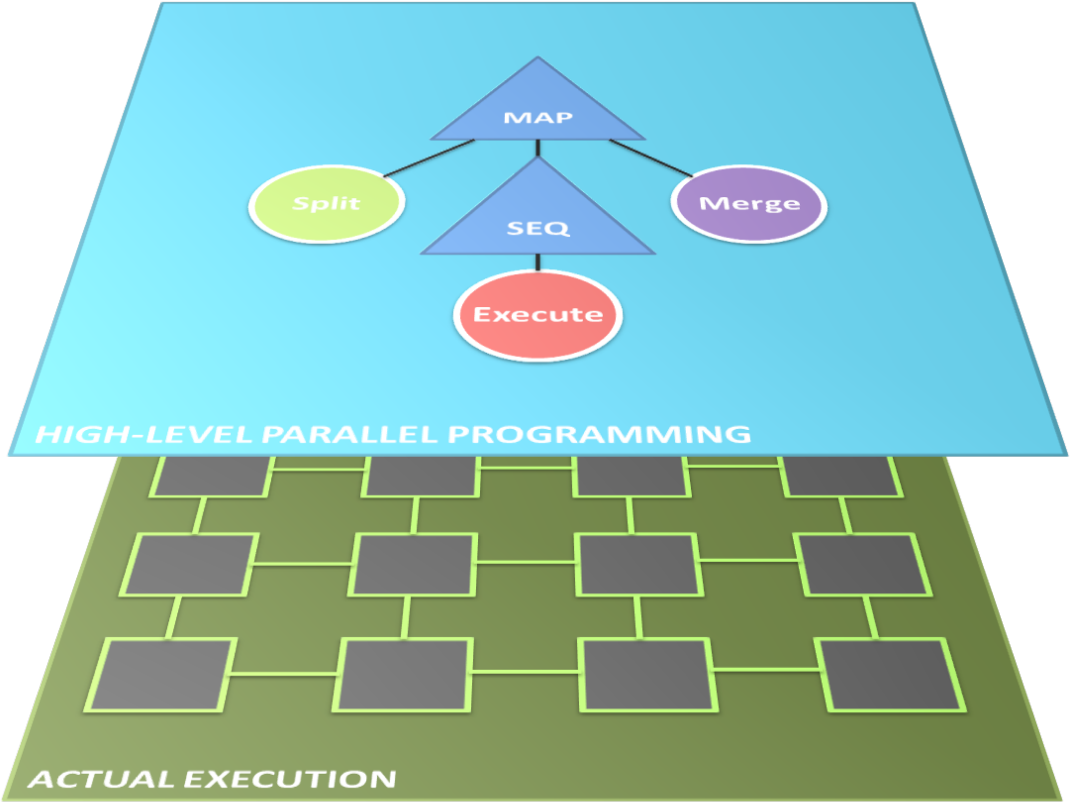

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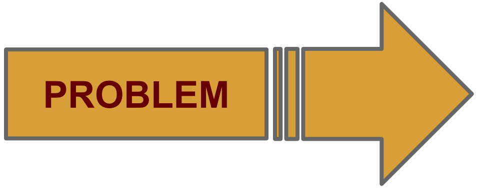

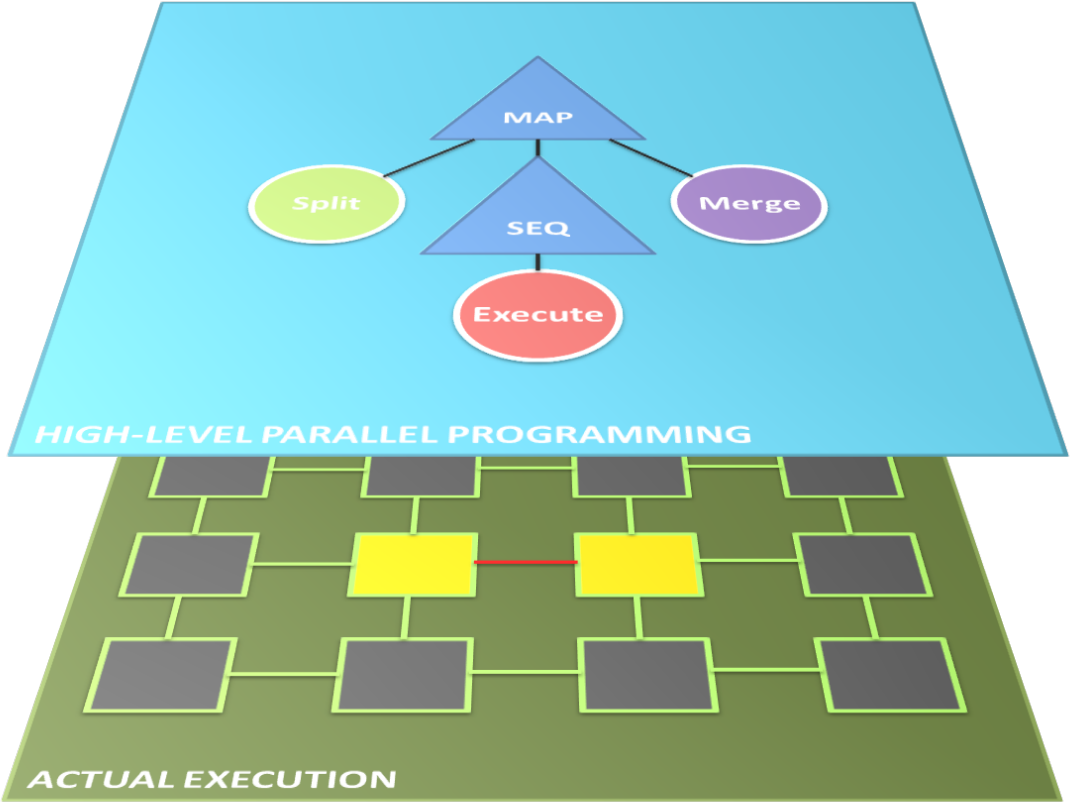

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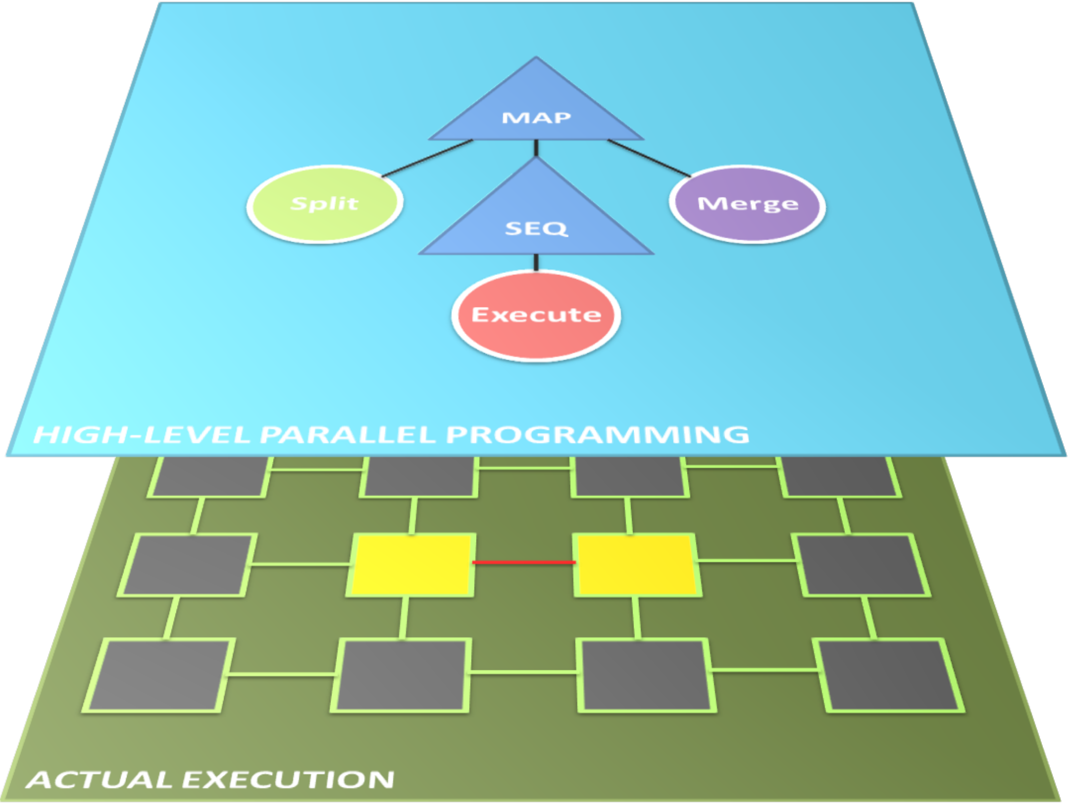

Goals:

- Monitoring the Skeleton's execution.
- Creating a clear separation of concerns (SoC)

Challenge: Inversion of Control.

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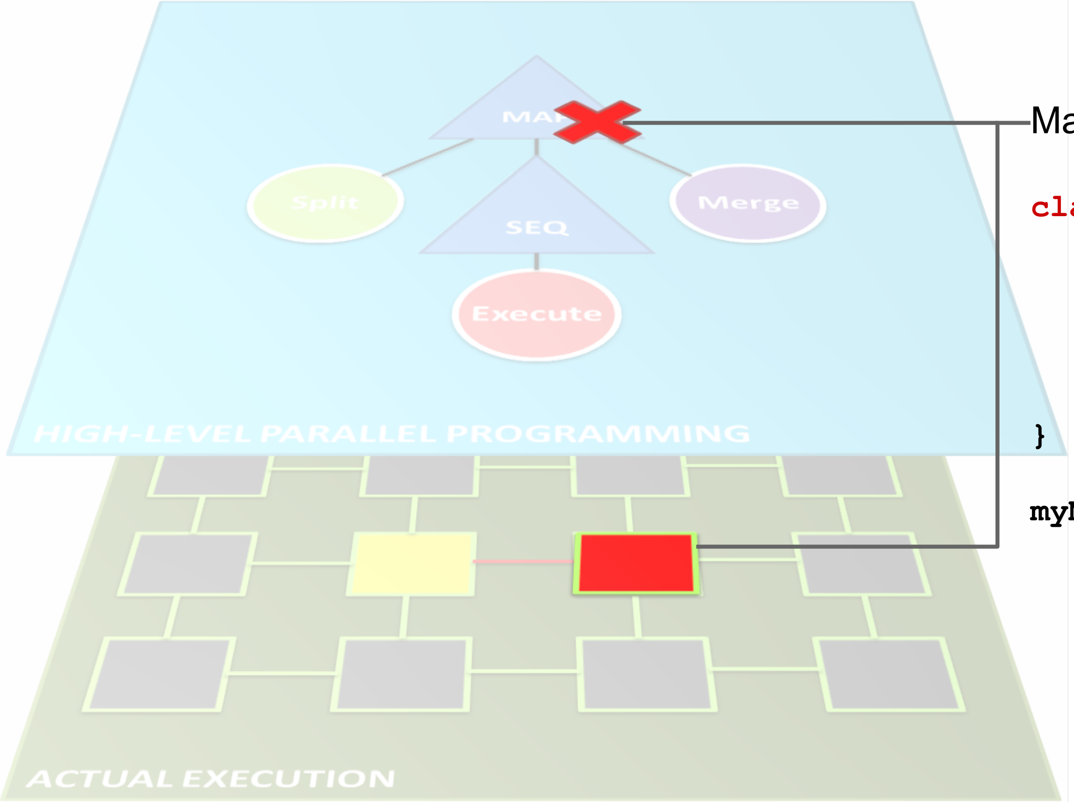


Map Before Merge

```
class MyListener implements ... {
    public P handler(P param,
                     Skeleton[] strace) {
        ...
        return param;
    }
}

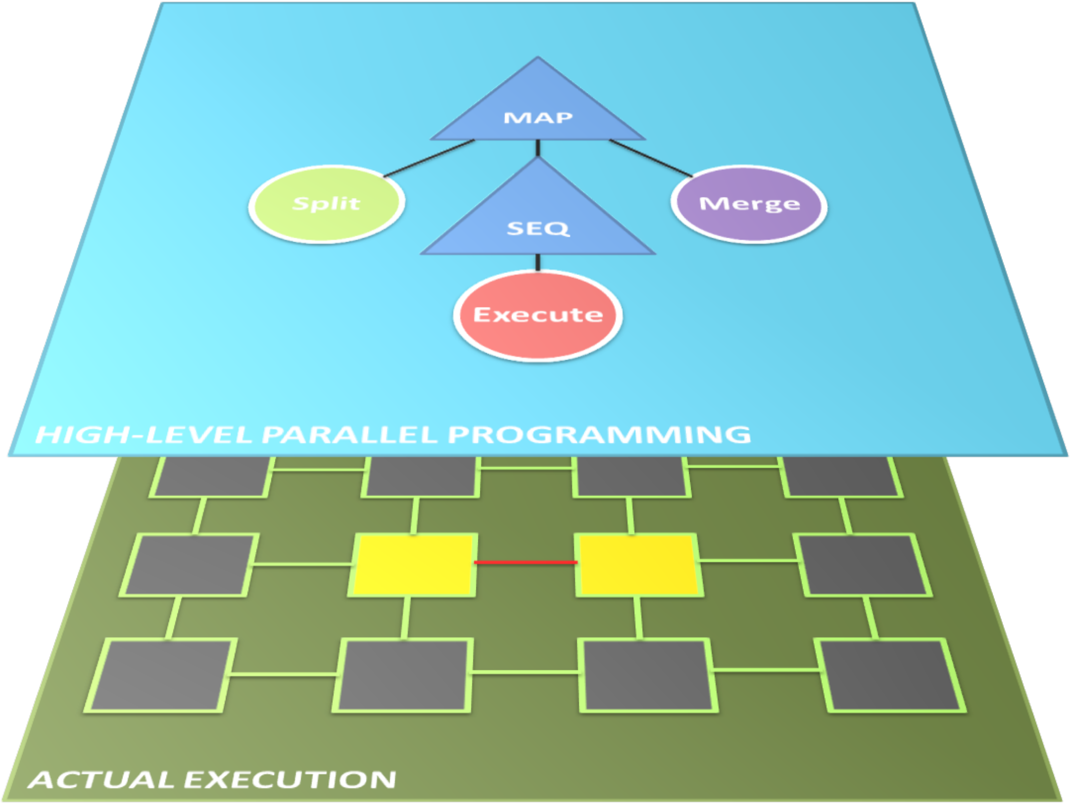
myMap.addBeforeMergeListener(myListener);
```

Self-Configuration and Self-Optimization Algorithmic Skeletons using Events

Let's say that

QoS Wall Clock Time (WCT): 12 seg.

WCT using 2 threads: **14 secs**.

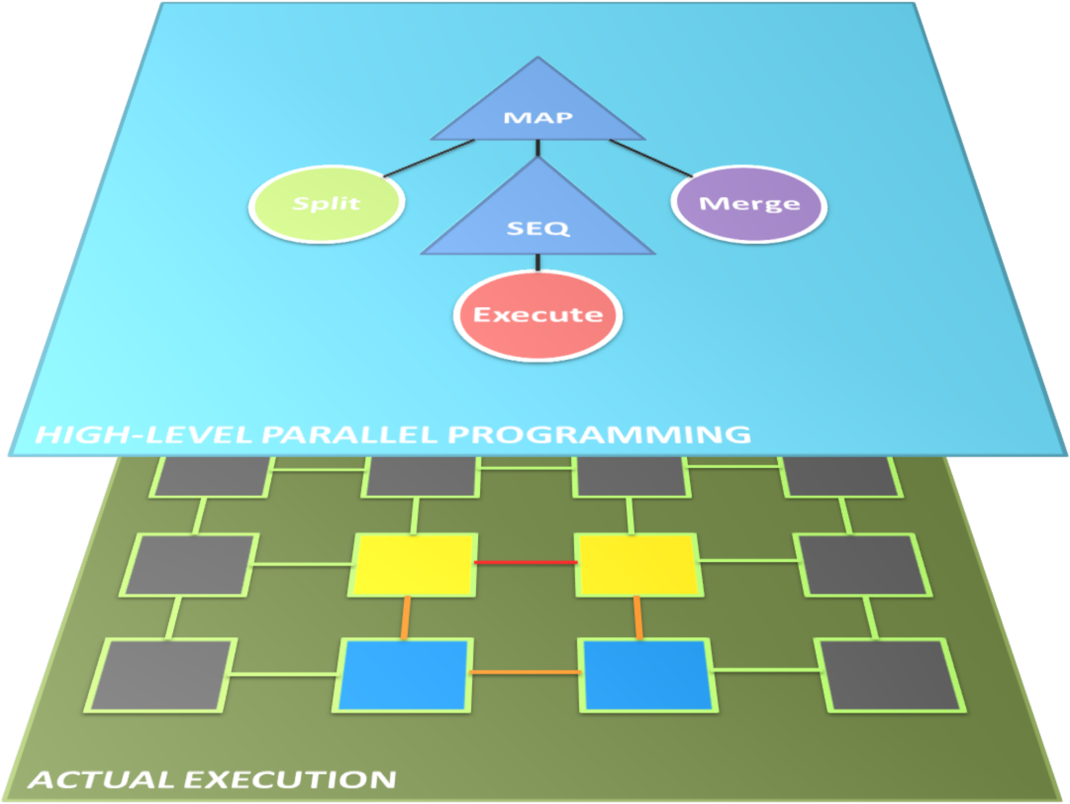


Self-Configuration and Self-Optimization Algorithmic Skeletons using Events

Let's say that

QoS Wall Clock Time (WCT): 12 seg.

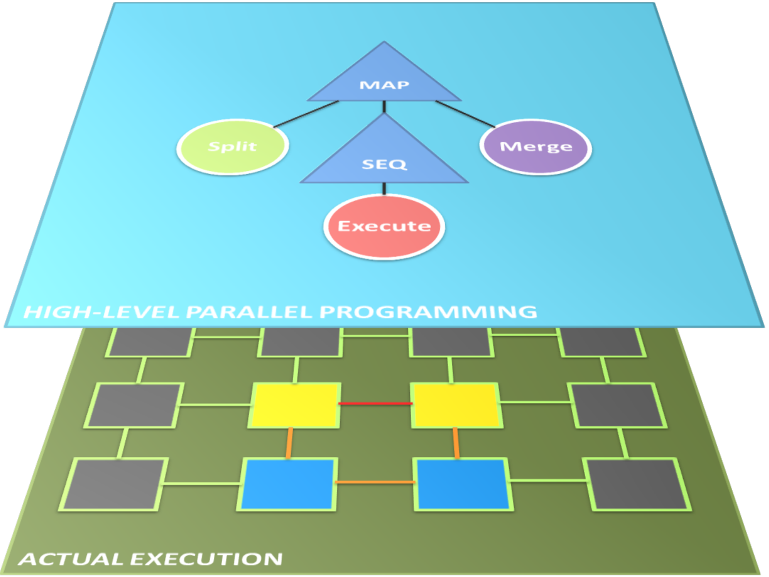
WCT using 2 threads: **14 secs**.
WCT using 4 threads: **10 secs**.



Self-Configuration and Self-Optimization Algorithmic Skeletons using Events

WCT using 2 threads: **14 secs**.
WCT using 4 threads: **10 secs**.

How to calculate them?



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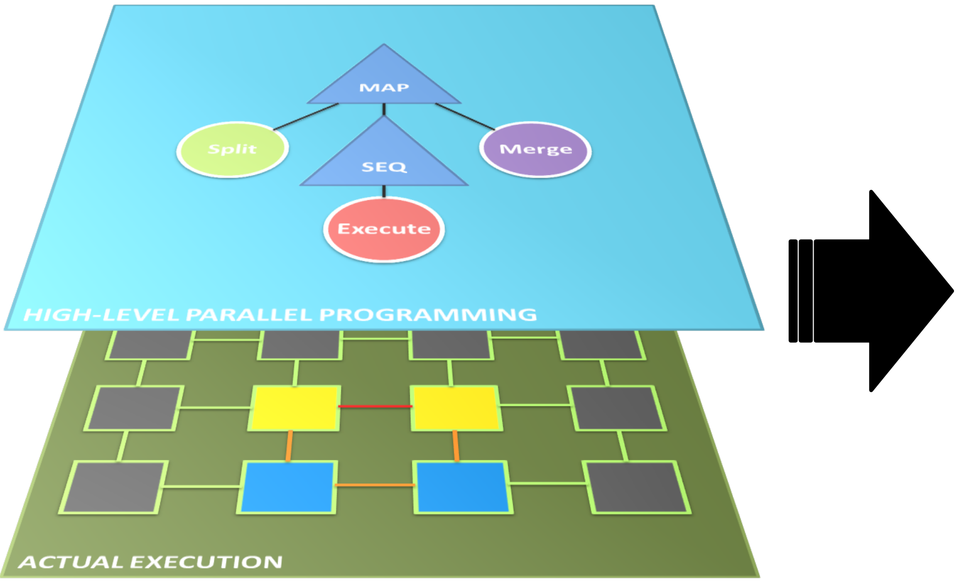
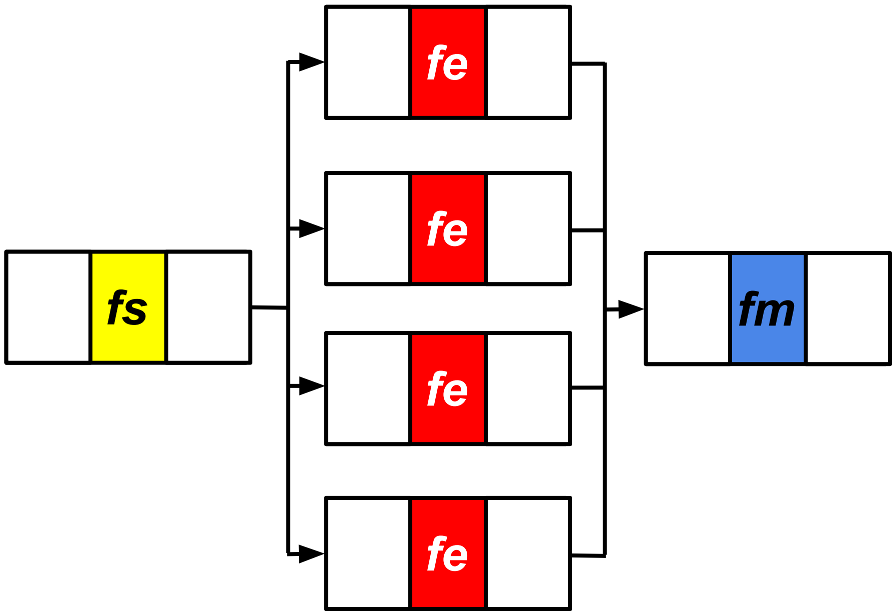


Activity Dependency Graph



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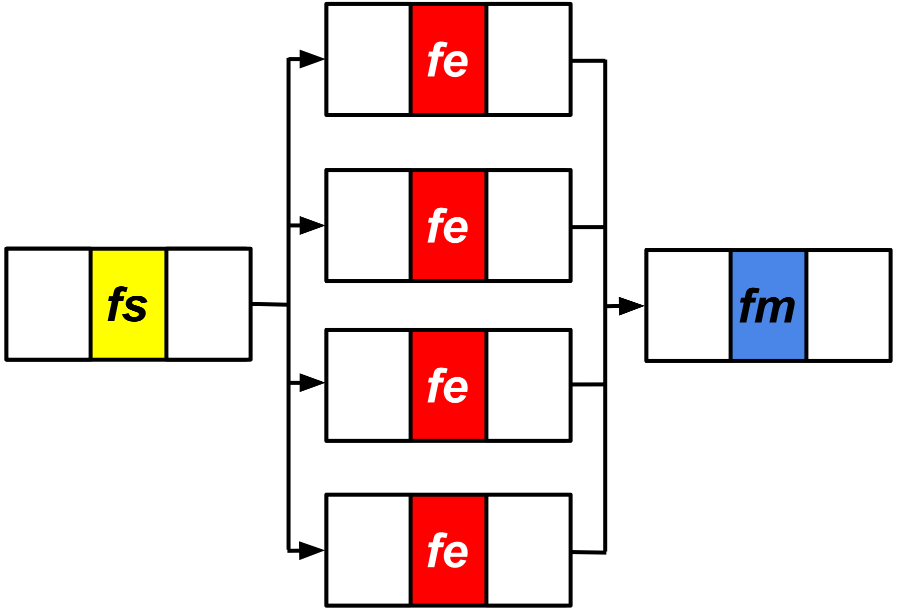

Activity Dependency Graph

Best Effort Estimation

Let's assume that we know in advanced the following values:

```
|fs|  = 4
t(fs)  = 3
t(fe)  = 4
t(fm)  = 3
```

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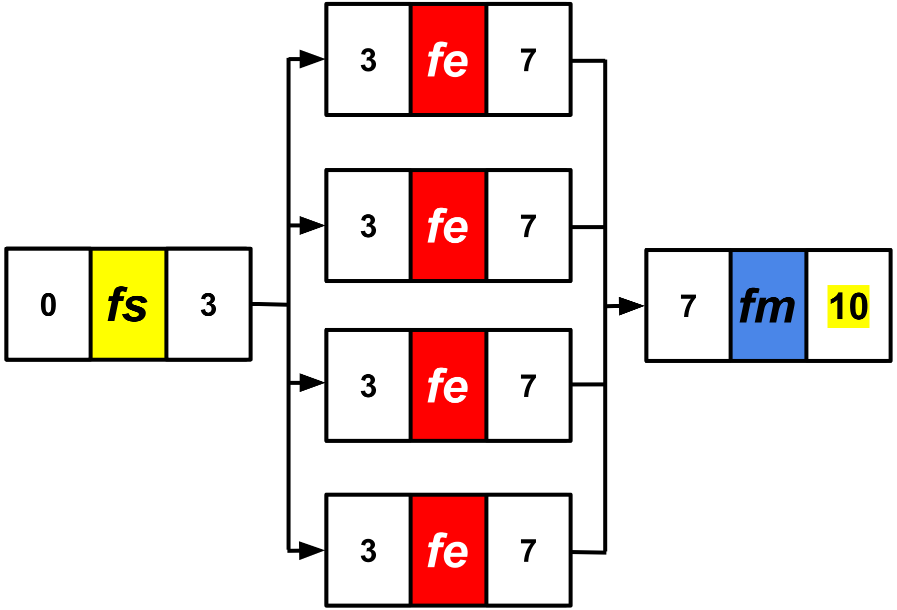

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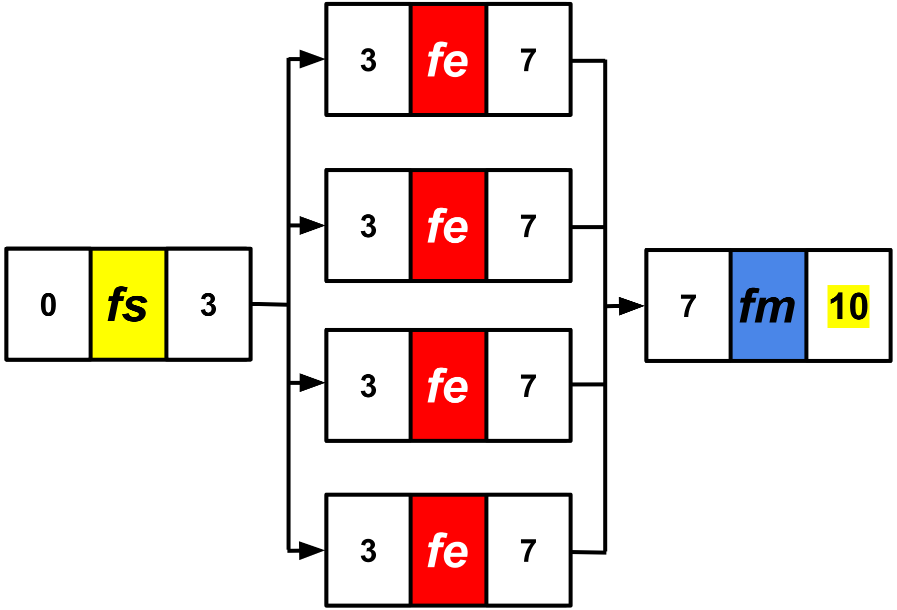

Activity Dependency Graph

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Estimated Execution Time Line

[0,3)	1
[3,7)	**4**
[7,10)	1

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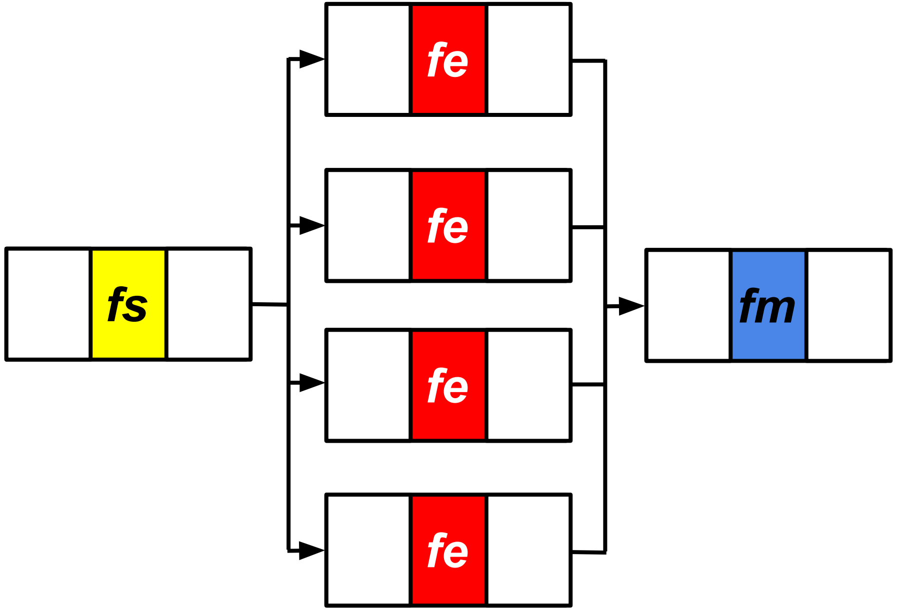

Activity Dependency Graph

Fixed Level of Parallelism(2)

Let's assume that we know in advanced the following values:

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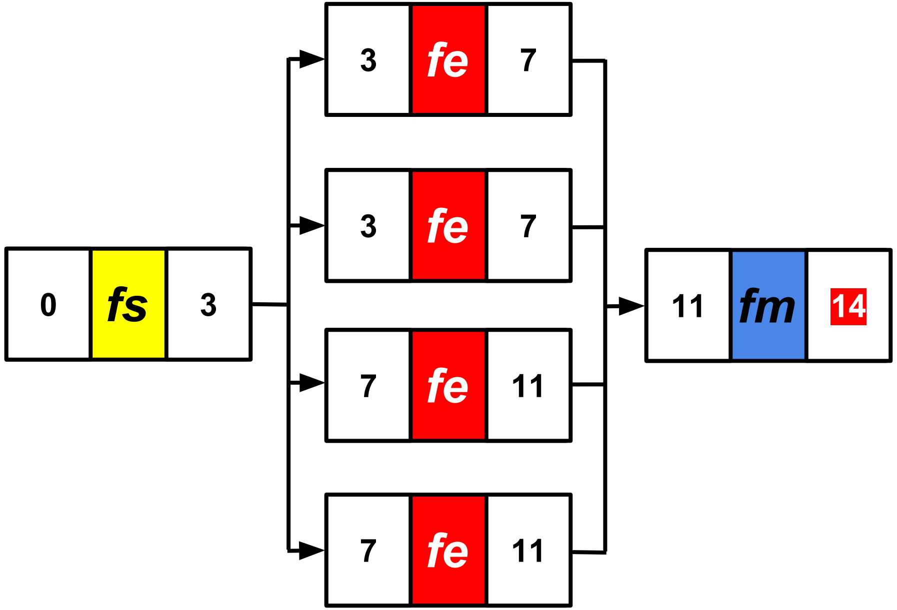

Activity Dependency Graph

Fixed Level of Parallelism(2)

Let's assume that we know in advanced the following values:

|fs| = 4
t(fs) = 3
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t(fm) = 3

Estimated Execution Time Line

[0,3)	1
[3,7)	2
[7,11)	2
[11,14)	1

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Estimating Future Work

Let's assume that we know in advanced the following values:

```
|fs|  = 4
t(fs)  = 3
t(fe)  = 4
t(fm)  = 3
```

How to estimate this values on the fly?

Self-Configuration and Self-Optimization Algorithmic Skeletons using Events

Estimating Future Work

Let's assume that we know in advanced the following values:

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```

How to estimate this values on the fly?

$$newEstimatedVal = \rho \times lastActualVal + (1 - \rho) \times previousEstimatedVal$$

$$0 \le \rho \le 1$$

Self-Configuration and Self-Optimization Algorithmic Skeletons using Events

The executive summary of our proposal is to extend the Algorithmic Skeleton model by:

1. Introducing separation of concerns using events (monitoring)
2. Implementing autonomic concerns by using
   a. Activity dependency graphs
   b. Estimating future work based on:

$$newEstimatedVal = \rho \times lastActualVal + (1 - \rho) \times previousEstimatedVal$$

Related Works

ParaPhrase

Seventh Framework Programme (FP7), 2011 - 2014

Aims to produce a new design and implementation process based on adaptable parallel patterns for component based architectures, where the autonomic features are more related to structural adaptations. Our approach contributes to provide autonomic features for the computational aspects, and it is not related to a specific architecture.

Related Works

ASPARA Project

H. Gonzales-Velez, M.Cole. 2010

This work proposes a methodology to introduce adaptability in skeletons. On ASPARA, structural information is introduced during compilation.
Compared to ASPARA project, our solution allows the introduction of structural information during execution.

Related Works

Auto-tuning SkePU

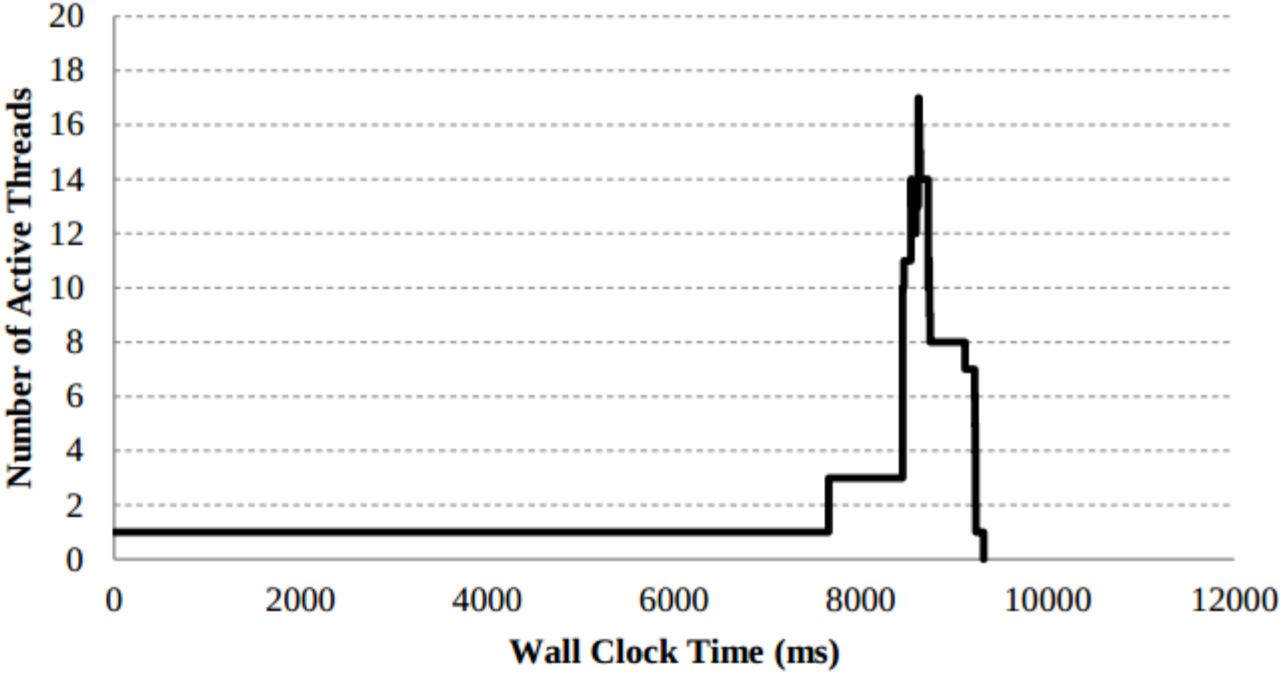
U. Dastgeer, J. Enmyren, C.W. Kessler. 2011

Here the prediction mechanism at execution time uses online pre-calculated estimates to construct an execution plan for any desired configuration with minimal overhead.
Our solution does not need pre-calculated estimates. It calculates estimates at runtime.

Execution Example

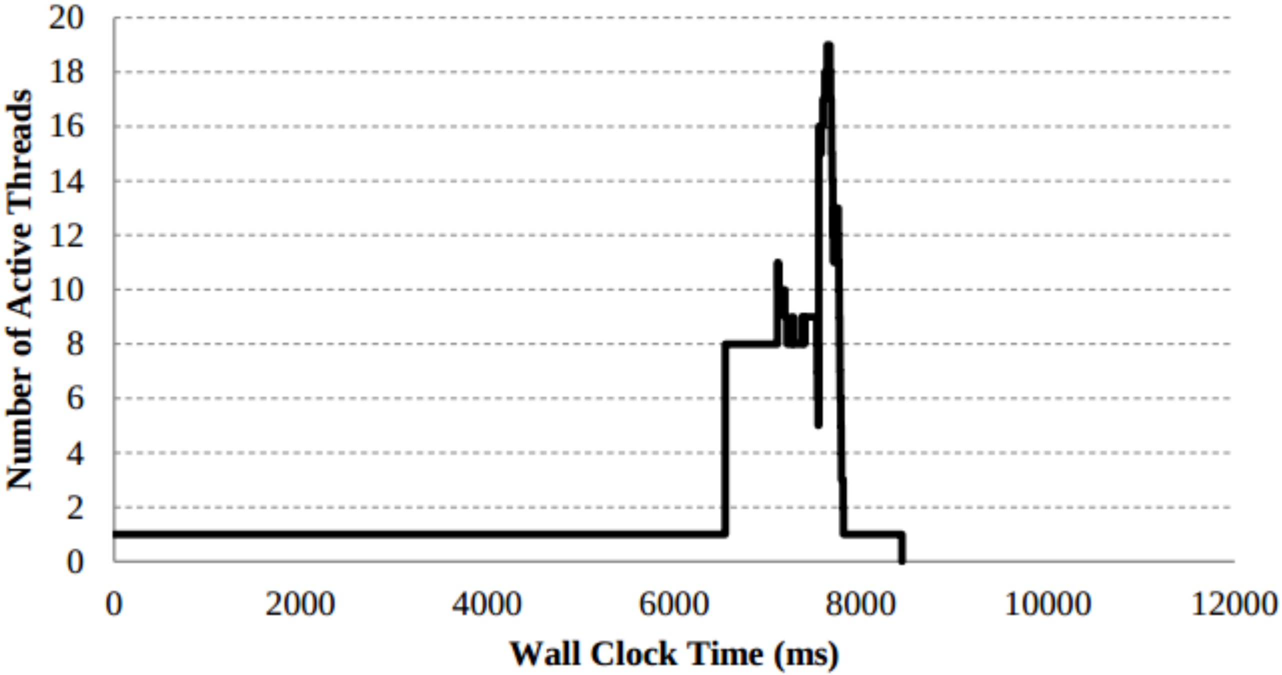
- Problem: Calculate the top 5 of hashtags and commented users on 1.2 million of Colombian Twits from July 25/13 to August 5/13.
- Used architecture:
  - Intel(R) Xenon(R) E5645 a 2.4 GHz per core, 12 cores y 24 CPU Threads. 64 GB RAM
  - Skandium v1.1b1 on JRE 1.6
- Execution scenarios
  - A achievable goal but stressful:
    - Goal of 9.5 secs without initialization
    - Goal of 9.5 secs with initialization
  - A goal with clearance (not that stressful): goal of 10.5 secs

Execution Example - Goal of 9.5 secs without initialization



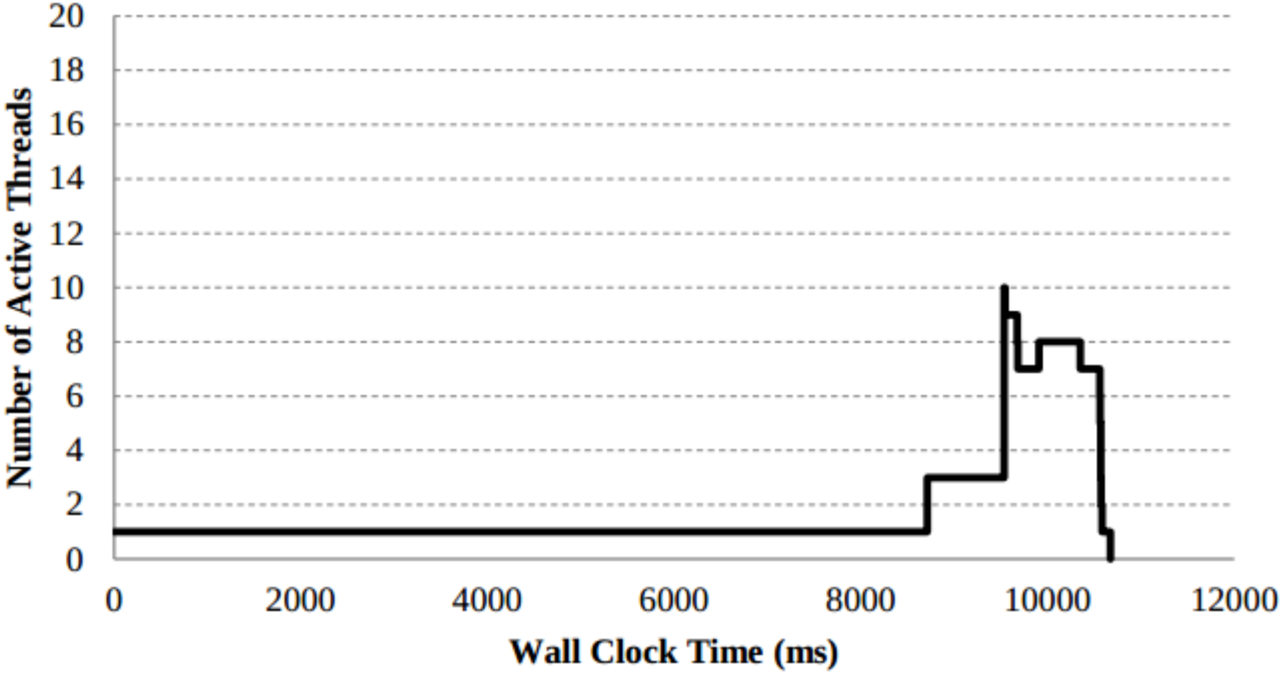
WCT=9.3s

Execution Example - Goal of 9.5 secs with initialization



WCT=8.4s

Execution Example - Goal of 10.5 secs (clearance)



WCT=10.6s

Conclusions

- We have shown how skeletons together with autonomic computing present a promising solution for the autonomic adaptation of applications.
- Our approach relies on the use of events for creating a clear separation of concerns without lowering the high-level parallel programming of skeletons allowing us to precisely monitor the status of the execution, and react on the fly to make behavioural changes.
- We have shown the feasibility of our proposal by introducing self-configuration and self-optimization autonomic characteristics to skeletons using events related to the Wall Clock Time and Level of Parallelism QoSs.

Future Work

- Distributed Autonomic Skeletons using this approach.
- Introduce different QoS to improve scalability, maintainability and security: self-healing and self-protecting characteristics.
- Analyses of different WCT estimation algorithms comparing its overhead costs.
- More experiments are conducted on other benchmarks

Self-Configuration and Self-Optimization Algorithmic Skeletons using Events

Thank you very much for attending

The executive summary of our proposal is to extend the Algorithmic Skeleton model by:

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