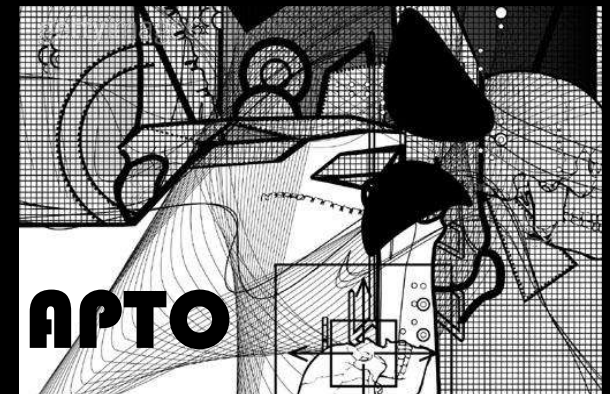




# Structured Parallelism on Computational Grids: Adaptive Performance Techniques for Optimization

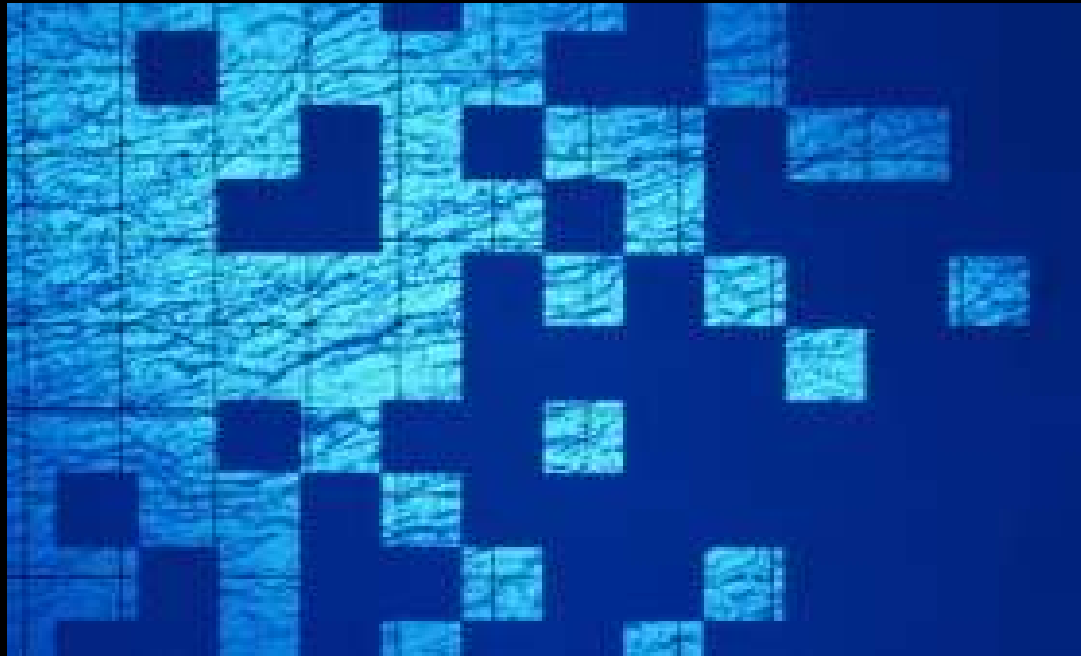
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# Objective

- Improve the Performance of Structured Parallelism on Computational Grids





# APTO

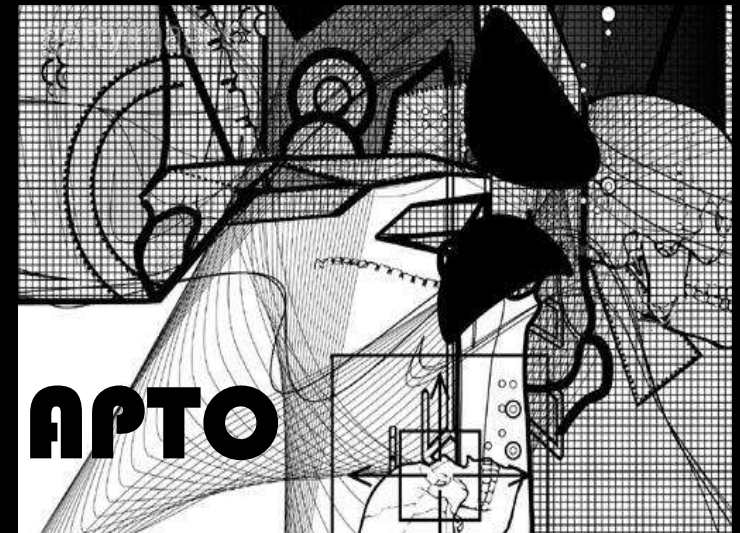
## Adaptive Performance Techniques for Optimization

- Performance Techniques (Actions) applied to the Grid for a given skeletal nesting:

*ska(skb(... ski(data | process) ....))*

→

*action(grid)*





# APTO Actions

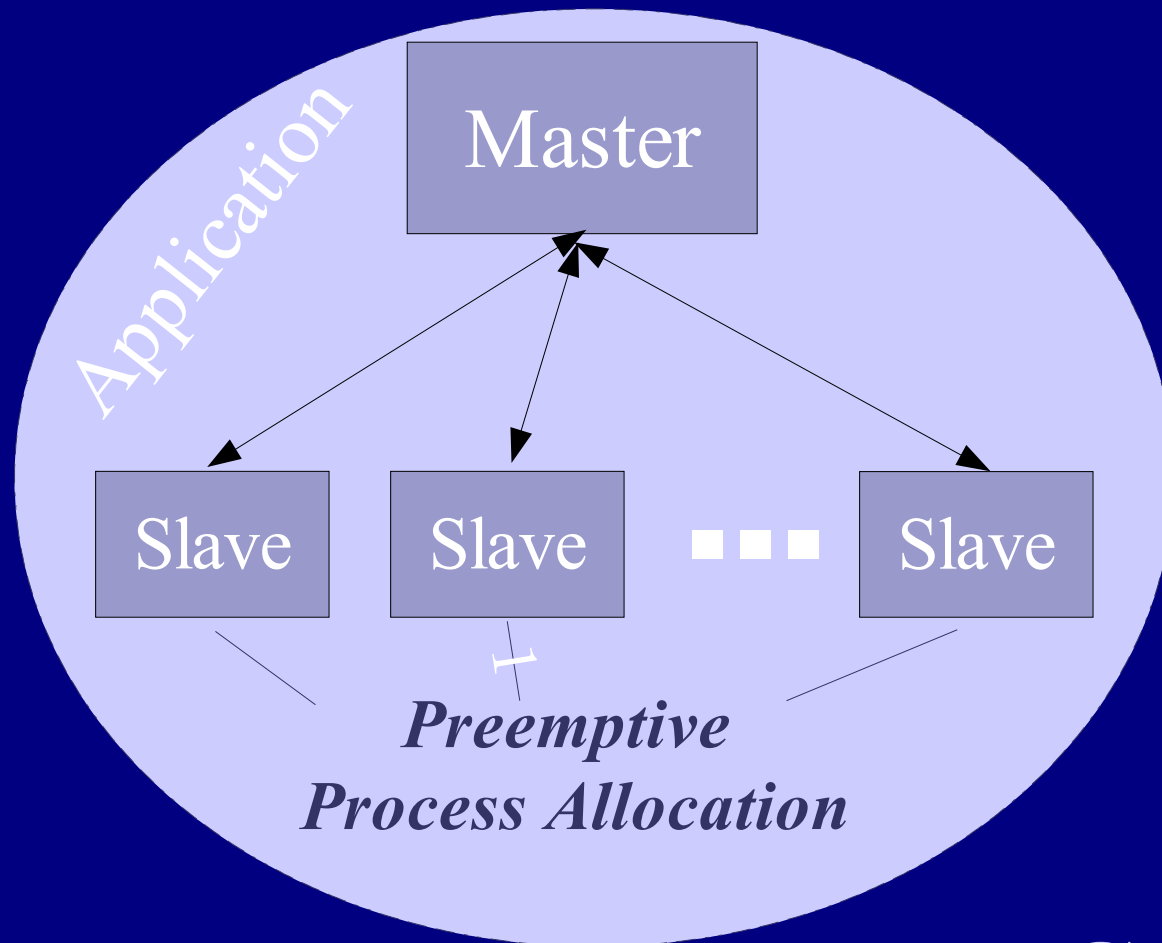
- Data Migration
- Preemptive Process Allocation
- Pre-Allocation of Communication Channels



Compiler Optimization Analogy



# APTO on Process Farm






# Don't Be a Stranger

- Questions, Comments, Suggestions ?

Give us your feedback at the poster session



## Structured Parallelism on Computational Grids: APTO (Adaptive Performance Techniques for Optimization)

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### On Grids and Skeletons

A **Computational Grid** is a hardware and software infrastructure that provides dependable, consistent, pervasive, and inexpensive access to distributed computational capabilities.

"The Grid" vision now encompasses:

- Virtual Organizations
- Middleware (Application/Programming)
- Architectures
- Data
- Information Systems and Performance
- QoS Provisioning
- Scheduling
- Security

The use of proven grid programming paradigms has become an issue. Current trends in scientific application programming for computational grids include:

- Comprehensive Distributed Frameworks
- Portals
- Transformational Methodologies (Compilers, Agents, Templates, Patterns, Skeletons)
- Middleware
- Message-Passing and RPCs

Due to the transformational and constructive programming approach, the use of structured parallelism is advocated.


The algorithmic skeleton concept was originally introduced as a higher order function corresponding to a good parallel algorithmic technique and has evolved into structured parallelism.

**Structured Parallelism** is the composition of algorithmic skeletons for the development of programs where the control is localized through the structure and the programmer adheres to top-down design and construction.

- Transformational approach
- Architecture Independent and Language Agnostic
- Formal Methodology and Notation

### The APTO Framework

Automatic cost analysis and transformational rules of skeletons help to prove commutative and equivalence properties. Such proofs facilitate performance minimization of skeletons before execution, but provide no guidance on how to structure the performance cost to a given combination of skeleton has been selected for a certain platform and, in particular, grids.



The APTO (Adaptive Performance Techniques for Optimization) framework is composed by a set of performance skeletons (actions) to be applied to the grid when constructed with a given skeletal combination.

$sk_1(sk_2(\dots sk_n(\text{data/process}) \dots))$   
↓  
**action(grid)**

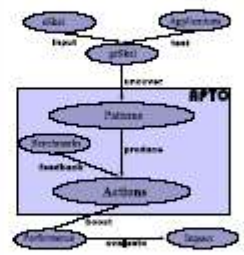
Illustrative APTO actions are:

- Data Migration
- Preemptive Resource Allocation
- Fine Allocation of Communication Channels

An APTO action can be considered as a macroscopic analogy to a compiler optimization technique.

### APTO Actions

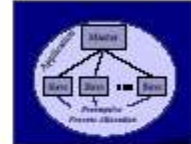
The project starting point is the global strategy, a grid-enabled version of the Edinburgh Skeleton Library (ESL).



Reproducible-compiler and communication patterns are discovered by observing the behavior of parallel-based applications on grids. These communication-communication patterns are fed into the APTO framework to define actions. It is important to distinguish these patterns, extracted by the observation of "skeletal behavior", from the actual skeletons.

In a nutshell, patterns are to be mapped into APTO actions to improve the performance of skeletal programming in grids.

As an example, identifying a program from an APTO action is preemptive process allocation.



### To Take Home

APTO action enhance skeletal performance from a systems infrastructure analysis. The adaptability is defined by the grid topology, state, and workload. In contrast to theoretical performance minimization approaches, APTO actions are based on the observed communication and computation patterns from the use of skeletal applications on a non-ideal grid.

### References

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