



ANTAREX: AutoTuning and Adaptivity appRoach for Energy efficient eXascale HPC systems

EXDCI Workshop, Prague, May 10, 2016

ANTAREX	AutoTuning and Adaptivity appRoach for Energy efficient eXascale HPC systems
Call:	H2020-FET-HPC-1-2014
Type of action:	H2020: Research & Innovation Actions (RIA)
Topics:	HPC Core Technologies, Programming Environments and Algorithms for Extreme Parallelism and Extreme Data Applications
Subtopic	b) Programming methodologies, environments, languages and tools
Project Coordinator	Cristina Silvano, Politecnico di Milano
EC Contribution	3, 115, 251 euro
Project start:	September 1st, 2015 (duration 3 years)



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IT4Innovations
national
supercomputing
center



Dompé





Target Scenario

- ▶ To reach the DARPA's target of **20MW** of **Exascale supercomputers** projected to 2023, current supercomputers must achieve an energy efficiency “quantum leap”, pushing towards a goal of **50 GFlops/W**.
- ▶ **Heterogeneous systems** currently dominate the top of the **Green500 list** and this dominance is expected to be a trend for the next coming years to reach the target of 20MW Exascale supercomputers.
- ▶ **Energy-efficient heterogeneous supercomputers** need to be coupled with a radically new software stack capable of exploiting the benefits offered by heterogeneity to meet the scalability and energy efficiency required by the Exascale era.



Target Scenario

- ▶ To reach the DARPA's target of **20MW** of **Exascale** supercomputers

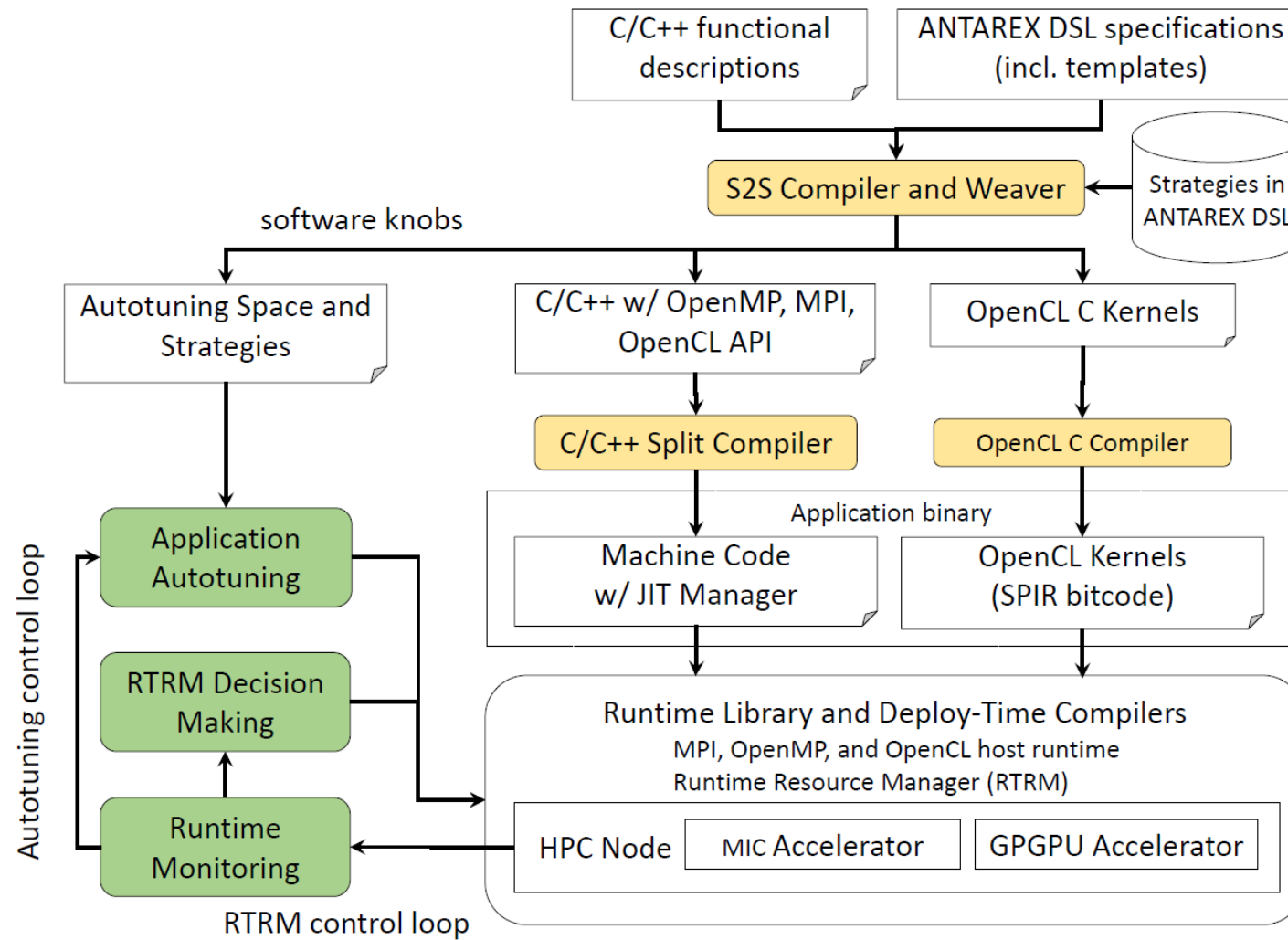
The main goal of the ANTAREX project is to provide a breakthrough approach to express by a Domain Specific Language the application self-adaptivity and to runtime manage and autotune applications for green and heterogeneous High Performance Computing (HPC) systems up to the Exascale level.

Energy efficient heterogeneous supercomputers need to be equipped with a radically new software stack capable of exploiting the benefits offered by heterogeneity to meet the scalability and energy efficiency required by the Exascale era.

ANTAREX Main Objectives

1. **Dynamic self-monitoring and self-adaptivity** or «autotuning» **HPC applications** with respect to changing workloads, operating conditions and computing resources.
2. **Programming models and languages to express self-adaptivity and extra-functional properties.** Enable **separation of concerns** between functional and non-functional (self-adaptivity, parallelisation, energy/thermal management) descriptions and strategies by the design of a new aspect-oriented **Domain Specific Language**.
3. **Monitoring** the evolution of the supercomputer and exploiting heterogeneous computing resources in Green HPC platforms by **runtime resource and power management**

ANTAREX Toolflow

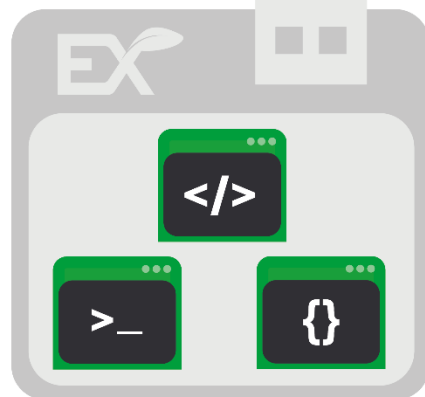


Domain-Specific Language (DSL)

to express:

- Runtime Adaptivity Strategies
- Complementary Knowledge and Execution Scenarios
- Compiler Optimization Strategies

- Autotuning
- Performance Improvements
- Compiler Optimizations



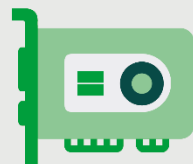
Protein Folding



Graph Algorithms



Supercomputing Centers



Accelerate:

- Productivity
- Performance
- Innovation



A **biopharmaceutical** application for accelerating drug discovery

A **self-adaptive** navigation system for smart cities



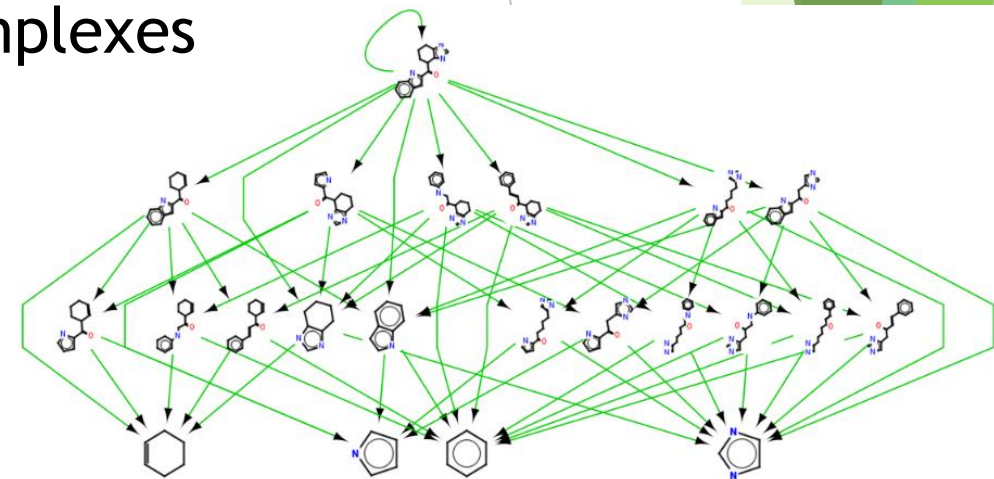
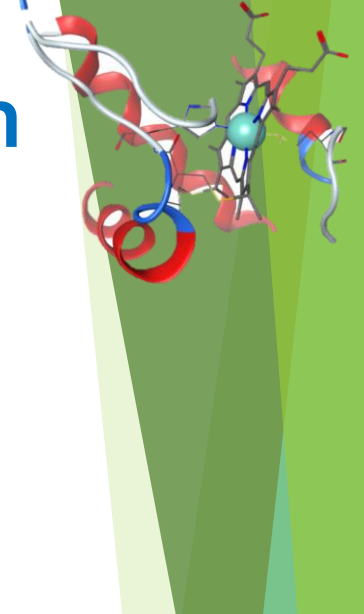
Energy-Efficient Computing up to **Exascale** era

- Scalable Monitoring
- Power Management

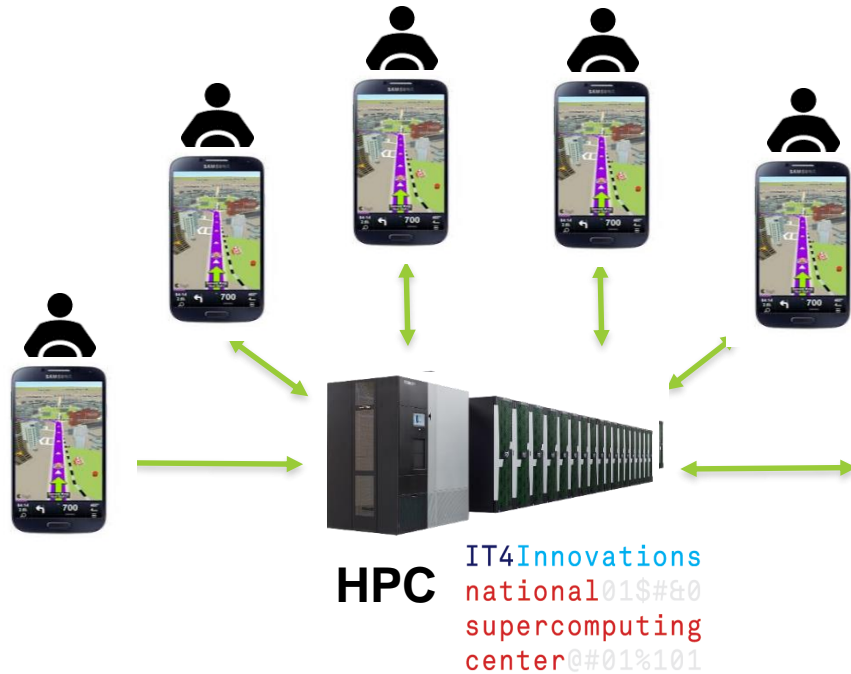


Use Case 1: HPC Accelerated Drug Discovery System

- ▶ Personalized Medicine will enable to “*treat the right patient with the right drug at the right dose at the right time.*” [FDA]
- ▶ Need of HPC in Drug Discovery: HPC Molecular Simulations
- ▶ Huge exploration space
 - ▶ Prediction of properties of protein-ligan complexes
 - ▶ Verification of synthetic feasibility
- ▶ Massive parallelism but ...
 - ▶ Unpredictable imbalances in computation
 - ▶ Dynamic load balancing is critical



Use Case 2: Self-adaptive Navigation System



Sygic Company develops world`s most popular offline navigation application & provides **professional navigation software** for business solutions

- ▶ Exploit synergies between client-side and server-side: Many drivers – many routing requests to HPC system
- ▶ Smart City Challenge: Serve all city drivers' requests with global best under variable workload

ANTAREX in the EU HPC ecosystem

- ▶ Benefits of auto-tuning for the HPC ecosystem
- ▶ International cooperation: cross-dissemination of the project at DATE 2016, Dresden, HiPEAC CSW 2016, Porto, ACM Intl. Conf. on Computing Frontiers 2016, Como
- ▶ EXDCI as platform for information exchange on (auto-tuning) projects (also beyond FET-HPC-1)
- ▶ Auto-tuning Extreme Scale Demonstrator together with ALLScale and READEX? For an application (CoE/FET-HPC-1) partner?

Kick-off Meeting held at CINECA (Italy), Sept. 2015



<http://www.antarex-project.eu/>

