



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

***EXDCI Workshop, Prague, May 10, 2016***

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| <b>ANTAREX</b>      | <b>AutoTuning and Adaptivity appRoach for Energy efficient eXascale HPC systems</b>                                  |
| 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)   |

x-project.eu





## 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

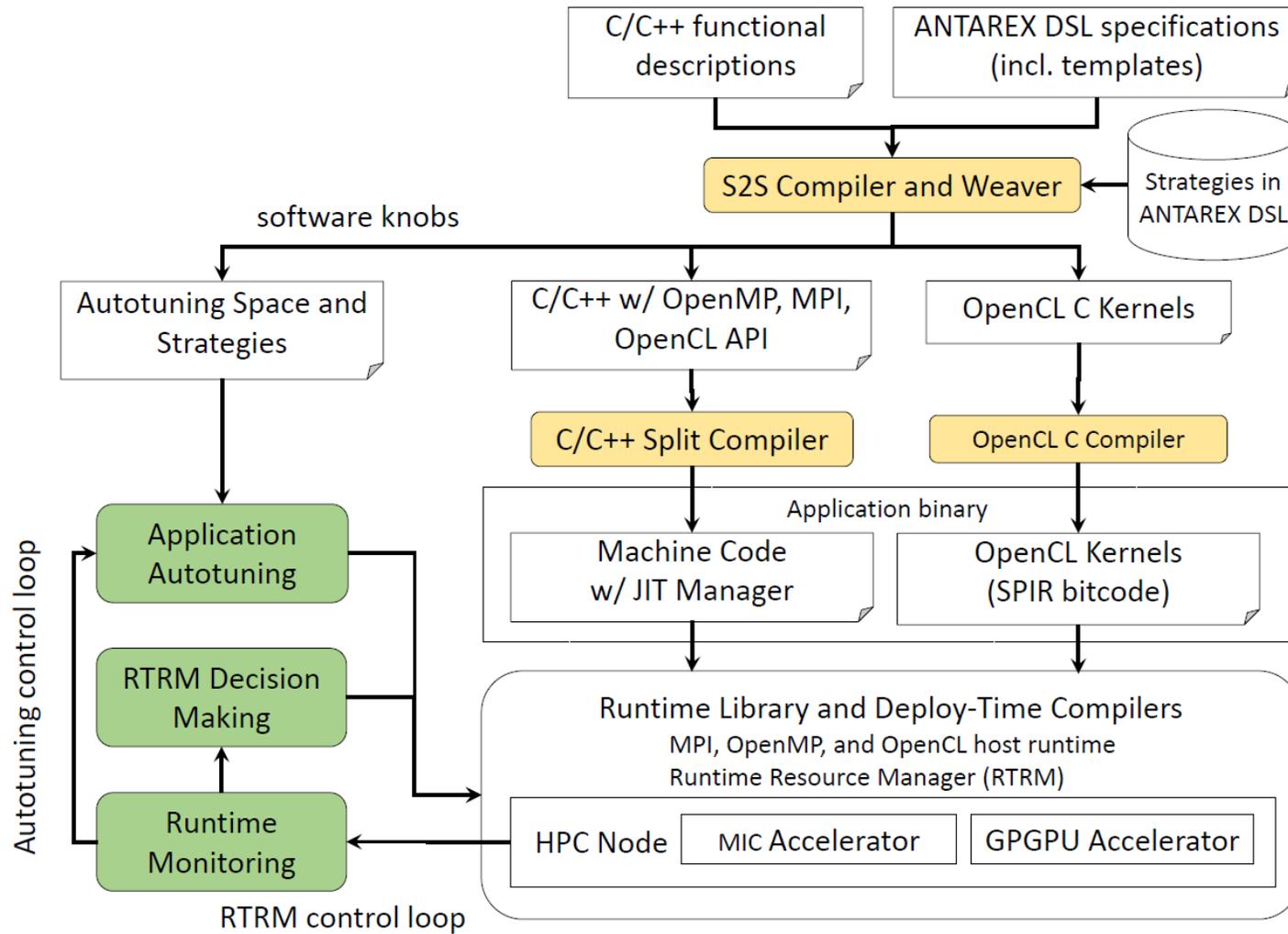
The main goal of the ANTAREX project is to provide a breakthrough approach to express by a Domain Specific Language the application self-adaptivity and to runtime manage and autotune applications for green and heterogeneous High Performance Computing (HPC) systems up to the Exascale level.

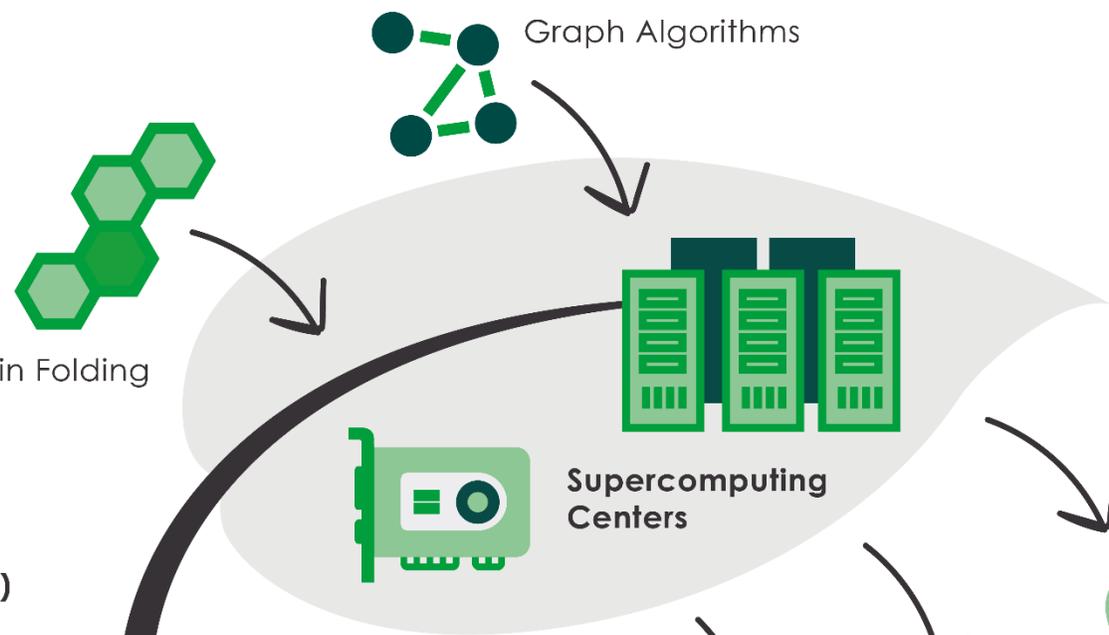
with a radically new software stack capable of exploiting the benefits offered by heterogeneity to meet the scalability and energy efficiency required by the Exascale era.

# 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

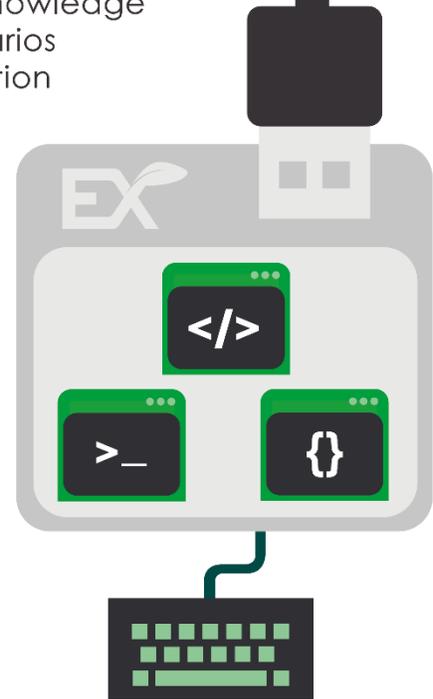




**Domain-Specific Language (DSL)**

- to express:
- Runtime Adaptivity Strategies
  - Complementary Knowledge and Execution Scenarios
  - Compiler Optimization Strategies

- Autotuning
- Performance Improvements
- Compiler Optimizations



- Accelerate:
- Productivity
  - Performance
  - Innovation



A **biopharmaceutical** application for accelerating drug discovery



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

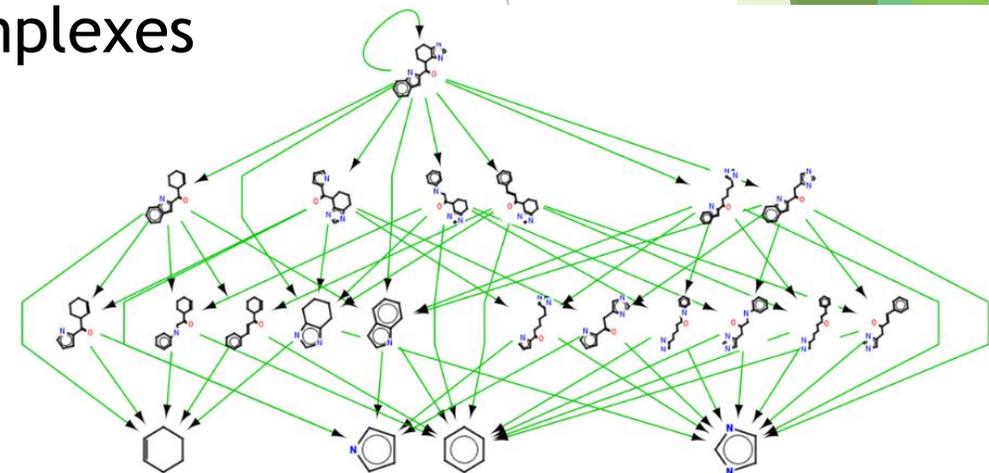
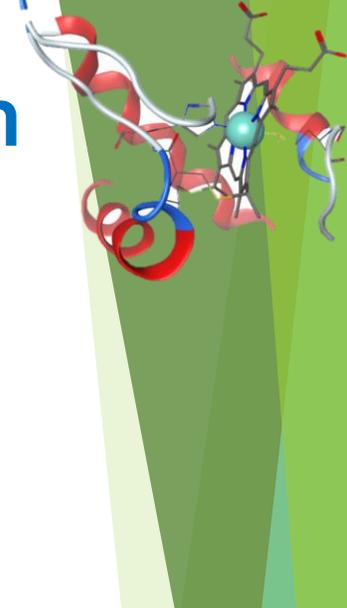
**Energy-Efficient** Computing up to **Exascale** era

- Scalable Monitoring
- Power Management

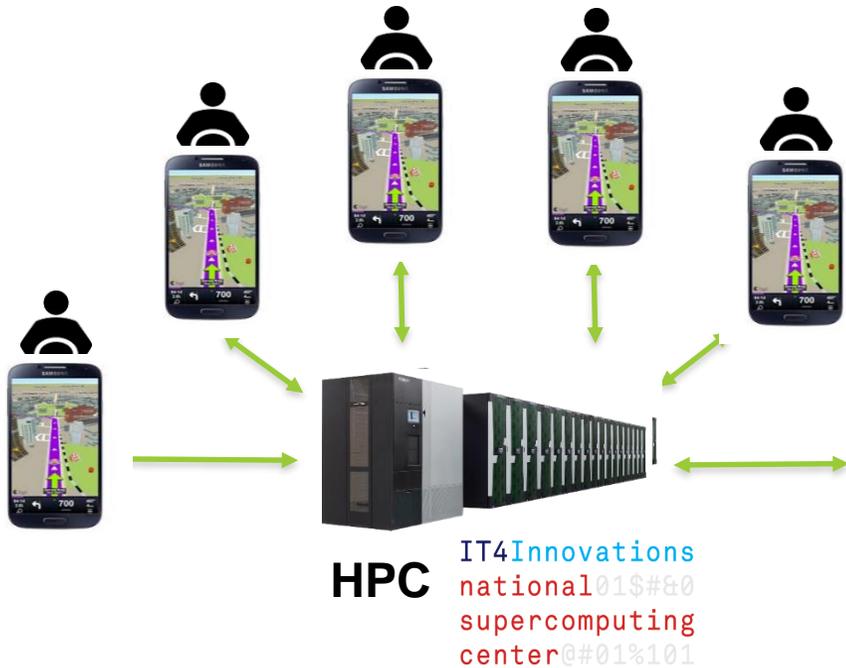


# Use Case 1: HPC Accelerated Drug Discovery System

- ▶ 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/>

