SmartApps: An Application Centric Approach to High Performance Computing

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The New Computing Challenge

- Today's Applications: Bio, Multi-physics, etc
  - Time Consuming => need optimized parallel codes
  - Dynamic/Irregular => need automatic optimization
- Today's Systems: Heterogeneous, Parallel, Distributed, General multi-purpose, the WEB
  - portability => need high-level software tools & libraries
  - efficiency => need automatic optimization techniques

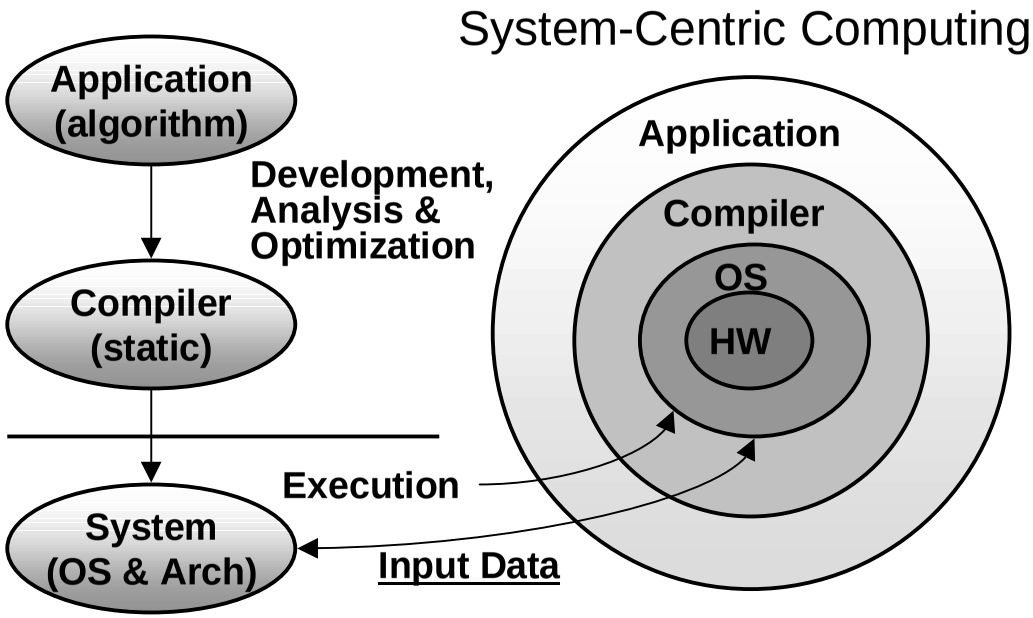
The Challenge: Easy to Use & High Performance

ASCI Codes	Multi-physics
DMOL	Quantum mechanical simulation of molecules
GAUSSIAN	
CHARMM	Molecular dynamics of organic systems
FIDAP	Complex fluid flow
SPICE	Circuit simulation
DYNA	Structural dynamics

Today: System Centric Computing

Classic avenues to performance:

- Parallel Algorithms
- Static Compiler Optimization
- OS support
- Good Architecture



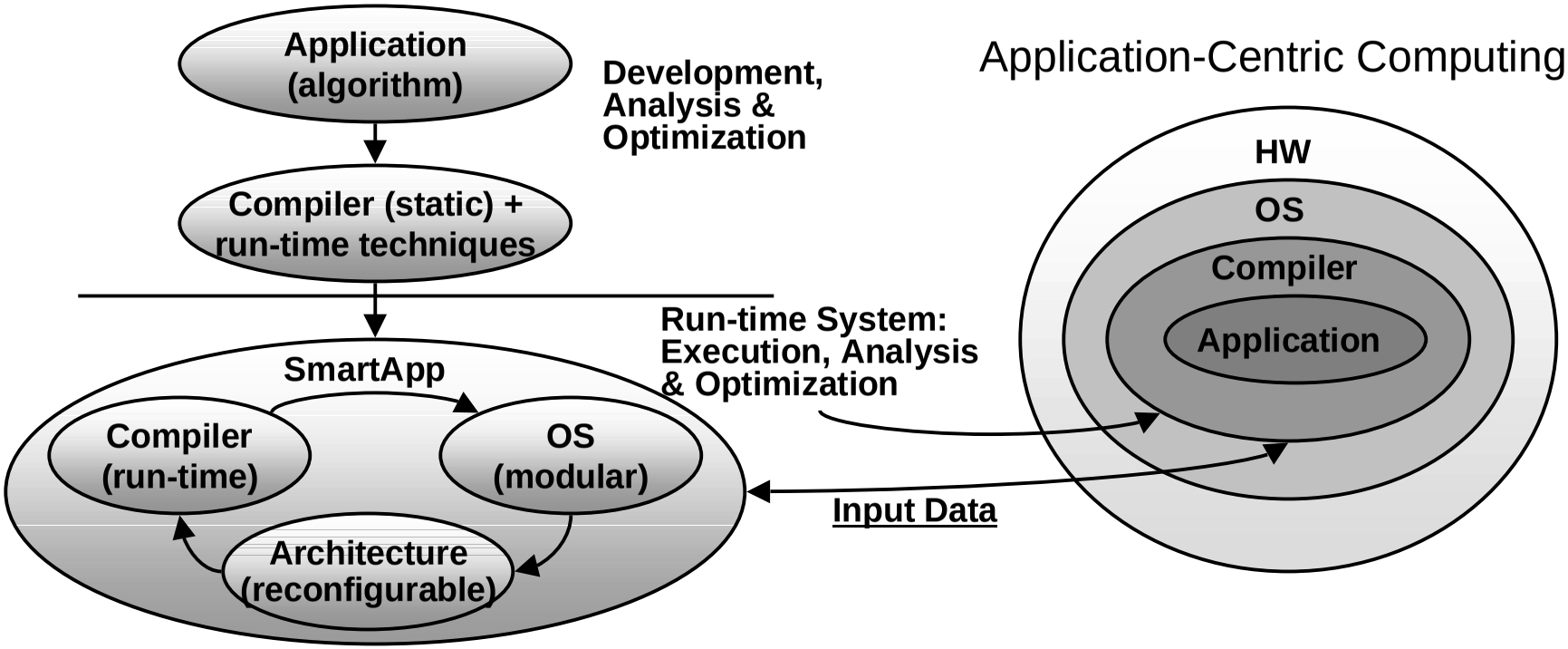
WHAT's MISSING ?

- Compilers are conservative
- OS offers generic services
- Architecture is generic

<u>No Global Optimization</u>

- No matching between Application/OS/HW
- intractable for the general case

Our Approach: *SmartApps* Application Centric Computing



Application Control

↓ Instance-specific optimization

Compiler + OS + Architecture + Data + Feedback

Overview of *SmartApps* Project

- Run-Time Optimization
  - Run-time parallelization
- Adaptive algorithm selection
  - high-level - STAPL C++ Library (Parallel STL)
  - low-level - customized algorithm implementations
- Run-Time Compiler
- OS Customization (IBM TJ Watson K42 OS)
- Toolbox: Performance Modeling
- Architectural Support for
  - Run-time parallelization
  - Selective Privatization & Reduction parallelization

SmartApps Architecture