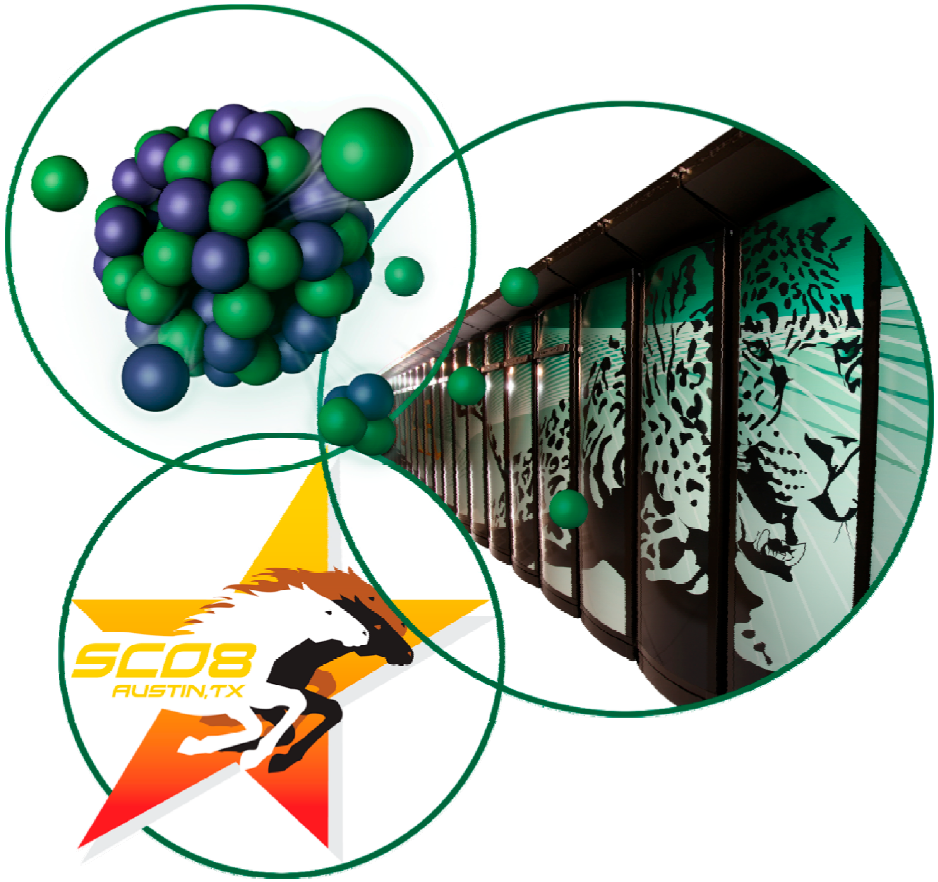
The Harness Workbench: Unified and Adaptive Access to Diverse HPC Platforms



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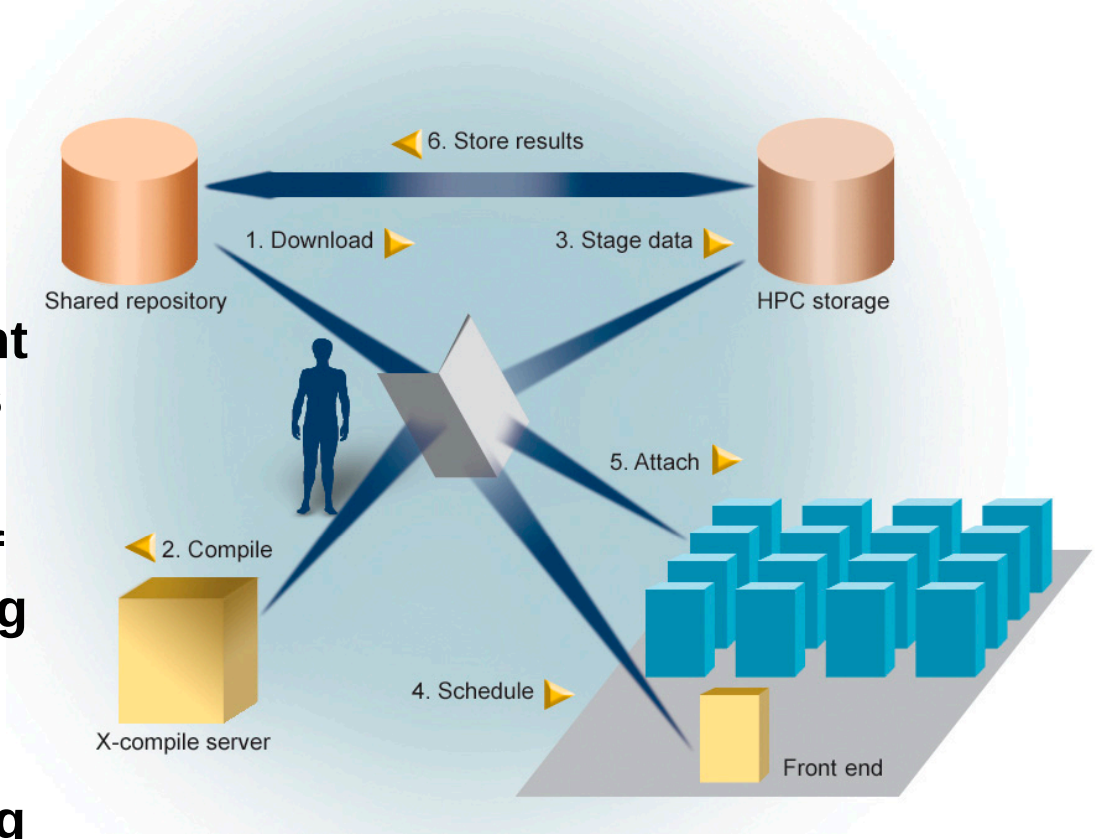
Research and development goals

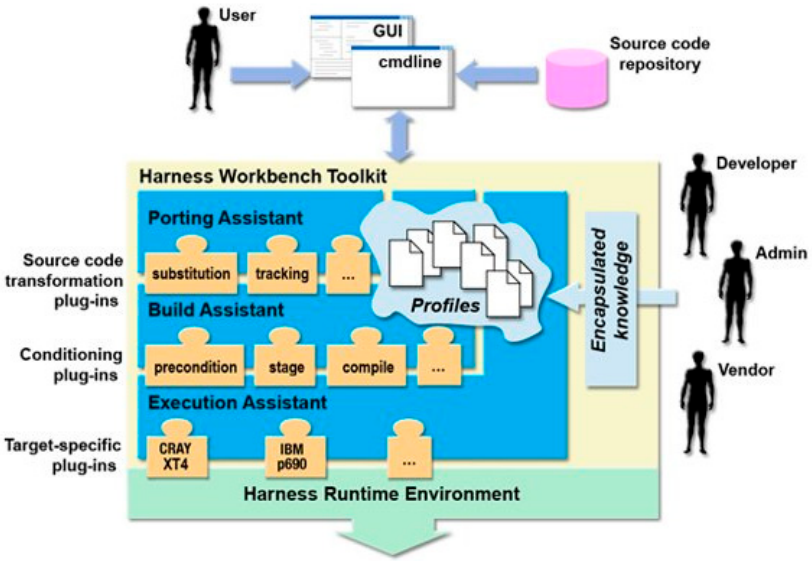
- Increasing the overall productivity of developing and executing computational codes
- Optimizing the development and deployment processes of scientific applications
- Simplifying the activities of application scientists, using uniform and adaptive solutions
- "Automagically" supporting the diversity of existing and emerging high–performance computing architectures

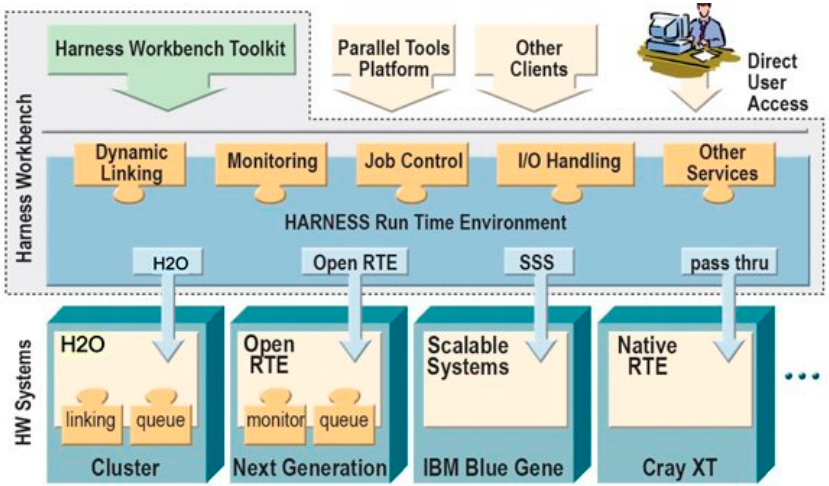


Typical scientific application development, deployment, and execution activities

Harness Workbench core components

- **Harness Workbench Toolkit**
  - Unified development, deployment, and execution
  - Common view across diverse HPC platforms
  - User-space installation and virtual environments

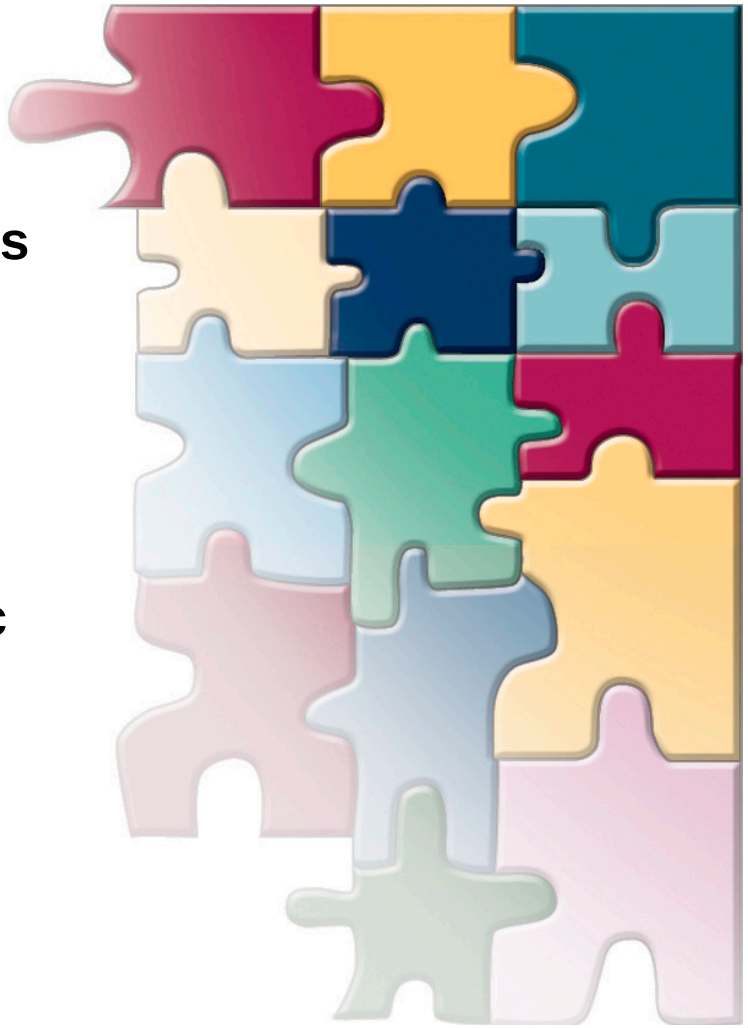




- **Next-generation runtime environment**
  - Flexible, adaptive, lightweight framework
  - Management of runtime tasks
  - Support for diverse HPC platforms

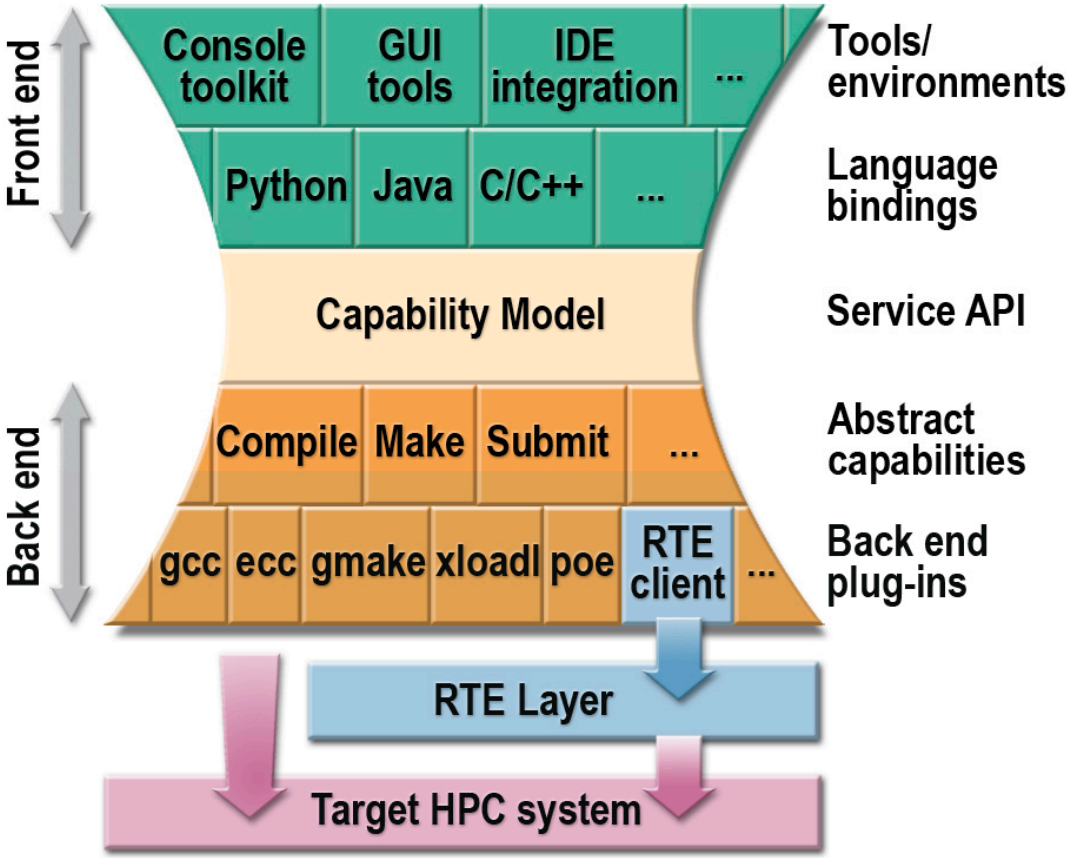
Harness Workbench core technologies

- **Automatic adaptation using pluggable modules**
  - **Harness Workbench Toolkit plug-ins**
  - **Runtime environment plug-ins**
- **Development environment and toolkit interfaces**
  - **Easy-to-use interfaces for scientific application development, deployment, and execution**



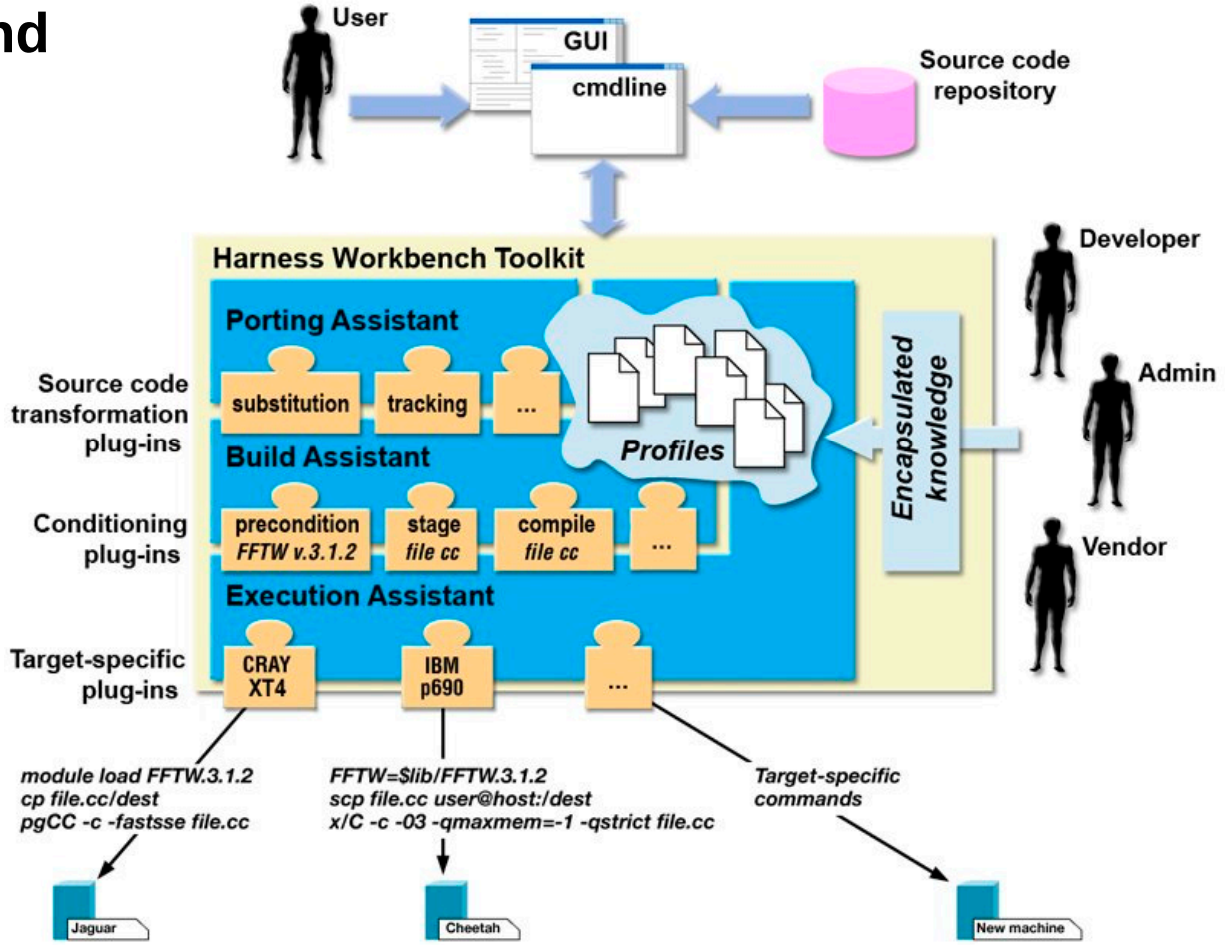
Common view across diverse platforms

- Various interfaces and bindings to external development and deployment tools and environments
- Generalized model for unified access to common development and deployment activities
- Mapping of generalized activities onto platform-specific toolkits and runtime environments (RTEs) via pluggable modules



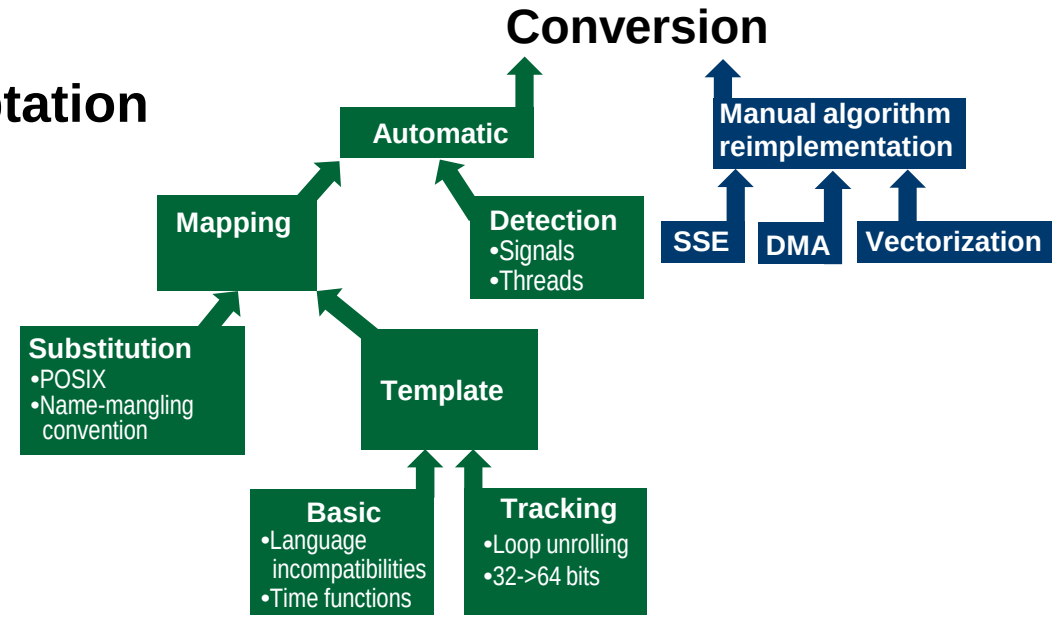
Harness Workbench Toolkit

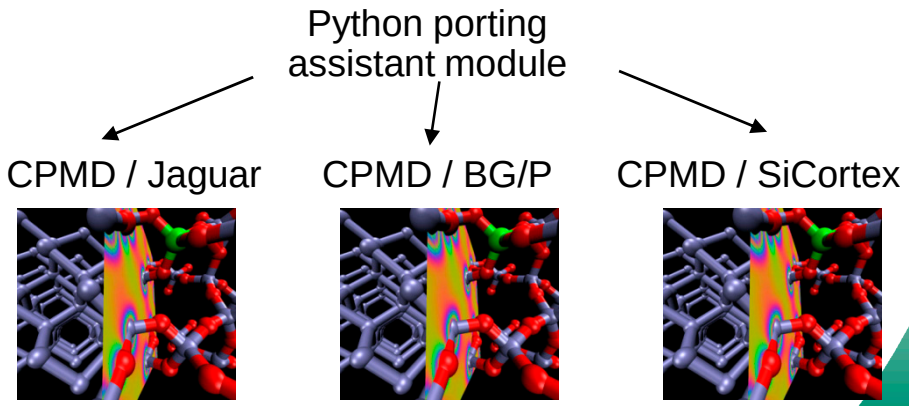
- Unifying abstraction over heterogeneous HPC resources
- Command line and GUI tools
- Translation into fine-tuned invocations of native toolkits
- Behavior encapsulated in plug-ins
- Configurable through profiles
- Tunable by end users



Harness Workbench Toolkit porting assistant

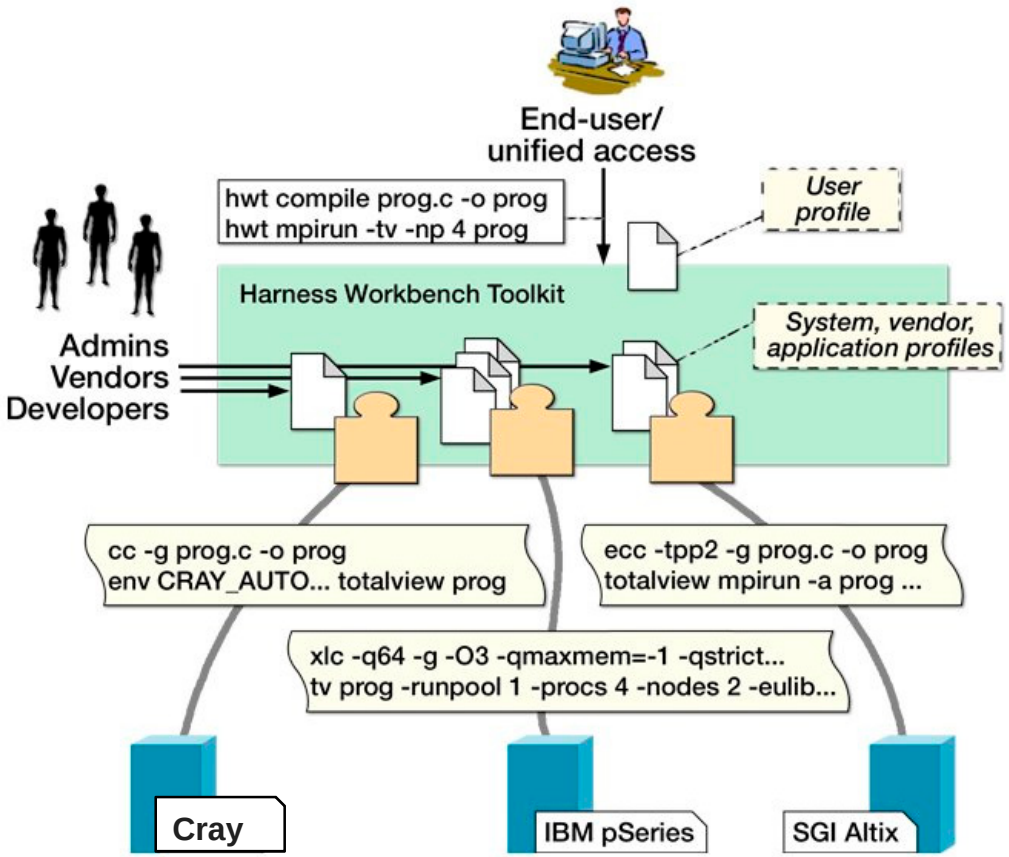
- **Facilitates source code adaptation through specialized plug-ins**
  - **Suggests safe conversions**
  - **Highlights manual code replacement areas**
  - **Guided by situation-specific profiles**
- **Prototype**
  - **Plug-ins as Python scripts**
  - **Porting CPMD across**
    - **Jaguar Cray XT4**
    - **IBM Blue Gene/P**
    - **SiCortex**
- **Example conversions**
  - **Detection, function mappings, data type size changes**





Harness Workbench Toolkit build and execution layer

- Abstraction layer between users and platform-specific compilers, linkers, libraries, testing and debugging software, launching systems, etc.
- End-users issue generic build commands that are processed to produce a target-specific set of commands
- Pluggable modules to deliver back-end functionality

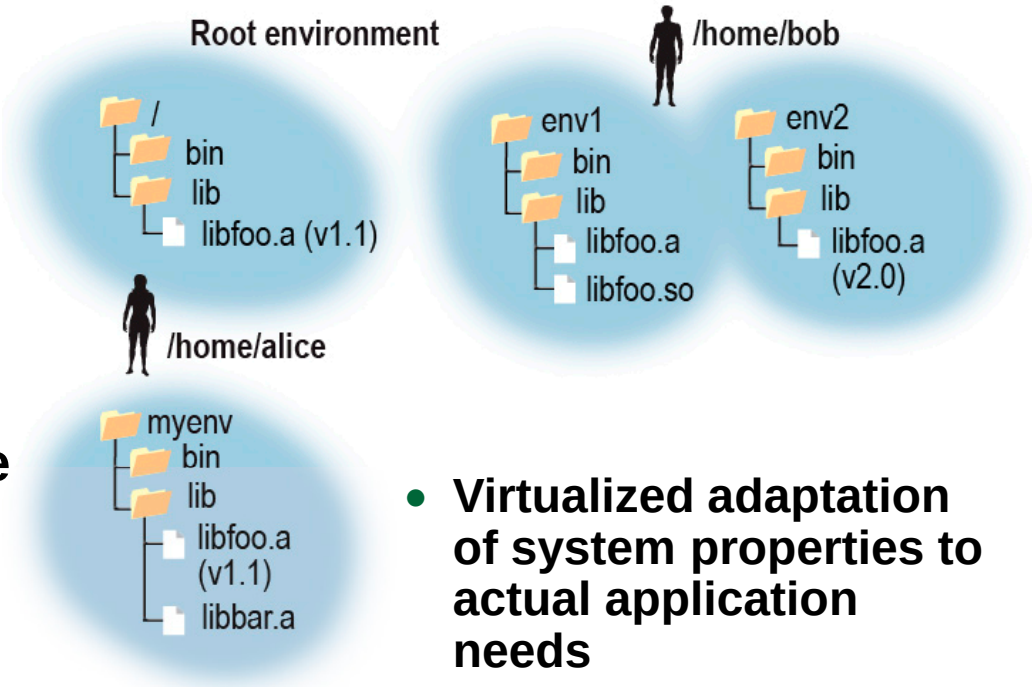


Harness runtime environment (HRTE)

- **Adaptability and flexibility via plug-ins**
  - Lightweight pluggable component framework
  - Components for various HPC platforms and runtime environments
- **Scalability and resilience with fully distributed approach**
  - Binomial graph network topology
- **Runtime fault tolerance through self-stabilization**
  - Oracle for resource discovery
  - Failure detector to deal with crashed processes
- **Runtime support for virtualized environments**

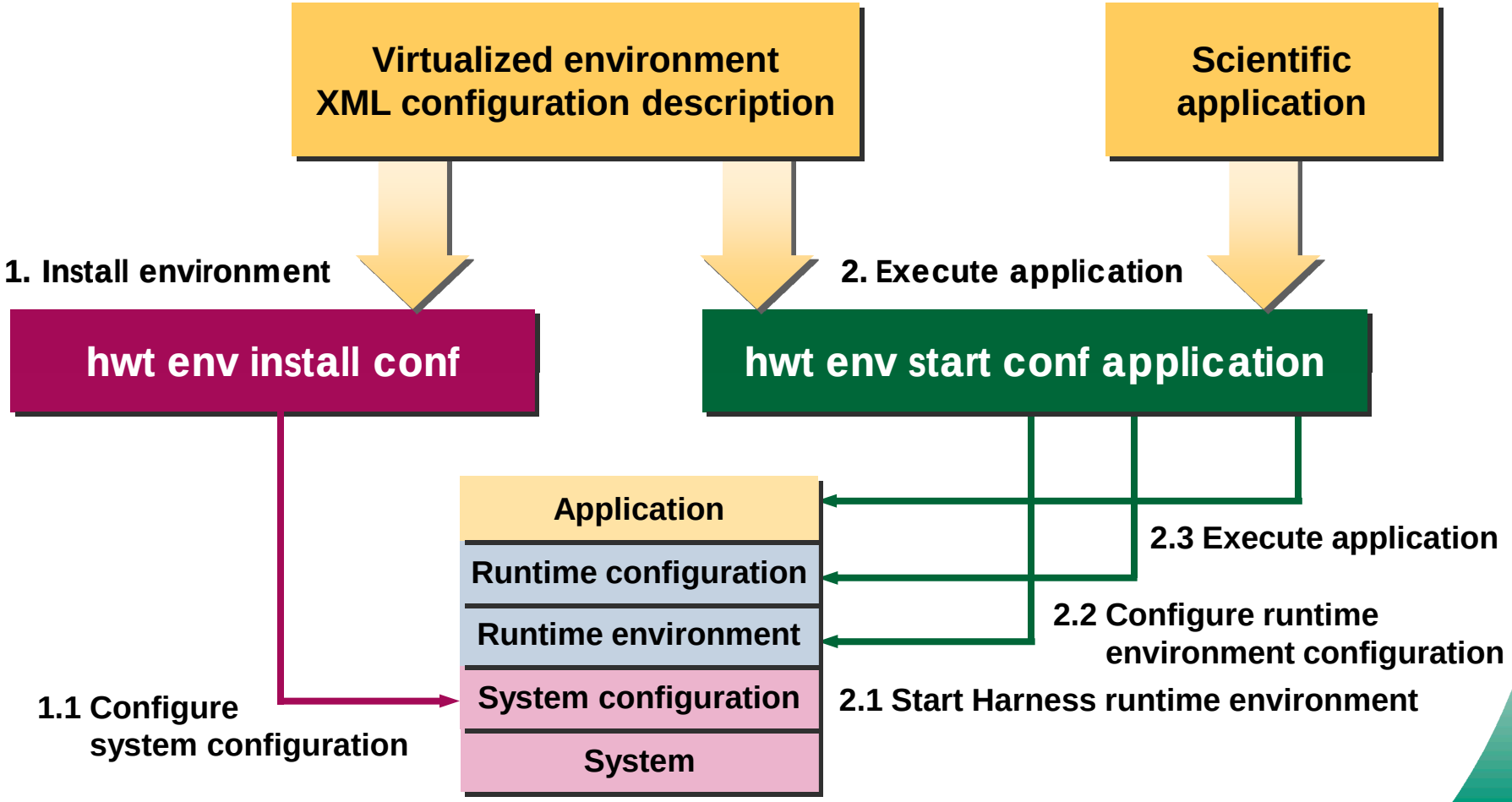
Harness Workbench Toolkit /HRTE virtualized environments

- **Problem**
  - Application dependencies may cause conflicts with system-wide installed libraries
- **Solution**
  - Use co-existing, alternative user-space installations
- **Approach**
  - Provide isolated installation environments ("sandboxes")
  - These can inherit from one another to build nested hierarchies

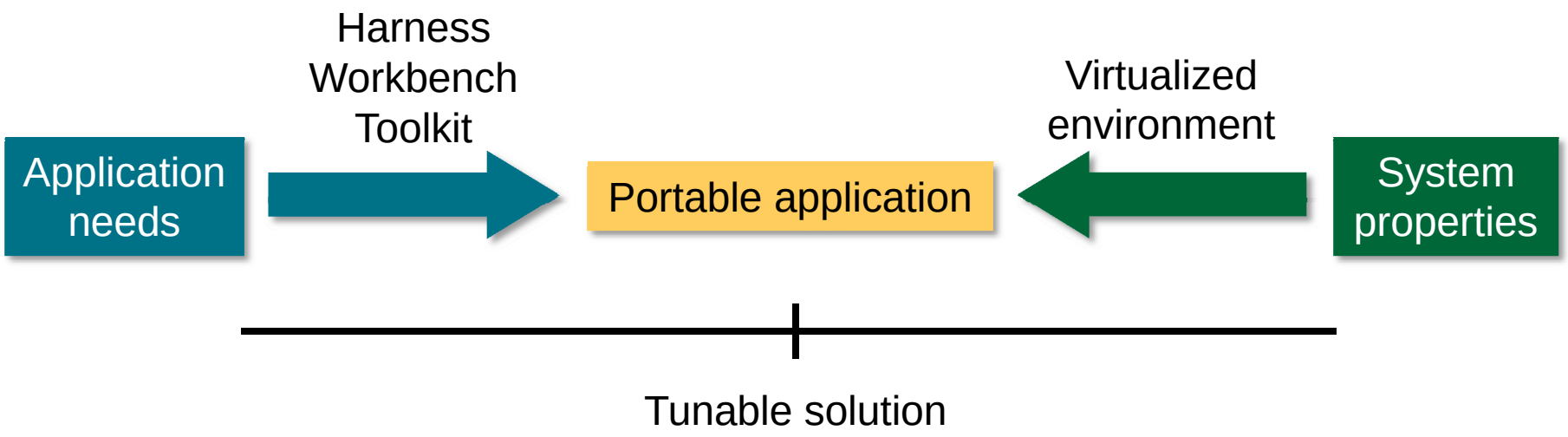


- Virtualized adaptation of system properties to actual application needs
- System and runtime environment virtualization

Configurable "sandboxes" for scientific applications



Tunable portability for day-one operation



- **Harness Workbench Toolkit for adaptation of application to HPC system properties**
- **Virtualized environment for adaptation of HPC system to application needs**
- **Tunable solution, where applications can move from one HPC system to another with initial minimal changes enabling day-one operation**
- **Continued adaptation to actual target platform properties ensures eventual performance gains by gradually taking advantage of new system features**

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