Simplify and optimize heterogeneity

Clara Pezuela (Atos)
HIPEAC Computing Week, Stuttgart, 26 Oct 2017
Simplify & Optimize Hardware Heterogeneity

Simplifying the way developers approach the development of next-generation applications based on heterogeneous hardware architectures, configurations and software systems including heterogeneous clusters, chips and programmable logic devices.

Optimizing various dimensions of software design and operations (energy efficiency, performance, data movement and location, cost, time-criticality, security, dependability on target architectures).
Need to design more flexible software abstractions and improved system architectures to fully exploit the benefits of heterogeneous hardware.
The Motivation

- **Innovative** architectures, algorithms, and specialized programming environments and tools are needed to efficiently use these heterogeneous hardware.

**Approach**
- Use a top-down approach to propose a reference architecture
- Consider requirements engineering, software design, parallel programming environments, and heterogeneous distributed/parallel architectures
- Optimisation should include
  - energy efficiency
  - performance
  - Other factors: dependability, data movement, security and cost-effectiveness
Keep this to the min, Aim for the max!

Many diverse Applications

Define a Common Architecture

Catalogue of Tools and Technologies
**TANGO Architecture**

- **IDE**: modelling, design and construction of applications

- **Middleware**: application deployment and placement considering energy / performance requirements on target heterogeneous parallel architectures.

- **Fabric**: Heterogeneous parallel devices management
TANGO Toolbox

- Open and freely accessible set of tools for managing heterogeneity
- Downloadable from: [http://www.tango-project.eu/node/177](http://www.tango-project.eu/node/177)
Placer is a design-time tool that thoroughly optimizes the placement and scheduling of complex software onto heterogeneous multi processing hardware platforms.

Poroto enables the generation and early performance characterisation of FPGA-offloaded kernels for user defined computations.

Code Profiler is a tool for analysing Java code for its energy efficiency.

Programming Model and Runtime Abstraction Layer is a combination of COMPSs and OmpSs task-based programming models, which simplifies the development of parallel application for distributed heterogeneous platforms.
Monitoring Infrastructure monitors the heterogeneous resources to provide metrics about the status of the different devices and also historical statistics.

**ALDE** is responsible for the workload scheduling and the management of the application life-cycle while it is executed.

**Self-Adaptation Manager** is responsible for the adaptive behaviour of heterogeneous architectures.

**Energy Modeller** forecasts future application and host power consumption, as well as reporting current and historic energy usage.
Device Emulator finds an efficient mapping of the application tasks onto the nodes/cores in low time, i.e., which application task should run on each node/core.

Device Supervisor in TANGO is an extension of Slurm (JobPack) which is an open-source cluster resource management and job scheduling system.
TANGO for embedded
# Users - Components Mapping

<table>
<thead>
<tr>
<th>Role</th>
<th>Responsibilities</th>
<th>Tools</th>
</tr>
</thead>
</table>
| Software/Hardware Designer  | • Combine energy-awareness with the principles of requirements engineering and design  
                                 • Specify performance/energy goals to evaluate the efficiency of an application                                                                 | • Placer  
                                 • Design Time Characteriser  
                                 • Device Emulator |
| Software Developer          | • Program applications on heterogeneous distributed hardware  
                                 • Produce energy efficient code                                                                                                                      | • Code Profiler  
                                 • Programming Model |
| App. Deployer - Business    | • Measure the energy consumption / map the energy profile for the application  
                                 • Identify the workload profile and its energy model  
                                 • Provide actual energy measurements as KPIs                                                                                                     | • Energy Modeller  
                                 • Self-Adaptation Manager  
                                 • Device Emulator |
| App. Deployer - Technical   | • Deploy application/services in an energy efficient environment                                                                                                                                             | • ALDE  
                                 • Device Emulator |
| HW Infrastructure Manager   | • Use energy placement and power management policies  
                                 • Schedule/manage hardware devices efficiently  
                                 • Monitor energy consumption and adapt accordingly                                                                                               | • Device Supervisor  
                                 • Monitoring Infrastructure  
                                 • Self-Adaptation Manager |
| Integrator                  | • All of the above                                                                                                                                                                                                | • All components |
Validation of toolbox

- Remote processing
- Embedded water meters
- HPC miniapps
Impact on real market

- Major impact in embedded world:
  - Programming Model can be a breaking advance in parallel programming for embedded applications.

- Major impact in HPC world:
  - Energy Modeler can define new way to understand and manage the applications
Heterogeneity Alliance

we want to embrace the opportunity
... and influence & develop the market

we are creating an alliance of organizations
interested in technologies & tools related to take
advantage of heterogeneous hardware

development
deployment
operations
and optimization

energy & performance & more

Academia  Research Projects  Open Source Initiatives  Interested Parties  Standardization Bodies
Defining the Common Architecture & Catalogue of Tools and Technologies

Establishing Working Groups (periodic meetings & sessions)

Governance Structure & Membership Agreement

Launch MarComm Campaign: leverage visibility at HiPEAC, Catalogue, Reference Architecture, Website & Materials (whitepapers, demonstrators & success stories, etc.)
Get connected...

- Visit our web site: www.tango-project.eu
- Follow us on Twitter @TANGOModel
- Subscribe to our Newsletter:
- Download and contribute to our tools
- Be member of Heterogeneity Alliance: http://heterogeneityalliance.eu/
- Or contact us by email: clara.pezuela@atos.net
Thank you!