Reconfigurable Computing and Runtime System for Future Exascale Systems

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Outline

- Objectives
- Hardware
- Software (Programming)
- Relevance to EsD
- Conclusion
Objectives

- Use MPI+OpenCL to utilize reconfigurable computing
  - Get orders of magnitude more performance with conventional software development process
  - Get an order of magnitude higher energy efficiency by having dedicated hardware modules for power hungry tasks
  - Get orders of magnitude higher reliability in terms of MTTF since FPGAs can easily be reconfigured after deployment
Create a computing node incorporating FPGAs and high-end ARM cores tightly together

Provide hooks to allow for the interconnection with vast storage efficiently (Through the ExaNest project)

More complex Processing units will be seamlessly integrated (Through the ExaNode project)
Nice Hardware ... what about Software

- The whole system will be programmed by “conventional” MPI and OpenCL
  - The programmer will not be aware of the FPGA’s intricacies
  - Even the reconfiguration of the system will be done in a “zero latency” manner
- Most OpenCL kernels would be automatically translated into efficient hardware accelerators
- Certain optimized OpenCL kernels will be initially developed while a complete such repository is envisioned (through an EsD project?)
Relevance to EsD

- ECOSCALE can be the utilized within an EsD project in several manners:
  - Integrate the end reconfigurable platform with other homogeneous and/or heterogeneous large scale HPC system(s)
  - Port to the end platform novel HPC low-level software (e.g. intercommunication middleware, adapted OSs, tools for monitoring, debugging, performance analysis, security, QoS etc)
  - Optimize novel HPC applications for the ECOSCALE platform and/or create an ECOSCALE optimized library
  - Perform a design space exploration of ECOSCALE’s main applications in other HPC systems
  - Open to any other suggestions!
Conclusion

- ECOSCALE provides an ecosystem comprising of a High Level programming environment coupled with a novel runtime environment running on top of a novel hardware environment.
- ECOSCALE utilizes:
  - Distributed Reconfigurable Logic
  - MPI+OpenCL programmability
  - Hidden runtime reconfiguration
- So you get performance, power efficiency and resilience for free in terms of development time (almost 😊)
- ECOSCALE can (and should ?) be a part of an EsD project so as to be commercially exploited and allow highly demanding HPC applications to take advantage of its unique features.
Euroexa is coming for more 😊