Programming for Future 3D Architecture with Many Cores

Wednesday, May 5th, 2010

christian.fabre1@cea.fr

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

PRO3D Consortium

PRO3D Consortium

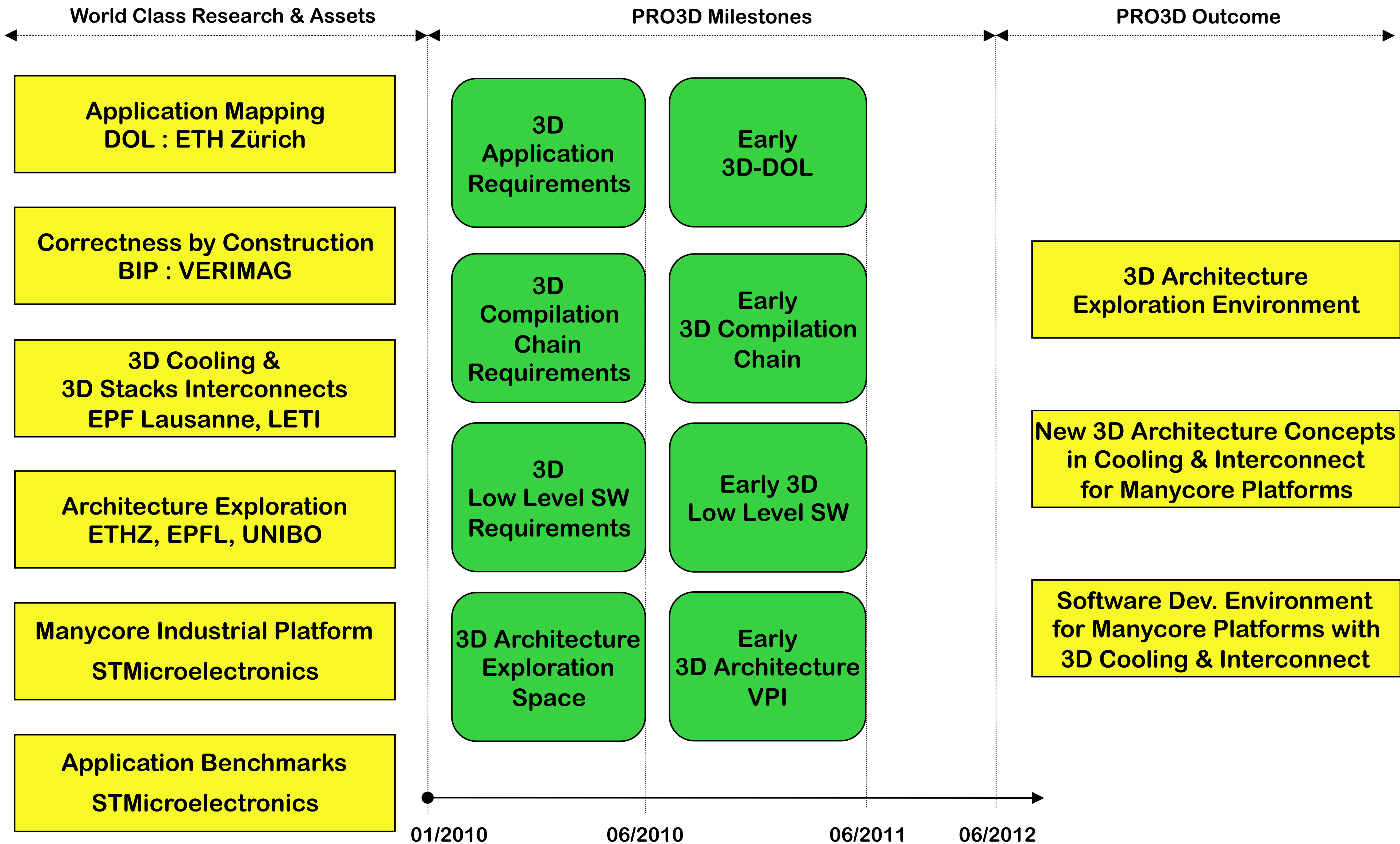
Partner	Role
CEA LETI (A. Jerraya & V. Olive)	Through Silicon Vias (TSV), low-level software & back-end
VERIMAG (J. Sifakis)	Correct by construction software component methodology
ETH Zürich (L. Thiele)	Automatic application mapping & architecture exploration
Università di Bologna (L. Benini)	3D network-on-chip & memory architecture exploration
STMicroelectronics (E. Flamand)	Industrial-grade manycore platform & application
EPF Lausanne (D. Atienza, Y. Leblebici & G. de Micheli)	Active cooling & architecture exploration

Aims & Objectives

Embedded Computing Walls and How to Break Them

- Technologies which worked well during the last decades…
  - Exponential grow in clock speed
  - Exponential growth of transistor per die
  - Maximizing computation per clock cycle
- … are reaching diminishing returns
  - Voltage scaling & power reduction: power wall
  - Instruction-level parallelism: complexity wall
  - Memory latency hiding: memory wall
  - Reliability & Process variability below 32 nm: yield wall
- Manycore Architectures
  - Massive integrated parallelism addresses complexity wall but requires parallel programming, which is difficult
- 3D Integration bring opportunities & issues
  - Memory-on-processor stacking allows to keep increase bandwidth and reduce memory latencies
  - Cooling becomes difficult, as thermal management requires cooperation from the OS & the developer

PRO3D Assets, Workplan & Outcome



Key Result

Key Result : Holistic 3D Methodology

New 3D Architecture Concepts
in Cooling & Interconnect
for Manycore Platforms

Software Development Environment
for Manycore Platforms with
3D Cooling & Interconnect

3D Architecture
Exploration Environment

- System software flow that operates transparently on parallel manycore platforms
- Formal methods for software design to guarantee composability and correct operation of HW+SW
- Explore impact of 3D on computing architectures
- Extend the software flow to 3D manycores

Long Term Impact

PRO3D Long Term Impact

- Industrial: Integrated HW/SW approach
  - Productivity improvement
  - Reduce system-wide development costs
  - Reduce time-to-market
- Academic: Advances in several fields
  - 3D stacking, active cooling & control
  - 3D architecture exploration & software mapping
  - Show that software quality can be improved while addressing massive parallelism

Beyond

Beyond PRO3D

- Hardware: 3D architecture opportunities
  - Operators & processors in 3D ?
  - Message passing & hierarchical NoC ?
  - Computing power scalability ?
  - Fine grain thermal, power and variability control
- Software: massive parallelism
  - Formal methods for software composability & distribution
  - Programming models: Message passing vs. Von Neumann
- Integration: HW/SW co-development
  - Formalisms shared by HW & SW development
  - Integrated quality assessment of SW on its HW
  - Seamless & continuous HW/SW development