INFORME EXPERT EXTERN / INFORME EXPERTO EXTERNO / EXTERNAL REFEREE REPORT

Nom de l'expert / Nombre del experto / Name of the referee **Vassilis Papaefstathiou**
Categoria / Categoría / Category **Researcher & Instructor**
Departament, Universitat a què pertany / Departamento, Universidad a la que pertenece / Department, University to which s/he belongs **Foundation for Research and Technology Hellas (FORTH) – Institute of Computer Science (ICS)** **University of Crete (UoC) – Computer Science Department (CSD)**

Títol de la tesi / Título de la tesis / Title of the thesis **Exploiting Asymmetric Multi-Core Systems with Flexible System Software**
Nom del doctorand que presenta la tesi / Nombre del doctorando que presenta la tesis / Name of the student presenting the thesis **Kallia Chronaki**

Especifiqueu les raons que avalen la qualitat de la tesi per a la seva defensa pública:
Especificar los motivos que avalan la calidad de la tesis para su defensa pública:
Specify reasons endorsing the quality of the thesis for its public reading:

Quins objectius s'han assolit amb la tesi?
¿Qué objetivos se han logrado con la tesis?
What objectives have been achieved with the thesis?

This thesis first studies the performance impact of scheduling alternatives in HPC applications that execute on asymmetric multi-core processors. It compares schedulers at the user-level, at the OS-level and at the runtime system level and demonstrates that scheduling at the runtime system of task-based parallel programming models is the best option because it balances the load most efficiently.

Following this study, three novel dynamic scheduling policies are proposed and implemented in a runtime system that supports task-based parallel programs. The proposed scheduling policies identify the critical tasks in the task dependency graph and exploit asymmetry by scheduling the critical tasks on the most capable/fast cores in the system. The proposed dynamic scheduling policies offer significant performance improvements on asymmetric multi-core systems.

Moreover, the thesis shows that task creation is a major source of overhead for the runtime system in applications with fine-grain tasks and becomes a scalability bottleneck when the number of cores increases. To address this challenge, the thesis proposes and implements a hardware-software co-design scheme that separates the task generation functionality from the rest of the runtime system and offloads task generation to hardware optimized for such functionality. This scheme offers many-fold performance improvement on both symmetric and asymmetric systems with large number of cores.

Finally, the thesis address scheduling for soft real-time applications running on mobile devices under temperature constraints. Specifically, this part of the work exploits core asymmetry to increase the frame rate of mobile games while keeping the temperature stable.

Originalitat del treball:
Originalidad del trabajo:
Originality of the work:

This thesis tackles the challenging problem of scheduling parallel applications on asymmetric multi-core systems. The thesis advances state-of-the-art by: *(a)* improving the performance of dynamically scheduled task-parallel applications with novel criticality-aware scheduling policies, *(b)* addressing a major scalability bottleneck in task-based runtime systems by designing a cost-effective hardware-software scheme that accelerates task creation, and *(c)* improving the performance of mobile real-time applications under temperature constraints. The novelty of the proposed techniques is supported by high-quality publications in important peer-reviewed conferences and journals of the area.

Metodologia emprada / hipòtesis contrastades:
Metodología usada / hipótesis contrastadas:
Methodology used / hypotheses tested:

The experimental methodology used in this thesis is sound and the quantitative studies and evaluations are performed on real commercial asymmetric multi-core platforms whenever available. For evaluations of larger multi-core systems, which are not commercially available, the thesis uses simulations appropriately. The proposed scheduling policies and runtime modifications are implemented on a real full-fledged runtime system, i.e. Nanos++, and important parallel applications from well-established benchmark suites are used for evaluations. This methodology allows the author to provide credible insights about the impact of scheduling decisions on performance and energy, to show the deficiencies of prior scheduling techniques, to reveal important scaling overheads in the runtime system, and to test the validity of the proposed solutions.

Valoració absoluta i/o ponderada de la tesi en relació amb altres treballs d'investigació:
Valoración absoluta y/o ponderada de la tesis presentada en comparación con otros trabajos de investigación:
Absolute and/or relative assessment of the thesis in comparison with other works of research:

This is a high-quality thesis that advances state-of-the-art and makes novel contributions in the topics of: *(a)* dynamic scheduling for efficient execution of parallel applications on asymmetric multi-core systems and *(b)* cost-effective performance and scalability optimizations for the runtime systems supporting task-parallel programming models.

Considera que la tesi esmentada és apta per al tràmit de lectura i la defensa pública?
¿Considera que la tesis anteriormente mencionada es apta para su lectura y defensa pública?
In consideration of all the above, is the thesis judged to be suitable for public reading?

☒ **Si / Yes** ☐ No

Observacions:
Observaciones:
Observations:

None.

Signatura i data
Firma y fecha
Signature and date **September 10th, 2018**

(*) Si és necessari adjunteu les respostes en els fulls annexos / Si es necesario adjunten las respuestas en las hojas anexas / If necessary, enclose the answers in the annexed sheets

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