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Scheduling Transparent Real-time Virtual Resources

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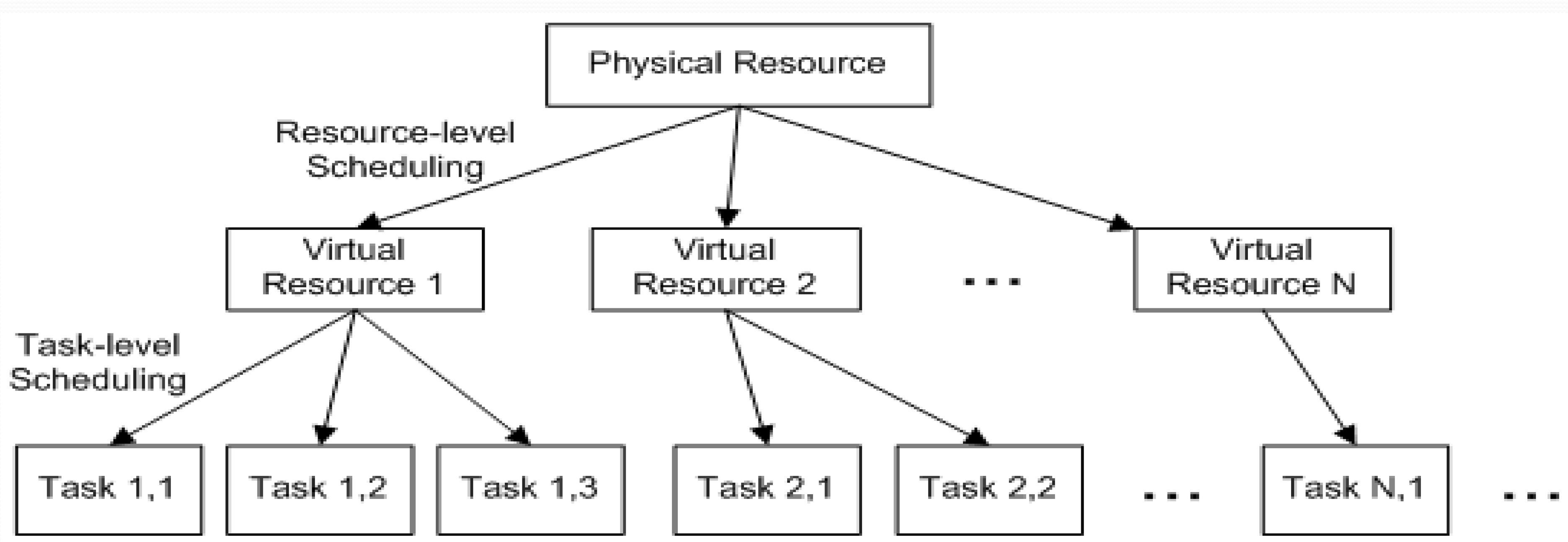
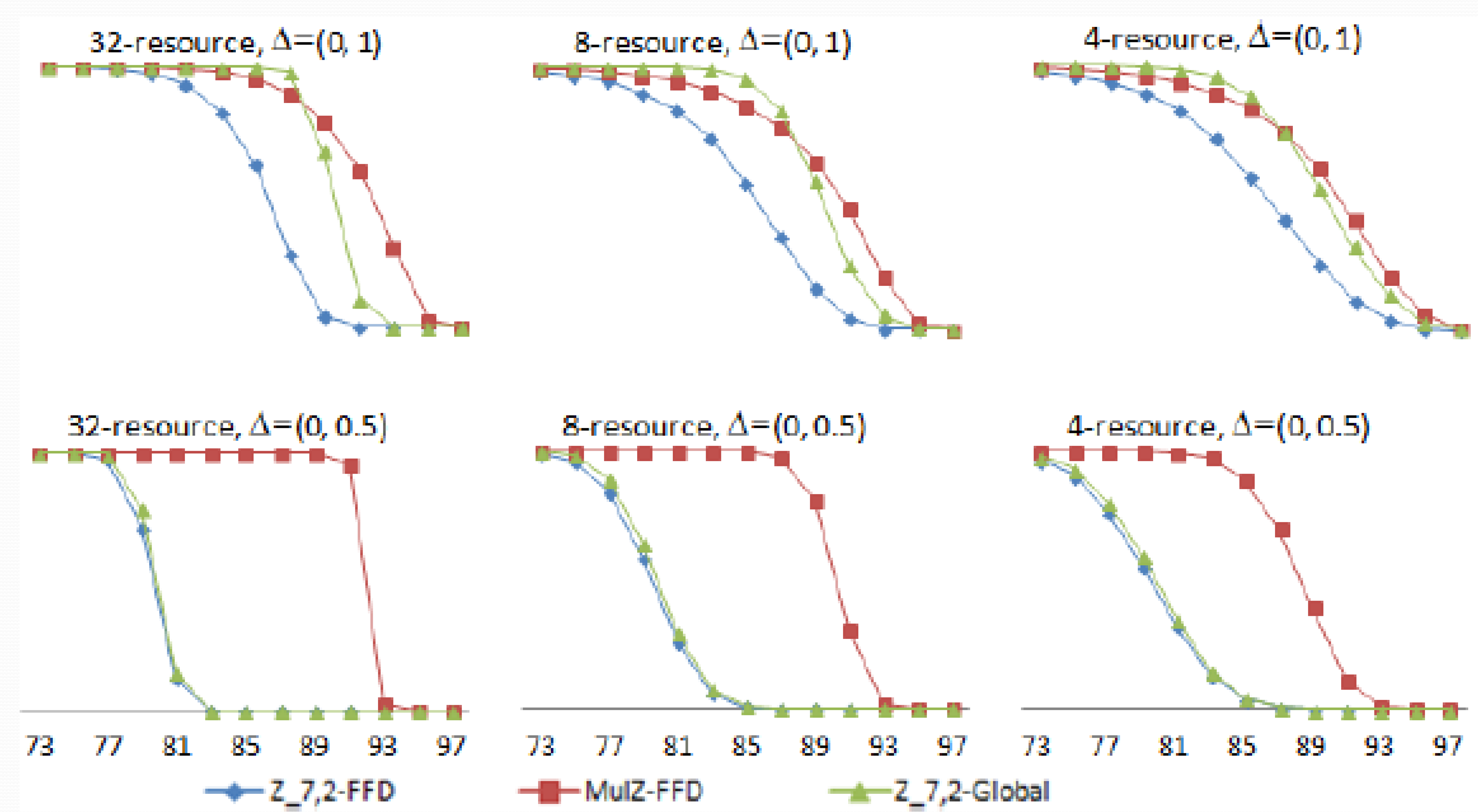
Transparency to the guest operating systems is an important feature of a virtualization system. In the real-time scenario, the scheduling policies are crucial. When we build a virtualized real-time system, one of the top considerations is how to keep the original scheduling policies unchanged when we schedule real-time tasks on a Virtual Resource instead of a Physical Resource.



The Regular Partition is the only known type of real-time virtual resource that is able to provide transparency for some scheduling policies. In this work, we focus on the resource-level problem of regular partitions in the multi-resource scenario. It is announced NP-hard, and the current solutions fall into the category of approximation algorithms. We introduce the concept of Approximation Boundary Sequence (ABS) to check general approximation algorithms for scheduling regular partitions.

$$\mathcal{G}_{1,2} = \langle \tfrac{1}{2}, \tfrac{1}{4}, \tfrac{1}{8}, \tfrac{1}{16}, \tfrac{1}{32}, \dots \rangle$$
$$\mathcal{Z}_{2,2} = \mathcal{Z}_{4,2} = \langle \dots, \tfrac{31}{32}, \tfrac{15}{16}, \tfrac{7}{8}, \tfrac{3}{4}, \tfrac{1}{2}, \tfrac{1}{4}, \tfrac{1}{8}, \tfrac{1}{16}, \tfrac{1}{32}, \dots \rangle$$
$$\mathcal{Z}_{3,2} = \langle \dots, \tfrac{23}{24}, \tfrac{11}{12}, \tfrac{5}{6}, \tfrac{2}{3}, \tfrac{1}{3}, \tfrac{1}{6}, \tfrac{1}{12}, \tfrac{1}{24}, \dots \rangle$$
$$\mathcal{Z}_{5,2} = \langle \dots, \tfrac{39}{40}, \tfrac{19}{20}, \tfrac{9}{10}, \tfrac{4}{5}, \tfrac{3}{5}, \tfrac{2}{5}, \tfrac{1}{5}, \tfrac{1}{10}, \tfrac{1}{20}, \tfrac{1}{40}, \dots \rangle$$
$$\mathcal{Z}_{7,2} = \langle \dots, \tfrac{55}{56}, \tfrac{27}{28}, \tfrac{13}{14}, \tfrac{6}{7}, \tfrac{5}{7}, \tfrac{4}{7}, \tfrac{3}{7}, \tfrac{2}{7}, \tfrac{1}{7}, \tfrac{1}{14}, \tfrac{1}{28}, \tfrac{1}{56}, \dots \rangle$$

There are two dominating categories of scheduling algorithms for the multi-resource scenario : global scheduling and partitioned scheduling. Global scheduling allows regular partitions to migrate between physical resources, and partitioned scheduling does not. In [1],we proved that Z7,2 is optimal for global scheduling if only one single ABS is used for approximation. And in [2], we found a group of sub-optimal ABSes in the single-resource scenario. Based on them, we came up with a partitioned scheduling algorithm, MulZ, which outperforms the global scheduling algorithm with Z7,2 even without considering the migration overhead due to global scheduling.



[1] Y. Li, and A. M. K. Cheng. Static Approximation Algorithms for Regularity-based Resource Partitioning. RTSS, 2012.
[2] Y. Li, and A. M. K. Cheng. Partitioned Scheduling of Transparent Real-time Virtual Resources. Submitted to ECRTS, 2014.