Multi-Processor Scheduling: Paradigms and Challenges

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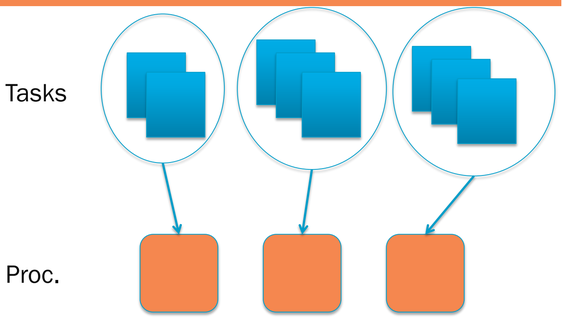
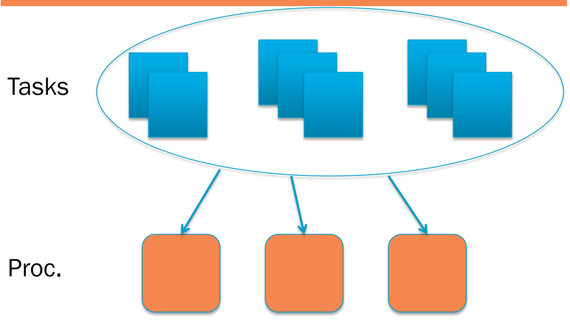
Scheduling Paradigms

Partitioned



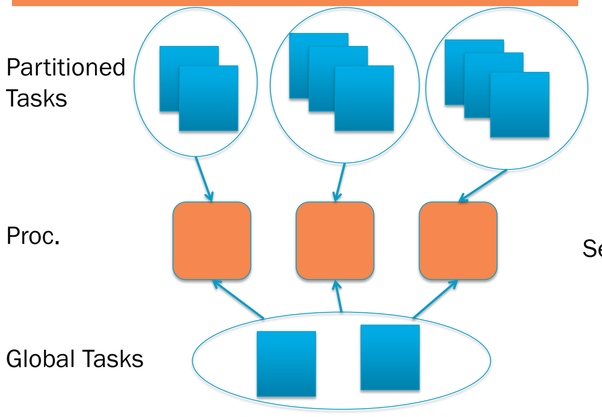
- ✓ Reuses the well mature uniprocessor theory
- ✓ Efficient implementation
- ✗ Poor utilization of the resources

Global



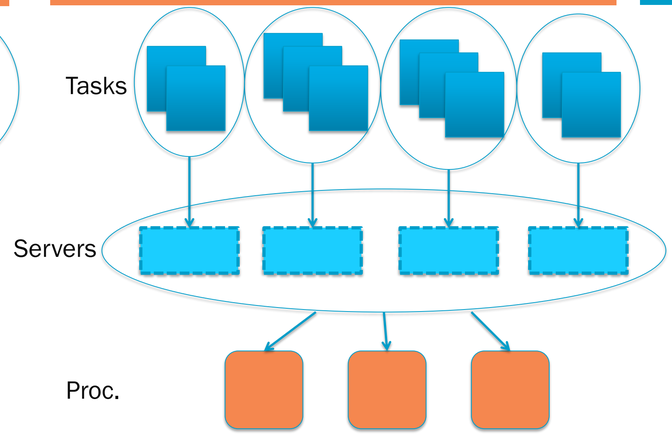
- ✓ Good utilization of the resources (up to 100%)
- ✗ Efficient implementation is harder
- ✗ Task migrations have a cost
- ✗ Increases difficulty and pessimism in timing analysis

Semi-Partitioned



- Trade-off between partitioned and global approaches
- ✓ Implementation is usually a simple variation of partitioned schedulers
- ✓ Good resource utilization

Hierarchical

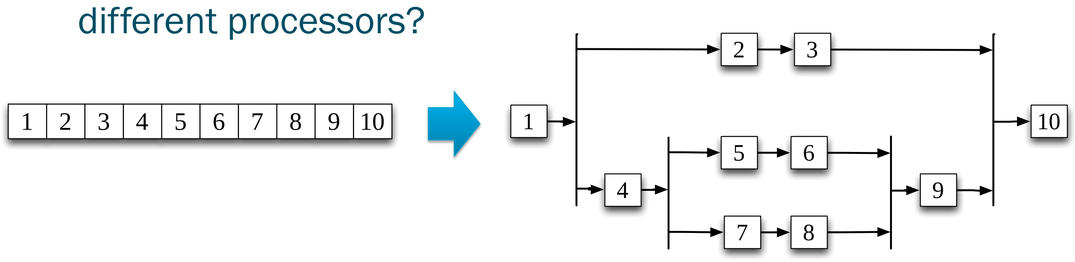


- ✓ Improves task isolation (limit error propagation) at the scheduling level
- ✗ Reduces effective utilization of the resources

A Few Challenges

Task Parallelization

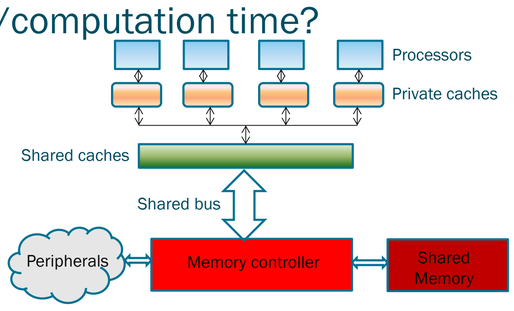
- How can we parallelize code?
- How can we benefit from parallel tasks?
- How can we synchronize the threads if they are mapped on different processors?



Resource Sharing

- Explicit: Shared data or peripherals between tasks
- Implicit: Communication networks, memories, caches, …

How can we compute a worst-case access/response/computation time?

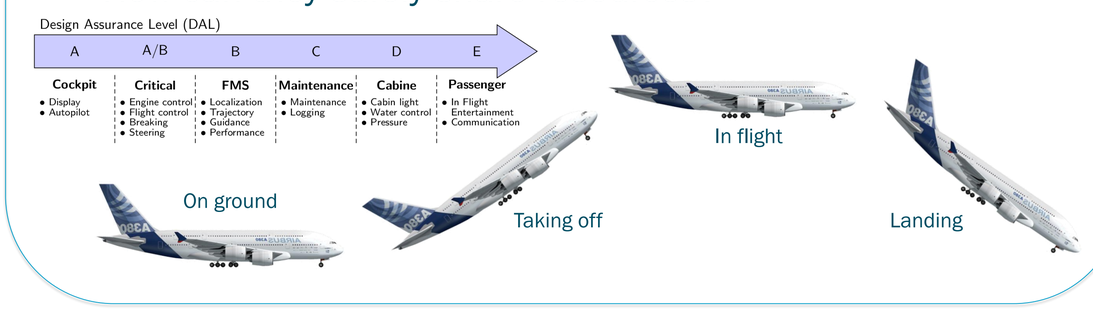


Implementation

- Task preemptions/migrations (cache related delays) and the scheduler execution have a cost
- How can the scheduling theory be efficiently implemented?
- How can we back-propagate the actual scheduling overheads to the scheduling theory?

Mixed-Critical & Multi-Mode Systems

- Must go through a certification process
- How can we reduce the design time and cost?
- How can we isolate tasks from different criticality levels?
- How can they safely share resources?



References:

- Sousa, P. B., Souto, P., Tovar, E., Bletsas, K., "The Carousel-EDF Scheduling Algorithm for Multiprocessor Systems", To appear in the proceedings of 19th IEEE International Conference on Embedded and Real-Time Computing Systems and Applications (RTCSA), 2013.
- Raravi, G., Andersson, B., Bletsas, K., Nélis, V., "Task Assignment Algorithms for Two-type Heterogeneous Multiprocessors", Published in the proceedings of 24th Euromicro Conference on Real-Time Systems (ECRTS 2012), pp.34-43, Pisa, Italy, 2012.
- Nelissen, G., Berten, V., Nélis, V., Goossens, J., Milojevic, D., "U-EDF: An Unfair But Optimal Multiprocessor Scheduling Algorithm for Sporadic Tasks", Published in the proceedings of 24th Euromicro Conference on Real-Time Systems (ECRTS 2012), pp.13-23, 2012.
- Burmyakov, A., Bini, E., Tovar, E., "The Generalized Multiprocessor Periodic Resource Interface Model for Hierarchical Multiprocessor Scheduling", Published in the proceedings of 20th International Conference on Real-Time and Network Systems (RTNS), 131-139, 2012.
- Dasari, D., Nelis, V., "An Analysis of the Impact of Bus Contention on the WCET in Multicores," Published in the proceedings of 14th IEEE International Conference on High Performance Computing and Communication & 9th IEEE International Conference on Embedded Software and Systems (HPCC-ICESS), pp.1450-1457, 2012.

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