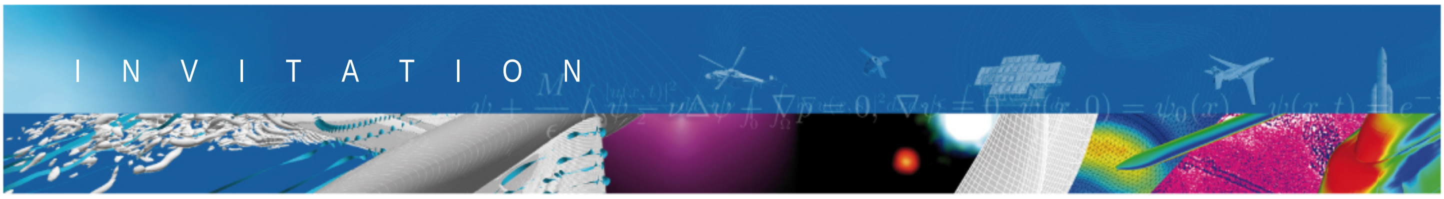

Schedulability Analysis of Probabilistic Real-Time Systems

Soutenance de thèse – Jasdeep Singh
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Résumé

The objective of this thesis is to perform schedulability analysis of probabilistic real-time systems. The task execution is described using a probabilistic Worst Case Execution Time (pWCET) which is a probability distribution. The pWCETs are assumed given. The tasks are scheduled to ensure that all tasks are allowed a processor time. In order to ensure that all tasks are scheduled, schedulability analysis is performed. Because task execution is described probabilistically, the schedulability analysis must also be probabilistic. This implies a probabilistic modelling of the system to probabilistically ensure that all tasks are scheduled.
Assuming continuous pWCET distribution, a formal approach towards the probabilistic analysis of the system through Continuous Time Markov Chain (CTMCh) uses CTMCh to model jobs of the tasks which are scheduled using Earliest Deadline First or Fixed Priority scheduling algorithm. Differences between continuous and discrete pWCET distributions are highlighted with the advantages and disadvantages of each.
Searching for reducing pessimism through real-time systems by using a Discrete Time Markov Chain (DTMCh) model for a Mixed Criticality (MC) probabilistic Real-Time System (pRTS) allows to quantify the probability of the system entering high criticality. Moreover that pessimism can be further reduced in a probabilistic environment by letting go of the classical schedulability algorithms.
A schedule which is safe and ensures schedulability of high criticality jobs is obtained using the graph based exploratory model for MC pRTS developed in this thesis. At the same time, the low criticality jobs are scheduled whenever possible. This approach drops the classical idea of suspending all low criticality jobs when a high criticality job enters high criticality mode. Here, probabilities can only be quantified because they arrive from pWCET and pWCET does not depend on the schedule.
Tasks enter high criticality at runtime implying that response time, and not execution time, must be used to decide criticality modes. Since the response time is affected by the schedule, this schedule can be optimized with respect to a probability criterion. Usability and hidden assumptions are presented for the classical convolution operation between pWCET distributions in the context of real-time systems. It leads to a MC schedule with minimal probability of system entering high criticality. At the same time, if the system does enter high criticality, the schedulability of high criticality jobs is ensured with allowing low criticality jobs to execute. The schedule is also adaptive, which means that depending on the when and which job enters high criticality, the following schedule is decided accordingly. The schedule is ensured in the worst case. A first step towards dependence between the tasks which is apart from the scheduling is also presented.

Mots-clés

Markov chain; probabilistic scheduling; mixed criticality; graphs; dependence

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