Chapter 4

Analysis of Monoprocessor Systems

This chapter presents an exact approach for analytically determining the expected deadline miss ratios of task graphs with stochastic task execution times in the case of monoprocessor systems.

First, we give the problem formulation (Section 4.1). Second, we present the analysis procedure based on an example before we give the precise algorithm (Section 4.2). Third, we evaluate the efficiency of the analysis procedure by means of experiments (Section 4.3). Section 4.4 presents some extensions of the assumptions. Last, we discuss the limitations of the approach presented in this chapter and we hint on the possible ways to overcome them.

4.1 Problem Formulation

The formulation of the problem to be solved in this chapter is the following:

4.1.1 Input

The input of the analysis problem to be solved in this chapter is given as follows:

- The set of task graphs $\Gamma$, 

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• The set of task periods \( \Pi_T \) and the set of task graph periods \( \Pi_\Gamma \),
• The set of task deadlines \( \Delta_T \) and the set of task graph deadlines \( \Delta_\Gamma \),
• The set of execution time probability density functions \( ET \),
• The late task policy is the discarding policy,
• The set \( \text{Bounds} = \{b_i \in \mathbb{N}\setminus\{0\} : 1 \leq i \leq g\} \), where \( b_i \) is the maximum numbers of simultaneously active instantiations of task graph \( \Gamma_i \), and
• The scheduling policy.

4.1.2 Output

The result of the analysis is the set \( \text{Missed}_T \) of expected deadline miss ratios for each task and the set \( \text{Missed}_\Gamma \) of expected deadline miss ratios for each task graph.

4.1.3 Limitations

We assume the discarding late task policy. A discussion on discarding versus rejection policy is presented in Section 4.3.5.

4.2 Analysis Algorithm

The goal of the analysis is to obtain the expected deadline miss ratios of the tasks and task graphs. These can be derived from the behaviour of the system. The behaviour is defined as the evolution of the system through a state space in time. A state of the system is given by the values of a set of variables that characterise the system. Such variables may be the currently running task, the set of ready tasks, the current time and the start time of the current task.

Due to the considered periodic task model, the task arrival times are deterministically known. However, because of the stochastic task execution times, the completion times and implicitly the running task at an arbitrary time instant or the state of the system at that instant cannot be deterministically predicted. The mathematical abstraction best suited to describe and analyse such a system with random character is the stochastic process.