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ON APPLICABILITY OF DEADLOCK PREVENTION POLICIES WITH UNCONTROLLABLE AND UNOBSERVABLE TRANSITIONS

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Abstract. *In deadlock prevention, much work has been done under the assumption that all the transitions are controllable and observable. This paper develops a method to decide whether a deadlock prevention policy is applicable to a plant with uncontrollable and unobservable transitions. By solving a set of linear programming problems, a set of critical controllable transitions and a set of critical observable transitions are obtained. A sufficient and necessary condition is developed, under which a deadlock prevention policy is still applicable when there exist uncontrollable and unobservable transitions. It is concluded that a deadlock prevention policy is applicable if and only if the transitions in the set of critical controllable transitions are controllable and the transitions in the set of critical observable transitions are observable.*

Keywords: Petri net, Deadlock prevention, Flexible manufacturing system, Uncontrollable transition, Unobservable transition

1. **Introduction.** Flexible manufacturing systems (FMS) have been extensively studied in recent years, e.g., sensitivity and uncertainty analysis of equipment run efficiency in semiconductor manufacturing systems [9], multi-platform environment semiconductor manufacturing server reengineering [8], Petri net solver by decomposition to the semiconductor manufacturing [13], and deadlock prevention in FMS [3].

In the area of Petri net supervisor design for discrete event systems (DES), much work has been done under the assumption that all the transitions are controllable and observable. However, the existence of uncontrollable and unobservable transitions is a common phenomenon in an FMS. A deadlock prevention policy for a plant under the assumption that all the transitions are controllable and observable may not prevent the system from deadlocks when there exist uncontrollable and unobservable transitions. Moreover, the permissive behavior is one of the most important criteria in evaluating the performance of a liveness-enforcing or nonblocking supervisor. In some cases, a deadlock prevention policy usually leads to a supervisor with less permissive behavior than that derived from the same policy under the assumption that all the transitions in a plant model are controllable and observable. Thus, it is necessary to consider the controllability and observability of transitions when we design a liveness-enforcing supervisor for a plant.

A class of specifications called generalized mutual exclusion constraints (GMEC) is defined as conditions that limit weighted sum of tokens contained in a subset of places [5]. For some classes of Petri nets, Giua and DiCesare restrict the behavior of the system,