

Chapter 3. Behavioral Properties

After modeling systems with Petri nets, an obvious question is "What can we do with the models?" A major strength of Petri nets is their support for analysis of many properties and problems associated with concurrent systems. Two types of properties can be studied with a Petri net model: those which depend on the initial marking, and those which are independent of the initial marking. The former type of properties is referred to as *marking-dependent* or *behavioral properties*, whereas the latter type of properties is called *structural properties*. In this chapter, we discuss only basic behavioral properties and their analysis problems. Most of the behavioral properties discussed here can be made structural properties by letting them hold for all possible initial makings. Structural properties and their analysis will be considered in Chapter 7.

3.1 Reachability

Reachability is a fundamental basis for studying the dynamic properties of any system. The firing of an enabled transition will change the token distribution (marking) in a net according to the transition rule described in Chapter 1. A sequence of firings will result in a sequence of markings. A marking M_n is said to be *reachable* from a marking M_0 if there exists a sequence of firings that transforms M_0 to M_n . A firing or occurrence sequence is denoted by $\sigma = M_0 \ t_1 \ M_1 \ t_2 \ M_2 \ \dots \ t_n \ M_n$ or simply $\sigma = t_1 \ t_2 \ \dots \ t_n$. In this case, M_n is reachable from M_0 by σ and we write $M_0 \xrightarrow{\sigma} M_n$. The set of all possible markings reachable from M_0 in a net (N, M_0) is denoted by $R(N, M_0)$ or simply $R(M_0)$. The set of all possible firing sequences from M_0 in a net (N, M_0) is denoted by $L(N, M_0)$ or simply $L(M_0)$.

Now, the reachability problem for Petri nets is the problem of finding if $M_n \in R(M_0)$ for a given marking M_n in a net (N, M_0) . In some applications, one may be interested in the markings of a subset of places and does not care about the rest of places in