

## THE VIRTUAL SYSTEM METHOD FOR ESTIMATION OF PARAMETER IN SYSTEM TREE\*

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A machine, or other type of “system”, can often be divided into several subsystems and these subsystems again can be divided into several subsystems (second generation),  $\dots$ . This process forms a “system tree”. Suppose that the distributions of the life spans of subsystems in the system tree are exponential distributions. To estimate the parameter of the distribution of life span of the equipment (the entire “system tree”) based on data collected from subsystems, the virtual system method, an alternative to the obvious ML method, is presented in this paper. It is proved that the series of estimators constructed by the virtual system method is asymptotically efficient and that the calculation of the estimator is quite simple while the likelihood equation of the system tree is complicated.

**1. Introduction and Main Result.** In practice, an equipment (System) is usually divided into several subsystems and these subsystems again can be divided into several subsystems,  $\dots$ . Finally a system tree is formed. In this paper a system tree is denoted by a finite set of indices  $M = \{m = (i_1, \dots, i_k)\}$  satisfying

- (i)  $m$  is a finite series of natural numbers,
- (ii)  $m = (i_1, \dots, i_k) \in M \implies i_1 = 1$ ,
- (iii)  $(i_1, \dots, i_k) \in M \implies (i_1, \dots, i_{k-1}) \in M, (i_1, \dots, i_{k-1}, j) \in M, j = 1, \dots, i_{k-1}$ .

An example of the system tree is given in Figure 1. Later on, we also call  $m (\in M)$  a subsystem.

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