Relationship Between Cell Residence Time and Call Time Distribution in Cellular Mobile System

Kunmin Yeo* · Chi-Hyuck Jun* · Jihyun Ryu*

* Department of Industrial Engineering, Pohang University of Science and Technology

Abstract

This paper presents an analytic approach to investigate the relationship between cell residence time and call time in cellular mobile system with mixed platform environment. In modeling mobile cellular communication systems, the distribution of the cell residence time has been regarded as an important factor to compute the performance measures. Generally, the cell residence times may have different distributions according to the platforms on which mobiles can be mounted. Previously most researches assume an exponential distribution for the cell residence time distribution without analytic bases. But there may be some intrinsic characteristics of the cell residence times according to the platforms on which communicating mobiles are mounted. We assume that the cell residence time of each platform is differently distributed with a general form.

Previously, most researches have assumed an exponential distribution for call time distribution. Generally, handoff calls and ongoing calls have more possibility to terminate their call sessions than new calls. Exponential distribution has a difficulty to describe this situation because of its memory-less property. Some examples will be given in this paper to illustrate this shortcoming of exponential distribution. Presently, multimedia(such as data and video) communication using PCS is a important issue. Each traffic has an intrinsic characteristic in its call time distribution. For example, the call duration of data communication has a tendency to be longer than that of voice communication. So, general distribution should be assumed as call time distribution.

In mobile cellular communication systems, during communications with other people, mobile subscribers seize radio channels for certain amount of time while moving arbitrarily in a cell. So the time intervals that mobiles spend in a cell (i.e., the cell residence times) affect the availability of channels in the target cell. Because the blocking probability and the forced termination probability

are closely related to the cell residence time distribution, it may over- or under-estimate real systems to assume a particular distribution for the cell residence time distribution without analytic bases. Previously, for the sake of simplicity, in the absence of any proven probability distribution, most of researches dealing with the mobility problem have assumed, either explicitly or implicitly, the cell residence time to be an exponentially distributed random variable. Some researches have shown that the cell residence time can be described by the generalized gamma distribution. But the cell residence time may have different distributions according to a wide range of mobility characteristics of target regions. So "what is the proper distribution of the cell residence time" is a somewhat open question.

In real systems, each mobile can be mounted on various platforms such as cars or pedestrians. Practical cellular mobile communication systems that are currently envisioned must support a mixture of platforms having a range of mobility characteristics. So the distributions of the cell residence times for each platform are varied because of their different characteristics of mobility. Hence, we should take into account platform-dependent distributions for the cell residence time distributions in modeling mobile cellular communication systems. The present work is motivated by the recognition of this characteristic. Many works have been exerted to derive the expected channel occupancy time with mixed platform environment. But their approach was based on Markovian model and the cell residence time for each platform was treated as exponential random variable. In a recent paper, a *phase-type* distribution is used in order to describe the call times and the cell residence times in the environment of mixed platforms and mixed call types. Because it modeled system states as a multidimensional birth-death process, the size of the state space grows quickly while the number channels increases. Thus, some computational problems may exist as the number of channels in a cell grows though the number of channels per cell is normally low in the environment of *micro* cells or *pico* cells. Our system model can reduce the shortcomings of the birth-death model.

In this paper, the expected channel occupancy time of each platform is derived in the following situations: 1) general call time distribution and exponential cell residence time distribution 2) exponential call time distribution and general cell residence time distribution. We tested three distributions as cell residence time (or call time) distribution : 1) gamma 2) normal 3) exponential distribution, and investigate the relationship between cell residence time and call time distribution. Our analytic model is based on Laplace transformation of the distribution of cell residence time and call time. Our numerical results show that some heuristic amendment should be required in the formula of the expected channel occupancy time in order to describe real situations efficiently.