Chapter 15
A Survey on Classical Teletraffic Models and Network Planning Issues for Cellular Telephony

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ABSTRACT

Research on traffic characterization and analysis of cellular networks has been very active in the past decades. However, it is difficult for networks planners to incorporate new results to network engineering. On the one hand, some models are very complex and need advanced programming and skills to be properly computed. On the other hand, reliability on those models is poor because there is a general lack of published field studies to corroborate them. This paper proposes simple well-known teletraffic models for cellular networks compared to the conventional Erlang-B frequently applied when a first estimate is needed. To this purpose, the latest results on the characterization of the arrival process and service time in cellular systems are reviewed. According to the arrival and service characteristics, three models are proposed to obtain a first approach to the performance characteristics of the cellular system. The first two models are extremely simple, allowing direct computation of performance through closed formulas, while the third requires simple programming.

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Air pollution is an important environmental issue that has a direct effect on human health and ecological balance. Factories, power plants, vehicles, windblown dust and wildfires are some of the contributors to pollution. Reasonable simulation tools exist for evaluating large scale sensor networks; however, they fail to capture significant details of node operation or practical aspects of wireless communication. Real life testbeds capture the realism and bring out important aspects for further research. In this paper, we present an implementation of a wireless sensor network testbed for automatic and real-time monitoring of environmental pollution for the protection of public spaces. The paper describes the physical setup, the sensor node hardware and software architecture for “anytime, anywhere” monitoring and management of pollution data through a single, Web-based graphical user interface. The paper presents practical issues in the integration of sensors, actual power consumption rates and develops a practical hierarchical routing methodology.

INTRODUCTION

Motivation

In recent years, many papers have been published on models for personal communications in cellular networks. Mathematical analyses, simulations and field studies have been presented separately with little effort dedicated to the link between them and the engineering consequences of using a specific modeling tool. Most of these recent studies show that the classical Erlang-B theoretical hypotheses seldom occur in actual operative networks: arrivals might be not Poisson, channel-holding time not exponentially distributed, blocked handoff attempts not immediately lost if not attended, coverage overlapping areas, and so forth. Newer models try to overcome these issues through relaxing hypotheses and adding features to previous ones, but there is a general lack of comment on how the new hypotheses and features fit the real cellular world, what happens when these hypotheses are relaxed, and how to apply new models. The consequence is that the planner fails to take advantage of the huge amount of research work carried out in this field and often remains loyal to the conventional Erlang-B model.

Teletraffic modeling of cellular networks is a complex issue because there are many variables involved. Some of them are traffic related: the channel-holding time (CHT) is a fraction of the duration of the whole connection (i.e., unencumbered holding time), arrivals are not always Poisson (specifically handoff arrivals), and so forth. Others are mobility related: speed and direction of the Mobile Node (MN), different user patterns, and so forth. There are also radio constraints: propagation, multi-path, antenna radiation diagram, cell shape, and so forth. This is merely a very brief summary of related variables, since it is almost impossible to produce a comprehensive list of all of them.

In addition there are strong relations between variables. For instance, the cell shape obviously depends on all the variables related to the radio environment. The consequences of the traffic load on the cell shape are not so obvious, but the planner cannot overlook the fact that under heavy load, the MN is often connected to a base station (BS) that is not the nearest one. As explained below, MNs within overlapping areas may belong to different cells depending on the traffic circumstances.

Goals and Organization

This work deals with the first stage in network planning: applying simple teletraffic models to draw approximate figures of capacity-related performance figures. This first step is necessary before carrying out simulations, which consume a much greater amount of time and resources. The advantage of simple models is that they quickly
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