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System Capacity Calculation for Packet-Switched Traffic in the Next Generation Wireless Systems, Part II: Batch Arrival M/G/1 Nonpreemptive Priority Queueing Model for Transmission over a Radio Channel

Hideaki Takagi[a)], Hitoshi Yoshino[b)], Naoto Matoba[b)], Mitsuhiro Azuma[c)], and Masashige Shirakabe[b)]

[a)]University of Tsukuba, Tsukuba-shi, 305-8573 Japan; takagi@sk.tsukuba.ac.jp
[b)]NTT DoCoMo, Inc., Yokosuka-shi, 239-8536 Japan;
{yosino, shirakabe}@mlab.yrp.nttdocomo.co.jp matoba@nttdocomo.co.jp
[c)]Fujitsu Laboratories Ltd., Kawasaki-shi, 211-8588 Japan; azuma@labs.fujitsu.com

Abstract: We propose a method of determining the required system capacity for several service categories of packet-switched traffic for the future development of the third generation (3G) mobile radio systems and systems beyond 3G. Based on the batch arrival M/G/1 nonpreemptive priority queueing model, we calculate the system capacity so as to satisfy the user's Quality of Service (QoS) requirement of the mean delay and/or the delay percentile. Numerical analysis is given for the sensitivity of the required system capacity to such parameters as the offered traffic intensity, the mean delay requirement, and the packet size distribution.
Keywords: M/G/1 nonpreemptive priority queue, mobile radio systems, packet-switched traffic, sensitivity analysis, system capacity calculation.

1 INTRODUCTION

International Telecommunication Union Radiocommunication Sector (ITU-R) is developing a new methodology for calculation of radio spectrum requirements in the year 2010 onward for the future development of the third-generation (3G) mobile radio systems and systems beyond 3G. The conventional methodology [4, 5] was developed by using the Erlang-B formula for circuit-switched traffic and using the Erlang-C formula for packet-switched traffic. In the new methodology, the traffic of a mix of packet-switched service categories should be handled appropriately due to the forecast that the majority of future traffic will arise from multi-media applications and that the communication will be based on Internet Protocol (IP). In response to the request by ITU-R, we have developed a new spectrum calculation methodology and proposed it to the ITU-R. Together with a companion paper [3], this paper presents an alternative spectrum calculation methodology that has been approved as a Japanese proposal in a recent meeting of the ITU-R Working Party 8F.

For the new methodology, a *single arrival* M/G/1 nonpreemptive priority queueing model was proposed by Irnich and Walke [2], and it has been elaborated further [3]. A customer in their model represents an IP packet. Considering the fact that each IP packet is segmented into several frames, which are then transmitted separately over a radio channel, we propose a *batch arrival* M/G/1 nonpreemptive priority queue. In our model, each arriving batch represents an IP packet and each customer constituting the batch represents a radio frame. The formula for