

Chapter 16

Traffic Control of Two Parallel Stations Using the Optimal Dynamic Assignment Policy

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ABSTRACT

In this chapter, the authors study some optimal dynamic policies of assignment to control the entrance of a system. This system is formed of two waiting lines (queues) in parallel. Every line is composed of a server and a waiting room (buffer). Upon arrival to this system, the authors suppose the existence of an assignment policy. The role of the policy is to assign dynamically the customers (the customers here may represent a physical customer in the entrance of a cinema or bank, packets in a computer networks, calls in a telephone system... etc.) to the one or to the other of two lines or it may reject (or assigned to other system). This assignment is done according to policies in order to achieve some performance criterion.

INTRODUCTION

The phenomena of waiting are observable in the domains of the data processing and telecommunications, we can mention the waiting of the queries made to a data base, the waiting of tasks until the CPU executes them, the waiting of loading a web page, the waiting time of the packet to be route (routing process) in the Internet system and many

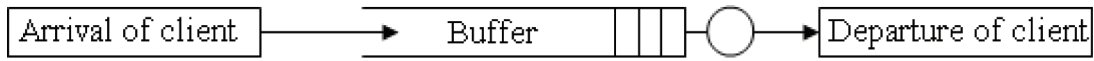
others situation. From here the importance of this study to simulate, analyze and propose a model to optimize the working of these systems.

MATHEMATICAL BACKGROUND OF THE QUEUE

We start by defining Markov's chain, before formulate a waiting line (**queue**) mathematically. After that, we will model a network formed by

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Figure 1. Waiting line



several connected waiting lines (**queues**) in parallel. We consider a system that can take different states $E = \{E_i, i=1, 2, \dots\}$. The states change occur in the Markov chain in different time that we note $t_1, t_2, \dots, t_k, \dots$. We call $P_n(t_k)$ the probability that in the instant t_k , the system is in the E_n state. We suppose the transition of the E_i state to the E_j state depends only of these two states. We note p_{ij} the transition probability from the state i to the state j . The initial time t_0 and the initial probabilities $p_n(t_0)$ are known.

The set $\{p_{ij}, p_n(t_0) \text{ and } E_i, i=1, 2, \dots\}$ forms Markov chain. If the set E is continuous, the Markov chain is continuous. If the change of the time is continuous, we can define a process of Markov in continuous time.

Waiting Line (Queue)

The diagram shows a waiting line (Figure 1).

A customer arrives according to a certain process A . If the ticket window of the service is free, the customers enter and it is served with a process S , if he is not alone in the waiting line (**queue**) during his arrival, a queue discipline (QD) is applied. The most classic are:

- FIFO (first in first out)
- LIFO (last in first out)
- PS (shared process)
- SJF (Shortest job first)

A waiting line can have several servers and can only receive a finite number of customers (line with finite capacity). If a customer presents alone when the line is full, he is refused or send it to other system. The queue discipline that we will use in this chapter is FIFO.

There are several ways to symbolize a waiting line; one of these notations is for example: (QD/K/N) where:

- **QD**: queue discipline.
- **K**: number of the servers.
- **N**: capacity of the system.

An M/M/1 queue is therefore a line, with a Markov process, in arrival and in service, only one server and an infinite capacity.

Thereafter, we will use the following terminology: A/B/s: d/e

Where:

- **A**: the process of arrival.
- **B**: describes the process of service.
- **s**: the number of servers.
- **d**: capacity of the system.
- **e**: queue discipline.

(According to the terminology of Kendall [TOHME, 97]).

In the modeling of complex systems, a simple waiting line is not sufficient; it is necessary to use networks of waiting lines.

The Arrival and Service Processes

The arrival process of the customers corresponds to a time uncertain events; therefore we can describe it by a Poisson distribution of parameter λ , where λ is the arrival rate of the events. The service process is described by an exponential distribution. This process is called birth-death process (Hernandez, 1989). A birth-death process is a Markov chain where from state n , only two other states are accessible: the states $n+1$ and $n-1$.

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