Chapter 11

AN URBAN BUS NETWORK DESIGN PROCEDURE

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Abstract This paper describes a coordinated process to configure a bus transit network with its set of lines and frequencies using heuristic approaches. In this context, the planning procedure consists of the following phases: in the first phase, the main skeleton of the network of the public transport system, not articulated in lines, is defined through heuristic procedures based on the demand matrix and the road network, integrated by “fixed supply” such as underground, urban railways, and those transit lines identified by Authority and located on the road network as fixed links with characteristics constant with flows; in the second and third phases the lines of main and feeder networks are designed respectively. In regard to this classification, the 2 phases are applied to define express lines initially, and subsequently main, in which express lines become “fixed supply” for following main lines design. This model has been applied to the Public Transit Network Design of the city of Rome, Italy.

1. Introduction

This paper describes a coordinated process to design a bus transit network with a set of routes and frequencies. The nature of the problem precludes a solution by exact optimization models (Miller & Goodnight 1973, Morlok 1978, Newell 1979); therefore heuristic approaches to find “reasonable” result are utilized, but it is not possible to guarantee an optimal solution (Rea 1972, Rhome 1972, Mandl 1979, Marvah et al. 1984, Axhausen & Smith 1984, Van Nes et al. 1988, Ceder & Wilson 1986, List 1990). For a complete review of transit network design models we refer to Baaj & Mahmassani (1995), which also presents a new bus network design model.
The hierarchical procedures of modern transit network design have involved bus lines too, thus leading to a classification into express, main and feeder lines. In this paper only the urban transit network has been taken into account: for low demand areas other systems can be considered, for example Timed Transfer Systems (Carrese et al. 1998a) or Dial a Bus (Carrese et al. 1997). In particular, express lines are characterized by high frequency, a distance between two consecutive stops greater than 800 m, and the opportunity of overtaking main lines. Main line qualifications are high frequency, bus stop distances between bus stops equal to or longer than 400 m. Feeder lines, whose function is to lead passengers to Main Transit Lines (MTL), offer low-medium frequency, and distances between bus stops never greater than 400 m. The urban public transit network design procedure has been organized into three steps:
1. definition of the skeleton of a Main Transit Network (MTN);
2. identification of the network of Main Transit Lines (MTL);
3. definition of the feeder lines to improve MTL accessibility.

2. The main transit network (MTN)

The model to define the MTN is based on the attempt to exploit the economies of scale of the public transit system (PT) (Rea 1972, Morlok 1978, Newell 1979), where supply function is characterized by a Level of Service (LoS) which improves as demand increases; this is due to the decrease in headways necessary to meet growing demand and to the possibility of using higher performing PT systems (figure 1). This statement is not true, if the model is used in a verification problem. Figure 1 states, if the project phase is taken into account, where the number of people in a square metre can be imposed as a constraint. In this case, it could be useful to develop transportation system performances in terms of sub-modes. In particular, the flow range up to 7,000 pass./h can be divided into the three service classes already introduced. In this paper only the bus system is considered. For the selection of an optimal system, the reader is invited to refer to Carrese et al., (1998c).