1.0 Introduction

1.1 Background

In order to improve the responsiveness, timeless and efficiency of services, public transit agencies are increasingly turning to Intelligent Transportation Systems (ITS). Under the name of Advanced Public Transportation Systems (APTS), several new technologies have been developed, tested, and applied to public transportation including bus transit. APTS technology promises to improve the quality of transit operations, consumer satisfaction, and ultimately to increase ridership. These improvements could help reduce traffic congestion, air pollution, and energy consumption of the complete transportation system. This might explain why transit providers in dozens of U.S. and other countries are in the process of implementing advanced technologies. According to surveys conducted in a study funded by the Federal Transit Administration (FTA) a large number of transit operations are moving towards the use of APTS technologies such as smart traveler information / guidance, electronic billing, automated route guidance, and automated vehicle location (Casey, 1993).

For Automated Vehicle Location (AVL) technology only, in the period of 1992-1995, the usage of the technology in U.S. transit systems increased more than 100 percent. In 1996, there were at least 58 AVL systems in operation, under installation, or planned in the U. S. and Canada (U.S. DOT, 1996, a). This trend will probably continue and might even accelerate due to rapidly falling prices of technology.

One important question that arises from the technology drive is whether or not the agencies affected in the implementation truly realize the benefits of such systems before the actual implementation takes place. As ITS are intended to satisfy certain primary customer functions, functional analysis and many assessment methods such as analysis, testing, and validation have been focused on identifying these primary benefits of ITS

(IVHS America, 1992, b). However, partly due to short history of ITS implementation on transit services and partly due to the complexity and diversity of the technology, there is no established evaluation method or assessment technique until now. Until the early 1990's few of studies have been tried to derive general methods to assess the benefits and disbenefits of ITS using existing evaluation methods (IVHS America, Dec. 1992, a).

It is known that in some cases the implementation was not seamless and in some others disbenefits accrued from the actual implementation of the technology. However, complex systems such as ITS yield a variety of unintended side effects, both positive and negative. Knowledge of the benefits and costs of these technologies for both service providers as suppliers and users as consumers is important if one is to evaluate not only existing but also future systems in the context of the whole society where they are deployed.

While some reports insist that in most cases it would sufficient to apply existing evaluation methods to assess the benefits and disbenefits of ITS (IVHS America, 1992, b), new techniques and models that explicitly model the technology with given transportation system should be implemented to help us understand the complex interactions between technology and system performance gains of transportation systems. A model that considers these aspects in an integrated fashion in time-space scale would enable us to implement effective long range mass transit strategies from both the demand and supply sides.

There are increasing requests to answer some of policy maker's concerns by looking at the integration of advanced APTS technology into conventional transportation planning process. This approach is considered necessary because technology impacts affect in principle traffic patterns in the short term, and social and economic aspects of the study area in the long term. While there have been many operational tests of APTS technology through out the United States (U.S. DOT, 1996, c), few studies have fully considered the implementation of such technology using a systematic approach in the context of the public transit planning process. Most reports present the system evaluation results usually after the implementation stage mainly using field data and consumer responses. Until now most of the public transit planning projects involving ITS evaluation process have fallen into the traditional tactical planning scenario where the new technology is considered as an evaluation factor of short-term measures of effectiveness (mainly short term cost effectiveness evaluation). Several demand-supply oriented transit models have been described in the literature review (Chang and Schonfeld, 1993; Tsao and Schonfeld, 1983; Kocur and Hendrickson, 1982; Wirasinghe and Ghoneim, 1981). However, none of these incorporates the necessary feedbacks between demand and technology in a dynamic fashion thus rendering them unusable for the long term transit planning environment.

1.2 Research Objectives and Scope

The primary goal of this study is to develop an integrated modeling framework to evaluate and plan Advanced Public Transportation Systems (APTS). Specifically, the research focuses on the impact of AVL technology in transit operations. For this study, a modeling concept, model development and validation procedures are presented.

To capture the impacts of AVL technology on the transportation environment, a dynamic (time-dependent) mathematical model is developed. To capture possible impacts induced by APTS technology, the proposed approach uses the conventional UTPP and integrates it with several external models such as population allocation analysis, bus operation simulation, scenario analysis and economic analysis. These sub-systems are connected with each other by key common variables using the System Dynamics approach to reflect natural interactions over the life cycle of the model developed. To illustrate the possible application of the model, a case study was conducted using the data of Blacksburg Transit system (BT) in Blacksburg, Virginia. In the study, BT was evaluated using sensitivity and scenario analyses. The model presents suitable alternatives to improve BT operations in the presence of AVL technology.

1.3 Research Approach

This document is comprised of six chapters. The first chapter presents an introduction to the topic. Chapter 2 reviews the technologies and presents current research efforts to study the impacts of advanced technologies on public transit (mainly AVL on bus transit systems). The research presentation also focuses on several reports of case studies on AVL implementation, its evaluation process, and results. Chapter 3 proposes a modeling approach and includes a few introductory notions about this technique for the sake of completeness. The theoretical background of each model involved and their specific use are also introduced in this chapter. Chapter 4 presents the structure of the model developed including its four sub-systems: a) urban transportation planning, b) population allocation, c) bus operation simulation, and d) evaluation analysis. Chapter 4 also presents the relationship between all four sub-models and their integration process. Chapter 5 applies the modeling framework to a real-world example using Blacksburg Transit data. This chapter dwells on evaluation of model parameters, model calibration and model validation. Chapter 6 presents conclusions and recommendations for future research.