AHS MAGLEV SYSTEM ARCHITECTURE

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(ABSTRACT)

In the period between 1993-1998 a vision was presented of an Automated Highway System developed under a contract naming Virginia Tech one of the three ITS Research Centers of Excellence in the United States by the Federal Highway Administration. The AHS envisioned would consist of a guideway constructed in the rights-of-way of the Interstate Highway System which would utilized magnetic levitation ("maglev") to propel closely-space, individual vehicles at high speeds with full longitudinal and lateral control. In this dissertation the system architecture is described in detail.

The system architecture is organized according to system structural, system operational, and vehicle subsystem technological elements. The structural aspects are concerned with the decision making capability allocated between a vehicle and the guideway, the characteristics of the control and sensing equipment contained within the guideway, the traveling unit configuration, and certain of the vehicle's structural and equipment considerations. The operational aspects are concerned with vehicle entrainment policy, system fleet mixture, network type and control functions, and guideway lane separation requirements. The vehicle subsystem and the vehicle longitudinal and lateral control subsystem.

The operational architecture concentrates on developing and evaluating strategies for forming platoons of vehicles on the guideway since the average platoon sizes determine the practical capacity of the guideway as well as the safety of operation. It is instructive to review how platoons form naturally on conventional highways as a prelude to developing a strategy for forming platoon on the AHS Maglev Guideway. A novel, non-linear car-following model called "car maneuvering" is explored by defining the stimuli on the right-hand side of the model in terms of several vehicles ahead of the response vehicle. In order to add still more realism in developing a strategy for platoon formation in a guideway under automatic control, an additional spacing dependent term is introduced to achieve a "magnetic coupling headway" between platooned vehicles. Once vehicles are magnetically coupled, the desired intraplatoon headway is maintained through attraction and repulsion.

A vehicle traveling on the guideway can have displacements along the vertical and lateral axes as well as along the longitudinal axis. These three displacements are controlled by the three basic maglev technology functions – suspension, guidance and propulsion. For each dimension, a model is developed to include a magnetic force to restore position and a magnetic non-linear damping force to reduce oscillations and avoid excessive jerk.

In this dissertation the term "architecture" is interpreted in the broadest possible sense based on the assumption that any transportation system intended to serve society throughout the 21st Century and beyond must address a hierarchy of goals and issues ranging from the strategic (sustainable development) to the tactical (the concept of operations) and including the in-between (interfacing with the existing transportation system). In the past, transportation planning, policy, investment and operating decisions have been made in isolation from each other with incomplete information inputs from a broad base of disciplines and sectors, without a synthesizing instrumentality. A new approach is described to promote the best informed decisions governing planning and management. The approach features a realistic framework for allocating public sector-private sector effort, an instrumentality for generating the knowledge needed to conceive

and implement the new transportation paradigm, and a strategic vision for rallying support.

The new approach to the problem begins with a strategic vision for society's AHS infrastructure. We believe that the strategic vision must be based on the concept of "sustainable development." To affect this new strategic vision, higher budgets will be a necessary, but not a sufficient condition. A fundamental Decision Support System (DSS) with knowledge bases with contributions from the braid spectrum of science and engineering disciplines, and a methodology based on system dynamics capable of synthesizing these contributions is proposed.

The AHS Maglev Alternative is compared to a "Do-Nothing" Alternative and a "Traditional Expansion" Alternative using user and nonuser benefit analyses. The advantages of AHS Maglev are seen to be overwhelming. Moreover, the ability of AHS Maglev to alleviate airport congestion by reducing short and medium range of flights, and to serve as a structuring device for rational population distribution is shown.

Dedicated to the memory of my beloved father

Police Colonel Kamol Siridhara