CONCLUSIONS

AVHS encompass a wide and complex variety of technologies, such as artificial intelligence, image processing, machine vision, expert systems, advanced materials, and microelectronics. The status of various AVHS technologies in the United States may be found in table 2. OTA concludes that, although by themselves they cannot solve our urban traffic problems, AVHS technologies offer significant potential for:

- increased throughput and efficiency;
- more predictable travel time; and
- greater safety for all motor vehicles; as well as
- greater productivity and efficiency for commercial and fleet operations.

if employed with adequate attention to human factors, driver information and collision avoidance technology can speed travel by preventing accidents and resulting congestion, and improve safety by warning motorists of hazardous road and traffic conditions so they can respond accordingly. Sufficiently advanced automatic vehicle control technologies can respond even when appropriate action is not taken by motorists. in the area of commercial and fleet operations, AVI, AVL and WIM technologies have already been shown to improve efficiency by reducing administrative stop times and enabling effective distribution of fleet vehicles.

Experts predict throughput increases in the range of 10 to 20 percent, with commensurate reductions in delay and travel time, if existing, information-level AVHS technologies are implemented. However, if road capacity is increased and road travel made more desirable, more motorists can be expected to take to the roads, counteracting some reductions in congestion. Consequently, even in the most optimistic of scenarios, reductions in traffic congestion attributable to current AVHS technologies may turn out to be modest. AVHS is thus by no means the short-term answer to the Nation's urban congestion (and vehicle-caused air pollution) problems. if even moderate success is

Table 2.-- Status of AVHS Technologies

System	Capabilities	Technologies	Status	Current limitations
Automatic Vehicle Identification (AVI)	Exchanges data between vehicle and roadside reader	Radio frequencies; magnetics; optics; ultrasound	Used on some toll roads and bridges (Coronado Bridge, Dallas North Tollway, Lincoln Tunnel)	No standardization
Weigh in motion (WIM)	Determines weight of moving vehicle	Piezoelectric; bending plates; capacitive systems; bridge systems; deep pit systems; shallow weighscale systems	Operational testing taking place at State ports-of-entry (Crescent demonstration)	Accuracy limited to 10%
Automatic Vehicle Location (AVL)	Signals location of vehicle over a wide area	Satellite; Loran-C; dead reckoning with map matching	In use in commercial trucking (Geostar, Qualcomm); public safety (Etak, Motorola)	
Urban traffic control systems	Monitors and controls traffic flow on freeways and arterials	Signal controllers; ramp meters; changeable message signs; loop detectors; video cameras	Most U.S. systems use fixed timing plans; Los Angeles' ATSAC system is traffic responsive	Conflicts of scope (e.g., one city's system may cause congestion in a neighboring community) and jurisdiction (freeways and arterials rarely included in the same system)
Vehicle navigation	Guides driver by electronic maps or audio instructions	(Augmented) dead reckoning; infrared; radio frequencies; magnetic markers	Systems with no links to the infrastructure are in use, mostly by fleets; Pathfinder project will test interactive capabilities of this technology	Real-time traffic information not yet incorporated into system
Collision warning and avoidance	Warns driver of impending collision; enhanced systems apply brakes when necessary	Radar; infrared; acoustic	Systems still under development	Not 100% reliable; radar does not detect nonmetallic obstacles
Lateral control	Steers vehicle automatically	Electric cable; magnetic markers; optical methods; radar	Technology still under development; public (automotive) use not likely for a decade or more; guided buses with dedicated guide-ways operational in West Germany and Australia	Not ready for implementation
Automated incident detection	Detects incidents automatically	Detection algorithms incorporated into urban traffic control systems; machine vision	Simple detection algorithms are used in some traffic control systems; machine vision system installed in Minneapolis	Technology still under development

to be achieved in combating these problems in the near term, other strategies, such as car pooling, HOV lanes, use of alternative fuels, congestion pricing, and other forms of transportation systems management must also be pursued aggressively.

The good news is that AVHS poses no conflicts with these other strategies, can be used in conjunction with them, and indeed, may facilitate certain aspects. For example, vehicle identification technology can be used in congestion pricing schemes and in the enforcement of HOV and other transportation systems management-type restrictions. Moreover, AVHS can bring about improvements in road safety and traffic flow regardless of future changes in urban living and working habits. OTA concludes that these multiple benefits from AVHS argue for the immediate further development of AVHS and greater investment in research, development, and operational testing. More aggressive Federal leadership in organizing and supporting R&D could assist States and localities in addressing critical, urban transportation infrastructure problems. States and some universities have established cooperative programs that provide good models (see table3 for an example).

The Federal Role

Of the many AVHS technologies, several are effective, stand-alone systems without significant standardization issues - specifically, traffic-responsive urban traffic control systems and radar-based collision warning and avoidance devices. Traffic-responsive urban traffic control systems are underimplemented in U.S. cities, and more widespread use could bring immediate road capacity increases for congested urban areas, a fact long-recognized in other countries. Additionally, these systems constitute a fundamental building block or base for AVHS technologies. Thus, OTA concludes that real, short-term national advantages could come from Federal policies and programs to encourage implementation of such traffic control systems. Restrictions on using Federal grant money for these systems could be eliminated, and other types of urban transportation assistance could be made contingent on the installation of these systems. In

Table 3.- Ongoing Research in Advanced Transportation Technologies at a Major University

Project description	Sponsor	-Funding
In-vehicle guidance technology	State Advanced Technology Program	$125,000
2. Information and telecommunications approaches to improve transportation systems performance	U.S. DOT	$120,000
3. Research program on characterizing urban network traffic	Major automotive manufacturer	$300,000
4. Driver responses to traffic disruptions	State DOT	$205,000
5. Technological, engineering, and economic feasibility of a high-speed corridor	U.S. DOT	$110,000

SOURCE: OTA, based on State information.

many areas, coordination between systems in adjacent cities and between freeway and arterial traffic is essential. Federal policies could encourage and facilitate the interjurisdictional coordination necessary for such systems.

Complementary advanced driver information and automatic vehicle identification technologies compatible with these systems could lead to more and longer-term safety and capacity advantages. Radar-based collision warning and avoidance technologies promise substantial safety benefits, since they alert drivers to impending collisions, giving them more time to respond. However, an aggressive program of operational testing, demonstration, and investigation into associated legal issues is necessary before these devices can be implemented in everyday use. Liability concerns are raised by private sector developers of collision warning and avoidance devices. Federal participation in testing and demonstration programs of this technology could encourage further technical development and avenues for reducing manufacturers' liability risk. Government leadership in addressing standardization issues early would also aid development of these complementary technologies.

Market incentives are strong for private sector development of in-vehicle navigation devices, particularly those with communication links to the roadway. However, equipment manufacturers are keenly aware of the private sector risk associated with developing these devices, which are dependent for successful operation on beacons, detectors, and other components based in the infrastructure and usually supplied by the public sector. Without assurance that the State or local governments will equip the transportation network with such beacons and detectors, manufacturers are reluctant to press ahead, despite the threat of foreign competition.

Moreover, a second roadblock exists in the need to ensure that navigation maps accurately reflect the street network of a given city. New streets are constructed, existing streets become blocked off due to repair or other special circumstances, and existing streets become altered in unusual ways (one-way to two-way, or vice versa, for example). For safety and congestion reasons, it is important that information on such changes, which are typically coordinated by public sector agencies, be kept current and communicated in a timely manner.

Since market incentives for private sector development of much equipment are dependent on public sector programs, Federal dollars invested in assisting State and local governments could do double duty. They could provide assistance for much needed programs to address urban congestion as well as boost industry by helping create the public infrastructure necessary to communicate with products that are almost market ready. The California Smart Corridor project provides an admirable model of cost sharing for such programs between industry and Federal, State, and local government.

Automatic vehicle identification and automatic vehicle location are highly developed technologies that are already seeing widespread use. The diverse application of these technologies -- both public and private and in other modes of transportation -- calls for flexible systems that are compatible between modes, in different areas of the country (even in other countries), and in areas of application. The Federal Government could provide leadership for development of performance standards for AVHS equipment to ensure such compatibility.

Finally, how drivers interact with AVHS technology is not fully understood. The driving task may be sufficiently complicated by the introduction of in-vehicle devices that drivers become distracted and safety levels are reduced. Attention to safety and human factors is a top priority, and active participation in these areas by Federal agencies responsible for highway safety is warranted.