Information Infrastructure
(Breakout 1 of 2)

Steven Ditmeyer and Gary Ritter, *Cochairs*

The transportation information infrastructure envisioned for the U.S. transportation system in the 21st century has a number of attributes and components, some of which will be provided by private transportation companies and some of which must be provided by the public sector.

- The transportation information infrastructure must include or have access to data bases containing information about the transportation infrastructure, transportation vehicles, and the nature and status of items being transported. The transportation infrastructure data bases must contain information about the physical attributes and capacities of the links and nodes that make up the networks of each of the transportation modes.
- The information infrastructure must generate and have access to information about where transportation vehicles, vehicle crews, cargoes, and passengers *were*. This historical information is needed to perform analyses regarding system performance, capacity constraints, and investment requirements.
- The information infrastructure must generate and have access to information about where and how things *are*. This information must be in real time and must be accurate to permit safe control of vehicles (aircraft, ships, trains, and transit vehicles). Current weather information is mandatory, and information about the current condition of vehicles and cargoes and the status of links and nodes is valuable.
- The information infrastructure must generate and have access to information about where things *will be*. This information, which is needed to carry out the planning required to optimize transportation system performance, can be generated only if accurate information is available on where things *are*. The Federal Aviation Administration's Air Traffic Management System is a good example of a system that generates and uses such information about the future. Accurate traffic and weather predictions are very important.
- The information infrastructure must generate and have access to information about where things *need to be*. This information results from the needs of shippers and travelers as conveyed to the transportation carriers.

- The information infrastructure must have optimization algorithms that determine how best to get things from where they *are* and *will be* to where they *need to be*—safely and on time.
- The information infrastructure must be able to convey instructions to vehicles and confirm that the correct instruction is conveyed to the right vehicle—and only the right vehicle—and that the vehicle receives and complies with these instructions.
- The information infrastructure must be designed with human users in mind.

Issues

For the transportation information infrastructure to be developed with the aforementioned attributes and components, a number of issues must be resolved. Both the public sector and the private sector must be involved in the resolution of these issues.

- *Location.* A nationwide system for providing location information to all modes of transportation with a common reference system and suitable precision is required. The Global Positioning System (GPS) could serve as the basic platform for providing such information. The provision of GPS signals, including differential corrections, to all modes of transportation, with sufficient accuracy, coverage, and integrity for each, must be addressed. This represents a logical extension of the U.S. Department of Transportation's (DOT) ongoing research, engineering, and development activities for GPS.
- *Communication.* Availability of wireless communication channels for command, control, communication, and information uses for each of the transportation modes must be ensured. Current activities at the Federal Communications Commission (FCC) regarding the "refarming" or possibly even auctioning of certain portions of the radio frequency spectrum have the potential for disrupting, delaying, or rendering financially infeasible the development of communication-based control systems for certain transportation modes. Consideration should be given to the establishment of an office in DOT that would represent the interests of the various transportation modes in their dealings with the FCC on spectrum-related issues.
- *Automated equipment identification (AEI).* A uniform method of AEI for all surface freight transportation modes needs to be established to further facilitate intermodalism. Even though this is largely a private-sector issue, the federal government could play a role in encouraging and promoting the establishment of AEI standards.
- *Protection at modal interfaces.* There is an urgent need for the exchange of information at locations where highways and railroads intersect, to reduce the likelihood of collisions. This is an activity that needs to be addressed by the Intelligent Transportation System (ITS) program and raised in priority under the implementation of the Intermodal Surface Transportation Efficiency Act.

Federal Role and Priorities

A strong federal role in exercising national leadership is desirable in the establishment of a transportation information infrastructure. The intent is to have the federal government carry out what state and local governments and private industry cannot, such as the establishment of national and international policies, standards, and protocols. This does not suggest that a prescriptive role is intended. Instead, federal leadership that includes the interests of various public and private stakeholders is desired.

The National Science and Technology Council's draft Strategic Implementation Plan appears to downplay the importance of information technology to the future of transportation relative to other elements of the plan. The relative importance of a transportation information infrastructure should be firmly established and clearly communicated. This, more than anything else, should be a top priority. A good transportation information infrastruc-

ture has the potential to dramatically improve the productivity, safety, and efficiency of the entire transportation system.

The overall federal role should first focus on the establishment of a core transportation information infrastructure. A key foundational element is the creation of spatial data infrastructure. Critical elements of that infrastructure include the following:

- *Spatial data reference systems.* The Department of Commerce, through the National Oceanic and Atmospheric Administration, maintains a first-order spatial reference system that is used as a common reference for various reference systems throughout the nation. A concerted effort to further coordinate and unify these disparate systems may be needed to enhance future compatibility and interoperability. Continued federal efforts to enhance GPS and other positioning technologies is needed in conjunction with spatial data reference models.
- *Geographic information system (GIS) standards.* A clear need exists for common definitions of standard transportation features, attributes, and data. Current limitations and GIS variations limit the utility and transferability of spatial data for multiple uses. A need exists not only to improve the ability to share spatial data within transportation, but also to improve the ability to exchange data with and correlate transportation data with other spatial infrastructure. Efforts should be made to ensure spatial data and GIS compatibility and interoperability between transportation and other GIS application domains, especially those of particular interest to transportation.
- *Spatial data.* There is a federal role in coordinating the development, documentation, and dissemination of unified sets of transportation spatial data. The role is to ensure that core national spatial data elements are developed consistent with an overarching national spatial data framework.
- *Spatial data tools and methods.* New analytical tools and methods are needed to apply spatial information infrastructure. National test beds for assessing and demonstrating the utility of advanced concepts would be useful, especially for investigating how the basic methodological construct of location/time/event can be adapted to serve specific needs, yet conform to common protocols that permit economies of scale to emerge for supporting information and communication systems and technologies. Likewise, spatial data interchange translation and manipulation tools are essential.

Finally, the federal role includes outreach to industry and other public agencies in the formulation of cooperative national plans, programs, and agendas. Priority should be given to the development of new and improved mechanisms for cooperation, especially with regard to opportunities for cost-shared cooperation with industry.

Immediate Priorities

A series of suggested federal priorities emerged during the breakout session. Although it is recognized that this is not an exhaustive list of needs or opportunities, the list reflects pressing concerns within the transportation community. Topics identified for priority attention include the following:

- Unified terms and methods for accurate location and positioning across all modes, in all locations;
- Intermodal system approaches for AEI electronic tagging and tracking and highway-railroad grade crossing safety;
- Intermodal modeling and stimulation tools, such as ITS-oriented planning and impact assessment models, management and control algorithms for total system optimization, and forecasting models for trip planning;

- Communication R&D to develop integration by FCC and DOT of wireless spectrum utilization and allocation strategies, digital two-way wireless data links, and improved transoceanic communications for ships and planes;
- Traffic surveillance technologies and sensor image processing techniques;
- Weather information analysis and associated weather advisory distribution techniques; and
- User interfaces.

And last, but not least, we need

- A better understanding of the human aspects of technology assimilation, and
- Pilot projects to validate research findings and alleviate deployment risk.

No attempt was made to prioritize this list. However, many of the items highlighted relate to areas that have not traditionally been DOT strengths. These include intermodal approaches, digital wireless communication, weather information, and technology assimilation. It is also important to note that these priorities are viewed as additions—not replacements—to those outlined in the draft Strategic Implementation Plan.

The Fifth Mode: Virtual Transportation

The foregoing deals with the requirements of a transportation information infrastructure to be used for improving the performance and capacities of the nation's four transportation modes: air, water, road, and railroad. The rate of change of information technology is so great that any plan of action for developing a transportation information infrastructure today must be flexible and able to accommodate changes in information technology that most assuredly will occur, but that cannot be predicted today.

Nonetheless, these same changes in information technology also may cause significant changes in the ways members of society interact with one another in the course of carrying out commerce and living their lives. There is a reasonable chance that new developments in information technology may actually reverse what have been ever-growing requirements for freight and passenger transportation on earth. The use of information technology to replace the need for physical movement of people and goods can be called "virtual transportation," and the potential of its existence calls for everyone engaged in transportation, in both the public and private sectors, to take it into account when preparing future plans.

Information Infrastructure
(Breakout 2 of 2)

David Wormley and Donald Pryor, *Cochairs*

This breakout group reached three major conclusions:

1. Information infrastructure is a major component of the nation's transportation R&D plan. More emphasis is warranted given the potential benefits from research in this area.
2. Research objectives proposed in this area should be recast to include more integrated, less modally oriented aims.
3. More than any other area of transportation research, information infrastructure research depends on partnerships among all levels of government, the private sector, and universities.

The group was charged with assessing (*a*) the importance of information infrastructure R&D in the transportation R&D portfolio, (*b*) specific research needs, and (*c*) the roles of various organizations in progressing with research, technology development, and deployment. In each area, the group was asked to consider how well its views matched the National Science and Technology Council (NSTC) draft Strategic Implementation Plan. The group consisted of 15 individuals almost equally divided among federal government, state and local government, universities, and commercial organizations.

Information infrastructure can, and probably will, have a pervasive impact, affecting nearly all transportation customers. It is the most likely mechanism on the horizon to enable a major paradigm shift in transportation. Information infrastructure is the enabling technology most likely to make it possible to move off extrapolation of current conditions that would lead to crisis, toward a more efficient, less polluting way of moving people and goods.

The information industry does not yet recognize transportation as a major application area. Transportation is seen as a minor player in U.S. information infrastructure efforts. The national information infrastructure program should encompass efforts related to transportation. The global information infrastructure program, led by the European Community, Japan, and Canada, has begun transportation-related work. Communication and transportation research are more integrated in those countries than here in the United States.

Information infrastructure can be an important factor in changing people's work styles and life-styles and in coupling goods to people. In addition to having a direct impact on operations and management of the transportation system, information infrastructure can open a wide spectrum of other possibilities in home shopping, telecommuting, videoconferencing, and the like. People can make more informed decisions about mobility and goods transport—whether it is necessary to move, what mode to use, and what route to select. Information infrastructure can assist people involved in movement—from mobilizing responses to emergency needs to enabling more productive use of time in transit, thus making otherwise unpopular options more attractive.

The research objectives in the current plan focus on market development, satellite technologies, and system-level understanding. The group suggested these be replaced with a more encompassing set:

1. Enhance effectiveness and integration of existing modes in movement of people and goods;
2. Explore and demonstrate the impact of information technology on future demand for transportation; and
3. Ensure that standards, protocols, and practices develop both in national and international arenas that support effective transportation.

Several specific areas were recommended for federal research emphasis. Intelligent transportation systems is an important thrust that should be maintained and broadened to encompass all modes, without barriers limiting integration. The standards underlying information technology applications—interfaces, protocols, design and operating data, and regulated practices—require constant effort to establish and maintain leadership and enable system development. Research is needed in effective utilization of information in such areas as traffic management and control and in safe navigation in all modes. Research also is needed to understand the future impact of information infrastructure in transportation on society and institutions.

Information infrastructure will develop largely through the private sector. The role of the federal government in information infrastructure is likely to be more similar to its historical role in communication than to its role in physical infrastructure for transportation. It is important to develop partnerships between the transportation and information communities. Global competitiveness requires that the federal government play a role in maintaining a level playing field. Barriers to public-private partnerships should be examined carefully. NSTC should devise mechanisms to involve private-sector, state, local, and other interests directly.

The federal role should be concentrated on basic research and technology development, standards and regulations, and societal impact, including the impact on safety and equity. State and local governments should have a major role in technology deployment, with support from the federal government. Public-private partnerships should play a major role in federal research efforts, national programs, and regional coalitions. New types of relationships must be considered quickly because of the pivotal public role and interest in information infrastructure for transportation.