Realizing ITS: The Vision vs. The Challenge

Throughout its history, ITE has dedicated itself to significantly advancing the state-of-the-science and the state-of-the-practice of managing and operating transportation systems. As we leave one century and enter the next, the Institute is expanding its efforts in these areas, as demonstrated by this issue of ITE Journal, *which is dedicated to transportation systems management and operations.*

BY STEPHEN LOCKWOOD

FROM THE BEGINNING, INTELLIgent Transportation Systems (ITS) has been the focus of evolving and competing perspectives.

As is often the case with new ideas, ITS was first conceived in terms of a *vision*—how new technology and systems could revolutionize transportation (Mobility 2000). The vision was then decomposed in terms of specific *technologies* (IVHS operational tests). It was subsequently structured in a set of *systems* concepts (National Architecture). These concepts required an implementation *program* to support full deployment benefits (Operation TimeSaver). Only later is it apparent that changes in basic transportation *policy* are necessary to more fully realize the potential of ITS (System Operations). Finally, it becomes clear that the policy itself requires adjustment in *institutions* to have the desired strategic effect.

VISIONARIES VS. REALISTS

The range of perspectives about the potential of ITS includes both aggressive long-range views of ITS-driven transportation systems (the "visionaries") and conservative estimates of the short-range possibilities (the "realists").

Visionaries, many from outside transportation, have seen ITS as a transforming concept. Widespread adoption of the new technologies and systems—both infrastructure and vehicle-related—would enable active operations and management of the existing infrastructure and open the way for provision of a range of new service options (some of them priced). These visions (often included in the introductions of ITS plans), involve the possibility of reduced congestion through custom-tailored information, premium service levels via prices, convenient navigation support, voice-actuated web communication, automated regulation and a range of other improvements that imply dramatically improved transportation efficiency and service.

Realists, including many self-described transportation "insiders," have often viewed ITS simply as the latest technology for improving the efficiency of traffic operations and safety-related functions. These traditionalists maintain that limited resources, institutional conventions and conservative policies would limit ITS applications. They see competing missions and fragmented jurisdictions constraining the evolution of seamless regional delivery of improved services.

Is it possible that both groups are right? Is there significant untapped promise in the technology but more barriers in the institutions than might have been anticipated? Perhaps it is still too early in the evolutionary process to discount either perspective. Realizing the unique potential of ITS may depend both on a higher level of ITS deployment than yet achieved as well as an aggressive system-operations approach not yet envisaged by most stakeholders. Furthermore, reaching such an intense level of operations may be dependent on the development of new institutional arrangements and resource commitments.

THE STATE OF PLAY

Most traffic-operations professionals understand that real-time operations and management of regional transportation facility systems requires its own infrastructure (ITS) consisting of combinations of monitoring, analysis, control, communication and dissemination systems related to agency managers, travelers and vehicles—with various components combined into user services. Significant efforts have been made by the U.S. Department of Transportation (U.S. DOT) and other groups, like the Institute of Transportation Engineers (ITE) and ITS America (ITSA), to foster an understanding of the importance of integrating systems for increased cost-

effectiveness. Yet most early deployments have been implemented on a stand-alone project basis, providing individual services on a facility-specific basis.

The U.S. DOT deployment tracking of the basic components of nine fundamental ITS infrastructure elements in the top 75 metropolitan areas indicates the progress to date. About one-quarter of the nation's metropolitan freeways have integrated incident response programs. Almost none of the nation's freeway operations are interconnected with parallel arterials. Less than 5 percent of the nation's signalized intersections are operated as traffic-adaptive. Transit vehicle location technology is still limited to one-quarter of fixed-route vehicles. Despite widespread traffic reporting, less than 12 percent of key facilities in the top 76 metropolitan areas have route-specific data available. Private in-vehicle systems are in their infancy in the United States (as compared to Japan and Europe). MayDay features are standard equipment only in high-end vehicles. Levels of integration among systems are generally less than 20 percent.

Benefits of individual projects are clear and cost-effective, but the broader impact is barely perceptible at the current level of deployment across all ITS components. Progress is being made—but at a pace too slow for visionaries.

VISION RATIONALE: ITS AS A NETWORKED SYSTEM

Visionaries may be handicapped in communicating the full promise of ITS. Missing from the national dialogue is an understanding of the importance of the extension and integration of ITS to the regional scale to capture the "network" benefits of ITS that distinguish it from conventional strategies. These include economies of scale and scope, sequence efficiencies, leveraging effects, supply-demand interaction, joint and common costs, cross-subsidies, network externalities and coevolution features that characterize most complex systems.

This view suggests that the visible impact of ITS within a region will depend not just on how many ITS services are deployed but on the order and combinations of services implemented, the extent of geographic and hierarchy coverage, coordinated multiservice operations and extent of user interaction. Several network-effect features are important to the full ITS vision: "core" ITS elements may have little intrinsic value but can facilitate multiple services (communications support controls); user services increase in effectiveness if they are extended across functional systems (freeway ITS benefits from parallel arterial ITS); user services become more effective as they are extended geographically (multiple jurisdiction trips); intermodalism is promoted via use incentives (preemption); supply control effectiveness can be enhanced by demand-side information (incident information); automation of one function can affect the impact of another function (MayDay and emergency response); and pricing can support ITS service (and vice versa). In addition, certain technological innovations are critical to major advances (coevolution). For example, high-quality/low-cost nonintrusive detection will make arterial surveillance practical and dramatically improve traffic management.

The synergistic features of full ITS system/network implementation cannot be realized through piecemeal implementation. Nor does the mere presence of architecture substitute for a strategy that capitalizes on these unique features of ITS. A strategic approach requires a more consistent focus on strategies that combine the following characteristics:

- Establishment of a network-wide commitment to detection across arterial and freeway systems;
- Deployment of a broad range of ITS systems and services following in an order that would maximally leverage sequence economies of shared system components;
- Effective integration of services: spatially, on a regional basis at the scale of trips and intermodal interchanges;
- Systematic coordination between facility operation actions and information supplied to users;
- Deliberate linkages operationally among infrastructure information and in-vehicle products and services supplying in-vehicle services;
- Focus of infrastructure operations on the performance with highest customer-appeal; for example, with an emphasis on reliability over speed and capacity and public-sector support for private security, navigation and crash-avoidance products;
- Promotion of right-of-way technologies in traffic detection and surveillance to support the creation of multiple competing data sources;
- Aggressive synergy of ITS with closely related developments in traveler information services, workplace flextime, premium services (high-occupancy vehicles, high-occupancy tolls) and electronic payment systems; and
- Deliberate outreach through Internet services to create an informed consumer population energized by a whole new level of information regarding service level, options and responsibilities.

None of these concepts are new. Many are emerging on an individual basis. Yet few of them are systematically combined in state or regional plans or strategies. Part of the problem is that network effects and synergies are speculative and undemonstrated—except retrospectively. This, in turn, is hampered by the current modest state of deployment. Furthermore, the concepts underlying ITS, with the increased focus on management and on providing a broader range of specific user services to identifiable market segments, is at odds with the principal focus of the capacity-construction tradition. The current piecemeal state of deployment does not produce the same type of dramatic impacts as new major-capacity improvements. Therefore, where ITS competes for resources, it is a difficult "sell" among nontechnical decision makers and other transportation-improvement stakeholders. Most published data regarding ITS benefits refer to a limited number of isolated projects or specific new installations. There is limited evidence from more integrated deployments where mutually supporting applications leverage each other. In addition, important payoffs from ITS, such as the value of improved reliability, increased security and improved traveler information are less well known. Others, such as the reductions in delay from incident management, are hard to measure. Despite high cost-benefit ratios, the available data also show that the impacts of ITS tend to be modest, widely distributed and focused on users.

Overcoming these barriers may happen gradually over time or can be jumpstarted by more serious consideration of potential through simulation and study. In either case, a higher level of deployment may be necessary to demonstrate the benefits of a higher level of deployment!

REALIST RATIONALE: THE BARRIERS TO AN OPERATIONS AND MANAGEMENT PROGRAM AND POLICY

Experience to date suggests that a modest level of ITS implementation under a "business-as-usual" approach to deployment of ITS as "technology-and-systems" may be reached within the current organizational and resource constraints of state departments of transportation (DOTs), local governments and the existing metropolitan planning organization (MPO) planning and programming process. Indeed, the initial round of ITS deployment, as described above, has been achieved within existing agency objectives, the current level of resources devoted to operations, the traditional agency roles and relationships, and conventional staffing and technical processes. Inherited program priorities have not been challenged. There has been little formal adjustment in these institutional characteristics.

The visionary perspective suggests that changes in basic transportation policy are necessary to more fully realize the potential of ITS. Fully capitalizing on the system/network features described above cannot take place based on piecemeal implementation. A policy commitment and program setting for management and operations are necessary to provide the needed resources to support full ITS deployment. This would include a coherent systems management strategy within a framework of performance objectives, an authorizing environment that enables regional-level optimization and an organizational capacity that can deploy and actively operate the systems and related demand-management elements.

Such a policy and program are substantially at odds with current conventions of state and local transportation institutional arrangements with their major capital-improvement focus and related institutional arrangements and program structure. While program or budget line items called "ITS" may not be essential to deploying ITS technology, a commitment to systems operations and management implies an ITS program with a variety of interrelated and mutually reinforcing services and systems. This, in turn, requires a systems-engineering initiative, multistakeholder coordination and commitment to real-time operations. Beyond a modest threshold, increasing levels of commitment to operations and management requires a formal program, organization and budget recognition that cannot be easily accommodated within the institutional status quo.

Even the business-as-usual approach to deployment of ITS technology and systems has been dependent substantially on new institutions. However these have been "virtual" institutions that either by-pass or supplement the institutional conventions. These informal arrangements consist of piggybacked project budgets, offline planning and integration, informal institutional arrangements, including stakeholder roles based on personal relationships, and middle-level staff champions.

Therefore, the institutional challenge goes beyond the simple incorporation of new technologies and systems into existing programs. Substantial institutional changes are implied, starting with stakeholder institutions adopting new user-service policy and program concepts oriented toward systems operations and management. This in turn implies adjustments in public-agency roles, activities, budget and staffing, as well as new relationships with system users and private industry.

The broad institutional issue is "To what degree are *existing* institutional arrangements and activities of established transportation entities—state, local, regional and private—an inhibitor to more fully capitalizing on ITS?" A second, closely related question is "What is the nature and scope of the adjustments and innovations in the institutional setting necessary to fully realize the benefits of ITS?"

AN AGGRESSIVE SCENARIO

An aggressive scenario committed to comprehensive, regional operations and management and involving an increased rate of ITS systems deployment as described above is likely to require significant institutional changes. Such changes may never take place (as the "realists" suggest) or it may evolve gradually over many years, at different paces in different settings. In fact, the introduction of new concepts into an existing institutional environment can follow many paths and take place at various levels of intensity.

Realization of the potential of ITS as described above involves development of state and regional program activities that are committed to, and structured for, the provision of ITS user services through the implementation of related systems and technologies. The required program activities then introduce a set of demands on institutions that underlay the enabling policy commitment, program resources and processes, and stakeholder relationships. These institutional challenges facing ITS can be described in terms of six "preconditions" or factors that should be present, including:

1. An understanding of ITS concepts, elements and strategies, and the rationale for institutional change;
2. An authorizing environment formalizing the mission and providing the leadership, decision-making support and organizational structure;
3. New roles and relationships among various stakeholder agencies and entities necessary for effective ITS deployment and operations;
4. A planning and programming process adjusted to accommodate ITS-related strategies and investments competing for available resources;
5. Technology, staff and financial resources sufficient to support the deployment and operations of an ITS program; and
6. New public-private relationships as well as new private-sector business models responding to the specific potential of ITS.

There is no single institutional model through which these institutional challenges can be met. But there is no doubt that change is involved—change that must begin with a vision and education and end in articulated, supportable programs.

ITS—AN EVOLUTIONARY CONCEPT

Deploying ITS as a network system for real-time operations: Is this vision beyond our institutional capacity? An

evolutionary perspective suggests that, like the interstate systems that took 20 years to conceive and plan and 25 years to construct, ITS systems concepts and technology will follow a path of evolutionary development and elaboration.

ITS as a system concept has only been in existence for ten years. As is often the case with new ideas, it is following an evolutionary path: new technologies, systems concept, implementation program, new policy. This transition is still in its early stages. The potential of aggressive operational controls, synergism among technologies and interaction between supply operations and demand management are only beginning to be understood—much less realized—on the ground. The institutional preconditions that will support ITS and a strong operations and management framework remains to be developed. For both the visionaries and realists, there is a big job ahead. ■

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