Transportation System Management and Operations
Mega Issue White Paper
Institute of Transportation Engineers

Background

Short History

The transportation community has experienced the beginnings of a cultural shift toward embedding transportation system management and operation into our culture, work ethic, skills mix and vocabulary. But, what is transportation system management and operations (TSMO)?

Transportation systems management and operations (TSMO): An integrated program to optimize the performance of existing infrastructure through the implementation of systems, services, and projects designed to preserve capacity and improve security, safety, and reliability. The term includes improvements to the transportation system such as:

- Traffic detection and surveillance,
- Arterial management,
- Freeway management,
- Demand management,
- Work zone management,
- Emergency management,
- Electronic toll collection,
- Automated enforcement,
- Traffic incident management,
- Roadway weather management,
- Traveler information services,
- Commercial vehicle operations,
- Traffic control,
- Freight management, and
- Coordination of highway, rail, transit, bicycle, and pedestrian operations.

TSMO is not new. ITE documents show that many of these visions were part and parcel of the definition of traffic engineering when the Institute was founded in 1930. Traffic engineers came into being and created the branch of industry that communicated the physical roadway to people through signs, markings and signals. This profession has a long history of accomplishment and yet has rarely had the respect and prominence of those who design and build roads. While it seems self-evident that using the roadways was the point of constructing them, the "power" in the community has long rested with the designer and builders.

Long before the official completion of the Interstate in the United States, roads were becoming congested. In the US, States and FHWA recognized that even as new Interstates needed to be built, others were in need of maintenance and, in time, reconstruction. New national programs were created to address the growing need to maintain highway infrastructure. Programs included the Reconstruction, Rehabilitation and Resurfacing (RRR) program, the Interstate Maintenance program and Bridge

Rehabilitation program. While maintenance took root as a mission of the federal program, still the attention remained on physical construction and reconstruction.

Additionally, needs within urban areas and in cities were not well addressed as the US Federal-aid program had been built on a partnership with States. Travel in urban areas was difficult and becoming more so. Freeways tended to skirt urban areas or bisect them but did little to address travel conditions for the large number of people within a city center. As congestion increased and traffic conditions began to make news, other Federal programs were instituted such as Transportation System Management – otherwise known as "too small to matter", and Congestion Management Systems

Major urban areas in Europe, Canada, Japan, Australia and in other countries were experiencing similar issues with growing traffic congestion even though many cities had well developed transit systems.

There was a growing realization that the transportation system wasn't working well for travelers. Problems such as congested urban travel and opportunities such as the growth of information technologies began to converge. Intelligent Transportation Systems (ITS) came onto the horizon. In the early days of ITS there was much enthusiasm and excitement about the potential for technology to revolutionize transportation services. Maybe management strategies were no longer "too small to matter".

ITS initiatives and programs got underway in Europe, Japan, the US and other countries. In general, ITS began with an exploration of technologies and their applications through research and operational tests. Within a few years, attention moved into a deployment phase focused on encouraging wide-scale deployment of ITS. The USDOT, for example, set a deployment goal and began measuring deployment through "a few good measures". Even as this was happening the focus broadened to include integration of systems. Systems needed to be integrated to share data and information and, in some case, control. The transportation community learned about architecture and standards and incorporated new skill sets, such as system engineering, into its repertoire. Today, ITS architectures exist in the US, Canada, Europe, Japan and elsewhere.

As with any new technology, the period of early exploration and novelty is followed by finding ways to use the technology in daily application. This requires a critical mass of deployments with which to explore useful applications. The growing mass of ITS deployments, the explosion of the congestion problem, and the difficulties of building new roads made transportation system management and operation an old idea that was new again, but this time backed with glitz.

In the US, transportation system management and operation required rethinking the historical roles of transportation agencies, particularly at the State level. The roles of building and maintaining would expand to include managing performance – possible now through the application of new technologies.

Where We Are Today
As we assess where we are today, in general, we see a fledgling community that has developed a base of stakeholders and investments that are strong enough to keep it alive and viable. A decent foundation is built but much more remains to be done to institutionalize TSMO. A brief survey across the US community reveals the following.

Respectable-sized **ITS deployments** and **transportation management centers** are in place in most large urban areas. Most major urban freeways are instrumented, but few arterials report surveillance and other types of instrumentation. Increasingly, mid-sized metropolitan areas are installing "starter" ITS systems. Other types of deployments are growing as well. More US States and regions are deploying **511** systems mostly as State-based systems. Selected statistics from the deployment tracking database are shown in Table 1.

Table 1. Selected Deployment Statistics

Indicator	Freeway Mgt	Arterial Mgt
VMS coverage	37%	2
CCTV	21	4
Service patrols	47	9
Trav info: real-time status	44	26
Art control based on frwy	30	
Frwy control based on art		12
Frwy control based on incidents	44	
Art control based on incidents		31
511: State-based	18	
511: Metro/area based		6

Development of **regional architectures** is off to a good start, largely in response to US Federal regulation. The use and maintenance of regional architectures is the new issue. State DOTs are showing an increased sensitivity to the mobility impacts of construction **work zones**, partly in response to federal regulation and partly in response to public demands. **Traffic incident management** and **service patrols** are increasingly well established and supported by the public. Even with the growth of ITS deployments, however, **data** is limited in its quality and breadth. Data is still not available that will facilitate widespread, robust management of the transportation network.

Regionalism is growing with the increased recognition of the need to coordinate and collaborate across jurisdictional boundaries. Actual and "virtual" **regional operating organizations** are beginning to form as agencies recognize the value of and need for **regional concepts of operation**. Led by traffic incident management and security concerns, partnerships with **public safety** communities are also growing. There is an intense interest in the use of **performance measures** to assist in investment decisions and in gauging actual performance of the transportation system. We are in the early stages of fully incorporating transportation system management and operations into the transportation **planning process**. There is much discussion within the planning community and predictable struggles to understand the issues and inch toward appropriate responses that can be supported by the community. Slowly, we see **investment** in transportation system management and operation growing and, also changing slowly, is the **reorganization** of transportation agencies to reflect the organizational role of TSMO.

ITE's Role

ITE's Previous Roles
Long before "ITS" and "TSMO" were terms in the community, ITE was providing support for the traffic engineering community. The community of ITE members has a

long history of being on the leading edge of issues and establishing professional practice. Management and operations has long been a major part of ITE's mission, as reflected in the Institute's long-standing definitions of Transportation Engineering and Traffic Engineering. Therefore, it was natural that FHWA came to ITE to help launch the National Dialog on Transportation Operations. The intent was to facilitate the cultural shift toward managing the transportation system. ITE managed the steering committee and arranged the first national conference on operations, "Transportation Operations – Moving Into the 21st Century", that was held in Irvine, CA in 2000.

ITE's Strengths
ITE has many unique characteristics that set it apart from other associations that are active in TSMO. ITE can be most effective if it uses its strengths and positions itself to play roles uniquely suited to its organization. Below is a brief summary of some of ITE's attributes that set it apart.

- **Individual member** based, not organizational based.
- Ability to easily **tap into the knowledge of ITE's 17,000 members** (on-line surveys, roundtables, teleconferences, web conferences, specialty meetings, etc.)
- Ability to **distribute information** to ITE members (ITE Journal, Council newsletters, Executive Digest, Washington Weekly, web site, conferences, ITE bookstore, listservs, direct mail, direct email)
- Ability to reach **local government practitioners**
- Ability to reach **private sector practitioners**
- Ability to work with member **practitioners from a wide array of backgrounds** – State & local governments, private sector (consultants, vendors, integrators), academia, planners, and others
- Recognized within in the community for high quality **professional development**, training and guidelines for professional practice.
- Respected voice in the community that can serve as **an effective advocate for leading-edge issues**
- **Honest broker to gather feedback** from professionals from a variety of backgrounds

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Research ----------------------------------------------Implementation
     TRB                                               ITE
Single audience---------------------------------------Multi-disciplinary
     AASHTO – States
     AMPO  - MPOs                                      ITE
     APTA – Transit operators                          ITS America
     PTI – Local government
Organizations ----------------------------------------Individual members
     AASHTO                                            ITE
     AMPO                                              TRB
     APTA
     PTI
     ITS America
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Positioning ITE for the Future

Overview
With that background, we can reflect on where to go from here to advance transportation system management and operation and to thoughtfully position ITE to play leadership and other roles as appropriate for the Institute. There are many dimensions to TSMO. The objective is to identify those areas and roles for which ITE is uniquely suited to lead. It may be more prudent to identify a few lead roles to play in a small number of areas and focus the collective energy of the Institute.

Three dimensions of TSMO are presented below. ITE may play a role(s) in some or all of these dimensions. Candidate roles and actions are provided for consideration by the ITE International Board of Direction (IBOD).

TSMO Dimensions:
- Technical Topics
- Policy & Enabling Topics
- Audiences

Possible ITE roles:
- Provider
- Partner
- Convener
- Advocate
- Clearinghouse

Technical Topics
There are numerous technical topics related to TSMO. Table 2 contains a matrix that represents a broad array of technical topics and major audience groups who may be served. Each cell of the table includes a draft assessment of ITE's level of effort (high, medium, low) and role. As is evident from the matrix, there is a strong linkage between the audiences in Table 2 and the upcoming discussion of audiences in the following sections.

Below is a summary of recommended key roles for ITE and possible actions.

Traffic Signals, Arterial Management, Corridor Management

Primary Role:	Level of Effort:	Primary Audience(s):	Current Level of Effort:
Provider	High	All, focus on local metro	High

Candidate ITE Actions:
Position ITE to be a leader in traffic signals and arterial management.
- Review current publications, training materials
- Identify gaps
- Work within and outside of ITE to fill the gaps
- Pursue work related to traffic signals that fits ITE's provider role
- Encourage Council activity in these areas

5

- Engage in the US DOT integrated corridor management program
- Develop professional development materials for engineers, technicians and executive managers in support of traffic signal operations
- Become more engaged with the Integrated Corridor Management Program

Freeway Management

Primary Role:	Level of Effort:	Primary Audience(s):	Current Level of Effort:
Partner	High	Local metro	Medium

Candidate ITE Actions:
- Maintain the TMC web site

Traffic Incident Management, Emergency/Security/Evacuation Management, Special Event Management

Primary Role:	Level of Effort:	Primary Audience(s):	Current Level of Effort:
Provider Partner	High	Local metro	High (TIM), Medium (others)

Candidate ITE Actions:
State DOTs are well served through AASHTO. Many other associations are active in these areas. Position ITE to be a **provider** for local government involvement (particularly in metropolitan areas).
- Strengthen distribution of information and materials coming from the NTIMC through ITE's TIM committee
- Tailor materials for local government needs to support improved arterial TIM, emergency response and special event management.
- Enhance the TIM committee web presence to serve as a clearinghouse for TIM materials with a clear focus on arterial TIM.
- Use ITE members' relationships within their communities to involve public safety professionals.
- Continue the work of the ITE Security and Evacuation Advisory Committee.
- ITE should continue partnerships on special events and ensure distribution of information important to metropolitan areas.

Managed Lanes/ Toll Lanes

Primary Role:	Level of Effort:	Primary Audience(s):	Current Level of Effort:
Provider	High	Local metro	None

Candidate ITE Actions:
Initiate ITE activity in managed lanes as they pertain to metropolitan areas and local governments. Managed lanes shows signs of becoming an increasingly used strategy. There is growing interest in a variety of types of managed lanes projects.
- Recommend volunteer activity through Councils to review, assess and suggest ITE action.
- Consider IR on managed lanes, evolving into a RP as experience grows.

ITS Standards

Primary Role:	Level of Effort:	Primary Audience(s):	Current Level of Effort:
Provider Partner	High	Local metro	High

Candidate ITE Actions:
ITE should maintain it's current focus in ITS standards as a **provider** for traffic signal standards, a **partner** on other standards and a **provider** of training on standards.
- Maintain support for and emphasis on standards development, testing, deployment and education.

Work Zones

Primary Role:	Level of Effort:	Primary Audience(s):	Current Level of Effort:
Provider	Medium	Local metro	Low

Candidate ITE Actions
State DOT's are well served through AASHTO. Position ITE to be a **provider** for local government information (particularly in metropolitan areas) on applying the recent FHWA rulemaking and supporting mobility through work zones.
- Working with FHWA and AASHTO, distribute FHWA developed guidance on complying with the work zone rulemaking
- Assess the need to tailor information specifically for local governments on work zone mobility
- Encourage Council support and activity for this area
- Work with FHWA & AASHTO to develop training on the rulemaking, applicable for States and local governments.

511, Weather, Freight

Primary Role:	Level of Effort:	Primary Audience(s):	Current Level of Effort:
Partner, Advocate	Medium	Local metro	Medium (511), Low (others)

Candidate ITE Actions:
- Ensure ITE representation on 511 task force.
- Strengthen distribution of information and materials coming from the 511 task force managed by ITSA.
- Tailor materials for local government needs to support improved 511 use in metropolitan areas
- Advocate for more emphasis on serving local agency needs in 511, weather and freight.
- Address goods movement issues within metropolitan areas as a freight activity.
- Stay engaged in the evolving application of weather information particularly for traffic signal control.

Operations in Transportation Planning

Primary Role:	Level of Effort:	Primary Audience(s):	Current Level of Effort:
Partner	Medium	Local metro	Low

Candidate ITE Actions:

- Further engage Councils in clarification of the issues and development of materials to support metropolitan areas in particular.

Policy & Enabling Topics

In addition to technical topics, there are other policy and enabling topics that are key to moving forward with TSMO. Table 3 contains a matrix that represents some of these topics and major audience groups who may be served. Each cell of the table includes a draft assessment of ITE's level of effort (high, medium, low) and role. As is evident from the matrix, there is a strong linkage between the audiences in Table 3 and the upcoming discussion of audiences in the following sections.

M&O Professional Development

Primary Role:	Level of Effort:	Primary Audience(s):	Current Level of Effort:
Provider Clearinghouse	High	All	Medium

Candidate ITE Actions:
Position ITE as a clear **provider** and **clearinghouse** of professional development for all audiences.
- Working through NTOC, identify job categories and competencies
- Work within and outside of ITE to identify existing materials and to identify gaps
- Develop professional development materials for engineers, technicians and executive managers in support of M&O in areas where there are gaps and/or in emerging areas (done in partnership with universities and others as appropriate)
- Assess the feasibility of developing a professional development clearinghouse, to include financial sustainability.

Performance measures, Regionalism

Primary Role:	Level of Effort:	Primary Audience(s):	Current Level of Effort:
Partner Provider	High	Local metro	Low/Medium

Candidate ITE Actions:
State DOTs are well served through AASHTO. Position ITE to serve as a provider particularly for local metropolitan areas. ITE is particularly well suited to a leadership role in regionalism since ITE members span jurisdictional roles.
- Continue working with NTOC on performance measures
- Widely distribute performance measures paper and encourage use
- Engage Councils to encourage development IR on performance measures and their use
- Continue working with TRB and others to promote regional coordination and collaboration
- Consider an IR on regional coordination for TSMO
- Work in partnership with AMPO and NARC to further advocate and promote regional approaches to transportation mangement.

M&O Business Case, Investment analysis

Primary Role:	Level of Effort:	Primary Audience(s):	Current Level of Effort:
Partner Provider Advocate	High	Local metro	Low

Candidate ITE Actions:

Working through NTOC, position ITE to serve as a partner and provider in developing tools for making the case for M&O investment and advocating for increased investment

- Working with NTOC, participate in the development of the business case tool
- Use ITE members to distribute the business case tool
- Engage council members in this issue
- M&O investment analysis is an emerging topic that ITE should stay involved with. Investment analysis is on AASHTO's SSOM issue list. Engage with AASHTO and other organizations to begin discussions.
- Will require research initially (not ITE's role)
- Initially, ITE can be an advocate and, as the content becomes more clear, a provider, partner and or clearinghouse.
- Will likely be a professional development need eventually

Customer Service, Organizational Change

Primary Role:	Level of Effort:	Primary Audience(s):	Current Level of Effort:
Partner	Medium, Low	Local metro	Low

Candidate ITE Actions:

ITE's role is unclear at this time. AASHTO is providing leadership in the organizational change arena. Customer service is still emerging. ITE should stay aware of this issue and particularly to their applicability to local metropolitan areas.

Audiences

There are three public sector groups who are key to leading change and instituting a pervasive culture of TSMO: State DOTs, local departments of transportation, and transportation planners. Below is a short assessment of each. It should be noted that private sector consultants are key to the success of public agencies who are increasingly relying on the private sector for M&O services such as system design and integration, TMC staffing, software design and maintenance among other functions.

- State DOTs –
    - Served primarily through AASHTO,
    - Medium priority for ITE,
    - Partner role for ITE
- Transportation planners –
    - Served through AASHTO, AMPO, NARC and ITE.
    - Medium priority for ITE,
    - Partner role for ITE.
- Local DOTs-
    - Served through ITE, PTI, APWA

- o High priority for ITE
        - o Provider/partner role for ITE
- Transit Operators
    - o Served through APTA, ITSA
    - o Medium priority for ITE
    - o Partner role for ITE

Local Departments of Transportation or Public Works Departments:
The view of TSMO is different at the local level. On one hand, local agencies have operated their system – more or less – for years.   However, ITS deployment dramatically lags that of the State DOTs (Table 1). As a group, local transportation agencies are very diverse, very large in number, and with no easy communication channel. The range of transportation issues that they deal with is broad and may include:
- o Arterials
- o Pedestrians
- o Bikes
- o Parking
- o Curbside Deliveries
- o Security
- o Special events

Further, they are widely diverse contexts in which transportation issues arise, such as:
- o Central business districts
- o Residential neighborhoods
- o Historic districts
- o Suburban development

In some respects local DOTs have more experience with customer service and the realities of system performance than other transportation professionals, and yet, they have not been comprehensively engaged in many of the ITS and TSMO initiatives and discussions. Many national TSMO initiatives seek to include the perspectives of local agencies by appointing a handful of representatives to committees (511, TIMC, VII, ITS standards and architecture, etc). While helpful, it falls short of comprehensively including them in the fabric of TSMO and its vision.

As a result of fragmentation and the lack of full engagement of this group, we see few national leaders in TSMO coming from local agencies. Local agencies are not heard as a unified voice. They have limited influence on national directions and policies. Their needs are not well understood and there is not a unified voice to advocate on their behalf. And yet, urban areas are where the majority of the population resides and where the bulk of traffic congestion is. Recognition of regional solutions to transportation issues implies the need for local agencies to be full partners at the table. A key difficulty is the lack of institutional underpinnings that support and/or engage local agencies.
- There is no single association that provides "one-stop-shopping" for local agencies as AASHTO does for State DOTs nor is there likely to be one.
- There is no organized research mechanism to address needs unique to local agencies (NCHRP is the research arm for State DOTs although many projects seek to include representatives from local agencies.)
- There is no organized pooled fund study for local agencies.
- FHWA historically was organized to work with State DOTs and there has been limited success in broadening that to include local agencies.

- Further, most local agencies receive little Federal funding and are, therefore, farther removed for federal initiatives and regulatory authority.
- There are too many local agencies to effectively work with them all.
- The diversity of needs between local agencies is very great.

ITE Role:

A number of associations represent local governments; nonetheless, this is a role that ITE could choose to play as both a **provider, partner** and **advocate**. Within the local government arena, there are engineers, technicians, planners and executives. Additionally, the wide ranging needs of local agencies may be better served by addressing large, medium and small urban areas somewhat separately. As identified in the section on technical issues, ITE may choose to focus its resources specifically on local agencies.

Candidate ITE Actions:

- Support the NTOC proposed effort to increase the attention on local agencies and develop mechanisms to better engage local agencies.
- Establish a local government group (or a couple of groups by size of metropolitan area) to provide input on TSMO.
- Provide clearly focused activities within ITE for arterial and corridor management