MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CRITIQUE: THE REGIONAL ITS ARCHITECTURE FOR BOSTON METROPOLITAN REGION

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INTRODUCTION

"Boston is the capital of Massachusetts and the major center of economic and cultural life for all of New England. It is the hub of a metropolitan region which extends into neighboring states, and the center of the regional transportation system, with highway and rail corridors radiating deep into New England."[1] In light of this prestigious place in the region, the Commonwealth of Massachusetts developed a Regional Intelligent Transportation Systems Architecture for the Boston Metropolitan area, in a report dated January, 2005, with a stated goal to "establish a framework for an integrated transportation system in the region."[2] In addition to this overall goal, there are three more specific major objectives to the development of a regional architecture: Improved Interagency Coordination, Cost Savings, and Improved Services to the Public. These objectives are the key elements of the vision of regional ITS architecture deployment.

In an effort to ensure a seamless plan for Boston's ITS deployment, the first step of the architecture development was a detailed needs analysis of the region. This approach "ensured that the systems and technologies recommended for implementation were consistent with the needs and goals of the region."[3] During this needs analysis phase, the project developers identified 7 key regional needs that the stakeholders felt identified the key areas where ITS technology and concepts could be leveraged to assist the region in meeting its aforementioned goals and objectives.

These Regional needs were:

1. Safety and Security
2. Congestion Management
3. Transit Demand
4. Para transit Efficiency
5. Information Sharing
6. Communications Infrastructure
7. Operations and Maintenance.

We will start off by examining the Boston ITS architecture within the pretext of these regional needs analysis and present some general comments about issues with the Boston ITS Architecture. After that, we will analyze the Boston proposed architecture in terms of meeting user-needs using Thomas Horan's proposed framework and how ITS allows the provision of building flexibility into the transportation system. In the appendix, we look at the rules that FHWA sets up for Architecture and Standards and analyze if Boston and Massachusetts regions' architectures are consistent with the national architecture. We also include a remedy to Governor Romney's State Transportation Plan.

With regard to the regional needs, in essence, the stakeholders felt that if these above needs were met, then the goals and objectives of the ITS vision would be on their way to being met. Each sub-section below considers the main initiatives that are planned in the ITS Architecture implementation plan. As part of criticism and contribution, alternative ITS approaches or extra initiatives that would be appropriate to pursue within the next 10-15 years are also discussed. In addition, the discussion in the following 7 sub-sections is summarized in Figure 1, which can be found in the appendix.

BOSTON METRO ITS PLAN REGIONAL NEEDS ANALYSIS FULFILLMENT

Safety and Security.

The regional architecture does an excellent job addressing and enhancing transportation security. In light of sustained national focus, this security focus appears to have relevance in both the near and long-term time horizon. The terrorist attacks on 9/11 changed the transportation world forever, and this is evident in the Boston ITS architectural framework. The report demonstrates a detailed plan for Emergency Management, and includes critical elements to ensure success: updated surveillance coordination, pre-planned coordination, and an Emergency Management Network that attempts to integrate 19 distinct agencies into emergency response. However, despite robust planning and integration into security planning, they could have established loftier goals for future operations.

The main concern with the current security plan, and even parts of the safety organization, is that they dedicated most of their assets to response; the planners seem to have ignored any concept of proactively preventing accidents or incidents. While it is critical to have organized and rehearsed options to react to safety and security incidents, it is equally important, and some may argue more important, to develop measures or methods to prevent incidents from happening in the first place. ITS could have been leveraged to update security measures at the Boston Ports (Sea and Air). Also, based on the recent completion of a high-value target, the central artery tunnels could have benefited from automatic truck credentialing or other scanning measures to reduce their exposure to harmful acts or incidents. Putting these measures in place may prevent major incidents before they happen.

Nevertheless, true enhancements to safety remain a solid hole in an otherwise comprehensive package. Where the planners dedicated significant resources in security enhancements, we feel that the architecture merely scraped the surface on the ITS potential to enhance safety of the transportation network. The Safety issues addressed in the architecture amount to little more than additional transit call boxes, and CAD/AVL for emergency vehicles. In a Boston transportation report, May 2002, the city reported "There are about 38,000 daily trips by bicycle in Boston, 20% of which are work trips (CTPS), and approximately 15% of all intra-city trips are pedestrian."[4] Despite this seemingly large modal share of non-automobile or transit travel, the ITS plan could have spent additional resources to both enhance the network for individual safety, and/or system performance. Enhanced crosswalk detection/signaling, in pavement lighting traffic, and/or are merely examples of current, economical technology that could be used to meet this unique demographical structure present in Boston.

Congestion Management

Congestion in Boston is clearly a huge problem. About 2,700,000 trips either begin or end in Boston every day. Additionally, about 1,000,000 trips originate in the Boston metropolitan region. More than half of these trips are auto trips.[5] This is an enormous number of trips, particularly for an area with a fairly small core region. On average, the average driver was stuck in traffic or forced to drive below the posted speed limit for 51 hours in 2003 according to Texas Transportation Institute (TTI). Additionally, TTI ranks Boston as 13th most congested city in America.[6]

In order to mitigate congestion in the region, it is hoped that some ITS-related measures will help. Appropriately, the ITS Architecture document for the Boston metro region includes numerous initiatives that could at least marginally improve congestion in the city. The primary initiatives that have the potential to improve congestion are the Event Reporting System, Expansion of MIVIS, and the 511 Travel Information System. All these initiatives include essentially a congregation of traffic information and a subsequent dissemination of this information to the various interested agencies as well as to the public.

It is clear, though, that the Boston ITS plan could include somewhat more dramatic measures to improve the dramatic congestion problem. Two such solutions that have been under discussion amongst transportation specialists are congestion pricing and variable parking pricing. The idea behind both initiatives would be to decrease demand for auto travel in the region by increasing the price of such travel.

A Boston city councilor has proposed that a way to decrease congestion on Boston roads is to charge a toll for entry into the more congested areas, such as Chinatown and the financial district. Such a scheme would be similar to that already created in London, for example. The toll level would be on the order of $1-5. This plan has already drummed up support form high-ranking transportation professional. For example, MIT professor Yossi Sheffi showed that he strongly backs the plan in his published op-ed piece in the April 1, 2005 edition of the Boston Globe.[7] Such a scheme appears to an excellent idea particularly for Boston, since it has a relatively small problematic core metro area that could be outfitted with hardware required for such a system fairly easily. The benefits from doing so could be immense.

A second proposal to mitigate congestion in Boston's core is a variable parking pricing scheme. This idea stems from the fact that the particularly horrendous traffic congestion occurs during morning rush and evening rush hours, implying that people are clogging up Boston during their commutes to and from work. Thus, as one application, if the price of parking near large employment areas could be adjusted to increase the cost of auto travel to and from work, congestion should decrease.

Transit Demand

Boston has a fairly extensive transit system, administered primarily through the MBTA and regional transit authorities (RTAs) in the metro region. It is estimated that more that 20% of daily trips in the metro region are taken via transit.[8] However, the ITS Architecture document identifies a need to increase transit ridership by providing better service.

At this point of technological ITS development, we feel that Boston is planning the correct initiatives to improve transit services. Computer Aided Dispatching (CAD), Automatic Vehicle Location (AVL), and Transit Signal Priority are the key initiatives that will improve transit service, with all initiatives planned to be adopted by not just the MBTA, but by the RTAs as well.

Another identified goal for the region is a need for more parking capacity at commuter rail stations. ITS can do very little to address this need, and ITS Architecture initiatives that include electronic toll collection and regional fare card integration at MBTA parking facilities will in fact likely increase demand for commuter rail parking facilities. The only real practical solution to this problem seems to be to build more parking capacity. Such an infrastructure investment would be quite positive since this would encourage transit use. Also, as capacity increases, if space is still an issue at some stations and an ITS solution would still be sought, parking space availability information can be collected via revenue management systems at each commuter rail parking facility and disseminated real-time to pending commuter rail users driving to one of the stations. Users will then have a tool to help them decide, for example, which commuter rail station they will attempt to catch the commuter rail, if any at all.

Para transit Efficiency

Paratransit services are very important to maintain to allow citizens with special needs to have reasonable mobility. One of the regional transportation goals for the Boston metro area is to improve the efficiency of paratransit services. The key initiatives in regards to this service involve the development of CAD and AVL systems. These systems will be important in creating a more efficient dispatching of paratransit vehicles and a faster response time for paratransit services. At the same time, the ITS architecture appears to intend to include all significant transit service into their regional fare card integration scheme and the 511 Traveler Information System. Presumably, these initiatives will encapsulate paratransit service. Given this, along with the clear intention of CAD and AVL deployment plans, the ITS plans seems to be right on target to improve paratransit service efficiency.

Information Sharing

If there is one thing that the Boston Metro ITS Architecture does well, it is its extensive plans for information sharing amongst the local transportation agencies. Just the main initiatives that involve information sharing are the Event Reporting System, Expansion of MIVIS, 511 Travel Information System, and the Planning Data Archive. The first two initiatives will provide the framework that will provide a source of data for the second two. The Event Reporting System will keep all of the transportation agencies in sync in regards to relevant transportation happenings of the region and the MIVIS system will integrate video feeds, allowing for coordinated surveillance. 511 and the Data Archive will use both of these systems for day-to-day comprehensive information dissemination, in the case of 511, as well as the long-term storage of key transportation data and happenings for planning purposes, in the case of the Data Archive.

While plans for information sharing are robust, they will hinge on the successful improvement of communications infrastructure. Efficient communications will be vital. In this regard, it will be useful for Boston to consider such initiatives as the development of a Common Control Center in order to maximize face-to-face communications amongst agencies or the development of a large wireless LAN system in order to allow for a robust communication medium for both fixed and mobile entities. More discussion follows in the Communications Infrastructure and the Operations and Maintenance sections.

Communications Infrastructure

The Metropolitan Boston ITS architecture does an excellent job of focusing resources and effort to enhance the communications infrastructure. However, we feel that they should look more broadly at their options. Multiple agencies agreed that communication and coordination were paramount for them to enhance system operations, and many expressed concern about high cost of telephone lines; thus, the plan appears to link various agencies together with dedicated direct communications for use in contingency operations, resulting in quicker communications at a cheaper price.

This plan, while indeed an enhancement to current operations, and is essential to optimize the benefits of multiple, geographically separates agencies working towards common goals. However, they may find better use of technology could be adapted to solve communications holistically throughout the city. A wireless network, or radio network, rather than connecting the HQ's via wire would allow for communications on the go, requires less infrastructure cost to implement, and arguably retains more possibility for growth in the future.

Boston has a median age of 36.1 years[9], and clearly has a highly established love affair with technology and advancement. It seems that a joint venture could be established with commercial and other government agencies to fund a Boston area Local Area Network (LAN) that could provide the communication backbone to the transportation industry as well as other state agencies and provide a future stream of income as the city becomes more connected. Thus, by thinking outside of the scope of the ITS plan, the Boston transportation planners could provide the initial spark for long term innovation, while providing a real-time cost effective solution to communication problems; where ITS can serve as a catalyst towards institutional change in the transportation, here is an example where ITS can serve as the igniter towards changes in city management, and push bureaucracy into the modern age and beyond.

Operations and Maintenance.

This aspect of the ITS architecture is where we feel that the plan fails to truly meet the needs and requirements of the environment. It has been said that the days of building our way out of congestion are over, and we must now enhance operations to increase capacity and receive gains in efficiency. The Architecture identifies the need for communications, establishes rudimentary guidelines for connectivity, but fails to take the required step of creating sufficient change in the system to plant the roots for future growth. In essence, the Boston plan is for agencies to communicate and plan together, but at the end of the day they each retreat to their corner and play with their own toys, in the big sandbox. They may throw the ball to each other once in awhile, but in the end, they take there ball and go home. This is not an efficient way to build a cohesive team.

One can imagine the multiple agencies, while all well-meaning, are struggling for future funding, and have an inherent amount of self interest during their response. Additionally, these "competing and complementary" agencies will often duplicate efforts in a genuine concern to resolve problems. Until the Boston area or the State of Massachusetts realizes that one active command and control structure is the only way to ensure efficient use of available resources, they will continue to operate sub-optimally and fail to reach their full potential.

The BTD Traffic Control Center is currently undergoing a $3.2 million upgrade. This Traffic Control Center is the nerve center from which BTD engineers can monitor and control traffic throughout the Boston. We argue that, with limited additional funding, the stakeholders in the Boston area transportation enterprise have the ability to transform this center into a regional common command and control center. We imagine a large room that has representative from all major stakeholders. Each of the representatives support the goals of their organization, and are in a unique opportunity to share and receive expansive amounts of information and pass it to the key elements within his/her own agency. Construction areas are managed, emergency vehicles are dispatched, and collectively plans are quickly enacted to ensure a system optimal solution to varying sorts of problems. The US military developed a very similar concept in less than 120 days in Kuwait before Operation Iraqi Freedom, and they were comprised of individuals that had never worked together and were all in a new environment. Boston has none of these issues, but must leap over the institutional protective barriers to truly advance and enhance.

One critical element of the ITS Architecture is the Boston area demographics. In the making of this Architecture, 49 different stakeholders were identified and integrated into the process. The items discussed in this paper were simply the needs that the collective group agreed needed to be met. We felt that although some areas could benefit from more insightful and aggressive planning, the goal of establishing a solid framework is in sight, and the Regional Architecture plan will enhance the transportation enterprise in Boston. Now it is time to turn a plan to action. Often, this is the most difficult phase.

BOSTON METRO ITS ARCHITECTURE STRUCTURE AND SCALE

Some important structural and scale issues should be emphasized in regards to the Boston Metro ITS Architecture as well as the rest of the Massachusetts ITS Architectures. As discussed in the Operations and Maintenance sub-section above, a key decision that was made in Boston was to keep all of the existing transportation agencies intact and to not create a central overseeing organization such as Transtar in Houston or even an agency as loose as TransCom in New York. Although we feel that it would be good for Boston's ITS effort to have a team leader organization, according to Angus Davol, an IBI Group employee and project manager of the MA ITS Architecture projects, the political structure of the Boston region makes significant changes difficult.[10] The regional agencies have established significant power in their focus areas, and each group retains a vested interest in maintaining the status quo, and are inherently adverse to consolidating power or operations. Thus, in an effort to acquiesce the stakeholders, it was decided to keep the current organizational structure essentially intact. However, we suggest that it may be a good idea for the Massachusetts Executive Office of Transportation (EOT) to pass a ruling requiring these organizations to cede some of their power and allow for the creation of an overseeing transportation organization that will coordinate transportation initiatives and operations, including all ITS activities.

Regarding the question of scale, the current situation is that Massachusetts has 4 ITS Architecture documents, defined by the following regions: Boston Metro, Southeastern Massachusetts, Central Massachusetts, and Western Massachusetts. This apparently disintegrated state ITS Architecture was a result of the ITS Architecture bid order release process rather than any pre-planned decision to break up the architecture in such a manner. In fact, if you look at the 4 architectures, a large portion of the three non-Boston Metro architectures appear to essentially be copies of the Boston Metro architecture with just the appropriate adjustments made to account for different associated stakeholder organizations in those regions. It does not appear that the creators of the ITS Architecture documents considered some of the unique needs of each of the 4 regions. In its present form, there are no significant initiatives in the three non-Boston Metro architecture plans that are different from the Boston Metro plans. Thus, the good news is that the 4 documents should very easily mold into one state-wide ITS Architecture. The bad news is that it would be beneficial for Massachusetts to better consider the particular ITS needs of the state outside of Boston Metro.

METRIC FOR DEVELOPING A CUSTOMER-CENTRIC SYSTEM

Thomas Horan suggested the concept of developing a ‘customer-centric’ transportation system. This is a user-driven high performance system, one that is ‘highly dynamic, user-specific, demand responsive, and information intensive’[11]. The vision is to revolutionize surface transportation into a system that enables a close connection between end-users, the information guiding the system, and the system itself. In such a system, information is directly provided to the users. Travelers using the transportation system will also provide information about traffic conditions and traffic options. Thus, users are integrated into the transportation system, instead of being a peripheral ‘demand’ on the system. Horan suggested that the metric for analysis be taken in the following domains: multi-modality travel, flexible travel, emergency services and other services like commercial services.

Multi-Modality Travel

The transportation system extends beyond just vehicle drivers and includes alternative-modality users like those of public transport, ferries, rail, etc. Users are increasingly connected to each other via communication devices through mobile technology, internet etc. Thus, the platforms by which traveler information can be disseminated have increased, and the sources from which people can source for travel information have expanded as well.

With respect to this metric of measuring customer-centric needs, MBTA has an initiative to integrate Regional Fare Cards with non-MBTA transit services like local shuttles, trolleys, as well as with ETC transponders along the Mass Highways and at parking facilities in Boston. Such parking facilities include both metered parking as well as ticketed garages. Such is a first step by which the present ITS architecture addresses user needs in the multi-modal domain.

Flexible Travel

A flexible traveler is someone who can afford to make flexible commute choices, in order to attain an increased reliability in travel time. ATIS systems are useful since they provide reliability service metrics, as well as timeliness of service. Flexible travel on the part of the users can be enhanced if they can tap into accurate ATIS information on trip times. The commercial operators of freight vehicles also benefit from more accurate ATIS information since they can enhance their productivity levels if they know when to avoid peak hours, for example.

From the Boston architecture proposal, there are plans to deploy a regional-based ATIS which includes an Interactive Telephone-based System, kiosks-based and website-based information dissemination points. The main initiative is the "511 Travel Information System"[12]. This system will provide travelers with information consolidated from the roadway and transit agencies, and MassHighway will lead the implementation of this initiative. Users can expect to have information like real-time updates on incidents, planned events like constructions, or special events. The website will provide information like traffic advisories and CCTV images. The kiosks will be located along the MassPike, and provide similar information in addition to tourist information. Contracts have been formalized between SmarTraveler and MBTA as MassPike to provide traveler's information to these agencies.

Other ATIS plans addressing the flexible traveler include Variable Message Sign systems to be deployed on roadways. This VMS will display real-time traffic conditions and routing information, as well as parking space availability.

Emergency Services

ITS can help in the management of emergency responses, since enhanced communications like Global Positioning System (GPS) and cellular communications can facilitate an increased rapid response to emergency situations in the network. On the other hand, transportation users with mobile technology have also played a pivotal role in alerting the network to pressing safety hazards, and thus helped in enhancing more rapid incident management.

Institutionally, different organizations with roadway, transit, and emergency management functions would need to form partnerships in order to deliver efficient emergency services to the users. From the Boston architecture, guidelines have been drawn up with regard to the operational interface between such organizations like the MEMA (Massachusetts Emergency Management Agency), BEMA, MBTA, state police, MassHighway, etc. The proposed Emergency Management Network includes Interagency Communications Network as well as Event reporting and Video Integration Systems[13]. The architecture also proposes to have a central dispatch center to manage real-time tracking data of emergency vehicles, and deployment of emergency call boxes at transit facilities.

Commercial and Other User Services

MBTA is planning to replace the existing fare collection method with a cashless Electronic fare payment method. This will definitely bring unprecedented convenience to travelers. In addition, as mentioned above, this fare card will not only cover the MBTA services, but also be further integrated with other non-MBTA transit services like the Commuter Rail, as well as ETC transponders.

The Regional ITS Architecture for Metropolitan Boston does incorporate end-users into the transportation system at some level. According to the four measurement metrics that Horan proposed, the proposed initiatives are good first steps at integrating customers into the system, and providing such services to customers. Nevertheless, more can definitely be done to take the Boston Architecture to the next level of incorporating users fully into the system. This can be done by getting inputs from users, updating the central databases, and then disseminating the information back out to the users. Such is a 'highly dynamic, user-specific, demand responsive, and information intensive' customer-centric system that future Boston ITS Architectures should seek to provide.

ITS: BUILDING FLEXIBILIY INTO THE TRANSPORTATION SYSTEM

Flexibility is defined as the ability to change the future configuration of a system. It adds value to the transportation system, since it is a way of managing uncertainty in the future by allowing the transportation system to adapt to future changes. Types of flexibility include fiscal flexibility - where moving funding from project to project and from institutions to institutions is easy and allows for making funding decisions a part of the process. Institutionally, flexibility allows for reorganization of agencies, policies to improve operational efficiency and cost-effectiveness of projects, and enabling sustainable skill sets of people to manage a flexible transportation system. A flexible technical architecture allows for long-term increased system capacity additions, and dynamic technology management.

Designing flexibility into the life-cycle of a transportation system is a mammoth task, which requires all of the afore-mentioned areas like fiscal flexibility, institutional architecture flexibility, technical architecture flexibility etc. ITS technologies can be leveraged on to implement 'real options' on the system and hence be used to build a flexible transportation system. "An option is a right but not an obligation to take some action now or in the future for a pre-determined price"[14].

ITS capabilities are built on a foundation of information and communication technologies including computer hardware, software, mathematical models that enable new ways of managing the transportation system. With the usage of these new tools, ITS allows for operational flexibility since transportation systems can be managed and operated at lower costs than if traditional infrastructure investments were made. For example, congestion is a major problem in Boston and it is generally agreed that we can no longer 'build our way out of congestion'. ITS thus comes into play by enabling a more effective use of the existing infrastructure in Boston by building and providing for flexibility into the system. For example, there are initiatives set up to activate Variable Message Signs that can disseminate information to travelers. Electronic Toll Collection is another method by which ITS can be leveraged on to manage congestion more cost-effectively by using the existing architecture more effectively. Providing pertinent information to travelers is also another way to manage congestion, and this can be achieved via the planned 511 Travel Information System, and Event Reporting System.

In addition, ITS also allow for operational flexibility by enabling the sharing of information amongst different organizations and institutions. For example, in Boston, there are plans drawn up which encourages the sharing of information feeds like video images from different agencies. Such initiatives include the Event Reporting System, Expansion of MIVIS, 511 Travel Information System, and the Planning Data Archive. Video feeds will be coordinated, archived and shared amongst different agencies. By sharing, ITS capabilities provide a 'real option' on the system, by allowing the cameras to be switched from daily traffic monitoring functions to management of traffic incidents and security threats. Thus, this cross-cutting institutional sharing of information is an improvement of the communication architecture, and provides an example of how ITS capabilities allow for operational flexibility.

There is no doubt that ITS technologies allows for an increased flexibility on the transportation system over time. Increase flexibility is important to manage uncertainties and changes, as well as providing for more cost-effective solutions to operations and managements. However, a flexible system demands skill sets in management of the new flexible system. Not only do people need to have the skills to design the complex flexible systems, they must also be able to sustain the flexible system in the future. Under changing political climates and stakeholders involved, there comes up the question of whether institutions in charge will bank on the innate flexibility, and be able to recognize the time, when it comes to implement the built-in flexibility by exercising the options available to them, in the future.

RECOMMENDATIONS AND CONCLUSIONS

Boston has established itself as a technology hub, yet has failed to demonstrate an adequate focus on leveraging technology into enhancing existing infrastructure. More can be done to capitalize on the strengths of ITS in order to improve the transportation system in Boston. Some of our recommendations as afore-mentioned to better address the regional needs of Boston include: implementing pedestrians and bike safety initiatives, port and CVO security and safety initiatives, implementing pricing schemes like congestion pricing and variable parking pricings to better mitigate the problem of congestion in Boston, and wireless LAN infrastructure cutting across different agencies to enable better sharing of information. Thus, we recommend that more work be done to integrate advanced ITS technologies into a more efficient management of operations in Boston, while retaining flexible growth opportunities.

Another main hurdle that the Boston region faces is an inherent resistance to a fundamental institutional change. Insofar, the Boston transportation network has been operating as fragmented agencies. Each of these separate agencies has developed efficient processes to deal with the specific area problems, and has even developed ad-hoc relationships to address overlapping areas of responsibility. However, this is still not the most efficient and cost-effective way of operating a transportation system. The main challenge now lies in achieving seamless and optimal integration. Agencies must do more than communicate; they must integrate their management and operations. We thus recommend a Consolidated Operations Center to support this integration of agencies. This fundamental institutional paradigm shift would be difficult due to budget allocations, organization structure, and bureaucratic mindset and it also suggests an inevitable redistribution of power and funding. However, it is a first step, and a necessary one.

Boston planners have taken initial steps to improve the network and integrate ITS into the regional architecture, as seen in the initiatives proposed in the "Regional ITS Architecture for Metropolitan Boston". Nevertheless, more technical and institutional changes are essential to fully realize the benefits that ITS could potentially bring into the transportation system. ITS capabilities present transportation professions with a myriad of flexible and cost-effective options. Now is the time for these professionals to transition to the future by fundamentally changing the transportation system in order to leverage on these opportunities that ITS presents.

APPENDIX

FHWA RULES ON ITS ARCHITECTURE AND STANDARDS

The Final Rule by the Federal Highway Administration (FHWA) on ITS Architecture and Standards is strong in guiding regional architecture development and deployment to match national standards, but needs to go further to ensure full interregional interoperability in the name of truly defining a national standard. The large pieces missing from the Final Rule are federally defined standards for Operations and Management (O&M) of ITS systems, consistency between highway and transit projects, and more realistic timing and funding guidelines. The Final Rule also has several successful components, including the concept that regional architectures can choose their own subset of nationally standardized subsystems depending on that region's needs. The inclusion of both institutional and technical integration strategies in the Final Rule is another positive, requiring roles, responsibilities, operating strategies and procedures, and standards to be laid out before projects begin.

O&M is a new focus of ITS research and development. The technologies used in ITS usually have a much shorter lifespan than traditional transportation network elements, and the increasing amounts of information being gathered require new interagency cooperation or even new agencies. As private companies enter the field in partnerships with public agencies, the question of defining O&M procedures to ensure successful ITS deployment and interoperability is raised more and more. It is a shortcoming that the Final Rule deals only incidentally with O&M, stating in §940.11(c)(7) that O&M procedures and resources must be included in systems engineering analyses. Laying out this O&M framework is an important part of ITS development, but systems engineering only deals with the largest projects, so that individual components of a regional architecture (such as ramp meters at one freeway exit) may never take O&M into consideration during project development.

The Final Rule's framework for cooperation between institutions is a good basis for laying out O&M. The FHWA should then continue with a set of strategies on managing and maintaining both existing and new systems, including how to incorporate technological upgrades, as well as a timetable for converting each regional ITS architecture to meet defined O&M standards. Each region would have the freedom to choose which O&M strategies fit best with the existing and planned system structure. Depending on agency interaction, hierarchy, and funding, number of agencies, and other properties, each region may want to develop a new integrated agency for dealing with network information, or may want to update the existing agencies' roles and perhaps locations. There are of course many options for this, but those options should be developed and included in the federal plan.

To better address O&M in the Final Rule, there should be a provision for adopting new O&M strategies into an existing ITS system. Many portions of the federal ITS legislation are crafted to exclude existing systems from meeting regional architecture technological standards, but the Final Rule should provide for conformity to institutional and O&M standards. The spirit of not penalizing existing systems does not hold here, for every region must adopt new O&M ideas and forge new ties in order to implement a successful regional architecture, so whether ITS is already in the transportation system or not does not affect whether such a transition is feasible or whether it should be exempted. Thus in §940.9(d), what regional ITS architectures should include, a new section should be added: "(9) Operations and maintenance plan for system."

Another issue, addressed in comments on the original 23 CFR Part 940, is that highway and transit ITS projects are given different architecture requirements, as the rules for each have been created by the FHWA and FTA (Federal Transit Administration), respectively. Many of the comments asked whether a single Final Rule from both parties would be more appropriate, and in the interest of a unified regional architecture, the answer is yes. ITS cannot be separated into highway and transit projects; ITS is about regional transportation flows and the entire network, so all parts of the network must communicate with each other and, in the interest of interoperability, with other regional networks as well. For example, a region may desire to link information between a highway and a parallel light rail line, as well as with a subway and commuter bus service along the same corridor.

The other major deficiency in the federal ITS architecture is implementation guidelines. Only two years are allowed for development and implementation of a regional architecture, while many cities have either barely begun to look at ITS, or else have had their own systems for years that would need to be radically altered in concept and/or in design to meet the new federal standards. It would help if §940.11(g) only exempted projects already substantially complete from meeting standards, instead of also exempting projects that have reached final design even if no construction money has yet been spent. That way, a region would not get further behind by having more projects that do not meet the federal architecture requirements, or else it would have to alter its regional architecture to accommodate the projects as well as the national standards.

Another part of implementation is funding, and while new federally funded ITS projects are given guidelines under Part 940, there is no mention within the architecture of how to upgrade existing technology to the new standards. This is hardly in the spirit of a national architecture, as there is no incentive to upgrade older ITS subsystems – in fact, the Final Rule encourages upgrading the existing system without conforming to the federal architecture, so long as the system is within its useful life and upgrades are more cost-effective than conforming. On Interstate highways, the FHWA has a policy that all major projects must meet current Interstate standards, unless exemptions are applied for. This type of rule encourages updating far more than the policies of the Final Rule. Finally, the Final Rule does not even provide an incentive for new projects to meet standards, as "formal adoption of the National ITS Architecture is not necessary" [Federal Register 1450] – federal funding should be tied to meeting the guidelines.

The systems integration strategy guidelines, which the FHWA decided would be addressed on a separate timeline, should have been included in Part 940. Systems integration is important to O&M, as it sets up a framework for interagency communication and decision-making. Without it, the technological aspects of the regional architecture may be implemented without the appropriate institutional changes, making ITS a headache to manage and harder to convert to federal standards when the integration strategy guidelines are finalized. The Final Rule went so far as to acknowledge that Part 940 includes "no mention of the development of an integration strategy" (Federal Register 1448).

There are other assorted drawbacks to the Final Rule. The national architecture defines physical and logical architectures, but does not address the need for design standards; even if regional designs meet standards for interoperability, there is no guarantee that those designs will be compatible with those of nearby regions. The national ITS policy is not in any way integrated with or dependent on national transportation planning policy, which is poor form considering that more and more transportation projects will involve some measure of ITS; the new planning policy should result in an update of Part 940, and the two documents should be consistent in setting forth planning guidelines for projects involving ITS.

Finally, there are still questions, such as how ready different regions and technologies are, and if experimentation with new technologies (such as Automated Highway Systems) might yield better processes and refinement to the federal architecture. Such experimentation cannot take place with federal funding once the rules have been set. Overall, the "Final" Rule is more preliminary, as there is plenty more to be done to improve it before setting national standards.

APPENDAGE TO ROMNEY'S PLAN

Massachusetts is at the forefront of intelligent transportation systems (ITS) development. Massachusetts has SmarTraveler, a telephone system similar to national 5-1-1, in which anyone can find out Boston-area traffic, updated continuously. Roadside cameras and probe vehicles send traffic data back to the system. Also, Massachusetts is currently planning adoption of the 5-1-1 system. A critical part of ITS is the creation of regional architectures, as each region of the Commonwealth (Western, Central, Metropolitan Boston, Southeast) has certain specific needs.

Western Region. ITS can serve motorists on the I-91, US 7, Route 2, and I-90 corridors, the principal highways in this region, providing them with travel information. Transit service for cities such as Springfield and Pittsfield, including paratransit service, is a priority here. With lower population density and more space between municipalities, transit revenue and interagency coordination are the keys to a successful ITS architecture.

Central Region. Rural areas in the Central Region face the same problems as the Western Region faces. In the Worcester area, however, population density means that traditional methods of capacity improvement are not always feasible, so ITS must be used to mitigate traffic and transit delays. Successful use of ITS, such as traveler and parking information in the Worcester area, will promote economic development here. Existing ITS, including emergency management, computer-aided paratransit vehicle dispatching, and closed-loop signal systems, are to be updated and integrated into the regional architecture such that they meet federal guidelines. Proposals involving ITS will also be updated to the national ITS architecture.

Metropolitan Boston Region. ITS needs specific to this region include a prioritization of security, such as public surveillance and securing the Central Artery tunnels; the threat to Boston requires some systems redundancy and very fast response times. Another region-specific need, due to the existence of many public transportation services provided by the MBTA in this region, is transit improvement and optimization, including intermodal transfers and real-time schedule and delay information. As the central hub of Massachusetts, the Boston Region must facilitate interagency communication and be a center for operations and network management.

Various ITS services are already based in the Boston Region, including the SmarTraveler system, and many agencies such as MassPort and the MBTA are located there as well. These elements of the transportation system are expected to help design, implement, and manage ITS throughout the Commonwealth.

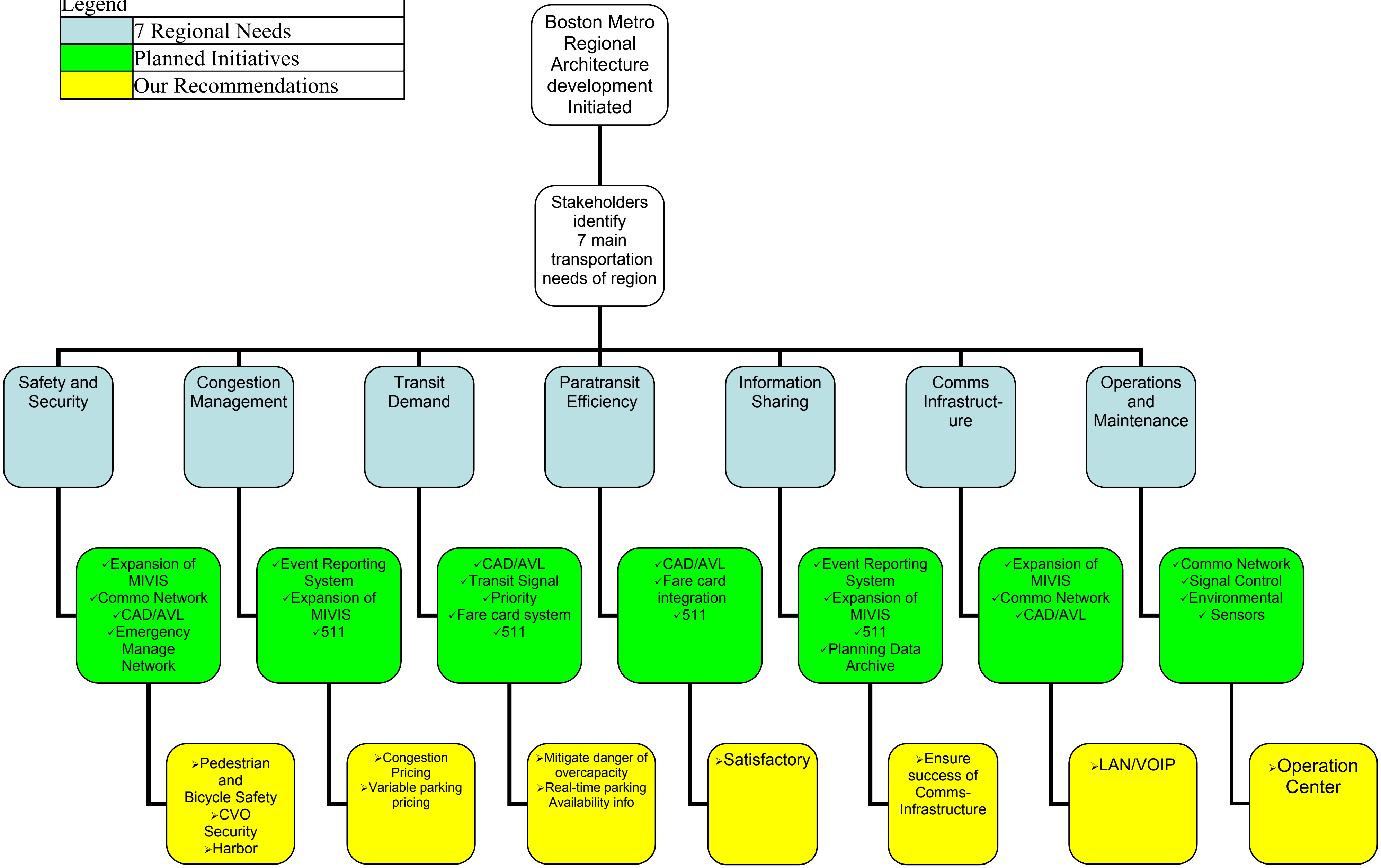
Southeast Region. Seasonal congestion due to Cape Cod and beach tourism is a unique concern to this area. Congestion delays are not limited to major highway corridors, but occur in many towns and cities that are tourist destinations. In addition, tourism impacts the use of transit and, in general, alternative modes of transportation. These seasonal needs can be addressed through ITS via travel information, traffic signal coordination, and intermodal ITS information.

Emergency management also is given special consideration, as severe storms necessitate orderly and efficient evacuations. ITS can be used to warn travelers and residents of evacuations and give route information. To successfully implement ITS in the Southeast Region, interagency and inter-municipal coordination must be reached. The long and narrow nature of Cape Cod presents a challenge in this regard, that must be overcome via communications technology.

All Regions. Emergency management is a key priority of Massachusetts ITS – making sure personnel can respond to incidents faster, and reducing interactions between emergency vehicles and other transportation system users. There are congestion issues around all Commonwealth cities that can be addressed by ITS, including providing bypass route information and estimating severity of delays. Paratransit services can also be improved by ITS, helping improve the way Massachusetts addresses the Americans with Disabilities Act.

Figure 1: **Boston Regional Needs, Planned Initiatives, and Our Criticism/Additional Recommended Initiatives**

Legend	
	7 Regional Needs
	Planned Initiatives
	Our Recommendations



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