EXECUTIVE SUMMARY

The transportation network has increased problems such as traffic congestion, accidents, and pollution. Attempting to combat these growing problems through conventional methods has proved to be less efficient due to limited space and resources. Realizing that an efficient highway system was necessary for stimulating the economy, Congress created a program, Intelligent Transportation Systems (ITS), from the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991. The function of ITS was to research, develop, and deploy innovative solutions to mitigate these transportation problems.

ITS has received $1.3 billion of federal support since FY 1991.[**13**] This amount has largely been for research and development of ITS systems. With the federal support, ITS has delivered projects such as emergency response/rescue systems, Traffic Signal Control Systems, and Never Lost Systems. An estimated $209 billion is needed to fully support ITS until 2011, but 80 percent of this expense is expected to come from the private industry.[**1,20**]

Many critics question the overall effectiveness and large-scale future funding of ITS. Section 3.0, Conflicts To Funding ITS*,* expresses majority of the political criticism towards ITS developed from a General Accounting Office (GAO) report, published February 1997. The GAO report found four issues that were considered challenges to widespread deployment of ITS: Standards, State and Local Officials' Knowledge of ITS, Cost Effectiveness, and Funding Priorities.

Section 4.0, Conflict Resolutions--The Road To Implementation, lists responses to the GAO report and describes why widespread deployment of ITS systems is ready to be set into motion.

Though widespread deployment of ITS systems was envisioned in ISTEA, no monetary language was constructed to support such a deployment. Multi-year funding is vital to see the program through deployment. Committed multi-year funding is also essential for research and development of future systems--as these two processes can not be completed in one year.

INTELLIGENT TRANSPORTATION SYSTEMS

1.0 INTRODUCTION

You check your watch for the fourth time in the past five minutes. Finally, it is five o'clock on a Friday afternoon and you are on your way out of the office. Rural Americans may already be in the luxury of their homes, but if you are like millions of Americans who live in cities, it may take you hours just to drive home. How much of your time is spent in gridlock or idled traffic? Do you think about how the environment is effected now or for future generations from all the vehicle emissions you emit in traffic? Are you thinking of running the next yellow light to get home a little faster? How many times do you slam on your brakes during rush hour to avoid an accident? How many accidents are there because of congested traffic?

- *Traffic congestion costs the American people an estimated $100 billion each year in the form of lost productivity.*
- *In 1993, traffic accidents claimed 40,115 lives and injured an additional three million people.*
- *Vehicle emissions are a major cause of air pollution. Trucks, buses, and automobiles idling in traffic emit tons of pollutants each year and waste billions of gallons of fuel.* [**1**]

We use our highways everyday to commute to work, school, retail stores, etc. We depend on them for shipping services (e.g., mail, produce, gas), vacations, and national defense. Our past philosophy to assist increased transportational needs have been to expand our national highways and roads, but how effective or feasible is laying new asphalt or building new roads in modern society? There are innovative and cost efficient solutions waiting to be implemented to battle increasing congestion, accidents, and pollution.

1.1 Historical Contributions to Our Transportation System

1.1.1 Safety In Maintenance

Historically highway acts have contributed several thousand miles of highways and interstates that are employed for commerce everyday. To travel in a safe and efficient manner, highways and interstates need to be in fair condition (30 percent of all fatalities are linked to poor road design and conditions).[**2**] However, maintenance of existing surface transportation infrastructure is inadequate to compensate for its

utilization. “The federal Department of Transportation (DOT) estimates that it would take $57 billion annually to maintain current conditions (we spend only $37 billion) and to improve conditions to optimal levels would require investment of $81 billion a year.” [**3**]

1.1.2 Increase Vehicle Capacity By Expansion

The traditional response to succor our fight against traffic congestion was to construct additional roads to dilute traffic. This approach cannot mitigate the nation’s problem any longer. Limited space and materials make constructing new roads uneconomical. These concepts combined with the fact that our national highway system has been completed, make the traditional response to combat traffic congestion obsolete.

1.2 Technology For Yesterday’s and Today’s Problems

How should automotive pollution, traffic congestion, and accident factors be dealt with today? The resolution should not be limited to investing time into policy for stricter air and traffic standards, and then spending billions of dollars on new automotive technologies to meet these standards. Implementing existing innovative technologies will make the use of highways more efficient: less automotive pollution, traffic congestion, and accidents.

The United States is the most technologically advanced nation in the world. Despite these advancements, there is a lack of technology when it comes to the country’s roads and highways. It is possible to be more efficient, less accident prone, and more environmentally safe through technological advancements. The challenge is to use innovative solutions which will be neither too difficult to deploy nor too expensive for their value.

A program, Intelligent Transportation Systems (ITS), was established in 1991 to address these inefficiencies by researching, developing, and implementing innovative solutions. Since its recent birth, ITS has already impacted society by enabling people and goods to move more safely and efficiently throughout our transportation system. A few examples are:

- **Traffic Signal Control Systems**--Lexington’s coordinated, computerized traffic signals have reduced “stop and go” traffic delays by about 40 percent and reduced accidents by 31 percent.
- **Freeway Management Systems (FMS)**--Minneapolis’ ramp metering has increased freeway speeds by 35 percent and freeway capacity by 22 percent, and reduced accident rates by 25 percent.
- **Transit Management Systems**--Kansas City has saved $400,000 in operating expenses and cut the response time under emergencies from four minutes to one minute by installing Automatic Vehicle Location (AVL) technology on 200 buses.

- **Incident Management Programs**--Chicago's Incident Management Program has reduced incident clearance time by 50 percent.
- **Electronic Toll Collection (ETC) Systems**--the Oklahoma Turnpike's ETC system minimizes driver delays and has cut the state's operational cost per toll lane by 91 percent.
- **Regional Multi-modal Traveler Information Centers**--Montgomery County, Maryland, broadcasts traffic conditions on major roadways to 180,000 homes via cable television. [**4**]

Christine M. Johnson, Director of the U.S. Department of Transportation's Intelligent Transportation Systems Joint Program Office, mentioned the opportunities from ITS systems have not been communicated to "average citizens."[**5**] The purpose of this report is to increase public knowledge of ITS applications and deployment status.

2.0 LEGISLATION BACKGROUND

2.1 A Cry For New Legislation

The nation's transportation system has been deteriorating since its creation. From waterways for steam boats, rail road tracks for trains, to streets and highways for automobiles; all of these transportation modes are plagued with a disease of deterioration and regression. Each infrastructure component that is constructed has a finite life span. The amount of wear-and-tear, over and above the design levels of these transportation systems, decides how much quicker they will breakdown.

The accumulation of silt is the major problem that plagues the inland waterways. This build up enables only the older ships, which have less cargo capacity of today's modern ships, passage.[**3**] The principle "upkeep" expenditure of the rail system involves the maintenance of box cars and rails. Poor maintenance, traffic congestion, and accidents are problems of the national highway transportation system.

Many of the cracks or stresses that lead to structurally deficient roadways are not detected easily, and require close observations by experts. Transportation planners and engineers believe that much of the highway infrastructure is nearing the end of its service life and needs major rehabilitation or replacement. "For example, according to Federal Highway Administration statistics, 23 percent of the 575,000 highway bridges in the United States are structurally deficient and another 19 percent are functionally obsolete."[**6**]

Understanding the nation's reliance on our transportation system to compete in a global marketplace, combined with the poor status of that system; congress viewed rebuilding our transportation system as a priority.

2.2 ISTEA

In the past, funding for different modes of transportation came from separate acts (e.g. Highway Act). Understanding that these acts set the foundation for our current mobile economy, they did little to help preserve the transportation system once the system was completed. Realizing that our vast transportation network was in demand of rebuilding, Congress enacted the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991.

ISTEA was a six-year bill to fund different modes of, or intermodal, transportation. The bill began in FY1991 and ends September 30, 1997--the date when all funding for transportation will cease unless a reauthorization bill is passed. The uniqueness of ISTEA was its approach to transportation issues from an intermodal standpoint. The bill not only funded modes of transportation, but it also funded the more environmental side of transportation including bike trails and air quality control (CMAQ programs[1]).

To "take care of what we have" left of the transportation systems, ISTEA attempts to improve the transportation network by making it more efficient by reducing automotive pollution, traffic congestion, and accidents through technology. Sections 6051-6059 of Title VI, Part B are designated to developing innovative solutions to combat our growing transportation problems.

Under the original ISTEA language, Section 6052(a) established the scope of the Intelligent Vehicle-Highway Systems program.

> (a) Establishment.-Subject to the provisions of this part, the Secretary shall conduct a program to research, develop, and operationally test intelligent vehicle-highway systems and promote implementation of such systems as a component of the Nation's surface transportation systems.[**8**]

A move to change the name of Intelligent Vehicle-Highway Systems came in 1992. ITS America[2] and Congress wanted a name for the program which better reflected the intermodal aspects of the program. The program designed to benefit transportation from an intermodal perspective was renamed Intelligent Transportation Systems.

2.3 What Are The Applications of ITS Systems?

[1]"CMAQ. Congestion Mitigation and Air Quality Program. This program considers projects or programs which will contribute to attainment of National Air Ambient Air Quality Standards (NAAQS) with a focus on ozone and carbon monoxide. Only ozone nonattainment areas receive CMAQ funds."[**7**]

[2]ITS America is a public/private coordinating organization in partnership with the U.S. Department of Transportation to guide the research, development, and deployment of activities associated with ITS.[**9**]

To fulfill the goals of improving transportation quality, the ITS program has started work on a variety of applications[3]. A Congressional Budget Office study, published in 1995, grouped these applications into categories as follows:

- *Travel and transportation management*, aimed at keeping highway traffic flowing smoothly, using such measures as clearing accident scenes and removing broken-down vehicles from roadways, controlling traffic signals, and providing information to travelers about routes and services.

- *Travel demand management*, to reduce travel by single-occupancy vehicles by providing information in advance about traffic conditions and the availability of transit services and ridesharing opportunities.

- *Public transportation operations*, to give transit users information enroute, enable transit officials to keep track of the locations of their vehicles and monitor ridership demands, and enhance the safety of transit operations.

- *Electronic payment*, to facilitate travel by allowing travelers to pay for parking, transit fares, and tolls with "smart cards."

- *Commercial vehicle operations*, to facilitate interstate trucking by substituting electronic clearance for paperwork now needed to comply with state requirements, weighing trucks at highway speeds instead of requiring them to stop at weigh stations, monitoring functions to enhance safety and improve efficiency, and providing for immediate notification of authorities in case of traffic accidents, especially if hazardous materials are involved.

- *Emergency management*, to provide for quick notification of authorities and prompt response in emergencies.

- *Advanced vehicle control and safety systems*, such as collision avoidance warnings or automatic braking controls and automated highway systems, on which vehicles could move without drivers.[**10**]

3.0 CONFLICTS

Adequate multi-year funding is essential for future development and deployment of ITS systems. Funding increase is needed for wide scale deployment of existing ITS systems. Even though wide scale deployment is envisioned in the establishment of

[3]For more information concerning projects and applications of ITS, refer to the Congressional Budget Office, October 1995 study, Chapter 3.

ITS in ISTEA, no monetary language for funding such a deployment has been constructed. Multi-year funding is also favored because the research, development, and deployment of such systems are goals that can not be achieved in a year and need stability. That is what made ISTEA a suitable legislation for ITS; it committed funding for the program for six years.

The current legislation, which invested six years of federal money into ITS, expires September 30, 1997. A superseding multi-year transportation act failed to be passed by a House or Senate Authorization Committee this summer[4]; however, the House and Senate Appropriations Committees voted on their appropriation bills for transportation for Fiscal Year 1998. The appropriation committees assumed a dollar amount expected for transportation in the upcoming year. The assumptions were based on previously appropriated money under ISTEA's legislation. If the authorization committees deem a larger amount suitable for the next authorized legislation, then the appropriations committees may adjust their approved bill for compliance. The final appropriation bill will likely set an expenditure amount between the House and Senate Appropriation Committee's bills.

On June 24, the House Appropriations Committee passed its appropriations bill for FY 1998 which provided $12.48 billion in discretionary budget authority for transportation. The House's bill allocates $94.6 million for ITS. This amount is less than the FY 1997 level by $27.4 million.[**11**]

On July 22, the Senate Appropriations Committee passed its appropriations bill for FY 1998 which provided $12.8 billion in discretionary budget authority for transportation. The Senate's faith in ITS was displayed in the bill by allocating approximately $5 million more than the FY 1997 budget for the ITS program.[**12**]

With a vast number of issues to deal with, politicians rely on divisions of government (i.e., Congressional Research Service, Congressional Budget Office, or General Accounting Office) to supply information to create opinions on these issues. In order to learn more and justify the ITS program, the General Accounting Office (GAO) was asked to perform an assessment of ITS.

The GAO published a document (GAO/RCED-97-74) titled *Challenges to Widespread Deployment of Intelligent Transportation Systems* in February 1997. Within the document are reported issues hindering the deployment, and in turn perhaps future funding of ITS. For this report, the issues from the GAO document are captioned as Standards, State and Local Officials' Knowledge of ITS, Cost Effectiveness, and Funding Priorities.

[4]An authorization bill is necessary to authorize government spending on an issue. Then an appropriations bill will establish exactly how much is spent on that issue.

3.1 Standards

ITS is comprised of two types of standards: architectural and technical. The architectural and technical standards are necessities for widespread deployment of ITS services.[**13**]

Architectural Standards: The architectural standards identify the basic components, the components functions, and the components relationship with each other. The ITS architecture was completed in July 1996.[**13**]

> *A commonly used metaphor in describing the architecture is a home stereo system. The stereo industry has determined the overall architecture--that is, the functions that will be performed by the speakers, amplifier, radio receiver, compact disc player, etc.,--as well as how these systems will interact to produce a desired sound. Within these constraints, the manufacturers may produce a wide array of product types, and an individual may design a stereo system suiting his/her own needs and budget.*[**13**]

Technical Standards: The technical standards explicitly define how the components will communicate with one another.[**13**]

The GAO reported that the standards are essential to deployment, and questioned effective deployment of ITS systems until these standards have been completed. The report states that "ITS technical standards will not be completed until 2001."[**14**]

3.2 State and Local Officials' Knowledge of ITS

GAO discussed potential for ITS deployment with transportation officials in 10 large urban areas. The officials mentioned concerns about the lack of knowledge of ITS at the state and local level, that most transportation engineers do not have the technical skills needed to operate and maintain advanced ITS computer and telecommunication technologies.[**13**]

The feeling that new skills are needed was also voiced by the executive director of the American Association of State Highways and Transportation Officials at an ITS conference. His conclusion was based upon most transportation agencies employing primarily civil engineers and not electrical engineers or system integrators.[**13**]

The latter paragraph reemphasizes the first paragraph, that most transportation engineers do not have the technical skills for operating ITS technologies. This is because transportation engineers have civil engineering degrees, and therefore are trained and experienced in solving traffic problems by conventional methods.

3.3 Cost Effectiveness

Does saving billions of gallons in fuel, reducing accidents, saving money in operational expenses, and creating jobs account for the $1.3 billion ITS has received in funding since Fiscal Year 1991? Many critics argue that proof of benefits from ITS is necessary before future federal funding is continued. "Several officials told [the GAO] that quantitative data proving that ITS could reduce traffic congestion or make transit more reliable would enable them to secure funding for ITS projects."[**13**]

Presenting cost benefit analysis could help politicians justify spending millions into ITS projects. However, since ITS is relatively new; long-term benefits have not been completely determined.

3.4 Funding Priorities

With many deteriorated roads and bridges in need of repair and considered high priorities, the transportation planning officials whom the GAO spoke with, were concerned that there would be little funding left for ITS projects. When GAO questioned the officials as to whether a large-scale federal funding program was appropriate for ITS, six of the 10 supported the idea. Those in support stated that without a large-scale effort from the federal government, ITS deployments would not be executed due to higher priorities. The four in opposition thought that "dedicated ITS funds would be too prescriptive and might result in poor investment decisions." [**13**]

4.0 CONFLICT RESOLUTIONS--THE ROAD TO IMPLEMENTATION

4.1 Standards

The notion of completing the technical standards before ITS services are capable of being deployed is a fallacy. The technical standards are an essential part of ITS deployment, but they are items that will not be finished. "ITS standards development is a continuing process, from determination of need through development, approval and publication followed by use, maintenance and modification." "The process depends upon all five major ITS players[5] working together on a continuing basis to define standards needs, develop new standards, maintain and revise existing standards, and retire standards no longer useful to the ITS community." This process has begun for ITS and will continue beyond 2001.[**15**]

[5]The five major ITS players are defined as ITS America, U.S. DOT / FHWA, Standards Developing Organizations, Private Sector, and User Communities. [**12**]

The architectural standards were completed in July 1996. To overcome the obstacle of needed skills at the local and state level, DOT has begun a training effort to ensure that transportation officials nationwide have an adequate understanding and knowledge of the architecture.[**13**] With this knowledge, state and local officials can integrate ITS systems in an area to receive the maximum benefits of ITS.

To summarize the status of ITS Standards:

> The 1996 Survey of Standards Needs conducted jointly by ITS America and U.S. DOT identified a number of areas as very high priority, requiring ITS standards development initiation within one year. Standards setting for all of the very high priority areas are underway. To date, 10 ITS-specific standards have been developed and published. By December of 1997, 12 more standards will be published, and another 13 standards will be drafted and ready for balloting.[**15**]

ITS standards should not be used as a deterrent for implementing ITS programs. The areas mentioned above were recognized as high priorities because certain communities realized the benefits of combating traffic problems via ITS and stated a need for certain standards. In some communities, even without standards in place, deployment is already occurring.[**16**]

4.2 State and Local Officials' Knowledge of ITS

ITS systems are innovative solutions created to supplement the conventional methods of fighting traffic congestion, accidents, and pollution. Realizing that new skills would be required to operate and manage ITS systems, DOT, through a two year cooperative agreement with PTI[6], has started an outreach and training program for local agencies.[**13**]

> Under the agreement, PTI/DOT have created a network of local government elected officials to help share information between DOT and local officials. DOT has also developed an ITS five-year capacity-building strategic plan for DOT staff, state highway agency staff, metropolitan planning organization staff, and other local government staff. The goal is to expand the knowledge of ITS among federal, state, and local transportation officials and to create a cadre of highly trained ITS professionals who are able to plan, design, implement, operate, and maintain ITS technologies.[**13**]

"Ultimately, the success of ITS will depend on two critical factors: funding and technical training."[**18**] Acknowledging this statement, the superseding legislation to ISTEA

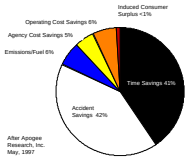
[6]"Public Technology, Inc. - advance technology in local governments. task force areas: telecommunications, environment, energy, public safety and transportation (ITS)." [**17**]

should provide government support for retraining state and local employees. Encouraging retraining of the engineers at the state and local level is a leadership role the federal government should take in the implementation of ITS programs.

4.3 Cost Effectiveness

To promote and justify funding of ITS, benefits from ITS projects can be found in a variety of publications. For the latest news on ITS, publications such as *Traffic Technology International*, *ITS Quarterly, ITS America News,* and *ITS America Intermodal News* are available*. Benefits of ITS*, published by Mitretech in 1996, provides cost benefit analysis. The most recent cost benefit analysis document was published by Apogee Research, Inc.[7], in May 1997.

Figure 1. Basic Metropolitan ITS Infrastructure Benefits (1996-2015)



The Apogee study found that the broad range of products and services offered from ITS will complement and enhance the performance of traditional systems, and show substantial benefits in the area of safety. "Moreover, expenditures on metropolitan ITS systems and a rapidly expanding market for ITS applications should continue to produce operational and economic benefits at an increased rate over the next 20 years."[**20**]
Apogee centered its study of ITS around three subjects: Benefits and Costs, Markets, and Economic Consequences.

4.3.1 Benefits and Costs

Just as machines brought cheaper operational costs to automotive factories, and computers brought more efficient means of communication to business, ITS can produce high level of benefits relative to the costs involved for transportation.[**20**] Examples noted by Apogee are:

[7]"Apogee Research specializes in ITS planning, including work in economics, finance, and market analysis. The firm has unparalleled success in ITS deployment through the use of innovative finance, public-private partnerships, communications, and institutional coordination for public and private clients."[**19**]

- ITS infrastructure will generate an overall benefit-cost ratio of 5.7 to 1 for the group of nearly 300 metropolitan areas examined in this [Apogee] study, with even stronger returns to the top 75 most congested cities (8.8 to 1).
- Present value of ITS benefits should exceed $250 billion over the next two decades.
- Unlike traditional highway capacity investments, safety benefits of ITS investments are equally as important as those derived from congestion reduction (see Figure 1).
- Though the level of benefits varies, ITS investments generate positive returns for all classes of metropolitan areas.[**20**]

4.3.2 Markets

Markets refers to the private and public sector of the economy. Markets for ITS services have grown rapidly over the last five years, and over the next 20 years, ITS products and services are expected to grow and cumulate nearly $420 billion.[**20**]

ITS calls for approximately $209 billion of investment from now and the year 2011.[**1**] However, it is estimated that the market for the private sector will grow to 80% of all investments into ITS through the year 2015.[**20**] As the market grows, private industry will find it more financially rewarding to invest in ITS.

4.3.3 Economic Consequences

Eliminating or shrinking the support for ITS would not be reasonable. Eliminating funding all together would equal almost a complete waste of prior invested federal money. Based on the Apogee study, ITS has proven results, and has potential to drastically improve our economy with $300-$350 billion in direct economic impacts and by creating 600,000 jobs over the next 20 years.[**20**]

Shortening the amount of federal aid to the program would lengthen the time it takes to receive substantial economic return. Without a commitment from the federal government, the private sector might shy away from investing into ITS, based on little assurance of the government's future intention with the program.

The economic outlook of the program goes beyond a national viewpoint. Japan, Germany, and United Kingdom are just a few countries also developing ITS standards and programs. The sooner ITS systems are established in the United States, the sooner our country has a chance to compete in establishing an international ITS standard. Acting as the model for ITS systems would give the U.S. an edge in the international transportation market with more opportunities for financial benefits.

4.4 Funding Priorities

The ISTEA legislation lacked any language to fund a widespread deployment of ITS systems; however, critics demand to see results. If ITS would have difficulty getting its projects funded on a small scale attempt due to other transportation areas (such as bridge and road maintenance), then a large-scale funding program would be appropriate.

How much does ITS services demand for complete deployment of basic ITS services across the nation by 2005[8]? ITS America, in its ISTEA Reauthorization Principles, said that it could reach the goal of deployment of basic ITS services by 2005 with "an amount equivalent to at least five percent of total surface transportation outlays." Five percent of the total surface transportation outlays means five percent of the total surface transportation budget.[**21**]

5.0 CONCLUSION

Basic ITS systems are ready for widespread deployment, and in reference to the Apogee study, has potential to drastically improve our economy. ITS should receive the credit deserved by a successful program and should be rewarded as such, through adequate funding, to support ITS efforts in its current and future roles in transportation.

Why should the federal government be responsible for the success of ITS? ITS systems are built upon a relationship between computerized vehicle components and public infrastructure. The federal government is needed to maintain the stability of the public infrastructure and to facilitate the communications between the two. The timing is right for the federal government to ensure an inner operable system, and secure the United States' lead in ITS technology. Our mobile transportation systems today have enabled us to have an edge on national and international trade. However, other countries such as Korea which have more traffic congestion than we do, are looking for substantial gains through currently available ITS systems to improve commerce.

To realize the benefits of ITS presented by Apogee, it is important that adequate government support be considered in the next transportation bill. Some bills, such as STEP 21 and TEA 2, do not contain references to the ITS program.[**22**] More important than considering ITS language in a bill, is that Congress responds to the call from every American to produce and pass a transportation bill, before ISTEA expires on September 30, 1997. That bill is necessary to fund the transportation network--that every American depends on daily.

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[8]The ITS National Surface Transportation Goal is "to have complete deployment of basic ITS services for consumers of passenger and freight transportation across the nation by 2005."[**18**]

LIST OF ACRONYMS

CMAQ	Congestion Mitigation and Air Quality Program
DOT	Department of Transportation
ETC	Electronic Toll Collection
FHWA	Federal Highway Administration
FMS	Freeway Management Systems
GAO	General Accounting Office
ITS	Intelligent Transportation Systems
ISTEA	Intermodal Surface Transportation Efficiency Act (of 1991)
NAAQS	National Air Ambient Air Quality Standards
PTI	Public Technology, Inc.
STEP 21	Streamlined Transportation Efficiency Program for the 21st Century
TEA 2	Transportation Empowerment Act

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Intelligent Transportation Systems

-IMPROVING YESTERDAY'S INFRASTRUCTURE WITH MODERN TECHNOLOGY

~ A GUIDE TO APPLICATIONS, CREDIBILITY, AND READINESS ~

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