U.S. Department
of Transportation

Intelligent Transportation Systems

The National Architecture for ITS:

A Framework for Integrated Transportation into the 21st Century

What's the National Architecture Program really all about?

The program to develop a consensus National Architecture for Intelligent Transportation Systems (ITS) has been a three year effort to map out an organized approach to implementing, in a consistent manner across the US, the various ITS services envisioned for the next 20 years or more.

The Architecture is the first step toward achieving the vision Congress put forth for ITS in 1991: a vision of a seamless, multimodal, national intelligent transportation system that would have a consistent character across the country.

Throughout 1993 and 1994, the Architecture Program examined in detail four alternative architectures—four very different concepts for creating the nationwide ITS infrastructure, developed by four independent teams—and held them up to the scrutiny of a broad range of technical experts and various ITS stakeholders across the country. Out of this process emerged the two teams that have jointly completed the development: Rockwell International, and Loral Federal Systems.

The National ITS Architecture Development Program was sponsored by the U.S. Department of Transportation in partnership with the Intelligent Transportation Society of America (ITS America).

For more information on these and other issues related to the National ITS Architecture, visit the USDOT ITS web site: http://www.its.dot.gov., or the ITS America web site: http://www.itsa.org.

Read On: This booklet provides a general introduction to the National ITS Architecture —and the program that shaped it.

What IS the National Architecture? What Does it do for ITS?

ITS is basically all about **information**—the collection, sharing, processing, and redistribution of information—to help move people and goods better. Information lets travelers make better decisions, and helps improve the efficiency and safety of the various elements of our surface transportation infrastructure: for example, transit systems, freeways, toll facilities, rail intersections, truck regulatory facilities and rural roadways.

Management of information to control an operation—and better serve its customers—is an idea that's very familiar to the air transport and rail freight industries…or, for that matter, any major organization that has to streamline its operations and get better performance at lower cost.

An architecture, then, is a framework that lays out the boundaries, players, and strategies for that process of information management. And in the case of ITS, it has to have an intimate knowledge of the way transportation works as well, in order to get the new systems to work well with the existing ones. The framework can then guide us in developing standards and making deployment decisions that will result in efficiency, economies of scale, and national interoperability.

The architecture will help all of us 'sing off the same sheet of music' as we develop Intelligent Transportation Systems—help us to use a common vocabulary, think about a common set of issues, and, eventually, use a common set of design and interconnection standards, as we gradually tie our advanced transportation systems together and create new ones.

In many ways, the National Architecture—reflecting as it does a fair consensus of the diverse parties that have had a role in its formation—provides a master plan for deployment of ITS technologies and systems into the next century…much as the architecture (or master plan) for the Interstate Highway System influenced a half-century of transportation development.

How Did a National Architecture Develop?

The primary need for the National Architecture development program was identified in the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), the law that formalized the ITS program:

The Secretary *[of Transportation] shall… promote compatibility among intelligent [transportation] technologies implemented throughout the States.*

The emerging ITS community, through the Intelligent Transportation Society of America, recommended that the U.S.DOT sponsor development of a National Architecture. The Department decided to tap the expertise of industry to competitively develop a master plan for ITS evolution that would fulfill this charter.

The flow of ideas that generated the Architecture as it now stands went something like this:

- **ISTEA**
- **USDOT**
- **ITS America**
- **public stakeholder forums**

Public discussion of what ITS can do for its users…and how much the ITS program should tackle

The National ITS Program Plan: USDOT/ITS America

Description of the Goals of the ITS Program * ITS is defined by 29 individual 'user services'

Architecture Development Teams

Basic system architecture:
- functions required by ITS
- information required by ITS
- physical components that would implement ITS functions and exchange information

USDOT Architecture Development Teams/National Consensus Process

Consideration of practical deployment issues
- real world constraints
- analysis (costs, etc.)
- broad user feedback

Architecture Development Teams

Coherent picture of a future for ITS: master plan and recommendations to facilitate speedy deployment

Next Step

- Standards
- Education
- Training

DEPLOYMENT

Architecture: A user-driven effort

What Does the National Architecture Look Like?

As we've mentioned before, an Architecture is basically a framework ...a way of thinking about the world of transportation and information management. Here's a quick overview of how the architecture developers eventually wound up seeing the world.

ITS relies on interactions among three 'LAYERS' of infrastructure:

1 **Transportation Layer** This is the 'real world'—our physical ITS infrastructure that is beginning to evolve and will continue to evolve. This layer identifies the key players and establishes a common terminology for existing and future ITS subsystems. The Architecture is made up essentially of ❶ travelers; ❷ vehicles; ❸ management centers; and ❹ roadside 'stuff'.

2 **Communications Layer**
This is the information infrastructure that connects elements of the transportation layer—it's what puts the 'System' in ITS—and allows coordination and sharing of information among systems and people. The Architecture carefully lays out ❶ what types of information and communication are needed to support various ITS services; ❷ how data should be shared and used by which physical entities (subsystems); and ❸ what types of standards are needed to facilitate this sharing.

3 **Institutional Layer** Our socioeconomic infrastructure of organizations and social roles—reflecting jurisdictional boundaries and including agencies at all levels of government, private companies, and those that may be impacted by ITS services. Activities on this level include developing local policy, financing ITS, and creating partnerships to guide ITS deployments. The architecture does not propose modifications to this layer, acknowledging that there are reasons why things are the way they are...and that they are very difficult to change. It does recommend who should be connected to whom; and what types of things they need to be telling each other.

Some Architecture Terms and Definitions

This is a basic set of 'vocabulary' used to describe the Architecture.

Users, Sensors, and Signals. There are about 55 classes of ITS 'external entities' as identified by the architecture—these comprise a range of people (travelers, operators, managers, planners), organizations (DMV's, emergency response, toll authorities, freight depots) and things (sensors, signals, and vehicle mechanical systems) that exchange carefully defined information with those systems we collectively call 'ITS.'

Subsystems. The next step the architecture takes is to divide up ITS into 19 separate Physical Subsystems. These are things that we think of as being logically independent entities: for instance, personal vehicles, traffic and transit and emergency management centers, various roadside devices, etc. The advantage of making these divisions is that the functions of ITS can be distributed systematically, and information can be shared between subsystems to take advantage of synergies (e.g., busses can gather information about roadways that's useful to traffic management centers and others).

Interfaces. Connections, or Interfaces between subsystems can be described after it's clear what each subsystem does, and what information it needs from the other subsystems. The architecture produced interface specifications that determine the nature of communications links needed between subsystems...which gives the technical community the data they need to gradually develop meaningful standards for these interconnections (which we'll discuss later).

Equipment Packages. The concept of Equipment Packages puts a little bit of 'flesh' on the architecture. In order to envision how ITS might develop (and how much it might cost a user), the architecture developers identified a bunch of 'things' that someone could actually buy to make ITS happen; these are called equipment packages at the unit level (e.g., transit on-board fare collection system; in-vehicle two-way communications system; an information kiosk; at-home information access system; etc.)

Communications: At the Core of ITS

Communications is what puts the 'S' (for 'system') in ITS. Ever increasing availability of communications, together with fast, cheap, and small computing technology, have combined to create an unprecedented opportunity for ITS development. The types of linkages advocated by the Architecture include:

- Wide Area Broadcast—such as your car's FM radio receiver
- Wide Area Two-Way Wireless—allows more advanced, interactive services over, for example, a cellular phone link.
- Dedicated Short Range Comm—such as the emerging wireless vehicle 'tags' for toll collection
- Vehicle-to-Vehicle Comm—which will someday help in avoiding collisions and improving vehicle control
- Wireline Comm—regular 'phone line' stuff: phone, fax, modem, video, and high speed data networks

ITS Market Packages: Bringing the Architecture to Life

Of course, no one system or 'gizmo' that anyone buys is going to deliver some ITS service all by itself...so the architecture groups equipment into sample **Market Packages,** each of which describes a group of elements (equipment packages) that need to work together to deliver a particular ITS service.

For example: *for a single ITS user service such as Dynamic Route Guidance, a range of equipment is needed:*

The traveler requires two equipment packages in the vehicle: a route guidance system; and some way of receiving dynamic information (for example, an enhanced FM radio that can receive data; or, better yet, a two-way interactive means of requesting and receiving routes from an ISP);

An Information Service Provider (ISP) needs to have the equipment to calculate route/traffic information, and the means to communicate it to the customer;

A Traffic Management Center (or other source) needs the means of collecting this information, and providing it to the ISP.

This suite of equipment together makes up the market package, the whole of which is necessary to deliver the service (dynamic route guidance) to the user.

The architecture recognizes that a diverse marketplace will result in a whole *range* of market packages that can deliver this user service. One should be able to find equipment with different levels of capability at correspondingly different prices.

Intelligent Transportation Infrastructure (ITI) and the National Architecture

The architecture development teams have taken extra steps to highlight which market packages represent the key components of the ITI—the essential ITS infrastructure that the Secretary of Transportation has urged the nation's metropolitan areas to install by the year 2005. The link between architecture and ITI is highlighted in *Building the ITI: Putting the National Architecture into Action*, available from the ITS Joint Program Office. This document describes the ITI in more detail, and presents the architecture's recommendation on how to integrate the systems that make up a full ITI.

What Does the Architecture Tell Us?

1 **First and foremost, the architecture is a tool,** or—as we've said—a framework, for the people who will be designing and building the systems that will deliver ITS services to YOU, the user. For instance, designers can find guidance on how much and what kind of information needs to be produced by a traffic management center, and what other systems it needs to be shared with.

The Architecture doesn't prescribe any technologies, designs, or policies; it provides the *framework*. It gives each ITS center, or system, or information device an understanding of how it should relate to the rest of ITS.

2 **The architecture documents prioritize** the key ITS market packages that bring the greatest benefits early on, and recommends early deployments: things that make sense to do NOW due to technological or institutional opportunity, high potential benefits, market demand, or pre-existence of required standards.

3 **The architecture leaves maximum room** for and strongly encourages private sector participation in ITS. Functions are broken out such that there is maximum opportunity for private sector involvement in providing ITS services—especially in the role of an Information Service Provider, or ISP..

4 **The architecture proposes implementation scenarios** that first enable islands of ITS development NOW, which leverages existing assets and ITS investments; and then encourage increasing integration over time, resulting in progressively greater interoperability and capability among systems.

5 **The architecture developers** have recommended policy to USDOT, for example: ❶ facilitate achievement of nationwide interoperability by supporting standards development efforts; ❷ maintain the architecture over time; ❸ develop education and training programs for the local ITS implementor; ❹ provide 'handbook'-type guidance for ITS design and procurement; and ❺ emphasize evaluation of systems to determine actual benefits derived from investments.

The Next Step: STANDARDS

As with any system, the critical links in ITS are the interfaces that tie together the different parts of the system—for instance, between a vehicle and roadside equipment; between a traffic management center and a company that repackages raw travel data; between two vehicles cruising on an automated highway.

The Architecture describes these interfaces to be *descriptive*, not *prescriptive*, in keeping with its role as a *framework*. There is not enough detail that a hardware or software designer could actually build a given interface. There are many different ways to design any architecture-defined interface.

That's why consensus standards are needed. No matter how solid an architectural master plan is, you still need standardized parts to carry out the plan consistently throughout the country.

Even as the architecture development program is drawing to a close, there are several efforts underway to ensure that the details of each key interface are being assessed, discussed, and debated in various forums. The architecture has already helped us in this debate by at least framing the appropriate subjects for discussion—a step forward! Over the coming years, agreement will be reached on how to standardize each of the critical links in the architecture which will ensure that users can interface with systems in a consistent way.

The architecture will continue to evolve, to accommodate new user services and—by guiding the standards development process—to preserve the ability of systems to operate throughout the nation.

Some of the organizations actively working on standards for ITS, with support from USDOT, include:

AASHTO	American Association of State Highway and Transportation Officials
ASTM	American Society of Testing and Materials
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
SAE	Society of Automotive Engineers

What Happens Next?

The development of the National ITS Architecture is only a first step toward the vision of a fully integrated, intelligent transportation system covering the nation.

USDOT intends to provide as much help as possible to the transportation community over the next few years, to ensure that the general concepts and technical information generated during development of the national architecture are adopted and put into practice.

For example, preliminary guidance has been produced on how to use the architecture to achieve integration of the Intelligent Transportation Infrastructure components. Other information to follow may include:

- Suggestions for applying the architecture, for ISPs who wish to provide ITS services
- Suggestions for public agencies involved in ITS procurements
- Tips on introducing architectural considerations in the transportation planning process
- Architecture tools for system designers

In addition, USDOT will continue to work with ITS America, its members, and state chapters to educate, assist local implementation efforts, and encourage public-private partnerships.

If you want to know more about the architecture itself, you can read the program documents for all the raw data, supporting assumptions, and analysis that the program has generated. These represent the formal establishment of the architecture—that is, the product that the government sponsored. It reflects a combination of good data, fact-of-life considerations, best-guess assumptions, and consensus input from the thousands of stakeholders who have been consulted over the past three years, in over 50 public forums.

However, these alone are far from enough to help the country realize the benefits of the architecture.

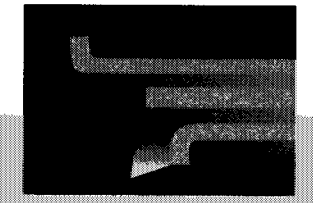
It will take time until a critical mass of transportation decision makers and practitioners have a good feel and a common understanding of key aspects of the architecture...that is, the architecture will take some time to be **mainstreamed** into the regular and established transportation planning and procurement processes.

Where Can I Get More Information?

The document *Building the ITI: Putting the National Architecture into Action* is available from the Joint Program Office (*see back cover for contact information*).

Periodic updates on the National Architecture program, standards development, and other ITS activities will be posted on the DOT web site on a routine basis, as are frequently asked questions on a variety of subjects.

Copies of the original architecture documentation are available through ITS America, and at reading rooms around the country. An electronic version is available on the Internet, and soon on CD-ROM. Information on all this can be obtained through the ITS Joint Program Office and ITS America (*see back cover for contact information*).



The 29 ITS User Services

Travel and Traffic Management

- Pre Trip Travel Information
- En Route Driver Information
- Traveler Services Information
- Route Guidance
- Ride Matching and Reservation
- Incident Management
- Demand Management and Operations
- Traffic Control
- Emissions Testing and Mitigation
- *...and coming soon: Highway-Rail Intersection*

Commercial Vehicle Operations

- Commercial Vehicle Electronic Clearance
- Automated Roadside Safety Inspection
- Commercial Vehicle Administrative Processes
- On-Board Safety Monitoring
- Freight Mobility
- Hazardous Material Incident Response

Public Transportation Management

- En Route Transit Information
- Public Transportation Management
- Personalized Public Transit
- Public Travel Security

Electronic Payment

- Electronic Payment Services

Emergency Management

- Emergency Vehicle Management
- Emergency Notification and Personal Security

Advanced Vehicle Control and Safety Systems

- Longitudinal Collision Avoidance
- Lateral Collision Avoidance
- Intersection Collision Avoidance
- Vision Enhancement for Crash Avoidance
- Safety Readiness
- Pre-Crash Restraint Deployment
- Automated Highway System

For more information about the architecture program—and how the architecture will continue to keep the vision for deployment of ITS—please contact:

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