Regional Architecture

Executive Summary

Knoxville ITS Communication Master Plan

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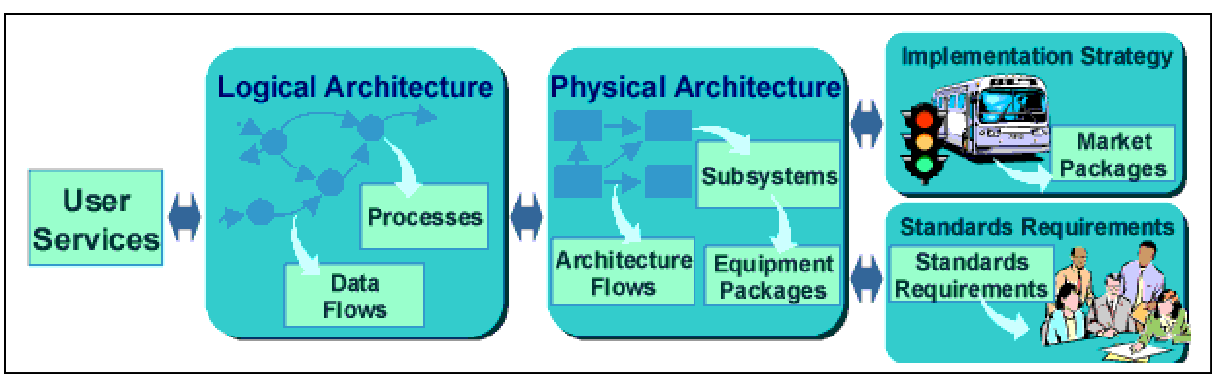
1 Background

The Knoxville Urban Area serves as a major crossroads on the national highway network, both in terms of private and commercial travel. The area lies within a broad valley in east Tennessee near the Great Smoky Mountains. Knoxville is at the center of the eastern United States, situated within a one-day driving time of 75% of America's population. The Tennessee Department of Transportation (TDOT) and jurisdictions in the Knoxville area have been implementing Intelligent Transportation System (ITS) technologies to improve traffic management for the area. ITS is the application of advanced information processing, communications, vehicle sensing and traffic control technologies to the surface transportation systems. The objectives of ITS are to promote more efficient use of the existing highway and transportation network, to increase safety and mobility, and to decrease the environmental impacts of congestion.

The next step after the Strategic Assessment has been to develop the regional architecture and the concept of operations to help further define the roles of the agencies and the planned ITS deployment in the region. This will provide a vision of regional ITS and traffic management for the Knoxville area.

The National Architecture version 3.0 divides an ITS architecture into several defined components as depicted in Figure 1. The intent of this technical memorandum is to define the User Service Bundles/User Services, Logical Architecture, Physical Architecture, implementation strategies, and required standards and Inter-agency Communication Interfaces. This will enable the Knoxville area stakeholders to develop an implementation plan to follow for deploying the desired user services.

Figure 1 – Components of National Architecture



User Service Bundles and *User Services* define the ITS user requirements that will assist in resolving the transportation problems for the Knoxville area. The *Logical Architecture* defines the Processes (the activities or functions) required to support the ITS User Services. The *Physical Architecture* forms a high-level structure around the processes and data flows in the Logical Architecture. The Physical Architecture defines the Subsystems and Terminators that make up an intelligent transportation system. *Equipment Packages* break up the subsystems into deployment-sized pieces. *Market Packages* represent slices of the Physical Architecture that address specific services like surface street control. Standards Requirements provide a view of the essential data requirements for on-going ITS standards activities. The *inter-agency communications interfaces* provide the media required to share the data between the different subsystems and agencies.

2 Regional ITS Roles

In order to define the operational roles in the region, a list was developed that proposes the operational roles for the principal agencies for the Knoxville Region. This was developed by allocating functions identified in the ITS Strategic Assessment and based on interviews with stakeholders. Generally, TDOT has the role of managing freeway operation, regional ITS planning and contract administration. The local City and County transportation agencies role includes surface street management and ITS planning. A lead agency within each sub-area will be responsible for managing the Sub-area Transportation Coordination Center. The Transit agencies role will be managing and maintaining the Transit operation. They will also be involved in the ITS planning and construction for Transit.

A joint role between all the involved agencies will be the Regional Transportation Management operation. This operation will be responsible for the coordination and management of the ITS operations and activities for the overall region.

3 Deployment Approach

3.1 Sub-area Deployment

The local agencies all have or are planning deployment of local transportation management systems, primarily centered on traffic signal management and traveler information services. This concept provides each sub-area group of agencies with the ability to share information and better manage sub-area transportation needs without having to be fully integrated with a regional system. A Coordination Management System in each sub-area would provide a central repository of sub-area pertinent information. This information would be used for sub-area agency coordination. Because each agency and sub-area would follow the overall regional architecture, each sub-area would also be able to integrate with the regional coordination center, when feasible and necessary. Jurisdictions that do not participate in the initial deployments can always integrate in the future as funding is available and needs dictate. By following the regional architecture, becoming a member of the network can be accomplished at any time.

3.2 Freeway Management System Deployment

TDOT is moving forward with deployment of the initial freeway traffic management system. Pilot projects and subsequent expansion projects are envisioned. Freeway traffic management generally embodies the field elements that provide surveillance, detection and information dissemination to fulfill the functional requirements.

3.3 Transit Management System Deployment

The transit authorities in the region are continuing to expand and improve their operations. Examples include providing vehicle tracking, and automated transit information. As the authorities continue to expand and improve their systems, links to the regional or sub-area networks will be needed.

3.4 Regional Transportation Management System Deployment

It is envisioned that a Regional Transportation Management System (RTMS) will emerge from the deployment process. The RTMS would be a functional "agency" sponsored by State and local agencies. Its primary purpose would be coordination of transportation management on a regional level.

4 User Service Bundles and User Services for the Knoxville Area

The concept of user services allows system or project definition to begin by establishing the high level services that will be provided to address identified problems and needs. A logical grouping of user services provides a convenient way to discuss the range of requirements in a broad stakeholder area. For the Knoxville area the applicable bundles include:

- Travel and Traffic Management,
- Public Transportation Management,
- Electronic Payment,
- Emergency Management, and
- Information Management.

At this time, the Knoxville area does not envision implementing Commercial Vehicle Operations and Advanced Vehicle Safety Systems. By utilizing the National ITS Architecture, these two bundles are not precluded from being implemented at any time in the future.

5 Logical Architecture

The logical architecture defines the functions that are required to perform ITS user services and the information or data flows that need to be exchanged between these functions. Data Flows identify the information that is shared by the Processes. Data flow diagrams (DFD) provide a graphical view of how the processes and data flows fit together. While particularly useful to system developers, the logical architecture is essentially a stepping stone toward defining the physical architecture.

6 Physical Architecture

The *Physical Architecture* partitions the functions defined by the Logical Architecture into *system*s, and at a lower level, *subsystem*s. Subsystems are composed of *equipment packages* each with specific functional attributes. Equipment packages are defined to support analyses and deployment, and they represent the smallest units within a subsystem that might be purchased. The Knoxville Physical Architecture diagram presents the relevant portions of the National ITS Architecture for the individual subsystems. The diagram includes only the architecture subsystems, equipment packages, system terminators, and architecture flows that are most important to the operation of the subsystem in order to simplify the presentation. The market packages provide an accessible, deployment oriented perspective to the national architecture. They are tailored to fit - separately or in combination - real world transportation problems and needs. Market packages collect together one or more Equipment Packages that must work together to deliver a given transportation service and the Architecture Flows that connect them and other important external systems.

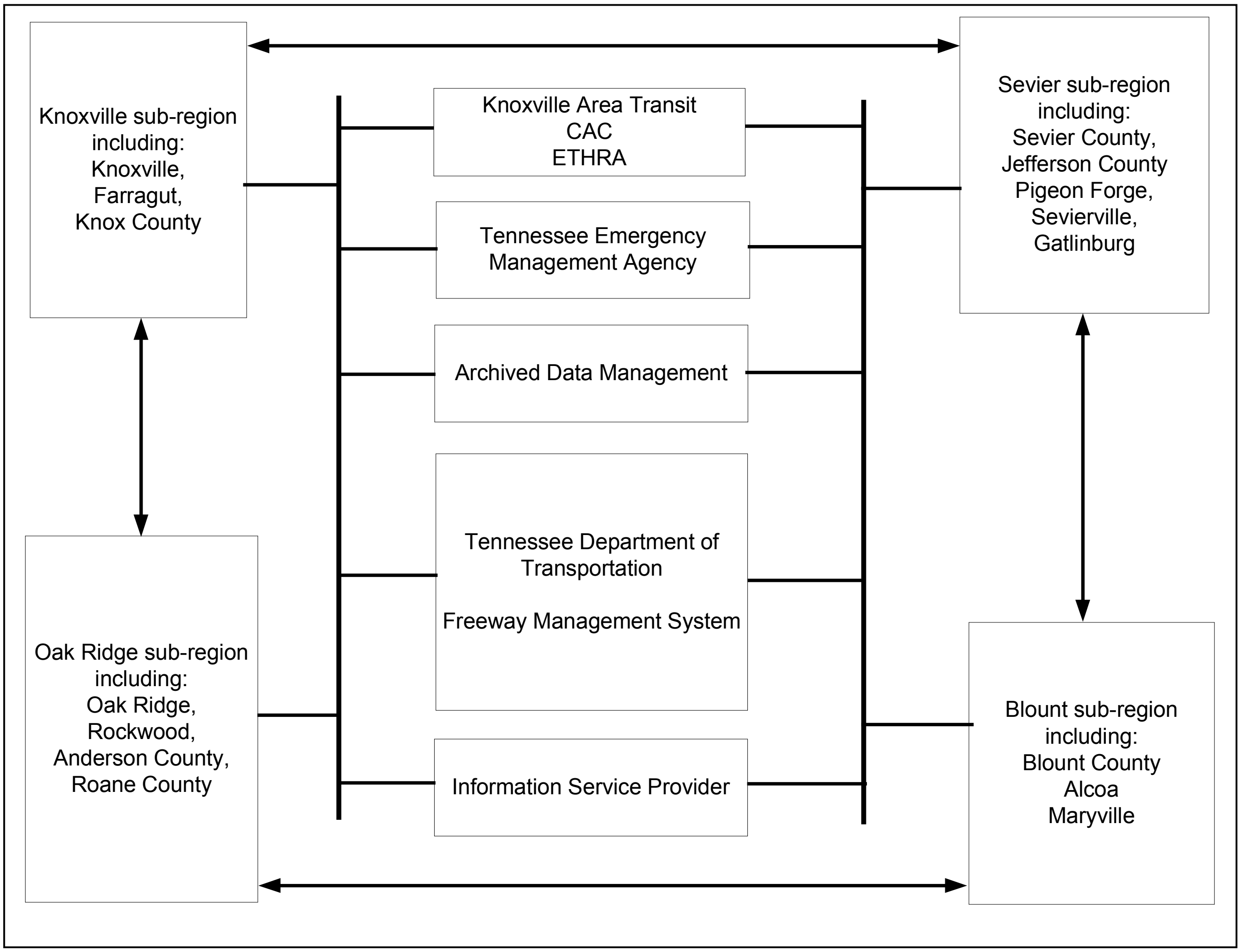


Figure 2 – Top Level Regional Physical Architecture

6.1 Subsystems and Equipment Packages

Subsystems and the associated equipment packages are listed below. Subsystems and equipment packages that were not included in Knoxville are noted. They are left within the document for reader convenience.

6.1.1 Center Subsystems

Commercial Vehicle Administration (not included in Knoxville)

Fleet and Freight Management (not included in Knoxville)

Toll Administration (not included in Knoxville)

Transit Management

- Transit Center Tracking and Dispatch
- Transit Center Information Services
- Transit Center Fixed-Route Operations
- Transit Garage Operations
- Transit Center Paratransit Operations
- Transit Center Fare and Load Management
- Transit Center Multi-Modal Coordination
- Transit Center Security
- Transit Data Collection
- Transit Garage Maintenance

Emergency Management

- Emergency Call-Taking
- Emergency Data Collection
- Emergency Dispatch
- Emergency Response Management
- Mayday Support (not used in Knoxville)

Emissions Management

- Emissions Data Collection
- Emissions Data Management

Archived Data Management

- Government Reporting Systems Support
- ITS Data Repository
- On-Line Analysis and Mining
- Traffic and Roadside Data Archival
- Virtual Data Warehouse Services (not used in Knoxville)

Traffic Management

- Collect Traffic Surveillance
- Highway-Rail Intersections (HRI) Traffic Management
- Rail Operations Coordination
- TMC for Automated Highway Systems (AHS) (not used in Knoxville)
- TMC Freeway Management
- TMC High Occupancy Vehicle (HOV) Lane Management (not used in Knoxville)
- TMC Incident Detection
- TMC Incident Dispatch Coordination/Communication
- TMC Input to In-Vehicle Signing (not used in Knoxville)
- TMC Multi-Modal Coordination
- TMC Probe Information Collection (not used in Knoxville)
- TMC Regional Traffic Control
- TMC Road Weather Monitoring
- TMC Signal Control
- TMC Toll/Parking Coordination
- TMC Traffic Information Dissemination

- TMC Traffic Network Performance Evaluation
- Traffic Data Collection
- Traffic Maintenance

Information Service Provider

- Basic Information Broadcast
- Infrastructure Provided Dynamic Ridesharing (not used in Knoxville)
- Infrastructure Provided Route Selection (not used in Knoxville)
- Infrastructure Provided Yellow Pages & Reservation
- Interactive Infrastructure Information (not used in Knoxville)
- Information Service Provider (ISP) Advanced Integrated Control Support (not used in Knoxville)
- ISP Data Collection
- ISP Probe Information Collection (not used in Knoxville)

Roadway

- Advanced Rail Crossing
- Automated Road Signing (not used in Knoxville)
- Roadside Data Collection
- Roadside Signal Priority
- Roadway Basic Surveillance
- Roadway Emissions Monitoring
- Roadway Environmental Monitoring
- Roadway Freeway Control
- TMC HOV Lane Management (not used in Knoxville)
- Roadway HOV Control (not used in Knoxville)

- Roadway In-Vehicle Signing (not used in Knoxville)
- Roadway Incident Detection
- Roadway Intersection Collision Warning (not used in Knoxville)
- Roadway Probe Beacons (not used in Knoxville)
- Roadway Reversible Lanes (not used in Knoxville)
- Roadway Signal Controls
- Roadway Systems for AHS (not used in Knoxville)
- Roadway Traffic Information Dissemination
- Standard Rail Crossing

Toll Collection (not included in Knoxville)

Parking Management

- Parking Coordination
- Parking Data Collection
- Parking Electronic Payment (not used in Knoxville)
- Parking Management
- Parking Surveillance

Commercial Vehicle Check (not included in Knoxville)

6.1.2 Vehicle Subsystems

Vehicle (not included in Knoxville)

Transit Vehicle

- On-board Fixed Route Schedule Management
- On-board Maintenance
- On-board Paratransit Operations
- On-board Transit Fare and Load Management

- On-board Transit Information Services
- On-board Transit Security
- On-board Transit Signal Priority
- On-board Transit Trip Monitoring

Commercial Vehicle(not included in Knoxville)

Emergency Vehicle (EV)

- On-board EV En Route Support
- On-board EV Incident Management Communication

6.1.3 Traveler Subsystems

Remote Traveler Support

- Remote Basic Information Reception
- Remote Interactive Information Reception
- Remote Mayday Interface (not used in Knoxville)
- Remote Transit Fare Management (not used in Knoxville)
- Remote Transit Information Services
- Secure Area Monitoring (not used in Knoxville)

Personal Information Access

- Personal Autonomous Route Guidance (not used in Knoxville)
- Personal Basic Information Reception
- Personal Interactive Information Reception
- Personal Location Determination (not used in Knoxville)
- Personal Mayday Interface (not used in Knoxville)
- Personal Provider-Based Route Guidance (not used in Knoxville)

7 Inter-agency Communication Interfaces

Inter-agency interfaces can be accomplished over the public switched telephone network (i.e. Bell South) or via a private communication system that is owned and operated by public agencies. For many interfaces, it may be necessary to establish the interface on the publicly switched network initially, and migrate to the private network as it becomes available.

Bandwidth requirements for an interface will vary depending on requirements of the agency. Interfaces may include the ability to transmit video (one way or both ways), data, and/or voice. Desired quality, intended use, and number of videos transmitted at the same time are important factors to consider when sizing an interface.

8 ITS Standards

ITS Standards are fundamental to the establishment of an open ITS environment that achieves the goals originally envisioned by the U.S. Department of Transportation. Standards facilitate deployment of interoperable systems at local, regional, and national levels without impeding innovation as technology advances and new approaches evolve. The regional ITS architecture for the Knoxville area has been defined assuming that local agencies will utilize FHWA sponsored ITS standards in acquisition and deployment of local systems. Adhering to this procedural policy will enable the region to move toward an integrated ITS environment with fewer constraints and greater opportunities for all agencies.