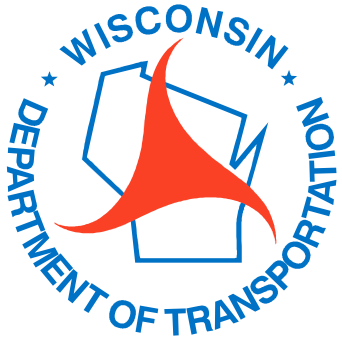

I90/94 Fiber Backbone Network and Spurs Build-out (Phase II)
Wisconsin Department of Transportation

Final Report and Local Evaluation

Prepared for the Federal Highway Administration

Grant Number: ITS-2004(806)

September 5, 2006

Contacts:
Sharon Bremser, P.E.
WisDOT ITS Project Manager
Email: sharon.bremser@dot.state.wi.us
Phone: 608-266-8460

Barry Larson
Consultant – WisDOT Fiber Project
Email: bllarson@chorus.net
Phone: 608-835-9438

Table of Contents

1. Executive Summary

The Wisconsin Department of Transportation (WisDOT) received 36 strands of dark fiber located on I-94 right of way, running the entire length of the corridor in Wisconsin. This was the result of a right of way exchange WisDOT executed in 2000. Although the fiber / conduit system wasn't operational since it didn't have any optical or electronic equipment attached, it provided the department a possibility of constructing an ITS fiber optic backbone network at relatively low cost.

A study was done in 2001-2002 to determine WisDOT ITS communication transport needs, to develop conceptual level alternative network designs, and to identify likely capital and operating and maintenance (O&M) costs to construct and operate an ITS fiber backbone network. This was followed by a Phase I design –construction pilot project in 2003, building an operational network segment between Madison and Milwaukee. Following the successful completion of that project, WisDOT decided to proceed with the design – construction of an ITS fiber optic backbone along the entire I-94 corridor, contingent on securing the necessary capital funding, and a sustainable revenue stream to operate and maintain the system.

It was thought that ITS Integration Funding would be available for the design – construction project. However, limited state match funding had precluded submitting grant requests for funding to proceed. In early 2004, FHWA approved the use of the asset value of the I-94 located WisDOT fiber as in-kind match for ITS fiber optic backbone projects. Subsequent to that decision, WisDOT requested and received a FFY2004 ITS Integration earmark to proceed with the project. Also, WisDOT had executed long term fiber exchange agreements with the University of Wisconsin System, and the Wisconsin National Guard, that would provide WisDOT with revenue streams sufficient to operate and maintain a backbone network.

The Phase II project was begun in the Fall of 2004 and was completed in late 2005. The WisDOT has an operational ITS fiber optic backbone running the entire length of the I-94 corridor from the Illinois border to the Minnesota border. The backbone has thirteen major add/drop nodes or connection points, and five signal regeneration facilities that also can serve as connection points to the backbone.

The following discussion describes the evolution of the WisDOT ITS fiber optic backbone, what the project set out to do, what was accomplished, and provides the Local Evaluation Report.

2. WisDOT ITS Environment

Evolution of the ITS Program

The ITS Program in Wisconsin had its beginnings in 1989 in the Southeastern part of the state. The initial focus was on creating an area-wide Freeway Traffic Management System, known as MONITOR, consisting of detectors, closed-circuit television, ramp metering, variable message signs, service patrols, and the related infrastructure necessary

to link and manage the field equipment. (e.g., communications network, control center, etc.). The primary objectives of the system were to reduce congestion, improve safety, enhance freeway operations.

Following that early work, ISTEA created several other initiatives within Southeastern Wisconsin. Specifically, the Gary, Chicago, and Milwaukee (GCM) Corridor Program and the Congestion Mitigation and Air Quality (CMAQ) Program. These programs have resulted in numerous other studies and activities to expand MONITOR from primarily a WisDOT freeway traffic management system to a multi-agency system used to operate and manage the entire regional transportation system in Southeastern Wisconsin.

ITS implementations in Southeastern Wisconsin lead to expanding the deployment of ITS services in other areas of the state. A focal point of the Wisconsin ITS Program Plan, I-90/94 Corridor Plan, I-39 Corridor Plan, U.S. Highway 41/Fox Cities Corridor Study, and Southwestern Wisconsin ITS Program Plan is incident management. Dane County was the first to identify the needs along the I-90/94 corridor, which lead to the Dane County Incident Management Plan.

The ITS Program in Southwestern Wisconsin consists of the initial deployment of the Freeway Management System. This included an initial implementation of a Traffic Management Center (TMC) for Southwestern Wisconsin. This initial deployment was completed in 2003.

Although many of the ITS planning studies have been statewide in scope, ITS deployments have been regional in nature. A critical element in moving toward an integrated statewide ITS program is the need for an underlying communications infrastructure that can enable linking together of disparate urban and rural ITS deployments.

WisDOT's Dark Fiber Asset

WisDOT entered into a fiber optic facility agreement with Touch America Inc in June 2000, that was the first step in establishing the necessary communications infrastructure needed for an integrated statewide ITS Program. Touch America installed approximately 420 miles of conduit and 36 strands of single mode fiber along the I94 corridor from the IL/WI Border to the WI/MN border for WisDOT in lieu of a cash payment for right of way use. WisDOT has an agreement for exclusive use of this fiber for public agency purposes. The fiber had no optical or electronic equipment associated with it, so it was not useable at the time Touch America completed the installation in mid 2001.

The WisDOT authorized a planning project in October 2001 to determine potential business uses for the fiber; costs to "light" the dark fiber; and identify likely funding sources for construction and ongoing operations. In addition, the study was to identify potential governmental partnerships that might be able to defray part of the DOT's network operating costs. The Planning Study found that the dark fiber would be of great value in serving as the underlying communications infrastructure for current and future ITS deployments either on or in the proximity of the I-94 corridor. Additionally, since the fiber went off route in urban areas, it had applicability for urban ITS deployments in those localities as well.

WisDOT subsequently authorized a pilot design-construction project to begin building the first segment of a backbone fiber optic ITS network. This initial design-construction

work was partially funded by an amendment to a FFY 1999 Great Lakes Earmark. WisDOT Federal Work Order # GL-21-FFY1999-SFY2003, I90/94 Fiber Optic Backbone Network and Spurs Buildout, describes this amendment. The earmark provided $701,000 for this initial Pilot Phase I backbone construction, and resulted in an operational fiber backbone segment between Madison and Milwaukee being completed in early 2004. This project demonstrated the operational and financial viability of a WisDOT owned fiber optic backbone for addressing ITS Program integration needs.

3. Project Description

3.1Background

WisDOT proceeded with a preliminary planning effort for a statewide fiber optic backbone implementation, in early 2004. This Phase II effort was intended to create a border-to-border fiber backbone along the length of the I-94 corridor, utilizing the dark fiber acquired in the Touch America R.O.W. exchange. Essentially, the initial pilot segment running from Madison to Milwaukee was to be extended from Milwaukee south to the Illinois border, and from Madison north to the Minnesota border.

Preliminary planning also addressed creating a segment running from Milwaukee to Green Bay and a segment running from Green Bay to Eau Claire, creating a statewide backbone ring. Since WisDOT didn't own any dark fiber that was usable for the Milwaukee to Green Bay to Eau Claire segments at the time, construction of these north and west segments were considered a future Phase III possibility, following the completion of the I-94 corridor related work.

3.2 Integration – Current and Envisioned

The WisDOT fiber backbone communication network is intended to serve as the infrastructure component to enable integration of urban and rural ITS deployments, public safety communications systems, and roadway security and monitoring.

Each major location on the backbone may have one or more connections to any other add/drop point on the backbone. These will serve as regional hubs to aggregate traffic to and from field equipment deployed in their region. They are in effect, the on/off ramps to the backbone, having connectivity with all other add/drop locations on the backbone.

Exhibit 1, titled "Integration Plan" on the following page depicts this regional hub concept.

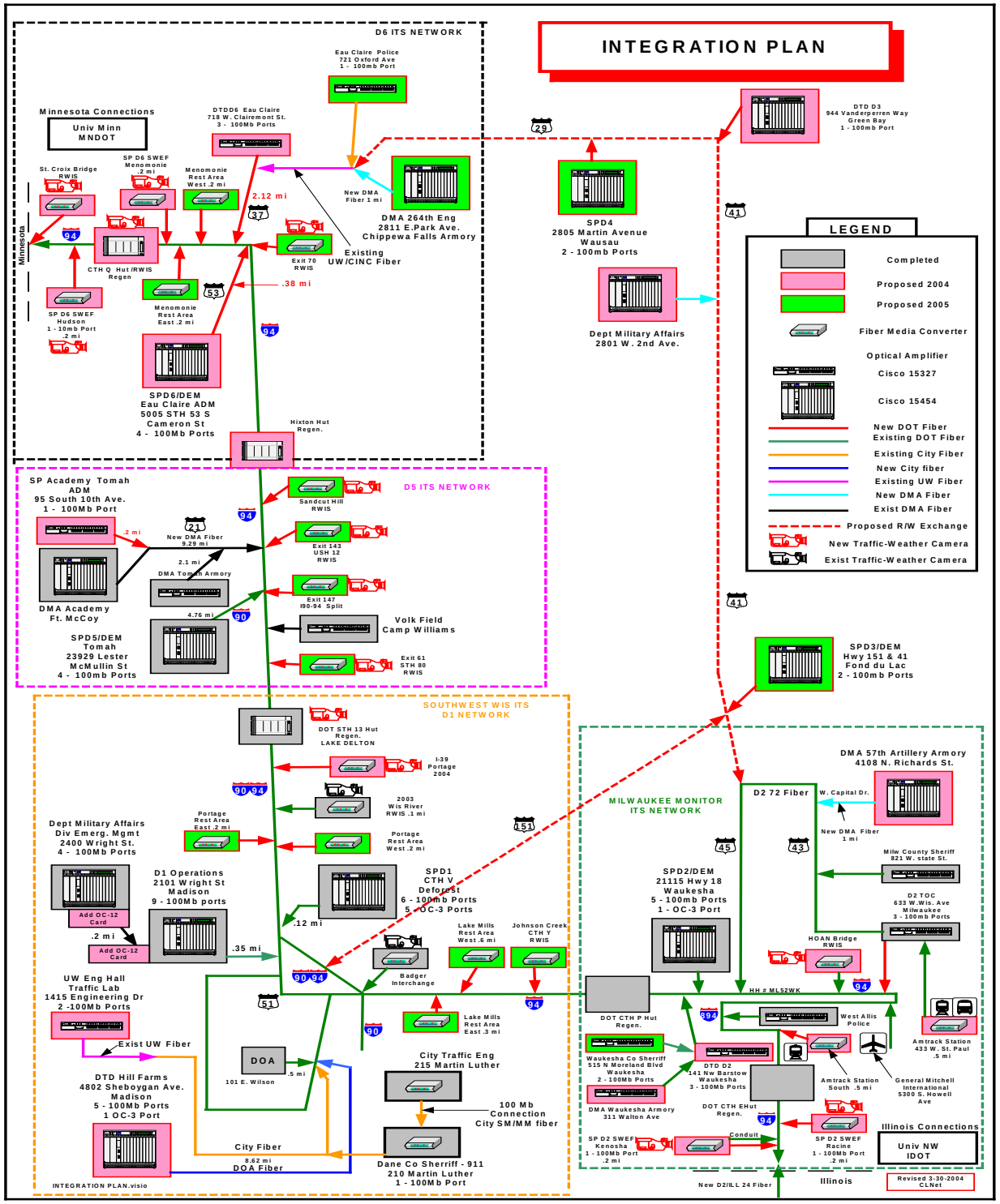

Exhibit 1

Essentially the fiber backbone provides a means of integrating regional urban ITS deployments, rural deployments, and makes it possible to have a single statewide operations center. Since the hub locations and field equipment and facilities connected to

those hubs consist of highway operations, public safety, and emergency management organizations, integration across these functional areas becomes possible, whether urban or rural, and can involve Federal, State and Local jurisdictions.

Again referring to Exhibit 1, the following discussion illustrates the integration potential from traffic management/highway operations, roadway security, and public safety communication perspectives.

Traffic Management and Highway Operations

The backbone currently provides a high capacity communications link to integrate Transportation Operations Centers (TOC) deployed in the Milwaukee and Madison locations. Completion of the Phase II project will provide a means of integrating rural ITS deployments with existing TOC's, where rural deployments are located on or near the I-94 Corridor. Road Weather System deployments and traveler alternate routing messaging systems along the I-94 corridor can be accommodated providing an integration of traveler information related field equipment with Traffic Management facilities. This would also serve as the communications infrastructure to integrate major regional ITS initiatives at the Wisconsin borders; specifically the Gary-Chicago-Milwaukee Corridor and NorthWest Passage projects.

Since the State Patrol and a number of local public safety organizations are also hubs and regional endpoints on the network, they also would be integrated within the context of ITS highway operations and incident management.

Security and Roadway Monitoring

The proposed fiber backbone will also serve as the enabling infrastructure for security related roadway monitoring.

Critical interchange structures on that route include: Marquette, Mitchell, Zoo, Badger, Portage and Tomah. Critical bridge structures include: St. Croix River, Wisconsin River, and the Hoan. The fiber backbone would include necessary communication interfaces to enable connection of roadway located field equipment such as surveillance cameras, and changeable electronic message signs to the fiber backbone facility. The backbone would then provide transport of surveillance camera feeds back to central monitoring sites, link this information to Wisconsin Emergency Management, law enforcement dispatch centers, as well as WisDOT Traffic Operations Centers. Since Regional FEMA organizations are co-located with Wisconsin Emergency Management and State Patrol Headquarters at Eau Claire, Tomah, and Waukesha, they could also be linked to surveillance and messaging equipment along the roadway.

Public Safety Communications Systems

Wisconsin's current statewide public safety communication system is a VHF microwave system, owned and operated by WisDOT's Division of State Patrol (DSP). The system provides mobile voice communication services for the State Patrol, and serves as the underlying transport mechanism for the statewide mobile data computer system used by approximately 150 local public safety organizations, in addition to the State Patrol.

There is considerable interest in using the fiber backbone to augment the microwave facilities. It would provide diverse routes and is a means of providing additional system capacity at relatively low cost. In effect, using the fiber backbone as a trunking mechanism to carry traffic between regional microwave hub locations, rather than using the microwave system itself for that purpose.

Using a combination of fiber and microwave would be a significant step in moving toward a hybrid statewide public safety communications system incorporating both wireless and wire line facilities, to greatly enhance bandwidth capacity. By virtue of the fact the same backbone is used by and terminated in traffic management and highway operations facilities, integration of these locations with the public safety communications network would be a natural extension.

3.3 Project Plan Details

The goal of the proposed project was to complete the detail engineering and construction necessary to provide a backbone ITS communication infrastructure capable of addressing the communication and integration needs of Wisconsin's ITS program. This encompasses Traffic Management and Highway Operations; Public Safety Communication Systems; and Security and Roadway Monitoring. The backbone will run the entire length of I-94 in Wisconsin and into major metropolitan areas along the route including: Milwaukee, Waukesha, Madison, and Eau Claire.

Network Segment Construction

The project consists of the following segments and network elements requiring detail engineering and construction to achieve the desired border-to-border fiber backbone network.

- **Milwaukee to Illinois border**

The regeneration hut at the CTH E location is constructed and DC power has been installed. Optical and electronic signal regeneration hardware needs to be acquired and placed into operation at this location. That will enable this segment to be lit and tied into the operational Milwaukee to Tomah fiber backbone.

- **GCM Connection at IDOT**

  A hand hole on I94 right of way adjacent to the Wisconsin / Illinois border will be the meet point for backbone fiber connections between WisDOT and IDOT.

  Work remaining includes final network continuity testing after IDOT has made its connections at the border meet point location, as well as WisDOT/IDOT testing of the connection between WisDOT D2 TOC and IDOT – GCM network management center.

- **Backbone spur to Transportation District (DTD) D2 at Waukesha**

  There is dark fiber is installed from close proximity to the State Patrol D2 Headquarters to DTD D2, location at Barstow Street in Waukesha. This work

will connect the DTD D2 to the mainline near State Patrol D2. This includes final engineering, splicing of the fiber into the DOT backbone near the DSP D2 location, and terminating the fiber at the DTD D2 Barstow facility. Additionally, DC power, and optical hardware need to be acquired and installed to make the site ready for use.

- **Backbone spur to WisDOT Central Office at Hill Farms**
  Dark fiber has been acquired via an inter-agency exchange agreement that runs from the Wisconsin Department of Administration (DOA) Building in downtown Madison to the WisDOT Hill Farms location. The DOA building serves as a cross connect location for DOT backbone fiber, City of Madison, and other state owned fiber in that area. Work remaining to be done to incorporate the Hill Farms location into the DOT fiber backbone includes fiber splicing at the cross connect and Hill Farms locations, final engineering, installing DC power and optical equipment needed to light this segment.

- **Backbone spur to State Patrol Academy**
  Dark fiber has been acquired from the Department of Military Affairs as part of the fiber lease agreement WisDOT executed with that agency. The fiber runs from the DOT fiber mainline just north of the I90/I94 split to the DSP Academy that is roughly 9.3 miles west of that location. Work required to activate this spur includes fiber spicing at the mainline, bringing the fiber into the Academy building and terminating. DC power, and optical equipment needs to be acquired and installed to add this spur location to the DOT fiber backbone.

- **Backbone segment from Tomah to Minnesota border**
  Dark fiber was installed from Tomah to the St. Croix River Bridge in 2001, as part of the right of way exchange agreement DOT executed with Touch America Inc. Considerable work remains, however, to "light" this segment and tie it into the Milwaukee to Tomah backbone segment that is currently operational, primarily signal regeneration related described below.

- **Signal regeneration hut related activities**
  a. Final engineering needs to be done to determine actual location of signal regeneration facilities. These are currently depicted as the Hixton and CTH Q (near Baldwin) huts, which are the general locations of these facilities, but specific sites need to be determined following the engineering analysis.
  b. Huts need to be acquired and placed at the specified site locations, with appropriate grading, driveways, security fencing and beam guard installation completed.
  c. Fiber spurs need to be constructed and spliced from the adjacent mainline fiber into the huts.
  d. A/C power service must be brought into the huts.
  e. DC power and power backup systems need to be installed.
  f. Optical regeneration equipment must be installed and tested.

- **Backbone spur to DSP D6**

DSP D6 will be an add/drop network connection point on the DOT Fiber Backbone. A number of tasks need be completed.

a. A fiber spur from the fiber mainline near the I-94 & US 53 interchange needs to be run approximately .4 mile to the DSP D6 Headquarters location.
b. Splicing the fiber spur into the DOT mainline.
c. Terminating the fiber at the DSP D6 facility.
d. DC power and power backup systems need to be installed.
e. Optical add/drop equipment must be installed and tested.

- **Backbone spur to DTD D6**
  DTD D6 will be another add/drop network connection point on the DOT Fiber Backbone. A number of tasks need be completed.
  a. A fiber spur from the DOT fiber mainline near the I-94 & STH 37 interchange needs to be run approximately 2.1 miles to the DTD D6 District location on Clairemont Ave.
  b. Splicing the fiber spur into the DOT mainline.
  c. Terminating the fiber at the DTD D6 facility.
  d. DC power and power backup systems need to be installed.
  e. Optical add/drop equipment must be installed and tested.

- **St. Croix River Bridge connection to MnDOT**
  The East end of the St. Croix River Bridge will be the meet point for backbone fiber connections between WisDOT and MnDOT. Conduit was attached to the bridge, as part of the WisDOT agreement with Touch America, Inc. WisDOT and MnDOT have a joint agreement with FWR Communications Network Inc that provides 12 strands of dark fiber for WisDOT-MnDOT use, in exchange for allowing FWR to place fiber in the conduit attached to the bridge.

  The hut that will be placed in the vicinity of the Baldwin interchange will enable the optical signal to reach the MnDOT location in St. Paul without further signal regeneration. Cabinets are located at either end of the St. Croix River Bridge. The fiber is spliced into the DOT backbone fiber at the east end cabinet and into State of Minnesota fiber at the west end cabinet. Fiber currently runs from the West end cabinet to a major cross connect point in downtown Minneapolis.

  Work remaining includes final network continuity testing after MnDOT has made its connections from the St Paul MnDOT building to the Minneapolis network hub location, as well as MnDOT installation of optical equipment that will be compatible with the WisDOT backbone installation.

- **Backbone Spur to UW Engineering Hall**
  A spur will be established to the University of Wisconsin – Engineering Hall to enable connection of the UW Traffic Lab to the backbone. Fiber exchange agreements will be made with the City of Madison and the University to get a fiber route to that location. DC power and optical equipment will need to be acquired and placed into operation, to tie this facility into the backbone.

- **Backbone Spur to Wisconsin Emergency Management HQ**

A spur will be established to the Wisconsin Department of Military Affairs location in Madison to enable connection of the Division of Emergency Management Headquarters, to the backbone. Optical cards will need to be acquired and placed into operation, to tie this facility into the backbone. Work to be done to enable this segment includes final engineering, splicing of the fiber into the DOT backbone at this location, and terminating the fiber at the Military Affairs – Division of Emergency Management facility.

4. Evaluation Plan

4.1 Goals

The high priority goals established as part of the ITS Integration Earmark Agreement submitted were focused on safety, mobility, and productivity. However, since the project is directed at deploying the necessary underlying infrastructure to support the Wisconsin ITS program, the effectiveness measures were oriented to providing the enabling infrastructure to integrate the ITS systems that directly contribute to the three primary goals.

4.2 Effectiveness Measures

Examples of ITS systems to be integrated that serve as effectiveness measures include:

- **Arterial Management Systems**
  D1 Traffic Operations Center to Dane County 911 and City of Madison Traffic Engineering to monitor an arterial during major reconstruction

- **Freeway Management Systems**
  D2 MONITOR system connection to D1 Traffic Operations Center
  D2 MONITOR and D1 Traffic Operations Center to State Patrol.
  D1 Traffic Operations Center to Dane County 911 and Madison Traffic Engineering.

- **Transit Management Systems**
  Connections between AMTRAK Milwaukee downtown and Milwaukee South stations, General Mitchell Field, and Milwaukee County Transit

- **Incident Management Systems**
  D2 MONITOR system connection to D1 Traffic Operations Center.
  D2 MONITOR and D1 Traffic Operations Center to State Patrol.
  D1 Traffic Operations Center to Dane County 911 and Madison Traffic Engineering.
  State Patrol Microwave trunking via fiber backbone

- **Emergency Management**
  Video feeds from major roadway structures and traffic cameras to D1 Traffic Operations Center and D2 MONITOR
  Video feeds from D1 Traffic Operations Center to Dane County 911
  Video feeds from D2 Monitor to Milwaukee Metro Public Safety organizations and surrounding counties
  D2 MONITOR and D1 Traffic Operations Center connections to State Patrol, Wisconsin Emergency Management & FEMA at Patrol Districts 1,2, 5,6, and State Patrol Academy at Ft. McCoy.

State Patrol Microwave trunking via fiber backbone

- **Traveler Information**
  RWIS road-weather information disseminated from Central Office to Rest Areas located at Menomonie east-west, Portage east-west, and Lake Mills east-west

4.3 Additional Evaluation activities

The Project Agreement committed to performing the following additional evaluation activities:

- *Evaluating institutional issues associated with achieving cooperation among public sector agencies and documenting how they were overcome.*
- *Providing a brief lessons learned report on the technical and institutional issues encountered in integrating ITS components.*
- *Providing an evaluation report on the lessons learned in employing innovative financing or procurement and/or public-private partnering techniques.*

5. Evaluation Findings

5.1 Project Outcome- Task Plan Deliverables

The project was successfully completed in late 2005, with all segments, nodes, and signal regeneration facilities described in section 3.3 fully operational. At this point, WisDOT has an operational ITS fiber optic backbone running along the I-94 corridor from the Illinois border to the Minnesota border, with spurs into Milwaukee, Waukesha, Madison, and Eau Claire. Major add/drop nodes on the backbone include:

State Traffic Operations Center – Milwaukee
Regional Operations Center – Madison
Transportation Regional Offices
    Waukesha
    Madison
    Eau Claire
State Patrol Posts
    Waukesha
    DeForest
    Tomah
    Eau Claire
State Patrol Academy – Ft. McCoy
WisDOT Central Office – Madison
Department of Military Affairs – Madison
University of Wisconsin – Traffic Lab – Madison Campus

Additionally, five signal regeneration facilities are located along the I-94 corridor in the vicinity of Racine, Johnson Creek, Wisconsin Dells, Hixton, and Knapp. These are secured, climate controlled structures and may also serve as regional add/drop nodes if necessary.

End point connections are ready to link MnDOT at the St. Croix River Bridge and IDOT at the Wisconsin / Illinois border. Neither of these connections has been made at this point, however.

5.2 Project Outcome- Measures of Effectiveness

- **Arterial Management Systems**
  Southwest Region (DTD D1) ITS field equipment deployed in the Madison metro area, and on I-94 are all linked to the DTD D1 office in Madison. Video feeds are provided to the Dane County 911 Center and to the City of Madison Traffic Engineering office to aid in arterial management of East Washington Avenue (US 151) during a multi-year major reconstruction of that arterial. Message sign control is also provided to the 911 Center.

- **Freeway Management Systems**
  The DTD D2 Traffic Operations Center (MONITOR) and the DTD D1 regional traffic management centers were linked, such that ITS field equipment linked to one center, could be viewed and controlled by the other. The integration capability provided by the backbone has resulted in a consolidation of all ITS control room activities into a single Statewide Traffic Operations Center (STOC), the MONITOR facility in Milwaukee. This STOC now has monitoring and control responsibility for all ITS field equipment located throughout the state. Video feeds and message sign information is made available to the four State Patrol Districts currently on the backbone. A number of local law enforcement agencies in the Milwaukee metro area also receive these feeds, as well as news media outlets in Madison and Milwaukee.

- **Transit Management Systems**
  Connections have been made between DTD D1 and the Madison Metro Bus System, providing selected video feeds to their location. Connections also have been made between the STOC and the Amtrak station in Downtown Milwaukee, providing that location traffic camera video and message sign information.

- **Incident Management Systems**
  With the consolidation of Traffic Operations Center activities into the STOC, staffing was also increased to provide 24 x 7 coverage. All ITS field equipment anywhere in the state is monitored and controlled from that location. Since the State Patrol Districts adjacent to I-94 are also integrated on the backbone, they also have monitoring and control capabilities for ITS field equipment in their localities. Inclusion of local agencies is also expanding beyond the initial Milwaukee and Madison area law enforcement connections, to include organizations such as Racine County Sheriff, and Milwaukee County Public Works.

  The State Patrol is also beginning to use the fiber backbone to augment their microwave mobile communication system trunking capability. It's anticipated that when the WisDOT is able to extend the backbone from Milwaukee to Green Bay, and Green Bay to Eau Claire, creating a backbone ring topology, the fiber backbone will become the primary trunking facility for the State Patrol Communications System.

- **Emergency Management Systems**
  Video feeds from many of the major interchange structures and bridges on the I-94 corridor are available to the STOC, and to multiple public safety organizations by virtue of their links to the STOC. The Wisconsin Emergency Management Headquarters is also a node on the backbone, and has access to all

ITS video and data via the STOC. Connections haven't been made to Regional FEMA field offices at this time, but would be a simple connection, as most of these offices are co-located with the State Patrol Districts which are already connected to the STOC.

- **Traveler Information**
  Rest Areas haven't been integrated on the backbone at this time, but this is certainly feasible, as the backbone runs adjacent to most of them on the I-94 corridor.

5.3 *Additional Evaluation Activities*

Activity #1 Institutional Issues – Achieving cooperation among public sector agencies

In many respects, there were fewer institutional issues associated with this project, since it was oriented to providing communications infrastructure. Thus there were fewer organizations directly involved, than a project dealing with the multiple stakeholders involved with a typical ITS integration project. The following describe major institutional issues encountered, approaches and outcomes.

- Financial Issues – These were without question, the critical issues facing the project. Capital.. operating cost.. UW, DMA, earmarks, etc
  State legislation enacted a few years ago has severely constrained state funding available for covering ITS operating and maintenance (O&M) costs. Additionally, state matching funds are also very limited for use with ITS federal grant funding. The R.O.W. exchange agreement WisDOT executed with Touch America, Inc, enabled WisDOT to avoid the majority of expense typically associated with constructing a fiber optic backbone network. However, because of funding constraints previously mentioned, WisDOT senior management would not have approved proceeding with the project unless new fund sources were identified to match available ITS grant funding, and to provide a sustainable O&M funding stream for the ITS fiber optic backbone.

  These issues were addressed with a combination of public- private, and public – public partnering approaches. This enabled the WisDOT senior management team to authorize proceeding with the construction of the fiber optic backbone. Details of these partnering arrangements are described later in this section under Activity #3 – Innovative Financing and public-Private Partnering Techniques.

- Oversight Agency Issues – The State Department of Administration (DOA) has statutory oversight responsibility for State departmental communication network activities, and also manage a statewide communication network service center operation. All state agencies are required to use their network service center. It was critically important that the WisDOT ITS fiber optic backbone project not be perceived as a competitive threat to the DOA service center, or somehow being in conflict with state directives concerning agency network activities.

  Considerable time was spent doing periodic briefing for DOA staff, concerning project activities, and continuing to reinforce the fact that the WisDOT backbone was a longitudinal network adjacent to major roadway corridors, to be used for ITS related purposes only, and simply wasn't appropriate for traditional IT network services which the DOA network provided. Additionally, operating costs comparisons were provided which clearly indicated a traditional IT network

transport facility such as DOA was operating was not a cost effective means of linking ITS field equipment located on major roadway corridors. This proactive, ongoing communication with DOA staff has resulted in a very cooperative relationship concerning WisDOT's fiber backbone activities.

- Regional Ownership Issues - The WisDOT ITS program had evolved over a number of years as regional deployments in the southeastern and southwestern areas of the state. The prospects of an operational statewide ITS backbone network gave a clear signal, that WisDOT was moving from ITS deployments being regional in nature, to that of a statewide ITS Program. Clearly, this integration was viewed with concern, particularly by those that had invested a great deal of time and energy in deploying successful ITS projects in their regions.

  Staff responsible for the design and construction of the backbone spent a great deal of time working with the key regional staff, involving them as much as possible in the entire project. Also, consultants on the backbone project attempted to provide assistance to regional staff on their own local projects in an effort to establish cooperative working relationships, and reduce concerns about the impact of ITS integration on their daily activities. This proactive involvement of key ITS staff throughout the Department on the project was of benefit not only for the backbone project, but in helping staff to accept the fact that an integrated statewide ITS Program was desireable.

Activity #2 – Lessons learned – Issues encountered in integrating ITS components
As mentioned in the Activity # 1 Section, it's likely there were fewer issues, since the project was oriented to providing communications infrastructure. Thus there were fewer organizations directly involved, than a project dealing with the multiple stakeholders involved with a typical ITS integration project. The following describe major institutional issues encountered, approaches and outcomes.

- Project Staffing – Although the WisDOT has a highly competent engineering staff, the very specialized fiber optic outside plant electrical engineering expertise required for the project is not typically found in a DOT organization. Nor were permanent staff available for reassignment to full time project work on the backbone project. The WisDOT chose to staff the project core team with two consultants, each at roughly 1200 hours per year, and a senior level WisDOT manager working part time on the project.

  The particular backgrounds and skill sets of the core team helped overcome many of the typical institutional issues encountered in projects of this sort. The senior level manager provided the senior management oversight for the project. This individual was well respected and had an in-depth understanding of departmental operations, having worked in senior management positions in a number of WisDOT divisions. Consequently, she was very well connected with key senior managers in WisDOT and was able to quickly obtain the necessary approvals as the project unfolded.

  The consultants were both very experienced individuals, one having spent over 25 years as a fiber optic design engineer for a large carrier, the other also having heavy network experience and had spent 25 years as a senior technology manager

in both the WisDOT and DOA. This consultant combination of heavy fiber optic network expertise, solid understanding of state government operations, and having good working relationships established with many staff throughout the WisDOT and DOA was essential to obtaining the necessary funding, handling the technical design and construction management, and working through the critical state processes involved such as procurement and budget.

- Trust and project buy-in
  Clearly, the unique background and experience of the project core team contributed to the acceptance of the ITS fiber backbone project. However, the key factor was the makeup of the fiber backbone planning team that preceded the Phase II project itself. That planning team was comprised of managers and professional staff from five of the WisDOT divisions, the Budget Office, the Office of General Counsel, and participants from DOA, FHWA, as well as two consulting engineering firms providing ITS consulting services to the DOT. The planning effort ranged from needs assessment, financing approaches, project organization and deliverables, relationship with existing ITS regional networks, and governance models for backbone operations.

  Since all organizations that would be affected by the fiber backbone project had members on the planning team, and were able to participate in the overall project design before the project was initiated, project goals were accepted throughout the department. Focus on the financing options and frank discussion concerning which organization would ultimately have ownership and operational responsibilities for the network was particularly useful in gaining acceptance and trust.

- Use of Standards and Protocols
  In the context of the Open Systems Interconnection (OSI) seven layer model, the proposed WisDOT fiber backbone project is essentially confined to Layer 1, the Physical Layer. As such, the ITS standards sets are not directly applicable to the project. However, all integration projects, whether integration of current ITS deployments, or integration projects involving some new deployments along the I-94 corridor, can be supported and will use the WisDOT fiber backbone network for the underlying ITS communications transport.

  Since the fiber backbone project does directly adhere to Telecommunication Industry standards such as SONET for example, that insures inter-connection with other Layer 1 industry standards, and enables it to support National ITS standards sets and protocols as well. The ability to establish an OC3 channel on the fiber backbone to enable interconnection of State Patrol Microwave multiplexing equipment, while sustaining multiple Ethernet channels for ITS application transport is an example of that.

Activity #3 – Lessons learned – Innovative Financing & Public / Private Partnering
As mentioned in the Activity #1 discussion, financing issues were without question, the critical issues facing the project. In particular, highly constrained state matching funds for use with ITS grant funding, and limited O&M funding to sustain ITS deployments. These issues were addressed with a combination of public- private, and public – public partnering approaches. The following points were central to the network

design/construction capitalization plan and in providing an ongoing O&M funding stream.

- Partnering with Touch America Inc
  The R.O.W. exchange agreement WisDOT executed with Touch America Inc in 2000 obviously was the key element in WisDOT's considering proceeding with a statewide ITS fiber backbone project. Construction of a 420 mile fiber route simply would have been cost prohibitive had it not been done in partnership with a private entity. Placing that much conduit and dark fiber would have been in the $40 million range. However, this exchange agreement also provided a number of opportunities for innovative financing that ultimately were based on the fiber and fiber value that WisDOT received in the exchange agreement.
- Following the acquisition of the dark fiber from Touch America, WisDOT requested two new appropriations be created. This was done via the biennial budget process. Act 16 (2001-03 Biennial Budget) created two appropriations (351 & 353) within the Department for managing revenues and expenditures associated with negotiating right-of-way access with telecommunications companies, and other public sector entities. These are specifically related to WisDOT telecommunications facilities, and were created in anticipation of WisDOT constructing and operating a fiber network for highway operations and roadway management purposes. This in essence gave WisDOT statutory authority to direct funds received for telecommunication related exchanges with either public or private entities into segregated appropriations to be used only for ITS communications network purposes.

- A lease agreement was executed with the UW System July 7th, 2003. This provided the UW with four fibers from the Illinois border to the Minnesota border, and space in DOT facilities to house UW electronic equipment to light the leased fibers. The agreement is for a 20-year term, with annual payments of $218,000 due at the beginning of the state fiscal year. Additionally, the UW was required to make a $218,000 deposit at the time of lease execution. These appropriation 353 funds were anticipated to be more than sufficient to sustain the O&M funding requirements of the anticipated I-94 located ITS fiber backbone.

- A lease agreement was executed with the Department of Military Affairs (DMA) on July 23rd, 2003. This provided the DMA with four fibers running from Madison to the intersection of I94 and STH 21 near Tomah, and space in DOT facilities to house DMA electronic equipment to light the leased fibers. The agreement is for a 36-year term, with annual payments of $57,000 due October 1st each year. In addition, DMA provided DOT with eight fibers from a 9.1 mile spur DMA constructed between the DOT mainline fibers near the I94 and STH 21 intersection and Ft. McCoy. This provides DOT fiber connectivity to the State Patrol Academy. DOT will have use of these fibers for the full term of the lease at no cost. These appropriation 353 funds provide an additional revenue stream to address O&M needs.

- FHWA approved the use of the asset value of WisDOT's fiber along the I-94 corridor as an in-kind match April 2004. The approved match value is $8,519,400. This match may be used for projects that support WisDOT's ITS backbone fiber infrastructure on the fiber donated by Touch America; or the

match may be applied to projects that directly benefit from the existence of the fiber. This was a key component of the capitalization plan, and enabled the WisDOT to request ITS Integration grant funding, since it now had the means of addressing the 50% match requirements.

Following completion of the I-94 fiber backbone construction, the remaining value of the dark fiber soft match is available as match on projects that extend or enhance the fiber backbone, or for ITS projects that use or are significantly benefited by the fiber optics network. Thus, match funding would be available for subsequent ITS backbone expansion, should additional ITS Integration grant funding be available.

- WisDOT applied for and received a FFY2004 ITS Integration Earmark to be used for continued construction of the WisDOT fiber backbone in 2004. The earmark value after takedowns, was $861,582, to be used for Fiber Backbone Phase II design & construction. This funding in combination with lease revenues described previously, provided sufficient capital funds to complete the ITS fiber backbone along the I-94 corridor in Wisconsin.

- During the course of the ITS fiber backbone fiber construction project fiber exchange agreements were executed with the following public entities, to reduce the spur construction needs and associated costs:

  UW-Eau Claire – fiber strands were provided on I-94 between UW-Eau Claire and UW-Stout in exchange for fiber running from the I-94 mainline to the Transportation District 6 Office. This enabled WisDOT to avoid construction of a $125,000 spur to that location.

  UW-Madison and City of Madison – Fiber exchanges were made to provide a fiber route to the UW-Traffic Lab, a node on the backbone. This also eliminated the need for construction of a spur to that location.

  DOA – fiber exchange agreements were executed to provide a fiber route from downtown Madison to WisDOT Central Office, and to provide fiber along the Madison beltline, a total route length of approximately 15 miles.