FLORIDA DEPARTMENT OF TRANSPORTATION
REQUEST FOR INFORMATION (RFI)

SHORTEST PATH BRIDGING OVER THE ITS WAN

The Department of Transportation, ITS Program of the Traffic Engineering and Operations Office is requesting information from prospective vendors regarding the following:

**Description of commodities/contractual services:**

Copper and optical Layer 2 & 3 Ethernet technologies employing Shortest Path Bridging (SPB) as a means for transporting packet data over a Wide Area Network (WAN).

**Specific Information Requested:**

Please refer to the attached document, “Exhibit A”.

**Contact for Questions or clarification:**

1. **Question and Answer Period**
   Vendors may submit questions to FDOT until 5:00PM (EST) on November 6, 2014, at which time no other questions will be considered.

2. **FDOT Response**
   FDOT will respond to Vendor questions by 5PM (EST) on November 26, 2015, at which point the Q&A period will close.

3. **Vendor Response**
   Vendors must submit any/all information by 5:00PM (EST) on December 18, 2014.

**SEND TO:**
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**AND**

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**NOTE:** Responses to this Request for Information (RFI) will be reviewed by the agency for informational purposes, and will not be considered as offers to be accepted by the agency to form a binding contract. Advertisement of any subsequent competitive solicitation that may result from this RFI will be posted on the Florida Vendor Bid System.
Florida Department of Transportation
Statewide Telecommunications Network
Next-Generation Network Upgrade Project

Request for Information on Networking Technology
SHORTEST PATH BRIDGING

RFI Prepared by:
Florida Department of Transportation
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Statewide ITS Network Upgrade – Shortest Path Bridging RFI

1. Description
The Florida Department of Transportation (FDOT), in support of Intelligent Transportation Systems (ITS), is seeking information to implement a turnkey solution to upgrade the existing FDOT Statewide Telecommunications Network (STN) to a “next generation” statewide ITS network. This turnkey solution is expected to be implemented in a phased approach, which will not encompass the entire state at once. The network upgrades will be implemented in stages as funding becomes available over several years’ time. This RFI is addressing the utilization of Shortest Path Bridging (SPB) technology. A successful RFI response will involve only SPB as a design consideration.

The two goals of this RFI are to determine if SPB is the best solution for the FDOT, and also to determine the type of phasing plan that will provide the greatest benefit to the FDOT.

The Statewide ITS network provides the backbone for Intelligent Transportation Systems equipment, such as traffic counters, traffic signaling, traffic cameras, dynamic message signs, highway advisory radio, and other such ITS devices. Respondents should note that this network’s purpose is not for telephony, or placing/receiving phone calls.

For this RFI, the FDOT is looking for a solution from a single vendor covering switching and routing technology where both microwave and fiber optics are used as transport. The FDOT realizes that multiple equipment vendors/manufacturers may be required to build a complex system such as this. The FDOT desires to know about your strategic alliances and how transport (microwave and fiber optics) offerings can be integrated into the solution.

Capital Expense (CAPEX) and Operational Expense (OPEX) budget analyses, including equipment, optional features, software licenses, element managers, spares inventory and ongoing maintenance costs should be included in your response.

Respondents should also include detailed technical information regarding interconnects, configuration samples, information regarding complexities of adding services/circuits, maintenance, and troubleshooting procedures. See the Questions in Section 2 of this document for specific technical questions the FDOT has regarding an SPB solution for our Next Generation Network (NGN).

It is the aim of FDOT to collapse three networks, the ITS WAN, the SMS, and the Turnpike Microwave System into a single, cohesive Statewide ITS Backbone which will create a redundant and resilient backbone to support today’s and future applications and traffic between the regional data centers.

A complete RFI response should include design responses for each of the scenarios in section 1.3, and answer all questions listed in Section 2.

1.1 Background
The FDOT operates a statewide ITS network, comprised of two transports; a statewide microwave system (SMS), and a fiber optic network (ITS WAN). Where fiber currently exists, it is the primary transport for most ITS traffic in the system statewide. Where there is no fiber, and in the event of multiple catastrophic fiber outages, traffic is transported over the SMS.
The primary mission of the statewide ITS network is to enable center-to-center (C2C) communications and interoperability between the FDOT districts' traffic management systems software installed at the FDOT districts' Regional Traffic Management Centers (RTMCs), and to share traffic management data and digital closed-circuit television (CCTV) traffic-camera video between the FDOT districts and other users. It is important to note that the districts autonomously manage their own ITS networks within their respective boundaries. The statewide ITS network transports data between the FDOT's districts, Florida’s Turnpike Enterprise (FTE), other FDOT partners, and their respective Regional Traffic Management Centers (RTMCs). There are additional applications whose traffic rides on the STN backbone which are listed below.

1.1.1 Existing Applications

Center to Center Applications

Traffic Camera Video
Sunguide Sharing (C2C)
FHP CAD
Managed Lanes Tolling
NOAA
VAS

Radio Applications

47MHz (Voted)
FTE UHF Radio – Road Rangers
ROIP FUTURE
SARNET ROIP (JPS Raytheon NXU-2A) UHF
Future Radio Applications

Field Data Network

RWIS
Intra-district data on the network
Tolls Revenue
Tolls SCADA
FTE ITS
FTE 4-Digit Dialing

Management

NetBoss PENSACOLA TAMPA LAKE CITY PORT ORANGE
Preside
ITSWAN MGMT
Tower infrastructure hard contacts
4-Digit Dialing EOW

Other Applications

SLERS
FirstNet
FCC Monitoring
1.1.2 Current FDOT ITS Statewide Network; ITS WAN, SMS

There are two sub-systems, the Statewide Microwave System (SMS) and the Intelligent Traffic Systems Wide Area Network (ITS WAN). There are currently two Network to Network Interfaces (NNIs) between these two IP networks allowing management and other traffic to communicate between them.

The SMS is a legacy infrastructure comprised of 74 sites built upon 6 GHz time division multiplex (TDM) microwave; specifically, the Harris DVM6-45 and Constellation microwave radios. These radios provide a 45 Mbps backbone via 28 T1s. At certain key sites (“hub” sites) within the system, the microwave radios are configured as terminals providing access to all 28 T1 circuits from each radio. At the remainder of the sites, the radios are configured as repeaters and a maximum of 16 T1 circuits (in each direction) is available. All T1 circuits are framed.

Two T1 circuits are dedicated statewide to a DACC/channel bank system that supports the FDOT’s 47 MHz repeater system.

Two T1 circuits are dedicated statewide to a management IP network constructed using Nortel ASN routers that transports SNMP, TL1 and other management traffic between the sites and the network management systems. An additional T1 is dedicated statewide to a field data network utilizing the same Nortel ASN routers, but in a different IP address space. The Field Data Network currently supports the FDOT’s RoIP system and field-based ITS equipment, including video.

In the 74-site SMS, fourteen (14) sites are considered “hub” sites. These sites are equipped with aDS3 multiplexer, which aggregates the unallocated microwave T1 circuits into a fractional, channelized DS3 format that is connected to the Ericsson Passport 15000 ATM switches. The ATM switches utilize this bandwidth to provide Ethernet Virtual LAN Services (EVLS) circuits to the adjacent “hub” site(s) in the microwave network. (See Figure 1.1.2-2 and 1.1.2-3 below). These EVLS circuits support both the field data network, as well as District-to-District applications. It is the intent of the FDOT to pursue the upgrade of the SMS to a hybrid Ethernet and TDM microwave transport solution to provide native Ethernet connectivity.

In addition to the 74 SMS sites, there is a second microwave network, Florida Turnpike Microwave System (FTMS) specific to the Florida Turnpike Enterprise. This network is comprised of 20 sites. This network is strictly a TDM network with no Layer 2 or 3 devices. However; there are a total of 9 sites which are co-located with either the fiber optic ITS WAN and/or SMS sites. During the upgrade project, the Florida Turnpike Microwave System will become part of the statewide ITS network.

While the fiber optic (ITS WAN) network is presently being built out, portions of the state are in operation on the network; primarily, the Southern half of the peninsula. The ITS WAN transports are comprised of both long-haul optical CWDM SONET providing up to 2.5 gigabits/second bandwidth, and Layer 3 connectivity to the RTMC’s. Conversely, the Statewide Microwave System (SMS) is fully deployed across the state and provides ITS WAN connectivity to key FDOT sites where fiber is not currently present.
Figure 1.1.2-1 - Baseline View of Existing Network(s)

Figure 1.1.2-2 – Typical “Key” Application Site
**Figure 1.1.2-3 – Typical “Hub” Site**

(Description of the diagram and table content as per the image)
1.3 Limitations and Constraints

The FDOT has made a considerable investment in the Statewide Microwave System, and wishes to leverage these assets (real estate, towers, antennas, wave-guide) as a means for providing redundancy for the fiber-optic ITS WAN. However, if the fiber-optic WAN experiences an issue preventing the flow of network traffic, potentially 2.5 gigabits/second will have to traverse a much slower 45 megabits/second (Mbps) microwave link. As the next-generation network will certainly have similar constraints (i.e.: a 10 Gbps fiber backbone coupled with a 300-400 Mbps microwave system), equipment features must be available to groom traffic via class-of-service/quality-of-service, queue prioritization, and other traffic shaping methods.

Network infrastructure equipment (switches, routers, hubs, etc.) in both networks are obsolete, and end-of-life.

The migration plan to a Next Generation Network (NGN) will be undertaken in stages, as funding becomes available, and in key locations where the FDOT has particular business needs to meet.

Therefore, the FDOT seeks information from key vendors about their specific technology offerings, and how they may fit into this unique upgrade scenario.

The purpose of the RFI is to develop a path to the “Next Generation Network” which will combine overlapping sites with a single WAN technology. The Next Generation Network shall leverage legacy TDM microwave sites (until they are phased out), newly upgraded microwave sites (hybrid TDM and Ethernet) and long haul optical technology to collapse the networks into a single cohesive network. The mission remains to support all existing TDM and Ethernet / IP applications and future ones as well.

1.2 Requirements

The solution recommended by respondents for the Next Generation Network (NGN) must meet the following requirements:

- Intra-domain IP multicast MUST be supported (multicast between next generation and legacy networks must function correctly).

- Multicast Source Discovery Protocol (MSDP) of inter-domain PIM-SM domains (multicast between next generation and legacy networks must function correctly). Multicast traffic can be native via rendezvous point(s), or tunneled from source to destination via an Intermediate System to Intermediate System Service Identifier (ISID) or Virtual Local Area Network (VLAN), as long as traffic from a multicast source reaches its destination efficiently. See drawing below.
• Support Transport T1 (TDM) circuits (i.e., pseudowire) either inherent to the system or through use of third-party equipment interfaced to SPB core.

• Support T1 aggregation (TDM) over Ethernet, either inherent to the system or through use of third-party equipment interfaced to SPB core (e.g: RAD Rici-16).

• SPB core must communicate with two OSPF zero (0) domains (SMS management and ITS WAN), and one OSPF ten (10) domain (data).

• SPB core must communicate with each of the districts who have their own OSPF areas (likely area zero (0)), which currently connects to the ITS WAN backbone at Layer 3 (Center to Center).

• Vendor/Manufacturer must specify routing protocols used between the legacy and next-generation networks (ISID, Intermediate System to Intermediate System [ISIS], SPB, OSPF, Static Route).

• Minimum of eight COS/QOS queues for traffic grooming on next generation equipment.

• Wire speed capabilities on all ports, all the time. FDOT does not want to deploy a piece of equipment at any particular site that could become a bottleneck for traffic in the event that the particular site has to process all traffic in the WAN; i.e.: catastrophic fiber outages in several locations force all WAN traffic to traverse through a single site.
• Operation and Management (OAM) between next generation and legacy networks (Simple Network Management Protocol [SNMP]); ability to work with external vendors’ “manager of managers” (MOM) applications (such as Harris NetBoss or MegaSys Telenium) for management. Specify any additional applications/hardware/middleware to independently support all hardware devices in the design. FDOT needs to understand what is needed to manage devices and costs associated with accomplishing a cohesive network management platform.

• Isolated management network via ISID and/or VLAN.

• Multi-tenant capabilities (services and/or entities). The next-generation network must be able to support multiple Autonomous System (AS) domains.

• Equipment currently available for sale, and support available for no less than seven years.

• 19-inch two-post rack mountable equipment

• Redundant -48V DC power

1.2.1 Assumptions
The current, legacy microwave system is TDM-based NxT1. The new microwave system will be an Ethernet and TDM hybrid system. The FDOT expects next generation microwave equipment to provide a minimum of 300 Mbps bandwidth per link (via single or multiple carriers), utilizing the existing tower infrastructure. Construction of new or additional tower sites is not being contemplated.

To facilitate the continued use of the existing microwave infrastructure for some portions of the network for a period of time, the FDOT is also looking for an Ethernet over TDM solution that can bond multiple T1’s for Ethernet connectivity. Some of these legacy sites may also have fiber connectivity which can be leveraged as on/off ramps and for redundancy.

The FDOT is looking for equipment to provide a minimum of 10 Gbps bandwidth over our fiber optic access. Approximate mileage between sites is provided so that respondents can specify long-haul optical networking and/or regeneration equipment for furnishing a minimum of 10 Gbps bandwidth via fiber.

Management and alarming systems for next-generation microwave radios, fiber optic equipment, network equipment, and hard contact closure alarms for tower maintenance should function with IP/Ethernet OAM.

1.3 Upgrade Scenarios
1. Turnpike Section Upgrade – Complete upgrade
2. Upgrade all Hub Sites and “key application” sites within the SMS – Leverage fiber optic connectivity where possible.

1.3.1 Upgrade Scenario #1 – The Florida Turnpike Upgrade
The Florida Turnpike currently has a 20 site microwave system based on TDM technology. The Florida Turnpike sites all have fiber optics in and out through them. Currently, ITS WAN has fiber strands allocated from Turnpike fiber to assist ITS Central Office to complete their mission with respect to the statewide ITS network.

Respondents should consider all 20 Turnpike sites as key locations where fiber and microwave networks can be leveraged for redundancy. Respondents should be aware that the fiber is the primary path for all applications and data center connections. In the event of a fiber outage, the traffic will be shifted to a second
or redundant fiber path, if available, and then ultimately traffic engineered over the microwave as a last resort. The FDOT is seeking respondents to provide a design for an SPB network using the Turnpike sites with fiber redundancy as the main protection and the microwave system as the secondary protection in the event of a complete fiber outage.

It is important to maintain connectivity between the upgraded Turnpike sites with the remaining legacy networks, to maintain the integrity of the statewide ITS network.

The FDOT would like the Vendor to describe the upgrade process and design of the Turnpike region. The design should include the type of equipment recommended at each site, and the modules necessary for connections to the fiber and microwave for redundancy. The vendor should include any third-party equipment that would be needed. The vendor should describe traffic redundancy process. The vendor should describe how the upgraded region would interface and network with the rest of the legacy network. The FDOT will use this information to make assumptions regarding the future upgrade of other geographical regions in a phased approach.

1.3.1.1 Site List
Distances are approximate, straight-line distances between sites for the purposes of determining the proper long-haul optical SFP modules for network devices.

One site (Site T) in the Turnpike microwave system, is also an SMS “Hub” site, as well as an ITS WAN site.
Site A
Microwave Hub Site: No
Site has Fiber Optics: Yes
Distance from Site B: 18.5 miles

Site B
Site has Fiber Optics: Yes
Distance from Site A: 18.5 miles
Distance from Site C: 16.8 miles

Site C
Site has Fiber Optics: Yes
Distance from Site B: 16.8 miles
Distance from Site D: 4 miles
Distance to Site E for Microwave Link: 12.36 miles

Site D
Site has Fiber Optics: Yes
Site has no microwave tower
Distance from Site C: 4 miles
Distance from Site E: 8.36 miles

Site E
Site has Fiber Optics: Yes
Distance from Site D: 8.36 miles
Distance from Site F: 24.3 miles
Distance to Site C for Microwave Link: 12.36 miles

Site F
Site has Fiber Optics: Yes
Distance from Site E: 24.3 miles
Distance from Site G: 22.1 miles

Site G
Site has Fiber Optics: No
Distance from Site F: 22.1 miles
Distance from Site H: 13.75 miles

Site H
Site has Fiber Optics: Yes
Distance from Site G: 13.75 miles
Distance from Site I: 17.3 miles

Site I
Site has Fiber Optics: No
Distance from Site H: 17.3 miles
Distance from Site J: 19 miles

Site J
Site has Fiber Optics: Yes
Distance from Site I: 19 miles
Distance from Site K: 7.5 miles

Site K
Site has Fiber Optics: Yes
Distance from Site J: 7.5 miles
Distance from Site L: 10.9 miles

Site L
Site has Fiber Optics: Yes
Distance from Site K: 10.9 miles
Distance from Site M: 17.7 miles

Site M
Site has Fiber Optics: Yes
Distance from Site L: 17.7 miles
Distance from Site N: 15.7 miles

Site N
Site has Fiber Optics: Yes
Distance from Site M: 15.7 miles
Distance from Site O: 5.5 miles
Site O
Site has Fiber Optics: Yes
Distance from Site N: 5.5 miles
Distance from Site P: 12.4 miles

Site P
Site has Fiber Optics: Yes
Distance from Site O: 12.4 miles
Distance from Site Q: 14.3 miles

Site Q
Site has Fiber Optics: Yes
Distance from Site P: 12.4 miles
Distance from Site R: 8.28 miles

Site R
Site has Fiber Optics: Yes
Distance from Site Q: 8.28 miles
Distance from Site S: 19.4 miles

Site S
Site has Fiber Optics: Yes
Distance from Site R: 19.4 miles
Distance from Site T: 18.5 miles

Site T
SMS Microwave Hub Site: Yes
Site has Fiber Optics: Yes
Distance from Site S: 18.5 miles
1.3.2 Upgrade Scenario #2 - Upgrade all Hub Sites and Key Application Sites

In this upgrade scenario, FDOT is looking for solutions to leverage the existing legacy microwave system while deploying updated SPB equipment to build a foundation for the next-generation network.

It is the desire of the FDOT, in this scenario, to replace each of the Ericsson Passport 15000s located at the hub sites with an SPB product. The Ericsson Passport 15000’s interface to the legacy microwave system via a channelized, fractional DS3. The FDOT is requesting that the vendor provide options for leveraging the available SMS bandwidth for the SPB network. Note that the DS3 multiplexers can be eliminated if direct access to the 24 channelized T1 circuits is desired.
It is also the desire of the FDOT to replace legacy routers at “key” application sites (see Figure 1.1.1.1-2) to provide SPB services at the site by leveraging the available capacity of the SMS. Key Application sites include all sites that require intranetwork multicast capability. However, these locations do not have access to the full 28xT1 bandwidth of the microwave system; but, they may have access to the fiber optic network. A maximum of 16 T1 circuits via the SMS, in each direction is available, 2-3 T1 circuits are dedicated to the channel bank system and 3 T1 circuits are dedicated to the legacy router network. These 5-6 T1 circuits are shared with other sites and therefore cannot be reallocated without upgrading all sites located between two hub sites. Of the remaining 9-10 T1 circuits, each of these T1s reallocated to provide transport to a “key” application site comes from the T1 circuits connecting the hub sites. That is, if the capacity of the fractional, channelized DS3 between two hub sites is 24 T1 and 8 T1s are reallocated to serve a “key” application site located between the two hub sites, the fractional, channelized DS3 capacity is reduced to 16 T1. Based upon the application requirements, the bandwidth requirement at the “key” application sites are relatively low at this time (~3Mbps), however, the flexibility of reallocating more T1s for transport is desired if a solution exists that does not detract from the capacity between hub sites (i.e., SPB traffic can efficiently and fully utilize both the hub-to-hub route and the hub-to-key site-to-hub site route).

It is also desired to eliminate the legacy routers, if feasible, at the hub site. As the legacy routers are T1-based, this requires a solution that will interface the SPB product to T1 circuits from routers at the adjacent sites. Finally, the FDOT desires options for transporting the TDM-based traffic from the DACC / channel bank system over the SPB network.

Describe how your solution can replace the Ericsson Passport 15000 ATM switches using the channelized fractional DS3s as transport for SPB traffic.

Describe how your SPB solution would integrate with legacy routers at the remaining SMS sites. Could the routers at the hub sites be replaced with an SPB product?

Describe how your solution will differ between key application sites with physical access to the fiber optic network, versus those key application sites without direct access to the fiber network.

The FDOT would like the Vendor to describe the upgrade process and design of specific sites throughout the statewide network. The design should include the type of equipment recommended at each site, and the modules necessary for connections to the fiber and microwave for redundancy. The vendor should include any third-party equipment that would be needed. The vendor should describe how the upgraded region would interface and network with the rest of the legacy network. The FDOT will use this information to make assumptions regarding the future upgrade of other key sites in the phased approach.
2. Questions for Vendors

Include answers to questions by repeating the question, and the stating answer.

1. Does your solution meet all the requirements listed in section 1.2? Respond to each bullet point in section 1.2. Explain variances or work-arounds for equipment that does/will not meet the listed requirements.

2. For the four different site types (hub site, legacy remote site, key application site, any site type with co-located fiber optic access) – provide a line item equipment configuration.

3. After the upgrade of entire state, will OSPF areas disappear and only ISIDs remain? If not, please explain.

4. In cost analyses, provide any equipment and/or software/license costs (build-out, tiered) for the network element manager.

5. How does your solution route traffic between SPB ISID domains and an OSPF domain(s)?

6. With regard to Upgrade Scenario 2: Describe how your solution can replace the Ericsson Passport 15000 ATM switches using the channelized fractional DS3s as transport for SPB traffic.

7. Describe the throughput the FDOT should expect from a 24-T1 transport of SPB traffic.

8. What is the minimum quantity of T1s needed to support SPB traffic for a “key” application site with a 3 Mbps throughput requirement?
9. With regard to Upgrade Scenario 2: Describe how your SPB solution would integrate with legacy routers at the remaining SMS sites. Could the routers at the hub sites be replaced with an SPB product?

10. Could the routers at the “key” application sites be replaced with an SPB product?

11. Do your products support end-to-end payload encryption? Please describe any encryption capabilities of your products.

12. What are the advantages and disadvantages to deploying a SPB solution instead of maintaining an all Layer-3 network?

13. What are the advantages and disadvantages to deploying a SPB solution instead of deploying an MPLS solution?

3. Acronyms
List of acronyms used within this document:

RFI – Request for Information
FDOT – Florida Department of Transportation
FTE – Florida’s Turnpike Enterprise
ITS – Intelligent Transportation Systems
SMS – Statewide Microwave System
STN – Statewide Telecommunications Network
ITS WAN – Intelligent Transportation Systems Wide Area Network
SPB – Shortest Path Bridging
MPLS – Multi-protocol Label Switching
LAN – Local Area Network
NMS – Network Management System
OAM – Operations, Administration & Management
MOM – Manager of Managers
NEM – Network Element Manager
OSPF – Open Shortest Path First
PIM – Protocol-Independent Multicast
PIM-SM – Protocol-Independent Multicast Sparse Mode
RP – Rendezvous Point
EVLS – Ethernet Virtual LAN Service
ISIS – Intermediate System to Intermediate System
ISID – ISIS Service Identifier
VLAN – Virtual Local Area Network
ATM – Asynchronous Transfer Mode
TDM – Time Division Multiplexed
RF – Radio Frequency
SLERS – Statewide Law Enforcement Radio System
RoIP – Radio over Internet Protocol
EOW – Engineering Order Wire
FCC – Federal Communications Commission
FHP CAD – Florida Highway Patrol Computer Aided Dispatch
NOAA – National Oceanographic and Atmospheric Administration
VAS – Video Aggregation Service
CWDM – Coarse Wave Division Multiplexed
DWDM – Dense Wave Division Multiplexed
SFP – Small Form-factor Pluggable