REGIONAL NETWORK
STATE OF NEBRASKA
INTEROPERABILITY PROJECT

STATEMENT OF WORK

FIRETIDE INC.
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Solution Architecture for Nebraska SWAN

The following architecture is recommended for the State Wide Area Network for Nebraska.

- **Hybrid network of wireless mesh and fiber for the backhaul connectivity between the primary tower locations.** The primary towers will be identified on a per regional basis. The regional tower will most probably be deployed at the regional administrative headquarters.

- **Wireless mesh network for last mile distribution** – for connectivity between the various public administrative and public safety institutions.

- **Wi-Fi network for end user access** – inside the premises of these government / public safety institutions.

The advantages of the above architecture are as follows:

- **Simple Three level Hierarchy:** in sync with the administrative and governance structures inside the organizations.

- **Peer Connectivity at each level of hierarchy:** Connectivity between the different offices and safety agencies within an administrative region.

- **Modularity and Coordination:** Provides a high level of flexibility and adequate level of decentralization of network management. Hierarchy of the overall structure ensures smooth flow of network policies from top to the bottom.

- **Responsiveness:** The peer connectivity at each level ensures network operations can be in sync between administrative and safety agencies, especially at a time of crisis where responsiveness is the most critical factor.
Basic Introduction to Wireless Mesh

Wireless Mesh networks are multipoint-to-multipoint adhoc networks with very high reliability. These networks demonstrate the following characteristics.

Reliability

- Multiple paths/routes exist between any two points inside the mesh network.
- Link redundancy is automatically created in a well-designed mesh network.

Self-forming

- Network elements (mesh nodes) are “meshed” into the network as soon as they are powered on.
- Minimal configuration effort at the deployment site.

Self-healing

- When one point in the mesh network fails, traffic is automatically re-routed through alternate links
- When the failed element is restored, the network automatically includes the node in the network and routes traffic on the revised best path.
- Network is resilient to failures and hence no network downtime.

Scalable

- Unlike point-to-point networks, which are not highly scalable and face performance deterioration for large multi-location deployments, the mesh network is highly scalable and expansion of network is quicker and easier.
Wireless Mesh Solution on the SWAN backhaul

Each of the towers in the above representation indicates a primary location where the Firetide HotPort mesh radios will be mounted. Firetide wireless mesh backhaul as easily as terminating on an Ethernet switch.

Firetide Differentiators

Ethernet-like mesh backhaul infrastructure

The Firetide mesh network operates as a distributed high-speed Ethernet switch. The multiple wireless nodes appear as a large, seamless Ethernet switch to an external application.

- Plug-n-play, open standards based IP interface.
- Extremely easy to deploy multiple IP devices or network segments
- Quickly roll-out multiple services for government and public safety applications.
High-performance network

Firetide delivers industry leading network performance that is critical for deploying latency sensitive triple play applications on a state wide area backhaul network

- **Best in-class throughput upto 70Mbps per hop.**
- **Multi-hop (>10) throughput upto 35 Mbps**
- **Best in-class low-latency, approx 1.5ms per hop.**
- **Best in-class mobility solution with < 10ms handoffs and high throughput for triple play streaming.**
- **Best in-class security standards**

The high speed bandwidth pipe on the Firetide mesh network enables the state to focus on deploying a variety of critical applications, current and future, without constant upgrades to the capacity or features of the underlying infrastructure.

Optimal Routing for triple play services

Firetide’s patented AutoMesh™ packet forwarding protocol provides the most optimal routing mechanism within the mesh. The routing is highly dynamic and takes into account the various RF changes and overall network topography to decide on the route.

Effectively, the end users are oblivious to the network architecture and get a very high performance backhaul to their applications.

QoS support for service segregation

Quality of service configuration is a critical requirements especially for networks distribution multiple levels and types of services. In keeping with the industry recommended standards and to support interoperability, Firetide mesh network supports:

- **IEEE 802.1p based traffic classification, on the mesh network**
- **Port based classification, on the mesh device.**
- **Support for extensive VLAN (incl. trunk) configurations**

Reliable RF Performance

Firetide utilizes a patented, highly advanced RF channel selection mechanism for high throughput performance under challenging RF environment.

Advanced RF optimization algorithm delivers “reliable, fiber-quality” transport layer for critical applications on a wireless medium.
Firetide mesh and access point radios can operate in IEEE 802.11 a/b/g standards in the 2.4 GHz, 5 GHz (unlicensed bands) and licensed 4.9 GHz.

**Comprehensive Network Management System**

Firetide HotView Pro™ management system:

- Supports SNMP standards
- GUI with client-server model on Java platform
- NMS software can be installed on standard server configurations.
- Full FCAPS support [Fault, Configuration, Accounting, Performance and Security]
**Interoperability on the wireless mesh**

Firetide recommends its wireless mesh solution for the distribution network for each of the regions within the state wide area network.

Firetide provides several advanced features on the wireless mesh infrastructure which make it the most ideal solution for large scale distribution networks that involve critical public safety institutions.

**Extensive VLAN configuration**

Firetide mesh supports VLAN configurations (including VLAN trunks) as per the IEEE 802 standards. Each mesh can support upto 4095 VLAN.

Each mesh node can participate in 32 VLANs which makes segregation of services very easy. E.g. the various government departments and institutions can be on their individual VLAN while sharing the same underlying infrastructure.

Only Firetide solution provides sufficient bandwidth capacity to allow multiple VLAN segments, carrying triple play traffic – voice, Video and data – without performance degradation.
MeshBridge™

MeshBridge™ facilitates creating bridges between remote Firetide meshes and transport traffic across meshes seamlessly.

Advanced Mobility Solution

Firetide mobility solution facilitates seamless end user connectivity to the network

- Mobility on public safety vehicles moving at 90 mph.
- Handoffs are less than 10ms. No dropped voice calls or missed video frames or disconnected browsing sessions.
- 256-bit AES, US Military spec FIPS140-2 certifiable: Highly secure mobile connectivity between the vehicle and the base network.
- Very high throughput upto 25 Mbps.
Seamless and Reliable Interoperability with wired backbone

Firetide provides robust and secure solution for integrating the wireless mesh network with any existing wired backbone. On a regular wired backbone, the mesh network can be directly plugged into the backbone using standard Ethernet connectors.

- Each mesh network is logically terminated on a wired backbone through a gateway server. This is a critical network link which demands very high availability. Hence Firetide provides a **redundant gateway server solution** wherein the secondary server automatically takes over on failure of the primary.

- Firetide provides **linear redundancy on its gateway solution**, wherein the wireless mesh provides an alternate backup connectivity when the underlying wired backbone is disrupted.

![Firetide Mesh Reliable Interconnection with wired backbone](image-url)
Security Features on the Firetide Mesh

Security is one of the prime concerns of end users when deploying wireless networks for critical applications on such a large scale. Firetide has addressed these concerns by introducing multiple layers of comprehensive security measures as described below.

End-to-End Network encryption

The data is encrypted using a FIPS140-2 certifiable 256-bit AES cipher at the network ingress point and is decrypted at the egress point in the network.

Wireless Hop encryption

The encrypted data (network level) is again secured by another level of encryption (128/256-bit AES/WPA) at the radio level for each wireless hop. The AES (en) decryption is hardware-assisted and has negligible impact on multi-hop performance.

Encapsulation

Within the Firetide mesh, the packets are encapsulated in proprietary Firetide headers which provide an additional layer of security against malicious agents.

Digital Certificates on nodes

Each node is embedded with a digital certificate. The administrator can configure the mesh to allow only those Firetide nodes with the appropriate digital certificates to participate in the network.

Digitally signed firmware files

The firmware on Firetide elements also carries a digital signature which lends a higher level of authenticity.

Access Control Lists (ACL)

The administrator can filter user access to the mesh using ACL on MAC addresses.
Summary of Firetide wireless mesh benefits

Firetide’s wireless mesh solution provides the ideal infrastructure for the Nebraska SWAN

- Reliable network infrastructure
- High performance, secure backhaul
- High availability mesh architecture
- High level of interoperability – Ethernet like solution
- High scalability for wide area network deployments
- Easy to configure, manage and control
- Easy integration with existing backbone
This Statement of Work outlines bid specifications for a turn-key project to design, implement, test and integrate a wireless IP point-to-point network. The network will connect with local public safety communications systems and the state wide area network.

Firetide will provide a wireless mesh multipoint-to-multipoint reliable wireless architecture as discussed above.

Project Plan

The project will be completed in phases. Sites and path profile information is provided as a starting point for the vendor to perform their technical design and submit their proposal. The vendor is responsible for the technical design, path profiles, and technical specifications for the wireless point-to-point equipment, and connection points on the network.

The first phase will be implemented and tested, and will be proven to operate successfully before the successful contractor will be awarded the remainder of the project. The entire project will create multiple regional wireless networks to integrate with a state wide area network, connecting tower locations and local public safety dispatch offices.

The state will coordinate with the contractor’s work plan to connect tower sites, antenna placement on towers, local connection points, and the overall design of the network. The project integrates other public safety resources, therefore all points of contact and contractor work will be coordinated through the state.

Firetide will support the end customer on the above issues.

Network Scope

Tower locations are specified where the network is anticipated to be implemented. Local areas are identified that are anticipated to be connected to the network. The first phase of the project identifies towers and primary local areas that will be connected to network. This first phase will be the contractor’s opportunity to prove the network. The network shall be optimized and the performance of sites and connections shall be documented to complete phase one of the network. All segments of the network shall be optimized and performance specifications shall be documented before the work is considered completed.

After the first phase is proven to operate successfully other segments of the network will be implemented. After the primary locations are connected additional towers and local areas will be added to the network.
Primary Locations

The map shows locations of towers to be connected on the state wide area network. Local area locations are shown that will connect to the towers. The point-to-point path profiles are preliminary work the state has provided as a basis for the vendor to plan their technical specifications and proposed equipment for the network. Additional Locations will be added after primary locations are connected to the towers on the state wide area network. Additional connections will be required as the primary network connections are established and the network expands. This work will be at the direction of the state and will be coordinated with other projects that are in process.

Firetide has recommended a solution architecture for the SWAN above.

Map of Towers and Primary Local Areas

The statewide map shows towers and local areas to be connected in the network. Phase one is indicated as the Western Nebraska Panhandle area. The contractor is required to prove their design and implementation successfully in this phase before the remainder of the contract will be awarded.

ADD STATE MAP OF TOWERS AND PRIMARY LOCAL AREAS

Path Profiles

Attachment A contains path profile information provided for the vendor to review. The path profiles are run from tower locations to local areas using assumed antenna heights and frequency band. This information is only intended to illustrate anticipated connection points and provide scope of the network design. The contractor is responsible for the technical design and performance of the network pathways.

ADD PATH PROFILE WORK IN SEPARATE ATTACHMENT

Technical Specifications

The equipment will provide reliable connectivity over the distances provided, minimize the number of intermediate hops, and minimize the antenna load on towers. The network should be a balance between number of connection points, antenna loads, reliability, maintenance, and cost.
The vendor’s design will specify the following.

1. **Maximum latency desired 500 ms**

   Firetide provides latency as low as 1.5 ms per hop.

2. **Bandwidth desired 3-10 mbps full duplex**

   Firetide provides mesh industry’s highest throughput of up to 70 Mbps. Firetide’s product roadmap comprises next generation of products whose capacity exceeds several hundreds of mbps.

3. **Equipment is desired that uses an adaptive rate to adjust bandwidth**

   Firetide equipment uses adaptive rate modulation to adjust bandwidth.

4. **Full duplex is the desired operation**

   Firetide mesh network support full duplex operation.

5. **Frequency band is desired to minimize interference, and minimize antenna loads**

   Firetide operates in a wide range of frequency bands and the solution is embedded with advanced algorithms that provide interference mitigation capabilities.

6. **Reliability desired is no less than 99.99%**

   The wireless mesh network architecture can be designed to ensure no overall network downtime.

7. **Redundancy will be considered in the design once reliable pathways are able to meet the above specifications**

   Wireless mesh architecture provides adequate link redundancy.

8. **Maintenance support of the network hardware**

   Firetide and the installation partner will provide the necessary maintenance supports.

9. **Measurement and documentation of network performance specifications**
Firetide HotView Pro mesh network management software will provide the necessary performance statistics for the network administrator to monitor and take corrective action as appropriate.

10. **Manufacturer specifications**

Equipment may be proposed that is upgradable to meet the desired specifications. The vendor shall specify costs to upgrade equipment and the contractor shall be responsible to provide upgrade services within the scope of this statement of work. Network statistics shall be documented and used as a reference in maintaining the network performance specifications.

Firetide’s current suite of wireless mesh network elements exceeds the requirements for the deployment of the Nebraska SWAN. Firetide will support the end customer in providing regular product and feature upgrade that are within the scope of the work.

**Frequency Bands and Licensing**

The contractor shall be responsible to license the proposed equipment using a frequency band that requires an FCC license. Where 4.9 GHz is proposed the contractor shall coordinate with the state frequency coordinator. Where an unlicensed frequency band is proposed the vendor shall address how the equipment and deployment methods will mitigate interference potential. For frequency bands proposed for use in the network the vendor shall describe the path distances and interference mitigation methods appropriate for the equipment proposed per manufacturer specifications.

Firetide mesh network elements can operate in the 2.4, 4.9 and 5 GHz frequency bands.

**Bandwidth and Reliability**

Throughput in the network must support a minimum bandwidth of 3 mbps to any location in the network. The equipment desired may be upgradable to increase the performance of the network. Adaptive rate capability is desired to maintain connectivity. Reduced bandwidth is acceptable if 99.99% connection reliability is maintained. This network will also rely on the state wide area network, which may carry traffic to and between connections on the wireless IP point-to-point network.
Firetide mesh solution will deliver end user bandwidths exceeding the requirements in this specification while maintaining network reliability.

**Contractor Experience**

Identify projects of similar scope and technologies the vendor has successfully implemented. Describe the maintenance services you provide to support the client’s network. Projects used as examples should address the information in this Statement of Work. For each project cited provide a point of contact who is able to discuss the details of their project.

**Maintenance Support and Service Levels**

The contractor shall provide maintenance of the installed network and the performance specifications. Performance of the network will be documented at initial optimization and used as a reference in monitoring the ongoing network performance. The vendor shall specify the maximum timeframes to troubleshoot and service the network.

**Bid Bond**

A bid bond in the amount of 100% of phase one is required. After contract award for the remainder of the project a 10% bid bond is required. A retainer of 10% will be withheld from payment until the project is completed.

**Vendor Network Design and Project Plan**

The vendor shall submit their technical design addressing the above information in the Statement of Work. The vendor project plan shall define clearly the timeframes, work to be performed, and steps to be performed to coordinate with appropriate state and local officials.

The vendor shall detail the information needed from the state to successfully implement the project. The state will support the contractor’s work plan and coordinate the contractor’s work with the implementation of the state wide area network and related projects.

The network design is provided above.
Project Timeline

The vendor shall include a project timeline in their project plan. The state is implementing other projects in coordination with this project. The state estimates the contractor should be able to complete phase one by September 1, 2009. The vendor shall detail the tasks and approximate timeline to complete the phases of the network through completion of the entire network.

Cost Proposal

The vendor shall detail their cost proposal as follows. The vendor’s cost proposal shall detail the complete project costs within the scope of this Statement of Work.

1. Wireless IP equipment and installation hardware, cabling, connectors, etc.
2. Labor to install, test and optimize the network
3. Other related costs to fully implement the network
4. Maintenance and service levels