16b. **Canopy**

### 16b.1.1. **INTRODUCTION**

The Canopy system will provide the Commonwealth of Virginia with a wireless method of extending network connectivity to remote locations. The Motorola Canopy system will enable the Commonwealth to extend STARS intranet connectivity to those offices that for economic or geographic reasons may be beyond the reach of other wired broadband technologies such as the STARS microwave system.

The Canopy system will use broadband equipment to provide point-to-point links between STARS Wide Area Network-equipped locations and selected Wireless LAN (WLAN) locations. The system is based on the WLAN remote sites connecting via Canopy to the closest WAN-equipped site. In select locations, Point to Multi-Point links may provide a method of connecting multiple WLAN locations that are in close proximity to each other and the WAN location, which allows for a flexible design.

The system is based on the primary assumption that there is a reasonable ability to obtain a “line of sight” Radio Frequency (RF) path between a STARS WAN location (Land Mobile Radio site, Microwave site) and a WLAN access location (Area Office, Courthouse, etc) where the WLAN Access Point will reside.

#### 16b.1.1.1. **System Equipment**

The Canopy Wireless Platform will be configured to form a point-to-point network connection used for wireless backhaul applications. In select locations, Point to Multi-Point links may be employed where feasible. Bandwidth efficiency is achieved using a proprietary, robust modulation scheme that allows for superior co-channel performance and mitigation of interference.

The Canopy system is based on a Time Division Duplex scheme with a re-configurable downlink/uplink boundary. This means the unit’s uplink/downlink bandwidth ratio for a hop is configurable in several bandwidth configurations such as 75 percent downlink and 25 percent uplink or 50 percent uplink and 50 percent downlink.

Canopy uses a four level Frequency Shift Keying (FSK) modulation for Point-To-Point links. This approach provides a very low Carrier to Interference (C/I) ratio providing robust performance in the presence of interference and high system traffic levels. Canopy’s data rate is fixed over a wide range of propagation conditions and varying signal to noise. Canopy’s FSK high index modulation scheme allows for no reduction in the data rate based on link distance. Since Canopy radios have a nominal C/I of 2dB, Canopy is extremely tolerant to interference from other sources as well as from other Canopy radios in the network.
Canopy operates in the 5 GHz-unlicensed National Information Infrastructure band, commonly called the U-NII band. (5.25 – 5.35 GHz and 5.725 – 5.825 GHz) All radios are approved by the United States Federal Communication Commission (FCC) Part 15, Class B.

The Canopy Backhaul Module is a Point-To-Point radio that will be used to carry traffic between two locations. A set of Backhaul Modules will be used as a low latency Ethernet bridge between two networks. Each Backhaul Module communicates to another Backhaul Module using a directional antenna.

The Point-to-Point links using Backhaul Modules operate with a raw data bit rate of 20 Mbps (aggregate) including overhead. Point to Multi-Point links operate at approximately 4 Mbps (aggregate) including overhead.

The Motorola Canopy’s standard connection is RJ45 10/100 baseT Ethernet.

The Canopy system will utilize SNMPv2 MIB-II (system and interface objects) with a full enterprise Management Information Base (MIB) for overall management. Alarms will be delivered via Ethernet to the network management system. The Canopy modules will be equipped with a built-in web server using a standard web browser. This provides a mechanism for configuration of the unit.

16b.1.1.1. Site Selection Criteria

Each potential location for Canopy equipment must be surveyed to verify feasibility of the RF link, or “hop.” In addition, most hops will require a path survey to confirm that line of site and Fresnel clearances are available. A path survey for each of the 179 hops will be conducted, and is included in the system pricing. Additional surveys can be purchased on a “per hop” basis if necessary.

Antenna height is essential when installing a Canopy hop. The Canopy Backhaul unit must be mounted higher than other objects located immediately around it such as trees, buildings, etc.

The Canopy Backhaul units that make up the point-to-point link must have a clear, unobstructed view of each other. In addition, there must be no obstructions that will interfere with the unit’s antenna. The area immediately in front of a Backhaul must be clear of all obstructions.

16b.1.1.2. Path Loss Considerations

The Fresnel Zone is a theoretical area around the line of sight of an antenna transmission that can affect the signal strength. Objects that penetrate the Fresnel Zone can cause fading of the transmitted signal. This fading is caused by the cancellation of the signal due to out-of-phase reflections. An unobstructed line of sight is important, but it is not the only determination of an adequate placement. Even though the path has a clear line of sight, if obstructions (such as terrain, vegetation, metal roofs, cars, etc.) penetrate the Fresnel zone, there will be signal loss. Figure 16B-1 illustrates a Fresnel zone.
As an RF signal travels through space, the distance from the initial transmission point attenuates it. The further away from the transmission point, the weaker the RF signal.

Tree and plant foliage will cause additional signal loss. Seasonal density, moisture content of the foliage, and other factors such as wind may change the amount of loss.

16b.1.1.2.1. Lightning Protection
A Canopy Surge Suppressor will be used to protect the Canopy equipment from electrical surges along the Ethernet cables that run between the Canopy Backhaul unit and the building.

16b.1.1.2.2. Security
Although Canopy equipment provides a measure of security from unauthorized monitoring of the link, Motorola is providing an additional layer of security for these links. At each end of the link, a router will be provided between the Canopy equipment and the LAN equipment that connects to the hop. This router will be equipped with IPSec and 3DES encryption to provide a secure LAN-to-LAN Virtual Private Network tunnel across the Canopy hop.

16b.1.1.2.3. Design Assumptions
It is assumed that there is a reasonable ability to obtain a “line of sight” RF path between a STARS WAN location (Land Mobile Radio site, Microwave site) and a WLAN access location (Area Office, Courthouse, etc) where the WLAN Access Point will reside.
For purposes of providing a baseline system design and pricing for the Canopy and AirMobile subsystems, assumptions were made as to the quantity of paths that may be viable. The percentage of paths that may be viable were based on the following assumptions:

- For paths of 0-2 miles, it is assumed that 95% of the paths will be viable.
- For paths of 2-5 miles, it is assumed that 50% of the paths will be viable.
- For paths of 5-10 miles, it is assumed that 20% of the paths will be viable.
- For paths of greater than 10 miles, it is assumed that none of the paths will be viable.

These are only assumptions, and no guarantees of path viability or the quantities thereof are expressed or implied. These assumptions however create the baseline for the contract.

System pricing is based on the price for a single hop multiplied by the total number of estimated viable paths as described in the formula above. When percentages yield a fraction, the number of hops estimated as viable is rounded up to the next integer. Based on the formula, the system pricing reflects 179 single hop Canopy links.

Since the Canopy links use unlicensed frequencies, no guarantees are made as to the path availability or throughput obtained on the link. It is assumed that the links will be used for non-mission critical traffic. Additionally, because Canopy operates in an unlicensed frequency band, interference from other systems can cause link performance to fluctuate unpredictably. Therefore, Motorola makes no specific guarantees as to Canopy coverage, path reliability or throughput.

The Canopy equipment will connect to a router inside the building. This router will be located in the network room within 3’ of the WLAN Ethernet switch.

It is assumed that the distance between the router and the Canopy demarcation at the Canopy/building Ethernet cable ingress point is no more than 100’.

Up to six point-to-point links can be co-located at a single location. This also assumes the path directions for multiple paths are not correlated. Final quantities will be based on the results of the site and path surveys, as well as local frequency coordination at the site. This will also be a factor in determining path viability.

The implementation of a Canopy hop assumes that the WLAN equipment associated with the site at each end of the hop has been implemented. Motorola will install equipment associated with the Canopy subsystem on racks and connect it to equipment installed as part of the WLAN and/or WAN subsystems. The Canopy routers must connect to the Ethernet switches supplied with the WLAN subsystem.

Motorola will mount the Canopy Backhaul unit at least 2 feet below the highest point at the site.

Motorola assumes the location is properly grounded for lightning protection according to the National Electric Code, Motorola R56 standards and applicable local codes that are in effect at the time of initial STARS installation. The Canopy equipment will be grounded to the tower or building ground, provided access to the ground bus is available within 10’ of the device.
Motorola assumes adequate grounding is in place at all required locations at all potential Canopy sites.

Pricing is based on links between two locations consisting of a single point-to-point hop.

In some cases, Canopy operation between two sites may not be viable. If an original WLAN site as shown in Appendix 4 matrix “Wireless LAN/Wide Area Network” is determined not to be viable, Motorola will survey one other site as an alternate link for the Canopy equipment. Pricing also includes a path study for one alternate link. The alternate link is assumed to consist of a single hop.

If an alternate location cannot be found, or the results of the site and/or path survey indicate the alternate hop is not viable, the Commonwealth of Virginia has the following options:

- Eliminate the remote WLAN site from consideration without replacement
- The Commonwealth of Virginia would provide connectivity via a leased T1 connection to the original WAN site
- Attempt to find another alternate location, subject to a “per location” price for a site and path survey.

The Canopy hop will transport IP-based traffic between mobile users across the WLAN to the WAN. In addition, file transfers will be accomplished through the AirMobile application. Transfer of this information across the link assumes the Canopy link is operational. The Commonwealth of Virginia acceptance of a Canopy link will be accomplished by virtue of successful completion of the WLAN and AirMobile ATPs for a given WLAN location.

The Commonwealth of Virginia must provide AC power receptacles within 6 cable feet of the Cluster Management Module at the WAN-equipped site, and within 6 cable feet of the Canopy Ethernet cable ingress point at the WLAN site. AC power receptacles must also be available within 6 cable feet of the router.

Pricing in this contract will accommodate forty (40) locations which may require a tower to elevate the Canopy unit above obstructions. This tower is limited to a height of 120’ and is designed to support only the Canopy antenna requirements.

Pricing is fixed for the equipment and configurations as outlined. Any system or site configuration found to be inconsistent with the assumptions of this design are outside this scope and can be priced on a case-by-case basis.
16b.1.2. Canopy Tower Specifications

TOWER MODEL  U-4.5 x 120' Self-Supporting Tower constructed of solid steel members.
- 4.5 ft. center to center distance between legs; triangular construction.
- Engineering drawings to be sealed by registered Virginia professional engineer
- Custom foundation design if soil report is supplied
- Cable-type safety climb system and harness
- Anchor steel with full-sized template to simultaneously position anchor bolts for all legs
- EIA grounding materials with lightning rod
- One 4-1/2" OD Microwave Dishmount
- Single T Transmission line hanger brackets: 1 run initially for four lines with 2"-6" vertical spacing.
- Hot-dipped galvanized sections and components
- Solid rod construction of tower sections
- Tower assembly hardware
- Horizontal members for climbing

WIND LOAD  80 MPH basic wind speed per EIA/TIA-222-F, and 90 mph 3 second gust per the 2000 International Building Code (Exposure C, Importance Factor of 1.0).

ICE LOAD  1/2" radial ice with 25% load reduction

TWIST AND SWAY  Twist and Sway at 0.74 degrees at an operational Basic Wind Speed of 50 MPH with 0.0 inch of radial ice at 70 ft. All operational basic windspeeds are calculated at 33 feet above tower base per EIA specification.

ANTENNA LOAD  120' - (1) 2' HP Dish with 7/8" line

ESTIMATED BASE REACTIONS
- Total Weight: 6.2 kips
- Moment: 249.0 ft kips
- Max. Compression (per leg): 66.0 kips
- Max. Uplift (per leg): 61.9 kips
- Max. Shear (total): 4.0 kips

FOUNDATION ESTIMATE  23.1 cu. yds. concrete for estimated unit base foundation
- Per normal soil as defined by EIA/TIA-RS222-F.
- Dimensions: Estimated 11'-9" square by 4'-0" deep and 6" above grade.