ADOT
Intermodal Transportation

# CERTIFICATION FOR PROPRIETARY-MATERIAL USE, ESSENTIAL FOR CITY OF PHOENIX WIRELESS MESH RADIO NETWORK

TO: Maysa Hanna PE, State Traffic Engineer

Michael DenBleyker PE, State Roadway Engineer

FROM: Adam McGuire, ADOT Project Manager

CC: Tracy Eberlein, PE COP Project Manager

DATE: May 3, 2018

RE: City of Phoenix Street Transportation Certification Request for the approval of Tropos Wireless Mesh Radio Self-Healing Routers

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ROUTE: **Eight Hawk Crossing Locations within City of Phoenix**
PROJECT NO: **0000 PHX 0(346)D /T014101C**
LPA/COUNTY: **City of Phoenix, Maricopa**

PROJECT DESCRIPTION: The project scope will install pedestrian beacons which when activated by pedestrians will signal vehicle traffic to stop allowing the pedestrians to traverse the roadway in a safe manner. The City of Phoenix Street Transportation would like to install eight pedestrian beacons (HAWK) at eight separate locations. All locations have high pedestrian crossing volumes with moderately high vehicle volumes that must be traversed over 4 lanes of traffic offering no pedestrian refuge points along the path. The project will develop, design and install the pedestrian beacons at the sites shown. The project provides a "signalized" crossing allowing for regulated crossings. The enabled crossing provides for greater connectivity between schools, transit riders and special needs persons in going from one neighborhood area to another. In addition, the crossings will improve neighborhood connectivity and improve safety for school routes and reduce interruptions to traffic flow. The project includes equipment to allow for remote monitoring and control to enable traffic optimization. As a part of the project scope, the signalized intersection will be equipped with wireless mesh radio self-healing routers to connect the HAWK beacons at each location seamlessly back to the Traffic Management Center.

FHWA OVERSIGHT: ☒YES ☐ NO

PROPRIETARY MATERIAL: Tropos Wireless Mesh Radio – latest model

1. **Description of Need**: The need is to purchase eight additional radios for this project that are fully compatible and interoperable within the current self-healing wireless mesh radio network management software.

2. **Product History**: In order to maximize the effectiveness of the fiber-optic backbone that the City of Phoenix had installed and to minimize the number of leased copper circuits to individual intersections, a study was undertaken in 2006 to determine the best approach to expand coverage. Utilizing competitive performance-based criteria, a wireless mesh radio system tied to the fiber-optic backbone was chosen as the most cost-effective method. Field testing was conducted to proof the concept of operations utilizing several systems and the Tropos radio system was chosen for deployment.

3. **Product Availability**: There are no other products that provide all the features and requirements necessary to provide redundancy and reliability for the self-healing wireless radio mesh network. See 5. Project Compatibility below for more details.

4. **Product Cost**: The product cost for Tropos Radios meeting our requirements is $6000 each. We will be installing eight radios with this project.

5. **Project Compatibility**: The City of Phoenix has over 1100 Tropos wireless mesh radio routers installed in a private network configuration using the Tropos central management system which, utilizing existing proprietary software and servers, optimizes the most efficient data path, based in part on data demand and available bandwidth and self-heals in the event of radio coverage loss by rerouting communications to other radios in the network utilizing proprietary algorithms within the closed system. While another manufacturer's product operating at the same radio frequencies can be made to work within the existing wireless mesh network, it can only operate in a point to point mode connecting to only one adjacent Tropos radio as a client only. It can't operate within the mesh by routing through an optimal path based on data demand and available capacity; it must operate by communicating to the assigned radio. The self-healing features of routing are defeated which is contrary to the original design considerations as communications reliability and redundancy were key features. With and installed base of over 1100 Tropos radios, all operating within the existing mesh network and utilizing the existing Tropos management software, it would be logical and prudent to complete this project's eight locations with the same mesh network equipment and software, instead of client radios, to provide complete compatibility. Therefore, the City of Phoenix requests certification of this unique product.

6. **Maintenance**: There are no maintenance issues with this product. We maintain current installations and keep replacement equipment in inventory. Other equipment purchased to perform these functions as an extension of the existing wireless mesh network will not meet technical requirements, and if used, we would need to maintain inventory for maintenance of product supplied which would be in excess of that needed today.

Prepared By: Bruce E. Littleton, PE, PTOE, Traffic Engineering Supervisor, Signals/ITS
Phone: 602- 262-4690 Date: 5/3/2018

APPROVED: _____ Date: 5/7/18

☐ State Roadway Engineer
☑ State Traffic Engineer

CONCURRED: _____ Date: _____
ADOT Project Manager

CONCURRED: _____ Date: _____
ADOT LPA Manager

DATA SHEET

# TropOS 6420

## Outdoor mesh core router

The TropOS 6420 outdoor mesh router is a cost-effective, easy to deploy, high-performance outdoor networking solution.

TropOS 6420 provides superior reliability by accessing 653 MHz of RF spectrum (463 MHz in ETSI) using automatic interference avoidance capabilities of TropOS Mesh OS. The TropOS 6420 uses the 802.11a/b/g/n wireless standards to deliver 600 Mbps total wireless data rate, 300 Mbps at 2.4 GHz and another 300 Mbps at 5 GHz.

**Wireless**

- IEEE 802.11b/g/n radio
  - Modulation: 802.11g/n - OFDM (64-QAM, 16-QAM, QPSK, BPSK); 802.11b - DSSS (DBPSK, DQPSK, CCK)
  - Media access protocol: CSMA/CA with ACK
  - TX power (dBm EIRP)

| Band (MHz) | FCC | ETSI | Brazil |
|---|---|---|---|
| 2400-2473 | 21-36 | N/A | N/A |
| 2400-2483 | N/A | 5-20 | 11-26 |

assumes use of 7.4 dBi antennas

  - 2x2 MIMO-antenna system: 2-TX x 2-RX
  - 7 dBi integrated omnidirectional antennas
  - RX Sensitivity:
    -98 dBm @ 1 Mbps
    -96 dBm @ 6 Mbps

- IEEE 802.11a/n radio
  - Modulation: 802.11a/n - OFDM (64-QAM, 16-QAM, QPSK, BPSK)
  - Media access protocol: CSMA/CA with ACK
  - TX Power (dBm EIRP)

| Band (MHz) | FCC | ETSI | Brazil |
|---|---|---|---|
| 5150-5250 | 21-36 | N/A | N/A |
| 5250-5350 | 15-30 | N/A | N/A |
| 5470-5725 | 15-30 | 15-30 | N/A |
| 5725-5850 | 21-36 | 21-36 | 15-30 |

assumes use of 8 dBi antennas

  - 2x2 MIMO-antenna system: 2-TX x 2-RX
  - 8 dBi integrated omnidirectional antennas
  - RX sensitivity:
    -95 dBm @ 6 Mbps
- Integrated GPS

**Interfaces**

- 802.11a/b/g/n wireless, 802.11a, 802.11n client compatibility
- One IEEE 802.3u autosensing 10/100BASE-T Ethernet port
- One 10/100/1000 BASE-T Ethernet port
- Serial: RS-232 or RS-485
- Protocols: DNP3, Modbus (RTU), Modbus (ASCII), raw (serial pass-through) support
- IPv4, IPv6-ready
- BGP
- 802.1q VLAN support (ESSID and IP based tagging)
- Support for static and dynamic addressing for wireless and wired clients
- Session-persistent mobility across subnets
- IP multicast forwarding, IGMPv3; IGMP Proxy
- Automatic rate, power, channel and band control
- IEC 61850 GOOSE messaging
- Reliable broadcast
- ABB System 800xA RNRP
- Network Address Translation (NAT) support for wired clients

**Quality of service**

- 802.11e 802.11e WMM
- 802.1p/q with 4 queues per VLAN and ESSID
- 802.1p and DSCP
- VoIP and VoWiFi support

**Management**
- Local and remote management tools via HTTPS
- Identity-based authentication (4 levels)
- Configuration save and restore
- Over the air software upgrades
- SNMP (standard MIBs)
- Wireless, network and client monitoring and statistics
- Infrared (IR) port
- Wireless rescue

**Security**
- IPsec VPNs with tunnels to wired client interfaces using AES
- Authentication: WPA, WPA2, 802.11i, RADIUS, 802.1x (includes EAP-TLS, EAP-TTLS, EAP-SIM, PEAP)
- Encryption: open, WEP, TKIP, AES-CCM
- AES encryption of mesh and control traffic
- Technical controls required to achieve NERC CIP v5 compliance
- Multiple BSSIDs & ESSIDs (ESSID suppression)
- Integrated firewall
  - Packet filtering on TCP/UDP port, protocol, SA, DA
  - Peer-to-peer blocking
  - Client access control lists
- Evil twin detection and reporting
- Denial of service (DoS) attack detection and reporting
- Jaming attack detection and reporting

**Environmental specifications**
- Operating temperature range: -40°C to 75°C
- Storage temperature range: -40°C to 85°C
- Weather rating: IP67 UL579/IEC 60529 IP67
- Wind survivability: >165 mph
- Wind loading (165 mph): <210 Newtons
- ASTM B117 salt fog rust resistance compliant
- Shock & vibration: ETSI 300-19-2-4 spec T4.1E class 4M3
- Transportation: ISTA 2A

**Power**
- 802.3at on the 10/100/1000BASE-T port
- 12-48 VDC on the 100/100BASE-T port
- 120/240 VAC with optional, external accessory (optional external battery backup available)
- Power consumption: 4 W typical
- Power-on and network status LEDs

**Physical**
- Dimensions (w/o mounting brackets): 8.75” (22.2 cm) x 7.25” (18.4 cm) x 14” (35.6 cm) high with antennas
- Weight: 5 lbs (2.3 kg) max., without mounting brackets

**Wireless approvals**
- FCC CFR 47 Part 15
- Industry Canada RSS 210
- EN 301 489-17
- EN 300 328
- EN 301 893
- EN 302 502

**Safety approvals**
- EN 60950
- IEC 950
- UL 60950-1
- CSA 22.2 No. 60950-1
- UL 579/IEC 60529 IP67 rated for outdoor use
- UL 1449/IEC 60664-1
- CE
- IEEE 1613

**Protection**
- Antenna protection integrated
- Electrical protection:
  - EN61000-4-4 Level 2 electrical fast transient burst immunity
  - EN61000-4-3 Level 2 EMC field immunity
  - EN61000-4-2 Level 2 (contact), Level 3 (air) ESD immunity

**Warranty**
- Five (5) year hardware warranty
- Software and hardware maintenance plans available

Click the link to find out more information about our wireless mesh routers.

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