

I. Description

- A. This technical specification describes the standards for implementation of a Distributed Antenna System (DAS) for the purpose of improving public safety wireless communications within Arlington County Government (ACG) and Arlington Public Schools (APS) facilities.

II. System Requirements

- A. Expansion. The DAS will be capable of supporting the following frequencies by modifying only the active components of the system. Additional components will comply with the specifications herein.

Table 1. Supported Frequencies

Band	Uplink, MHz	Downlink, MHz
Commercial 700 MHz	698-716, 776-787	728-746
700 MHz Public Safety	799-805	769-775
800 MHz Public Safety	806-824	851-869
Cellular	824-849	869-894
900 MHz	896-902	935-941
AWS	1710-1755	2110-2155
PCS	1850-1915	1930-1995
BRS/EBS	2496-2690	

- B. Active Distribution. Active components will be interconnected only with single-mode fiber optic cable.
- C. Remote Management. The DAS will provide for remote configuration, control, and monitoring of active components.
- D. SNMP (Simple Network Management Protocol) Alarm Reporting. The DAS will be deployed with SNMP alarm reporting technology capable of third party integration.
- E. Power. The DAS will be connected to a backup generator providing 8 hours of continuous power.
- F. Approval. The Contractor will design and implement a DAS capable of receiving approval of or certification from the wireless carrier(s) operating a respective band.
- G. Degree of Protection. Active components of the DAS will be installed in a NEMA Type 4 enclosure.

III. Substitutions

- A. Substitutions of DAS components will be accepted at the discretion of the County. A substitution that fails to meet or exceed the specifications described herein will not be considered. The Contractor will submit the following information with any request for substitution:
1. Product sample (passive only; cables, connectors, etc.)
 2. Hardware/software manual (active only)
 3. Detailed product specifications
 4. Independent test results verifying product specifications
 5. Mean Time Between Failure (MTBF) data (active only)
 6. Written guarantee from the manufacturer that the substitution will be supported and available for 10 years from the date of system acceptance
 7. For components required for commercial carrier signals, written guarantee from the respective commercial carrier that the substitution is approved for use within the commercial carrier's network

IV. Contractor Qualification and Workmanship

- A. The Contractor will provide documentation demonstrating five (5) years of experience designing, installing, and commissioning DAS solutions of a similar scope and complexity.
- B. The Contractor will provide documentation demonstrating employee certification from the manufacturer of the active components of the DAS.
- C. The Contractor will comply with the latest editions of the National Electrical Code, National Electrical Safety Code, National Contractor's Association Standard of Installation, relevant local regulations, and manufacturer's instructions during the design, installation, and commissioning of the DAS.

V. Performance

- A. The DAS will meet or exceed the Minimum Downlink Receive Signal Level (RSL) as described in Table 2.

Table 2. Minimum Downlink RSL

Band	Minimum Downlink RSL, dBm
Lower 700 MHz, BRS/EBS	-75
Cellular, 900 MHz, AWS, PCS	-85
700 MHz Public Safety, 800 MHz Public Safety	-85

- B. The contractor will confirm the frequencies used and guarantee coverage for all requested frequency bands according to Table 2 prior to the installation of the DAS.
- C. The DAS will meet the requirements of Table 2 for 95% of each floor within the building, to include the stairwells, elevators, basement, and garage.
- D. The DAS will comply with the latest edition of NFPA 1.
- E. The DAS will transmit the requested frequency bands simultaneously over one passive component installation.
- F. To accommodate periodic changes within frequency bands, the DAS will be capable of reconfiguration, without additional hardware or software, to meet the requirements of Table 2.

VI. Submittals

- A. The following submittals will be delivered with the bid response.
1. Component data sheets
 - a) Donor and in-building antennae
 - b) Coaxial cable, connectors, splitters, combiners, and couplers
 - c) Fiber optic cable and connectors
 - d) Bi-directional amplifier(s)
 - e) Fiber optic master unit(s)
 - f) Fiber optic remote unit(s)
 - g) Network Management unit(s)

2. Design documents
 - a) RF link budget
 - b) Overlay of system components on floor plans
 - c) Donor antenna(e) and grounding drawings
 - d) Bill of Materials (BOM)
 3. Sample Statement of Work (SOW)
 4. Sample Acceptance Test Plan (ATP)
 5. Recommended spares
 6. Warranty Documents
 - a) Manufacturer's warranty of components in Subsection VI.A.1
 - b) Contractor's system warranty
 - c) Manufacturer's extended warranty
- B. The following submittals will be delivered prior to the Notice to Proceed (NTP).
1. Final RF link budget
 2. Overlay of system components on floor plans
 3. Donor antenna(e) and grounding drawings
 4. Bill of Materials (BOM)
 5. RF propagation modeling
 6. Signal to Noise Interference Ratio (SNIR) map
 7. Description of the method used to avoid the interference of uplink and downlink frequencies
 8. Maintenance Service Contract
 9. Statement of Work (SOW)
 10. Acceptance Test Plan (ATP)

- C. The following submittals will be delivered at close out.
1. As-built drawings indicating:
 - a) Donor antenna, grounding, and lightning protection details
 - b) Cable routing, splitters, couplers, and in-building antenna locations
 - c) Active component locations, layout, and configuration
 2. Test reports indicating:
 - a) Compliance with the requirements of Table 2
 - b) Sweep testing results for all coaxial cable runs
 - c) Optical Time Domain Reflectometer (OTDR) results for all fiber optic cable runs
 3. Hardware and software manuals for all active components
 4. Warranty Documents
 - a) Manufacturer's warranty of components in Subsection VI.A.1
 - b) Contractor's system warranty
 - c) Manufacturer's extended warranty

VII. Warranty

- A. Manufacturer's Warranty
1. 1-year limited warranty from the date of system acceptance on active components
 2. 5-year limited warranty from the date of system acceptance on splitters, couplers, and in-building antennae
 3. 20-year limited warranty from date of system acceptance on coaxial cable, fiber optic cable and connectors
- B. Contractor's Warranty
1. The Contractor will warrant the performance of the DAS, as described in Section V, for 1 year from the date of system acceptance.

C. Manufacturer's Extended Warranty

1. The Manufacturer will administer a follow-on program through the Contractor to provide support and service to the County. The program will cover a certified system, defined as a DAS installation performed by a certified contractor using certified components while following all the Manufacturer's installation instructions, recommendations, and best practices. The program will include:
 - a) A 20-year warranty, provided by the Manufacturer and the Contractor, on all coaxial cable, fiber optic cable, and connectors
 - b) An assurance that, during the 20-year warranty, the DAS will support current and future modulation formats in the frequency bands for which it is designed
2. The Manufacturer and Contractor, using a schedule agreed upon by the County, will remediate any failure of the DAS whether during ATP, normal use, or the upgrade of the DAS to support additional frequency bands.
3. The Manufacturer will maintain ISO Quality Control registration for the facilities that manufacturer any component of the DAS.

VIII. Components

- A. Broadband Donor Antennas: Broadband Donor Antennas will feature a multi-band design, accommodating Cellular, PCS, LMR and AWS frequencies in a single small antenna.
1. Electrical:
 - a) Frequency bands, 806 - 960 MHz and 1710 - 2200 MHz
 - b) $VSWR \leq 1.8$
 - c) Gain: 806-960 ≥ 10.5 dBi, 1710 - 2200 ≥ 12 dBi
 - d) Maximum input power: 100 watts
 - e) Polarization: Vertical
 - f) Front-to-back ratio: 806 - 960 ≥ 18 dB, 1710 - 2200 ≥ 20 dB
 - g) Impedance: 50 Ω
 - h) Azimuth Pattern: As proposed by the manufacturer to meet the performance specifications in this Section.

2. Mechanical:
 - a) Radome material: UV-protected ABS
 - b) Pigtail cable: RG58, plenum rated
 - c) Connector: 50 Ω N Type Female
 - d) Mounting: Pole
 3. Environmental
 - a) Temperature: -40 °C to +60 °C
 - b) Lighting protection: Direct ground
 - c) Waterproof level: IP 66
 - d) Wind Speed, maximum: 125 mph
 4. Approved Manufacturer: Andrew CELLMAX-EXT-CPUSE or equivalent, in accordance with Section III.
- B. 700 MHz LMR Yagi Donor Antennas:
1. Electrical:
 - a) Frequency band, 746 - 806 MHz
 - b) VSWR \leq 1.5:1
 - c) Gain: \geq 11.1 dBi
 - d) Maximum input power: 100 watts
 - e) Polarization: Vertical
 - f) Front-to-back ratio: \geq 15 dB
 - g) Impedance: 50 Ω
 - h) Beam width, horizontal, degrees: 60
 - i) Azimuth Pattern: As proposed by the manufacturer to meet the performance specifications in this Section.

2. Mechanical:
 - a) Connector: 50 Ω N Type Female
 - b) Mounting: Pole
 3. Environmental:
 - a) Temperature: -40 $^{\circ}$ C to +60 $^{\circ}$ C
 - b) Lighting protection: Direct ground
 - c) Waterproof level: IP 66
 - d) Wind Speed, maximum: 125 mph
 4. Approved Manufacturer: Andrew DB499-A or equivalent in accordance with Section III.
- C. Omni-Directional Coverage: Omni-Directional Coverage antennas will feature a multiband design, accommodating multiple frequency bands in a single small antenna.
1. Electrical Band 1:
 - a) Frequency Band: 698 – 800 MHz
 - b) VSWR: $\leq 1.8:1$
 - c) Gain: ≥ 1.5 dBi
 - d) Maximum input power: 50W
 - e) Impedance: 50 Ω
 - f) Beam width, Horizontal: 360 $^{\circ}$ omnidirectional
 - g) Beam width, Vertical: 80 $^{\circ}$ nominal
 - h) Return Loss: 10.9 dB
 2. Electrical Band 2:
 - a) Frequency Band: 1710 – 2700 MHz and 800 – 960 MHz
 - b) VSWR: $\leq 1.5:1$
 - c) Gain: ≥ 1.5 dBi @ 800–960 MHz and ≥ 5.0 dBi @ 1710 – 2700 MHz
 - d) Maximum input power: 50W
 - e) Impedance: 50 Ω

- f) Beam width, Horizontal: 360° omnidirectional
 - g) Beam width, Vertical: 65° nominal
 - h) Return Loss: ≤ 13.9 dB
3. Mechanical:
- a) Connector: 50 Ω N Type Female
 - b) Mounting: Thru-hole ceiling mount
 - c) Radome material: ABS, UV resistant
 - d) Pigtail cable: KSR195, plenum rated
4. Environmental:
- a) Application: Indoor
 - b) Operating Temperature: 40 °C to +60 °C (40 °F to +140 °F)
 - c) Relative Humidity: Up to 100%
5. Regulatory Compliance/Certifications: RoHS 2002/95/EC
6. Approved Manufacturer: Andrew CELLMAX-O-CPUSE or equivalent, in accordance with Section III.
- D. Directional Coverage Antennas: Directional coverage antennas will feature a multi-band design, accommodating multiple frequency bands in a single small antenna.
1. Electrical Band 1:
- a) Frequency Band: 698 – 800 MHz
 - b) VSWR: $\leq 1.8:1$
 - c) Gain: ≥ 5.0 dBi @ 698 – 800 MHz
 - d) Maximum input power: 50W
 - e) Impedance: 50 Ω
 - f) Beam width, Horizontal: 110° nominal
 - g) Polarization: Vertical
 - h) Return Loss: ≤ 10.9 dB

2. Electrical Band 2:
 - a) Frequency Band: 1710 – 2700 MHz and 800 – 960 MHz
 - b) VSWR: $\leq 1.5:1$
 - c) Gain: ≥ 5.0 dBi @ 800 – 960 MHz and ≥ 6.0 dBi @ 2170 – 2700 MHz and ≥ 8.0 dBi @ 1710 – 2170 MHz
 - d) Maximum input power: 50W
 - e) Impedance: 50 Ω
 - f) Beam width, Horizontal: 90° nominal
 - g) Return Loss: ≤ 13.9 dB
 3. Mechanical:
 - a) Connector: 50 Ω N Type Female
 - b) Mounting: 4-hole wall mounting plate
 - c) Radome material: ABS, UV resistant
 - d) Pigtail cable: RG58, plenum rated
 4. Environmental:
 - a) Application: Indoor
 - b) Operating Temperature: 40 °C to +60 °C (40 °F to +140 °F)
 - c) Relative Humidity: Up to 100%
 5. Regulatory Compliance/Certifications: RoHS 2002/95/EC
 6. Approved Manufacturer: Andrew CELLMAX-D-CPUSE or equivalent, in accordance with Section III.
- E. Fiber Optic Cable and Connectors:
1. General Specifications:
 - a) Cables will be six-strand or greater, designed for point-to-point applications as well as mid-span access, and will provide a high-level of protection for optical fiber installed in interior building environments.
 - b) Higher optical fiber count cables will utilize a sub-unitized design with color-coded subunits for easy identification.

- c) Single-mode optical fibers will be 8.3 μm and use standard colored tight-buffered construction.
 - d) The single-mode optical fiber will be dispersion-unshifted optical fiber that meets ITU-T G.652c standards.
 - e) Cable will provide optimum performance over entire wavelength range from 1260 to 1625 nanometers.
 - f) Cable will support new and emerging applications that utilize extended E band, 1360 to 1460 nanometers.
 - g) Cable will also support existing and legacy single-mode applications that traditionally operate in 1310 and 1550 nanometer regions.
 - h) Cable will deliver a cost-effective upgrade path by expanding available wavelengths by 50 percent supporting 16 Channels of coarse wave division multiplexing (CWDM) on a single optical fiber and up to 400 Channels of dense wave division multiplexing (DWDM) on a single cable.
 - i) Fire ratings: Riser, plenum, and/or LSZH
2. Approved Manufacture: CommScope Fiber Optic Cable containing TeraSpeed Single Mode Optical Fiber. As an example, P-006-DS-8W-FSUYL, 6-strand breakout cable single-mode fiber or equal in accordance with Section III.

F. Fiber Optic Pigtails:

1. General Specifications:
- a) To maintain channel integrity, optical fiber patch cords and pigtails will be fabricated to meet the performance parameters corresponding to the optical fiber cable approved product type specified below. Patch cord and pigtail plug connectors will be equipped with boots, and will have same colors as related optical fiber backbone cables, unless specified or indicated otherwise. Optical fiber patch cords and pigtails will be available with the following options as specified or indicated:
 - b) Termination types: SC-APC
 - c) Connector/cable configuration: Simplex and duplex
 - d) Fire ratings: Riser, plenum and/or LSZH
 - e) Patch cord outside diameters: 1.6 millimeters (0.063 inches) and 3.0 millimeters (0.118 inches)

- f) Pigtails: Ruggedized and tight-buffered optical fiber—0.9 millimeters (0.035 inches) outside diameter
 - g) Lengths: As specified or indicated
2. Approved Manufacturer: CommScope TeraSpeed single reinforced buffered 900 μm , LightScope ZWP single-mode fiber, angled polished connector or equivalent, in accordance with Section III.
- G. Air Dielectric, Plenum Rated Cable:
- 1. Material Characteristics:
 - a) Jacket: Halogenated, Fire-Retardant
 - b) Outer Conductor Material: Corrugated Aluminum or Corrugated Copper
 - c) Inner Conductor Material: Copper-Clad Aluminum Wire
 - 2. Electrical Characteristics:
 - a) Impedance: $50 \pm 2.0 \Omega$
 - b) Frequency Band: 1 - 8800 MHz
 - c) Peak Power Rating: $\geq 40.0 \text{ kW}$
 - 3. Mechanical Characteristics:
 - a) Diameter Over Jacket: $\leq .627 \text{ in}$
 - b) Minimum Bending Radius: $\leq 5 \text{ in}$
 - c) One Time Minimum Bending Radius: $\leq 3 \text{ in}$
 - 4. Attenuation Characteristics:

Table 3. Plenum Rated Cable Attenuation

Frequency, MHz	Attenuation, dB/100ft
150	≤ 0.848
450	≤ 1.53
800	≤ 2.105
2000	≤ 3.564

Standard Conditions: VSWR 1.0, ambient temperature 20 °C (68 °F)

5. Approved Manufacturer: Andrew HL4RP-50A, AL4RPV-50A or equivalent, in accordance with Section III.
- H. Foam Dielectric Cable:
1. Material Characteristics:
 - a) Jacket: Non-halogenated, Fire-Retardant
 - b) Outer Conductor Material: Corrugated Copper
 - c) Inner Conductor Material: Copper-Clad Aluminum Wire or Copper Tube
 2. Electrical Characteristics:
 - a) Impedance: $50 \pm 1.0 \Omega$
 - b) Frequency Band: 1/2" Nominal: 1 - 8800 MHz, 7/8" Nominal: 1 - 5000 MHz
 - c) Peak Power Rating: $\geq 40.0 \text{ kW}$
 3. Mechanical Characteristics:
 - a) Diameter Over Jacket: 1/2" Nominal: $\leq .630 \text{ in}$, 7/8" Nominal: $\leq 1.1 \text{ in}$
 - b) Minimum Bending Radius: 1/2" Nominal: $\leq 5 \text{ in}$, 7/8" Nominal: $\leq 10 \text{ in}$
 - c) One Time Minimum Bending Radius: 1/2" Nominal: $\leq 2 \text{ in}$, 7/8" Nominal: $\leq 5 \text{ in}$
 4. Attenuation Characteristics: 1/2" Nominal

Table 4. Foam Dielectric Cable Attenuation

Frequency, MHz	Attenuation, dB/100ft
150	≤ 0.815
450	≤ 1.447
800	≤ 1.968
2000	≤ 3.251

Standard Conditions: VSWR 1.0, ambient temperature 20 °C (68 °F)

5. Attenuation Characteristics: 7/8" Nominal:

Table 5. Foam Dielectric Cable Attenuation

Frequency, MHz	Attenuation, dB/100ft
150	≤ 0.417
450	≤ 0.744
800	≤ 1.014
2000	≤ 1.683

Standard Conditions: VSWR 1.0, ambient temperature 20 °C (68 °F)

6. Approved Manufacturer: Andrew LDF4-50A, FXL-540-NHR, FXL-780-NHR or equivalent, in accordance with Section III.

I. Splitters, Combiners, Couplers, Coax Jumpers and Connectors:

1. Approved Manufacturer: Andrew or equivalent, in accordance with Section III.

J. BDA: The BDA(s) will be of modular design and use digital filtering to mitigate interference and accommodate public safety radio and commercial wireless carrier coverage.

1. Characteristics

- a) Operating Temperature Range: -33 °C to +50 °C
- b) Chassis: Will be of modular design with ≥ 4 frequency bands per 19" chassis. Chassis will not exceed four Rack Units (RUs) in height.
- c) Filtering: Digital
- d) Separate Control: Each RF amplifier will be capable of adjusting and controlling power levels for each commercial wireless carrier when multiple commercial wireless carriers share a single amplifier.
- e) FCC Part 90.219 Type Classification: Class A narrowband for LMR/SMR/ESMR frequency bands
- f) Alarming: Will support both SNMP and SMS using wireless modem.
- g) Mounting Options: Will support rack, wall and pole mounting.
- h) Frequency Bands Supported: 380 - 512 MHz LMR, 769 - 806 MHz LMR, 806 - 869 MHz LMR/SMR/ESMR, 896 - 941 MHz LMR/SMR/ESMR, 824 - 894 MHz Cellular, 1710 - 1755 MHz AWS, 1900 - 1950 MHz PCS

2. Compliance:
 - a) NFPA: The BDA will comply with NFPA-1 2009 Edition Annex O In-Building Public Safety Radio Enhancement Systems.
 - b) FCC: Will be FCC type certified.
 3. Approved Manufacturer: Andrew Node A or equivalent, in accordance with Section III.
- K. Fiber Optic Master Unit: The Fiber Optic Master Unit will convert radio over coax to Radio-Over-Fiber (RoF) for distribution to Fiber Optic Remote Units.
1. Characteristics
 - a) Transmission Media: Single-mode fiber at 1310 nm
 - b) Operating Temperature Range: +5 °C to +40 °C
 - c) Impedance: 50 Ω
 - d) Chassis:
 - (1) Will be of modular design capable of supporting ≥ 32 Remote Units per 19", 5 RU chassis
 - (2) Will support redundant power supplies
 - (3) Will have the capability to remotely power the Remote Units via composite fiber optic cable
 - e) Automatic Gain Control (AGC): Will provide AGC for optical loss compensation
 - f) Optical Budget: Will support ≤ 3 dB optical budget (~3 km or 2 miles)
 - g) Auxiliary Channel: Will provide an input to support 400 to 2700 MHz for future expandability
 - h) Interlink: Will support one fiber or two fibers bi-directional optical link for distances up to 20 km with a 10 dB optical budget

- i) Remote Supervision:
 - (1) Will support the TCP/IP protocol, SNMPv2, FTP, HTTP, Telnet, and be fully compatible with general purpose SNMP managers
 - (2) Remote access will be available via Point-to-Point Protocol (PPP), over circuit-switched/packet data and wired/wireless modems
 - (3) Each Active device will be manageable via a Web GUI
 - (4) Auto Mapping: Each board position will be automatically mapped during system turn-up
- 2. Frequency Bands Supported: 380 - 512 MHz LMR, 769 - 806 MHz LMR, 806 - 869 MHz LMR/SMR/ESMR, 896 - 941MHz LMR/SMR/ESMR, 824 - 894 MHz Cellular, 1710 - 1755 MHz AWS, 1900 - 1950 MHz PCS and 2496 - 2690 MHz BRS/EBS.
- 3. Approved Manufacturer: Solid Alliance Multi-Carrier or equivalent, in accordance with Section III.
- L. Fiber Optic Remote Units: The Fiber Optic Remote Unit converts the RoF signal back to radio over coax, as well as provides filtering so that multiple frequency bands can reside over the same passive cable and antenna infrastructure.
 - 1. Characteristics
 - a) Operating Temperature Range: +5 °C to +40 °C
 - b) Impedance: 50 Ω
 - c) Power Consumption: ≤ 105 watts, maximum

d) Output Power per Carrier at Antenna Port:

Table 6. Output Power

Band, MHz	Output Power, dBm
Analog 700	27
GSM 700	27
Analog 800 and 850	27
GSM 850 and 850	31
GSM 850 and 850 at band edges	29
iDEN 800 and 850	26
iDEN 800 and 850 at band edges	24
CDMA 800 and 850	29
CDMA 800 and 850 at band edges	27
Analog 900	29
iDEN 900	23
CDMA 1700	30
W-CDMA 1700	28
Analog 1900	31
GSM 1900	31
CDMA 1900	29
W-CDMA 1900	27

e) MTBF (excluding external power supply): $\geq 160,000$ hours

f) Physical: The Remote Unit will consist of the following:

- (1) Ingress Protection: IP31 or equivalent
- (2) Frequency Bands supported: 769 - 806 MHz LMR, 806 - 869 MHz LMR/SMR/ESMR, 896 - 941MHz LMR/SMR/ESMR, 824 - 894 MHz Cellular, 1710 - 1755 MHz AWS, 1850 - 1995 MHz PCS
- (3) Optical Port: 2xSC-APC connector (separated uplink/downlink)
- (4) Antenna Port: Single 50 Ω N type female connector
- (5) Auxiliary Ports: Two SMA female for future add-on modules

g) Uplink Noise Figure:

- (1) LMR 700, LMR 800, Cell850: ≤ 7.5 dB
- (2) LMR 700, LMR 800, Cell850 at band edges: ≤ 9.5 dB
- (3) LMR 900: ≤ 8.5 dB

- (4) AWS: ≤ 7.5 dB
- (5) PCS 1900 extended: ≤ 7.5 dB

- 2. Approved Manufacturer: Solid Alliance ROU or equivalent in accordance with Section III.

IX. Maintenance

- A. The Contractor will provide an optional 1-year maintenance contract, capable of annual renewal, covering preventative maintenance, system monitoring, spares, failure remediation, equipment repair, and response time.

X. Installation

- A. The Contractor will design, install, commission, and test the DAS according to the Manufacturer's instructions and recommendations.
- B. The Contractor will install the DAS according to the SOW as accepted by the County.

XI. Acceptance Testing

- A. The Contractor will complete the acceptance testing according to the ATP as described in Subsection VI.B.10.
- B. Acceptance testing will confirm compliance with the requirements as described in Section V.