MAJOR BENEFITS

- Support for new services and revenue opportunities
- Establish reliable unlicensed broadband reach in wilderness, rural and urban areas
- Reduce or eliminate VSAT and microwave reliance
- Reduce in-field telecommunications CAPEX and OPEX
- Strengthen enterprise OPSEC and in-field security

A COMPLETE INDUSTRIAL-GRADE BROADBAND WIRELESS NETWORKING INFRASTRUCTURE SOLUTION PROVIDING SUPERIOR RANGE AND COVERAGE FOR WILDERNESS, RURAL, AND URBAN OPERATIONS

CORE CAPABILITIES

- Excellent all-terrain performance
- End-to-end redundancy
- Robust platform security and data payload encryption
- Point-to-point, multi-point, and mesh architectures
- Robust operations and spectrum management support
- Extend reach of LTE/4G, WiFi, WiMax, M2M, and SCADA systems
STANDARD CONFIGURATIONS AND APPLICATIONS

STANDARD FEATURES

BROAD SPECTRUM OPERATING SUPPORT
- Complete Hi-Band VHF and UHF operation: 174-216, 470-602, 620-698 MHz
- Maximum FCC approved power output: +27.8 dBm
- Optimum link performance via automatic end-to-end signal integrity control
- Patented Embedded White Space Spectrum Management System for uninterrupted operation

NETWORK ARCHITECTURE
- User-configurable point-to-point, point-to-multipoint and peer-to-peer ad hoc mesh topologies
- Compatible with all IP-based network equipment
- Channel aggregations to increase payload capacity and system reliability

ANTENNA CONFIGURATIONS
- Single Tx/Rx and independent Tx/Rx antenna options provide maximum range and coverage

SECURITY
- Robust suite of hardware, firmware, and software tools to secure and defend against field intrusions and data theft

APPLICATIONS

INDUSTRIAL CONTROL AND SCADA SYSTEMS
- Oil and gas refineries and distribution networks
- Water and Waste Water Infrastructure
- Electric Power Transmission and Distribution Grid
- Chemical and pharmaceutical processing facilities

TELECOMMUNICATIONS SUPPORT
- LTE/4G/GSM Range Extension
- Remote WiFi/WiMax Off-load
- Rural and Urban Internet Distribution Systems
- Superior in-building penetration and coverage

TRANSPORTATION SYSTEMS
- Intelligent Highway Infrastructure Networks
- Rail Monitoring and Control systems
- Broadband Harbor and Waterways Network
- Highway Monitoring and Traffic Control

OPTIONS
- Extreme weather packaging (arctic to jungle)
- Class 1, Div. 2 Packaging available
- Add-on channel option provides increased payload rates, 1:N link redundancy and fault tolerant operation (requires one or more Channel Expansion shelves)
- Interfaces for legacy (non-IP) devices
- Custom DC input support from 12 to –48 VDC

WHITE SPACE SPECTRUM

In 2010, with the transition to HDTV, the FCC opened up unused VHF and UHF TV channels for unlicensed use on a geographical basis. Covering 270 MHz of prime spectrum in the VHF and UHF TV bands, White Space Spectrum offers superior propagation attributes over 900 MHz, WiFi, WiMax and microwave systems in nearly all terrain situations.
RAPTOR® NETWORK DESIGN

RAPTOR® WIRELESS NETWORK TECHNOLOGY OFFERS THE NETWORK DESIGNER, OPERATOR, AND SERVICE PROVIDER MAJOR PERFORMANCE ADVANTAGES OVER CONVENTIONAL LTE/4G, MICROWAVE, AND SATELLITE SYSTEMS.

Raptor®'s Spectrum Advantage

- Up to 5 times the range and coverage of WiMax and WiFi in urban and rural settings (see Table 1)
- Superior RF reach and coverage within structures, canopied, and vegetative areas
- Spectrum Agility and Frequency Diversity to increase throughput
- Scalable to meet coverage and capacity demands

<table>
<thead>
<tr>
<th>FREQUENCY (MHz)</th>
<th>BAND/TECHNOLOGY</th>
<th>NOMINAL RANGE (mi)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>IN-CITY</td>
</tr>
<tr>
<td>174–216</td>
<td>High-Band VHF</td>
<td>10</td>
</tr>
<tr>
<td>470–698</td>
<td>UHF</td>
<td>7</td>
</tr>
<tr>
<td>903–928</td>
<td>UHF</td>
<td>4</td>
</tr>
<tr>
<td>2400</td>
<td>802.11g/n WiFi</td>
<td>2.5</td>
</tr>
<tr>
<td>5800</td>
<td>802.11a WiFi</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 1 Analysis Parameters:
- Tx and Rx antenna height: 20 meters; Rx sensitivity: -75 dBm at 6 MHz bandwidth
- VHF/UHF power out: 27.8 dBm; Single channel payload rate: 4 Mbps
- 0.9, 2.4, 5.8 GHz systems at 27.8 dBm output.
- Longley-Rice propagation model.

Network Advantage

Raptor®’s embedded physical and network level multi-point (TDMA and CSMA) and peer-to-peer ad hoc unified mesh routing engine supports all network architectures—point-to-point, multi-point, mesh, star, and tree network configurations. These configurations are adaptable to nearly any real-world, network challenge.

Network Management Advantage

SafariView, Raptor®'s embedded Operations, Administration and Maintenance (OAM) tool provides secure local and remote administration and control of each Raptor® node and local network interface.

Cyber Advantage

Raptor®'s suite of security-focused hardware, firmware, and software supports your critical operations, physical plant, and information against internal and external wireless and network threats.

Application Versatility Advantage

RAPTOR®’s network scalability and versatility enables system planners to meet range, coverage, security, and revenue requirements with minimum life-cycle cost.

Economic Advantage

RAPTOR® is the low cost solution of choice. Its broad operating spectrum capability and longer reach mean less equipment and infrastructure, providing a real alternative to VSAT and microwave.

Need more information? Email us at raptorx@metricsystems.com
NETWORK SECURITY AND MAINTENANCE TOOLS

RAPTOR X DUAL CPU CORE, CRYPTO-ACCELERATED NETWORK PROCESSOR SUPPORTS SECURE CRITICAL INFRASTRUCTURE APPLICATIONS.

Standard network architecture and security capabilities include:

**FIREWALL/DMZ**
- Robust firewall rule construction
- Secure download of firewall rule sets

**AUTHENTICATION**
- Multi-factor authentication
- Remote access token-based authentication

**MALICIOUS CODE DETECTION**
- Deep packet inspection

**EVENT/STATUS MONITORING AND LOGGING**
- SNMPv3 enhanced security and remote configuration
- Maintenance logs
- Authentication
- Traffic monitoring and analysis
- Intrusion detection

**WIRELESS MAINTENANCE SUPPORT**
- Secure password support for remote management and configuration of wireless and network elements

**FAULT TOLERANT AND REDUNDANCY SUPPORT**
- Redundant Power Shelf provides 100% backup for all RF functions
- Dual channel operation supports frequency and space diversity providing high reliability data transfer over long and NLOS paths

**VLAN SUPPORT**
- Multiple independent VLANS
- VLAN trunking

**CYBER DEFENSE TOOLS:**

Embedded RaptorX tools detect and defend against an ARP Man-in-the-Middle/ARP spoofing attack.
- MAC address locking focuses MAC address association to a specific port
- Static Coding of ARP Tables
- Encryption along with strong authentication provides resilience to Man-in-the-Middle attacks
- ARPWatch tool monitors and logs Ethernet traffic activity e.g. changing IP and MAC addresses. RaptorX will notify and react if non-approved Ethernet/IP pairings occur.

SafariView Network Graph UI provides a visual monitor of all levels of connectivity and key statistics.

**INTERFACING WITH RAPTOR X**

Standard Operations, Administration and Maintenance activities with RaptorX are accomplished using SafariView, an embedded, web-based tool, platformed on all RaptorX Network Radio Shelves.

**SafariView | RaptorX Operations, Administration, and Maintenance (OAM) Tool**

RaptorX hosts a robust suite of network tools and applications to configure, monitor, administer, and control each RaptorX within the network. Capabilities under password and secure control include:
- Ability to locally or remotely configure any RaptorX within a network
- Robust firewall defense at each RaptorX WAN and LAN gateway
- Support for multiple secure VPN circuits Carrier MPLS circuits
- Redundant and Alternative Fault-Tolerant network scenario support
- Manual or automatic control of radio link services for each RaptorX site
- Embedded wireless controller support for secure local WiFi and third party wireless systems
- Support for non-IP devices and wireless voice and data systems

Need more information? Email us at raptorx@metricsystems.com
**POWER**

- **AC Input**: 110/240 VAC, 50/60 Hz
- **Power consumption**: Single channel: 70 Watts, Dual channel: 130 Watts (requires Channel Expansion Shelf)
- **RF channel output**: 27.8 dBm (avg pwr over 6 MHz bandwidth)

**SECURITY**

- **Payload Encryption**: 128/256-bit Advanced Encryption Standard (AES)
- **System Access/Authentication Capabilities**: Multi-factor authentication. Remote access token-based authentication
- **Authorization and Accounting**: Protection against unauthorized administration/maintenance and over-the-air access
- **Information Assurance Tools**: Integrated firewall and suite of information assurance tools

**NETWORK ARCHITECTURE**

- **VLAN**: Supports multiple laws; static and dynamic
- **Firewalls**: Robust rule support and encrypted download
- **Wireless MAC**: TDMA, CSMA, Peer-to-peer ad hoc
- **Network size**: Limited only by available RF channels
- **Network Architecture Capabilities**: Point-to-point, point-to-multipoint, peer-to-peer ad hoc mesh
- **Network Timing**: Multiple Network Timing Protocol (NTP) options
- **Maintenance/Diagnostics**: Over-the-air programming, integrated web-based administration, monitoring, and reconfiguration
- **System logs**: System security, authentication, information flow, traffic monitoring, and intrusion detection

**ANTENNA INTERFACES**

- **Standard**: Common Tx/Rx antenna
- **Optional**: Separate Tx and Rx antennas

**FREQUENCY STABILITY**

- **Internal Reference (standard)**: ±1.0 ppm, ±10 Hz
- **External Reference (optional)**: 10 MHz Stratum 3 Level

**SUPPORT ACCESSORIES**

- **Antennas**: Directional, omni, or sector
- **External GPS Geo Location/modes**: Provides NEMA 0183 format latitude and longitude output
- **Precision Frequency Synchronization Module**: GPS base precision frequency source (<± 0.1 ppm), ±1 Hz

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**GENERAL**

- **Standard Frequency Range**
  - **VHF High-Band**: 174–216 MHz, Channels 7–13
  - **UHF Low-Band**: 470–602 MHz, Channels 14–35
  - **UHF High-Band**: 620–698 MHz, Channels 39–51
  - **Channel Center Spacing**: 6 MHz
  - **Frequency tuning steps**: 1 kHz

- **Weight**
  - **Primary**: 6.4 lbs (2.9 kg)
  - **Expansion**: 6.0 lbs (2.7 kg)
  - **Power supply**: 7.3 lbs (3.32 kg)

- **Dimensions**
  - **Primary**: 14.5 in. D x 19 in. W x 1.75 in, H (368.3 mm x 482.6 mm x 44.45 mm)
  - **Expansion**: 14.5 in. D x 19 in. W x 1.75 in, H (368.3 mm x 482.6 mm x 44.45 mm)
  - **Power supply**: 14.5 in. D x 19 in. W x 1.75 in, H (338.3 mm x 482.6 mm x 44.45 mm)
  - **Operating temperature**: -10° to +65°C (+14° to +149°F)
  - **Humidity**: 95% Non-condensing

**RECEIVER/TRANSMITTER SPECIFICATIONS at 6 MHz Bandwidth**

<table>
<thead>
<tr>
<th>Modulation Mode</th>
<th>Minimum Signal Level</th>
<th>Required S/N</th>
<th>Time Division Duplex Rate (mbps)</th>
<th>Equiv. T1 Circuits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPSK</td>
<td>-80</td>
<td>6</td>
<td>2</td>
<td>1.3</td>
</tr>
<tr>
<td>QPSK</td>
<td>-75</td>
<td>9</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>16 QAM</td>
<td>-70</td>
<td>12</td>
<td>4</td>
<td>2.6</td>
</tr>
<tr>
<td>64 QAM</td>
<td>-65</td>
<td>17</td>
<td>5.5</td>
<td>3.5</td>
</tr>
</tbody>
</table>

- **Adjacent channel rejection**: 6 MHz Channel
- **VHF/UHF**: > 73 dB (300 kHz off-channel)
- **Image rejection**: > 70 dB

**RX Antenna Gain Options**

- RX Antenna Gain Options provide full rate capability at extended range

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**NEED MORE INFORMATION?**

Email us at raptorx@metricsystems.com
**GENERAL**

**What is unlicensed White Space Spectrum? Who can use it?**

White Space Spectrum is the term applied to unused VHF and UHF TV channels released when the U.S. went from analog to HDTV broadcasts. These unlicensed bands are in the 54–60, 76–88, 174–216, 470–602, 620–698 MHz TV spectrum. White Space Spectrum is usable by anyone with a FCC-certified TV band device.

**What are the basic FCC rules for using TV White Space Spectrum?**

- Only an FCC-certified TV band (TVBD) device can be sold and deployed.
- An FCC-certified database such as Google, jConnectiv, Spectrum Bridge, etc., must be used to determine available channels in your operating area.
- Maximum Tx conductive power cannot exceed 1 Watt (30 dBm); EIRP (Equivalent Isotropically-Radiated Power) cannot exceed 4 Watts (36 dBm).
- Every 24 hours, the TV band device must automatically contact an FCC-certified database using GPS location data to re-validate channel use.
- If a White Space radio loses contact with the FCC database, it must automatically cease operation by 23:59 of the next day. This situation can be avoided by providing an alternate internet connection via another White Space radio.

**SPECTRUM BENEFITS**

**What channels are recommended for Non-Line-of-Sight (NLOS) and Beyond Line-of-Sight (BLOS) communications?**

Non-Line-of-Sight (NLOS) paths are obscured by trees, and buildings, etc. In general, high-band VHF signals (174 to 216 MHz) and low-band UHF (470 to 698 MHz) channels perform well on NLOS and BLOS paths.

**CHANNEL SELECTION**

**How do I determine which channels are available?**

To determine available White Space channels anywhere in the US, enter the deployment location latitude and longitude coordinates, street address, or zip code using either of the links below:

- [https://www.google.com/get/spectrumdatabase/channel/](https://www.google.com/get/spectrumdatabase/channel/)

**Choosing a channel**

Operating channels should match your application. For example, the longer the range, the wider the required coverage, the lower the recommended operating frequency or channel.

**What channels are best for long range, urban, and high arboreal areas?**

In Line-of-Sight (LOS) applications, both VHF and UHF bands offer comparable service, although, when possible, the lower frequency provides additional margin. For outdoor to indoor operation, UHF is recommended. In high vegetative and beyond-line-of-sight (BLOS) applications, VHF and low-band UHF is superior.

**Can Metric Systems provide proprietary system solutions?**

Yes. White Space Spectrum opens the possibilities to solving persistent challenges. MSC welcomes the opportunity to work with you to provide customized solutions to fit your specific application.

**INTERFERENCE**

**What happens if there is channel interference?**

Link quality is continuously monitored. When communication is degraded by interference, the Raptor® can be configured to manually, or automatically do the following to maintain connectivity:

- Adjust the modulation format to a lower Bit Error Rate (BER) to maintain data flow.
- Increase Raptor®'s power to 27.8 dBm.
- Switch to an alternate authorized clear channel using Raptor®'s embedded SafariView Spectrum Management tools.
- Reroute the signal around the interference (requires mesh architecture).

**NETWORK CAPABILITIES**

**Can I aggregate multiple VHF/UHF channels to increase transport speed and reliability?**

Yes. Independent adjacent or non-adjacent channels in the same or different VHF/UHF bands can be bonded together to increase transport rate. In addition, channel bonding enhances frequency and spatial diversity to increase system reliability in the event of channel degradation by noise or fading.

**Note:** Multiple channel bonding requires at least one Raptor® Channel Expansion Shelf per link.

**Can I change channels remotely?**

Yes. Once your Raptor® securely registers over the internet and downloads the available channels per its GPS location, any of the channels can be selected for operation. Raptor®'s SafariView channel evaluator will automatically score each available channel for usability.

**ANTENNAS**

**How do I determine what antenna to use?**

- In a point-to-point application, directional gain antennas are recommended. Raptor® offers an Independent Receive Antenna option that allows the use of independent high-gain Rx antennas to increase Rx signal level for extended reach applications.
- For point-to-multipoint operations, recommended antennas range from 360° omnidirectional coverage to 90° to 180° sector antennas, providing defined geographical coverage.

**Can I integrate a Raptor® White Space network into an existing 900 MHz, 2.4/5.8 GHz, or microwave infrastructure network?**

Yes, the Raptor® is an internet protocol (IP) device using Ethernet and SCADA USB interconnect technology which is compatible with all other network devices including WiFi and LTE/4G systems. Raptor®'s internal routing allows you to integrate with any network-based communications system.

**Can Metric Systems provide RF planning and network design support?**

Yes, we welcome the opportunity to assist in the evaluation phase, provide training and after sales support to maintain optimum network performance.