MAJOR BENEFITS

- Support new services and revenue opportunities
- Economically support extended range for Femto and small cell operation
- Eliminate or reduce VSAT microwave reliance
- Provide carrier-grade service for challenging in-structure and enclosed areas at minimum CAPEX and OPEX
- Relieve spectrum congestion and demand on licensed spectrum

COMPLETE INDUSTRIAL BROADBAND WIRELESS NETWORKING INFRASTRUCTURE SOLUTION PROVIDING SUPERIOR RANGE EXTENSION AND BACKHAUL OPERATIONS FOR WILDERNESS, RURAL AND URBAN USE.

A

CORE CAPABILITIES

- Excellent all-terrain performance
- End-to-end redundancy and fault tolerance
- 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
WHITE SPACE SPECTRUM In 2010 the FCC opened up idle VHF and UHF TV channels for unlicensed use on a geographical basis. Covering 246 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® SYSTEM OVERVIEW

THE RAPTOR® IS A WHITE SPACE WIRELESS NETWORKING SYSTEM DESIGNED TO MEET THE RIGORS AND FIELD CONNECTIVITY REQUIREMENTS TO SUPPORT TODAY’S CRITICAL CARRIER BACKHAUL WIDE-AREA COVERAGE AND IN-BUILDING MOBILE OPERATOR INFRASTRUCTURE REQUIREMENTS.

THE RAPTOR® FEATURES A MODULAR HARDWARE AND FIRMWARE SYSTEM ARCHITECTURE TO KEEP PACE WITH EVER INCREASING TRANSPORT AND SECURITY REQUIREMENTS.

RAPTOR® STANDARD FEATURES AND APPLICATIONS

STANDARD FEATURES

SPECTRUM
- Complete Hi-Band VHF and UHF operation:
  - 174-216, 470-602, 620-698 MHz
- Maximum FCC approved power output: +30 dBm (1 Watt conductive)
- Optimum link performance via automatic end-to-end signal integrity control
- Proprietary embedded White Space Spectrum Management System for uninterrupted operation

NETWORK ARCHITECTURE
- User-configurable point-to-point, point-to-multipoint and ad hoc mesh topologies
- Compatible with all IP based routers, hosts and clients
- Bond multiple RF channels together to increase payload capacity and system reliability

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

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

APPLICATIONS

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

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

TRANSPORTATION SYSTEMS
- Intelligent Highway Infrastructure Networks
- Rail Monitoring and Control Systems
- Broadband Harbor and Waterway Networks
- Highway Monitoring and Traffic Control

OPTIONS
- Harsh weather packaging (arctic to jungle)
- Class 1, Div 2 Packaging available
- Add-on channel option provides increased payload rates, 1100% link redundancy and fault tolerant operation (requires one or more Channel Expansion shelves)
- Interfaces for legacy (non-IP) devices
- Custom DC inputs from 12 VDC to -48 VDC
RAPTOR® NETWORK DESIGN

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

Spectrum Advantage
- Up to 5 times the range, coverage and penetration within urban structures and rural settings than WiFi or WiMax (See Table 1)
- Superior RF reach and coverage within structures and canopied vegetative areas
- Spectrum Agility and Frequency Diversity to increase throughput and avoid, or by-pass on-air interference
- Incrementally deploy and add additional payload capacity to respond to coverage and capacity demands.

<p>| TABLE 1 RAPTOR® RANGE AND COVERAGE ADVANTAGE |</p>
<table>
<thead>
<tr>
<th>FREQUENCY MHz</th>
<th>BAND/TECHNOLOGY</th>
<th>IN-CITY RANGE/mi</th>
<th>RURAL RANGE/mi</th>
</tr>
</thead>
<tbody>
<tr>
<td>54-60, 72-88</td>
<td>Low-Band VHF</td>
<td>7-10</td>
<td>30</td>
</tr>
<tr>
<td>174-216</td>
<td>High-Band VHF</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>470-698</td>
<td>UHF</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>excluding 602-620</td>
<td>UHF</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>2400</td>
<td>802.11g/n WiFi</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>5800</td>
<td>802.11a</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

Network Advantage
Embedded physical and network level multi-point and ad hoc unified mesh routing engine supports all network architectures – point-to-point, multi-point, mesh, star and tree network configurations. With these configurations nearly any real-world network challenge can be solved.

Network Management Advantage
SafariView, RAPTOR®’s embedded Operations, Administration and Maintenance tool provides total secure administration and control of each RAPTOR® node and local network interfaces.

Cyber Advantage
RAPTOR®’s suite of security-focused hardware, firmware and software assists in defending your critical operations, physical plant and information against internal and external wireless and network threats.

Application Versatility Advantage
RAPTOR®’s network scalability and versatility allows system planners to meet specific range, coverage, security and revenue requirements at minimum life-cycle cost and system interruption.

Economic Advantage
RAPTOR® is the low cost solution of choice. Its broad operating spectrum capability and longer reach means less equipment and infrastructure, providing a real alternative to VSAT and microwave in challenging environments.
## OPERATING AND TECHNICAL SPECIFICATIONS

### GENERAL

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Frequency Range</td>
<td>VHF High-Band: 174-216 MHz, Channels 7-13</td>
</tr>
<tr>
<td></td>
<td>UHF Low-Band: 470-602 MHz, Channels 14-35</td>
</tr>
<tr>
<td></td>
<td>UHF High-Band: 620-698 MHz, Channels 39-51</td>
</tr>
<tr>
<td></td>
<td>VHF Low-Band (Available early 2015): 54-60 MHz Channel 2 76-88 MHz, Channels 5,6</td>
</tr>
<tr>
<td>Channel Spacing</td>
<td>6 MHz</td>
</tr>
<tr>
<td>Tx and Rx Frequency Options:</td>
<td>Common Tx/Rx Channel</td>
</tr>
<tr>
<td></td>
<td>Independent Tx/Rx Channels</td>
</tr>
<tr>
<td>Frequency tuning steps</td>
<td>1 KHz</td>
</tr>
<tr>
<td>Weight</td>
<td>Primary: 6.4 lbs (2.9 kg)</td>
</tr>
<tr>
<td></td>
<td>Expansion: 6.0 lbs (2.7 kg)</td>
</tr>
<tr>
<td></td>
<td>Power Supply: 7.3 lbs. (3.32kg)</td>
</tr>
<tr>
<td>Dimensions</td>
<td>Primary: 14.5&quot; D x 19&quot; W x 1.75&quot; H (368.3.6 mm x 482.6 mm x 44.45 mm)</td>
</tr>
<tr>
<td></td>
<td>Expansion: 14.5&quot; D x 19&quot; W x 1.75&quot; H (368.3.6 mm x 482.6 x 44.45 mm)</td>
</tr>
<tr>
<td></td>
<td>Power Supply: 14.5&quot; D x 19&quot; W x 1.75&quot; H (368.3.6 mm x 482.6 x 44.45 mm)</td>
</tr>
<tr>
<td></td>
<td>Operating Temperature: -10°C to + 65°C (+14°F to +149°F)</td>
</tr>
<tr>
<td></td>
<td>Humidity: 95% Non Condensing</td>
</tr>
</tbody>
</table>

### POWER

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Input</td>
<td>110/240 V AC 50/60 Hz</td>
</tr>
<tr>
<td>Consumption</td>
<td>70 watts (Single Channel)</td>
</tr>
<tr>
<td></td>
<td>130 Watts (Dual Channel) Requires Channel Expansion Shelf</td>
</tr>
<tr>
<td>RF Channel Output</td>
<td>1 Watt Average Power over 6 MHz bandwidth</td>
</tr>
</tbody>
</table>

### SECURITY

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payload Encryption</td>
<td>128/256 bit Advanced Encryption Standard (AES)</td>
</tr>
<tr>
<td>System Access/Authentication Capabilities</td>
<td>Multifactor Authentication. Remote Access Token Based Authentication</td>
</tr>
<tr>
<td>Authorization and Accounting</td>
<td>Protects Against Non-Authorized Administration/ Maintenance and Over-the-Air Access</td>
</tr>
<tr>
<td>Information Assurance Tools</td>
<td>Integrated Firewall and Suite of Information Assurance Tools</td>
</tr>
</tbody>
</table>

### NETWORK ARCHITECTURE

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>VLAN</td>
<td>Supports Multiple Laws; Static and Dynamic</td>
</tr>
<tr>
<td>Firewalls</td>
<td>Robust Rule Support and Encrypted Download</td>
</tr>
<tr>
<td>Dynamic Ad Hoc Network</td>
<td>Adaptive, self-forming, self-healing network</td>
</tr>
<tr>
<td>Network Size</td>
<td>Limited only by available RF channels</td>
</tr>
<tr>
<td>Network Capabilities/ Single Channel</td>
<td>Point-to-Point, Point-to-Multipoint, Mesh</td>
</tr>
<tr>
<td>Network Timing</td>
<td>Multiple Network Timing Protocol Options (NTP)</td>
</tr>
<tr>
<td>Maintenance/Diagnostics</td>
<td>Over-the-Air Programming, Integrated Web-based Administration, Monitoring and Reconfiguration</td>
</tr>
<tr>
<td>System Logs</td>
<td>System; Security; Authentication; Information flow; Traffic Monitoring and Intrusion Detection</td>
</tr>
</tbody>
</table>

### ANTENNA INTERFACE

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>Common Tx/Rx Antenna</td>
</tr>
<tr>
<td>Optional</td>
<td>Separate Tx and Rx Antennas</td>
</tr>
</tbody>
</table>

### FREQUENCY STABILITY

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal 10 MHz Reference</td>
<td>± 2.5 PPM, ± 25 Hz</td>
</tr>
<tr>
<td>External Reference</td>
<td>Optional 10 MHz Stratum Input</td>
</tr>
</tbody>
</table>

### SUPPORT ACCESSORIES

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antennas</td>
<td>Directional, Omni or Sector</td>
</tr>
<tr>
<td>External GPS Geo Location/ Modules</td>
<td>Provides NEMA 0183 format Latitude and Longitude Output</td>
</tr>
<tr>
<td>Precision Frequency Synchronization Module</td>
<td>GPS Base precision Frequency source (± .1 ppm), ± 1 Hz</td>
</tr>
</tbody>
</table>

### OPERATING AND TECHNICAL SPECIFICATIONS

**Disclosure Statement:** The RaptorX has not been certified by the FCC for sale in the U.S. Certification and first shipment are planned for Q4 2014. RaptorX is covered under one or more of the following U.S. patents: 6952563, 7013345, 7089014 and Canadian patents: 2417931, 2444805, 2444643.
NETWORK SECURITY AND MAINTENANCE TOOLS

THE RAPTOR® DUAL CPU CORE, CRYPTO-ACCELERATED NETWORK PROCESSOR SUPPORTS DEPLOYMENT IN NEARLY ANY CRITICAL INFRASTRUCTURE APPLICATION.

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-base 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 and data transfer over long and NLOS paths.

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

**INTERFACING WITH THE RAPTOR®**

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

**SafariView | Raptor® Operations Administration and Maintenance Tool (OAM)**

Raptor® hosts a robust suite of network tools and applications to configure, monitor, administer and control each Raptor® within the Network. Capabilities under secure password control include:

- Ability to configure locally or remotely any Raptor® within the network
- Robust Firewall defense at each Raptor®, 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 Raptor® site
- Embedded wireless controller support for WiFi and third party wireless systems
- Factory support for Non-IP devices and Wireless Voice and Data Systems

**CYBER DEFENSE EXAMPLE:**

Embedded Raptor® tools to detect and defend against an ARP Man-in-the-Middle/ ARP Spoofing Attack
- MAC address locking focuses MAC address association to specific port
- Static Coding of ARP Tables
- Encryption along with strong authentication provides resilience to Man-in-the-middle attacks.
- ARP Watch tool monitors and logs ethernet traffic activity e.g. changing IP and MAC addresses. Raptor® will notify and react if non-approved ethernet/IP pairings occur.
TYPICAL NETWORK AND RF SITE CONFIGURATIONS

**Basic Network Configuration**

- LED Status Field
- System Status and Control
- WAN1 LAN
- WAN2
- USB and Console
- Router (optional)
- Public/Private Internet
- Intranet
  - Local LAN
  - Middle mile and edge devices

**Single Channel/Single Antenna Configuration**

Channel 1: Network Shelf

- Redundant Power Unit
- AC Power 110 VAC

Choose antenna to meet footprint requirements:
- Omni (360°)
- Directional (60°–90°)
- Sector (90°–180°)

Use this configuration for point-to-point and multi-point applications.
(See Topologies Example page)

**Dual Channel/Dual Antenna Configuration**

Channel 1: Network Shelf
Channel 2: Expansion Shelf

- Redundant Power Unit
- AC Power 110 VAC

Use this configuration for the following applications:
- Independent point-to-point
- Bonded point-to-point (increases speed and redundancy)
- Relay and “add-and-drop” applications
- Dual independent multi-point applications
- Mesh configurations

Need more information? Email us at raptorx@metricsystems.com
RAPTOR® TOPOLOGY EXAMPLES

Flexibility and scalability are essential elements in successfully meeting today’s backhaul infrastructure requirements. The figures below illustrate Raptor®’s ability to meet virtually any topology challenge.

**Figure 1.** Point-to-point link using a single VHF or UHF channel.

**Figure 2.** Utilizing multiple channels increases throughput by doubling RF bandwidth and enhancing reliability through spare diversity (antenna separation) and frequency diversity via a secondary VHF/UHF channel.

**Figure 3.** Raptor® makes implementing VHF/UHF multi-point infrastructure links on VHF or UHF bands easy.

**Figure 4.** Dual channel multipoint network segments provide increased payload rates and enhance system reliability.

**Figure 5.** Combining Raptor®’s adhoc point-to-point and point-to-multipoint capabilities enables system operators to effectively reach out over urban, rural, and hostile service areas.

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GENERAL

What is White Space spectrum? Who can use it?
When the U.S. transitioned to HDTV transmission, channels otherwise used for analog TV broadcasting became idle. These idle bands are in the 54-60, 76-88, 174-216, 470-602, 620-698 MHz TV spectrum.

What are the basic FCC rules for unlicensed RF planning and operation in UHF/VHF TV band spectrum?
Only an FCC certified TV band device (TVBDs) can be sold and deployed. An FCC certified database must be used to determine available channels in your operating area. Every 24 hours, the TV Band Device must automatically contact an FCC certified database using its GPS-location data to re-validate available channel use.

How long will the FCC allow these channels to be used?
Channels can be used as long as the FCC database shows them available. Continued use requires automatic confirmation every 24 hours. If a channel becomes unavailable, RaptorX’s embedded spectrum management algorithms will automatically determine an alternate channel and switch channels to maintain continuous service.

SPECTRUM BENEFITS

What channels are best used for non-line-of-sight and beyond horizon communication?
Non-Line-of-Sight (NLOS) paths are obscured by trees, buildings, etc. In general, VHF signals in the 174-216 MHz bands out-perform UHF channels. With the RaptorX propagation at VHF and UHF bands can be evaluated to determine an appropriate operating channel.

1. For Beyond Line-of-Sight (BLOS), low (54-88 MHz) and high VHF (174-216 MHz) channels will perform best.
A Low-Band VHF RaptorX for the 54-60 and 76-88 MHz bands will be available in early 2015.

CHANNEL SELECTION

How do I determine what channels are available in my area?
By entering a latitude and longitude, or street address, one can determine available White Space channels anywhere in the U.S. RaptorX will automatically query and determine local channel availability for RF planning purposes.

Choosing a channel:
Operating channels should match your application. For example, the longer the range, or wider the required coverage, the lower the recommended operating frequency or channel. Operating over a relatively flat 10-mile range, a UHF channel will perform well with enough signal margin to survive 10-20 dB fades. Over the same range in a forested area, a High-Band VHF channel 7-13 will provide a high Rx Signal and increase fade tolerance.

What channels are best used 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, a lower frequency will provide additional margin. For outside to inside operation in high vegetative and Beyond Line-of-Sight (BLOS) applications, VHF is superior. RaptorX’s spectrum evaluation tool will assist in this process. Evaluation should be done for both VHF and UHF available channels.

INTERFERENCE

What happens if there is channel interference?
Link quality is continuously monitored. When communication is degraded by interference the RaptorX is configurable to manually or automatically maintain connectivity. This is accomplished by:

a) Switching to an alternate authorized clear channel using RaptorX’s embedded SafariView Spectrum Management tool;
b) Adapting modulation format to lower Bit Error Rate and maintain data flow;
c) Increasing power up to the legal maximum limit of 30 dBm, to overcome the interference.
d) In addition, a mesh implementation can reroute around the interference.

NETWORK CAPABILITIES

Can multiple White Space channels be bonded to increase transport speed and reliability?
Yes, independent adjacent or non-adjacent channels in the same or different bands can be bonded together to provide increased data speeds and take advantage of frequency and spatial diversity for enhanced system reliability in the event of channel degradation by equipment fault, noise, or fading. Dual or multiple channel bonding requires the use of one or more RaptorX Channel Expansion Shelves.

Can I change channels remotely?
Yes, once your RaptorX securely registers over the internet and downloads the channels available per its GPS location, any of the channels can be selected for operation. RaptorX’s SafariView channel evaluator will automatically score each available channel for usability.

ANTENNAS

How do I determine what antenna to use?

a) In a point-to-point application, directional-gain antennas are recommended. RaptorX offers an independent Receive Antenna Option which enables the use of a high-gain Rx antenna to increase Rx signal level for extended reach applications

b) For Point-to-Multipoint operations, recommended antennas range from Omnidirectional 360° coverage to 90-180° Sector Antennas providing defined geographical coverage.

Can I integrate a RaptorX White Space network into an existing 900 MHz, 2.4/5.8 GHz, or microwave infrastructure network?
Yes, the RaptorX 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. RaptorX’s internal routing allows you to integrate with any network based communication 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.

Contact Info:
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email: raptorx@metricsystems.com • web: www.metricsystems.com

Disclosure Statement: RaptorX is currently in the FCC certification process. Initial shipments are scheduled for Q4, 2014

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