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ADAPTRUM SALES OVERVIEW
September 2021

Business Partner Ferraris Inc. will be introducing Adaptrum's product .

www.ferrarispower.com

TVWS Standards

- IEEE (Institute of Electrical and Electronics Engineers)

  – **IEEE 802** standards are a family of standards dealing with local area networks and metropolitan area networks.

  – **IEEE 802.11** is a standard for Wireless Local Area Network (WLAN) with **IEEE 802.11af** being the standard for TVWS

  – **IEEE 802.22** is a standard for Wireless Regional Area Network (WRAN) using white space in the TV Bands

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Spectrum Access

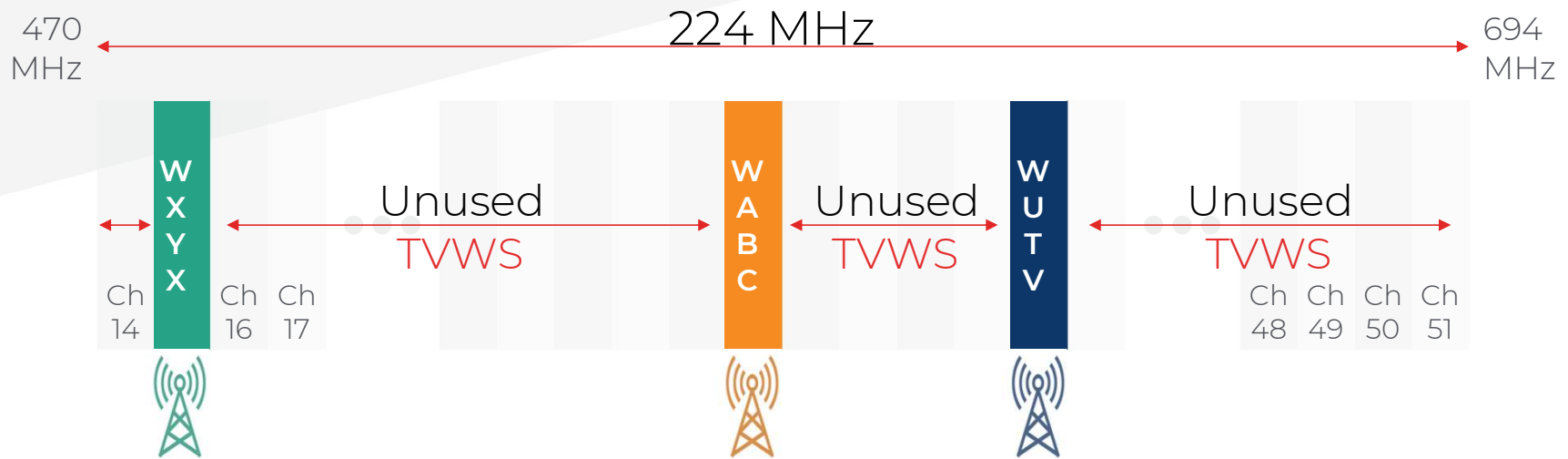| Licensed	Dynamic Access	Unlicensed
Cellular, Broadcast, etc.	Secondary use of licensed spectrum	WiFi, Bluetooth, etc.
Very expensive	No barrier of entry associated with purchase or lease of spectrum	2.4GHz, 5GHz
Massively underutilized		"Once thought unusable, the unlicensed bands are some of the most valuable bands in the world" *FCC Commissioner Michael O'Rielly*

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What is TV White Space Spectrum?

Unused TV-band channels

470 MHz ← 224 MHz → 694 MHz

WXYX Ch 14 Ch 16 Ch 17 Unused TVWS WABC Unused TVWS WUTV Unused TVWS Ch 48 Ch 49 Ch 50 Ch 51

Beachfront Spectrum
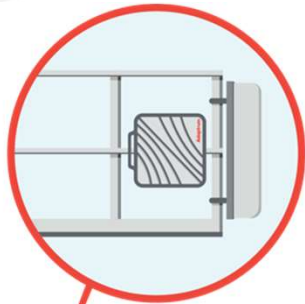
Sub-GHz   Abundant   Unlicensed
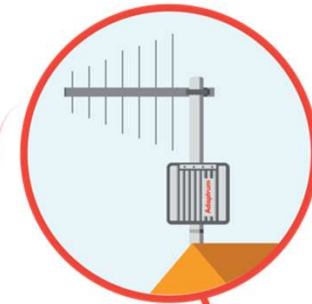
for wireless broadband

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Sub-GHz TVWS Spectrum: Ideal for Wireless Broadband

TVWS
Base

Long-Range
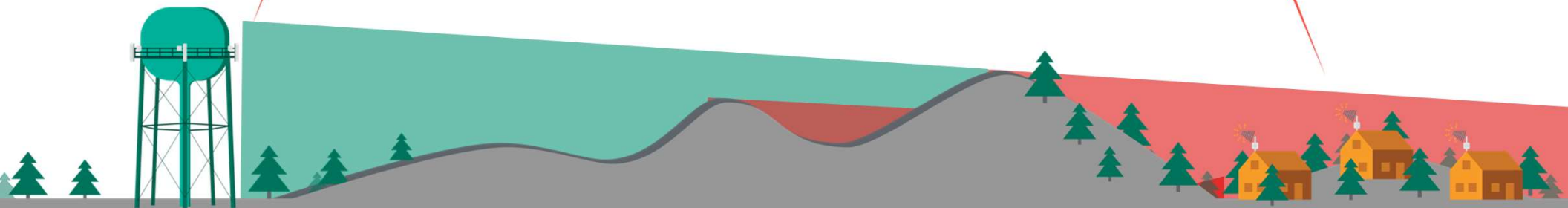Non-Line-of-Sight
Great Penetration
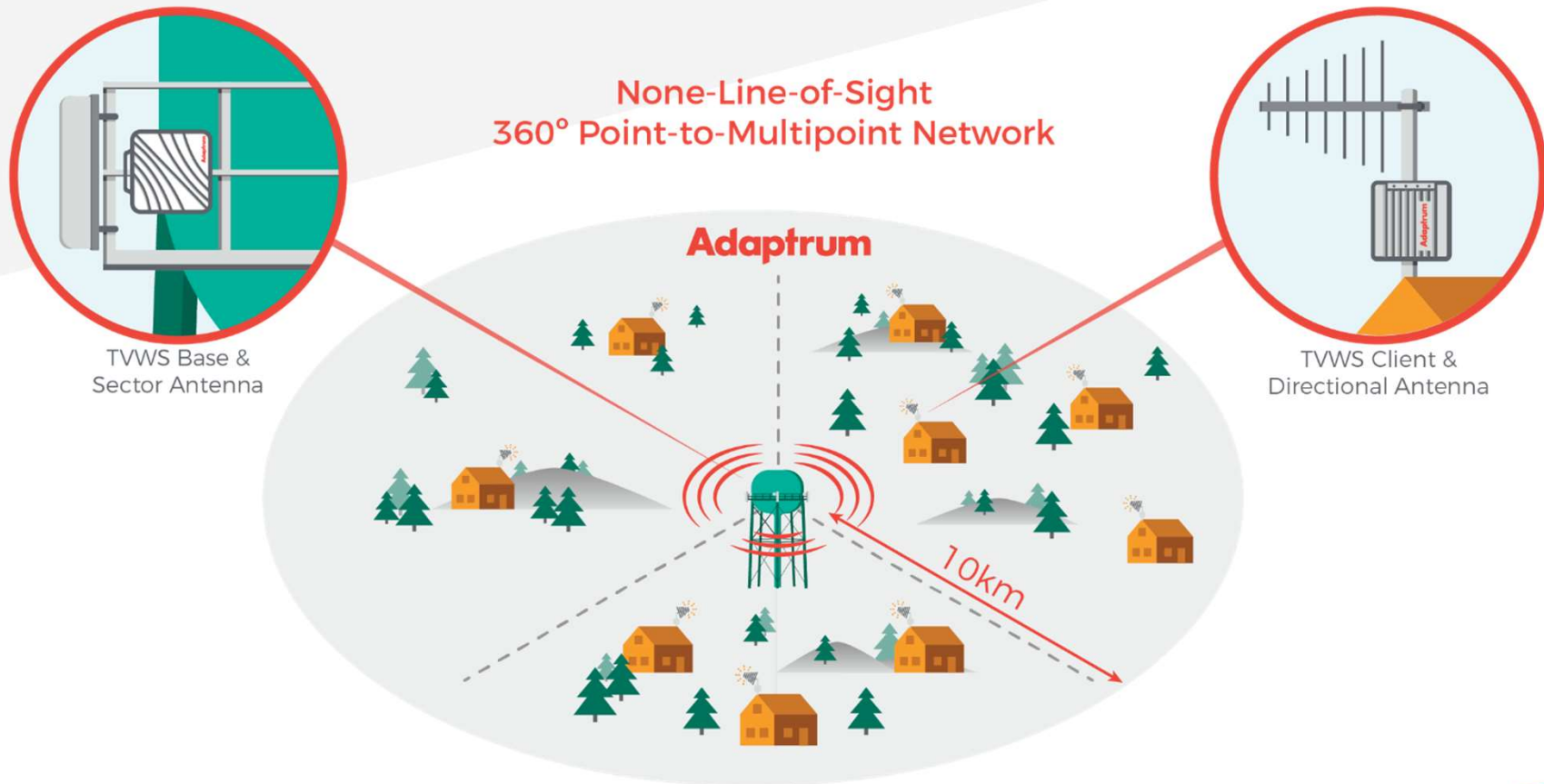trees, building, etc.

TVWS
Client(s)

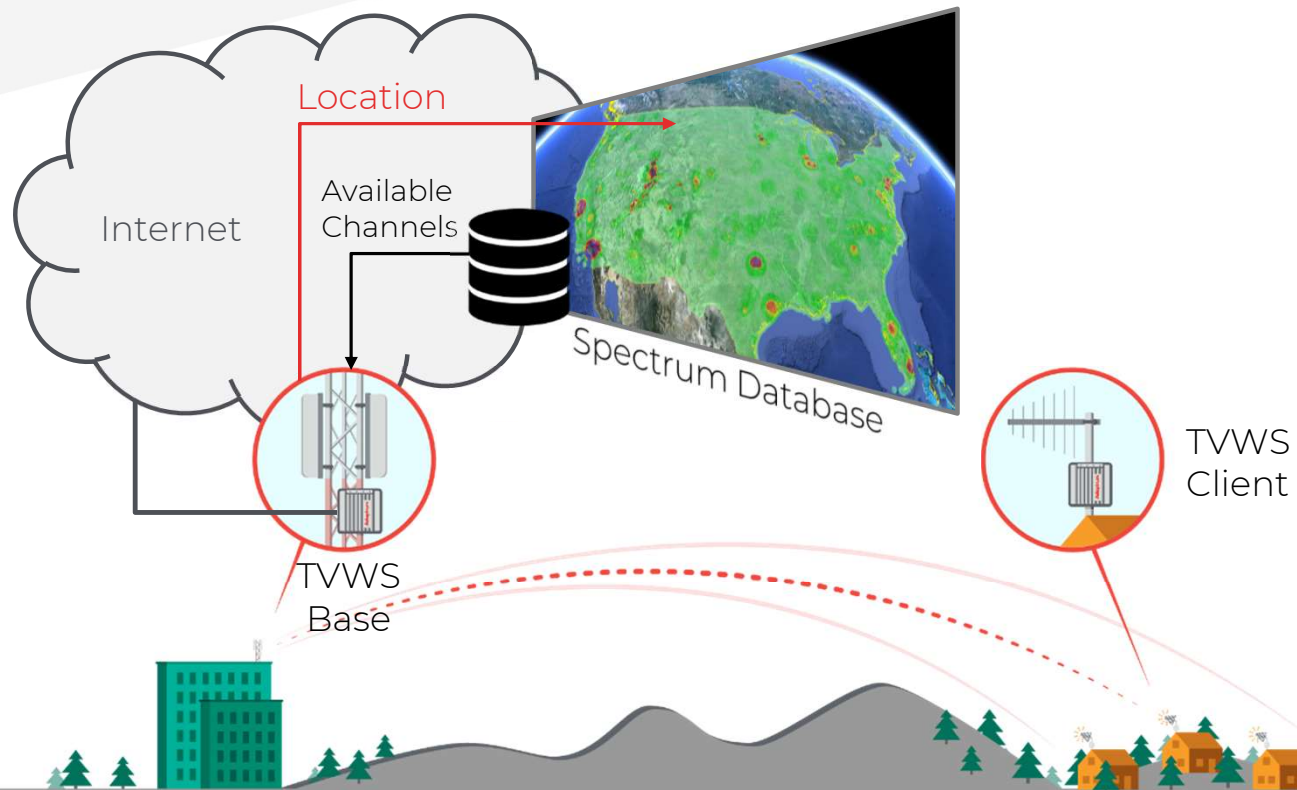6 mi / 10 km

Delivering Fixed Wireless Broadband over TVWS

TVWS Base & Sector Antenna

None-Line-of-Sight
360° Point-to-Multipoint Network

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10km

TVWS Client & Directional Antenna

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Dynamic Spectrum Access

Frequency agile radios dynamically operate across entire TVWS band

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Adaptrum Overview

About Adaptrum

Adaptrum is a pioneer in dynamic spectrum access technology that enables access to unused and underutilized spectrum in the worldwide TV bands and beyond.

Our Mission

Empower next generation wireless network operators to use unlicensed and/or dynamically licensed spectrum to serve billions of people and tens of billions of devices globally

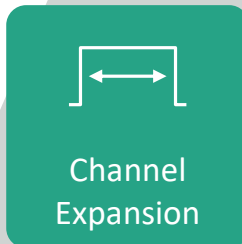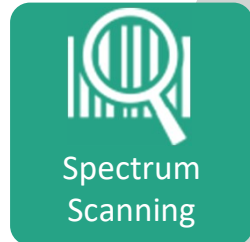# Adaptrum Deployed in over 30 countries across 6 continents

Product Overview

ACRS2 — **B1000**

- Single Radio Base station
- Ideal for low density rural deployments

18 Mbps

6/7/8 MHz UHF

Channel Expansion

10W EIRP

Spectrum Scanning

POE

Rugged

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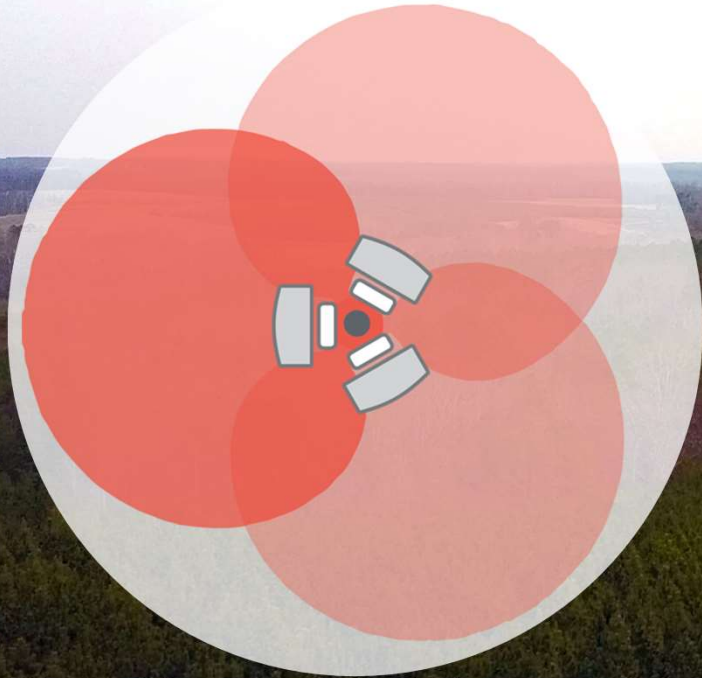# Base Antenna 360deg sectorized coverage

| 11 dBi | 90° H-BW | 0°/8° Downtilt | Single Port / Dual Port | Vert Pol / X Pol |

ACRS 2.0
Client Radio

Single Channel
Long-Range Client
Ultra-compact
Easy to mount

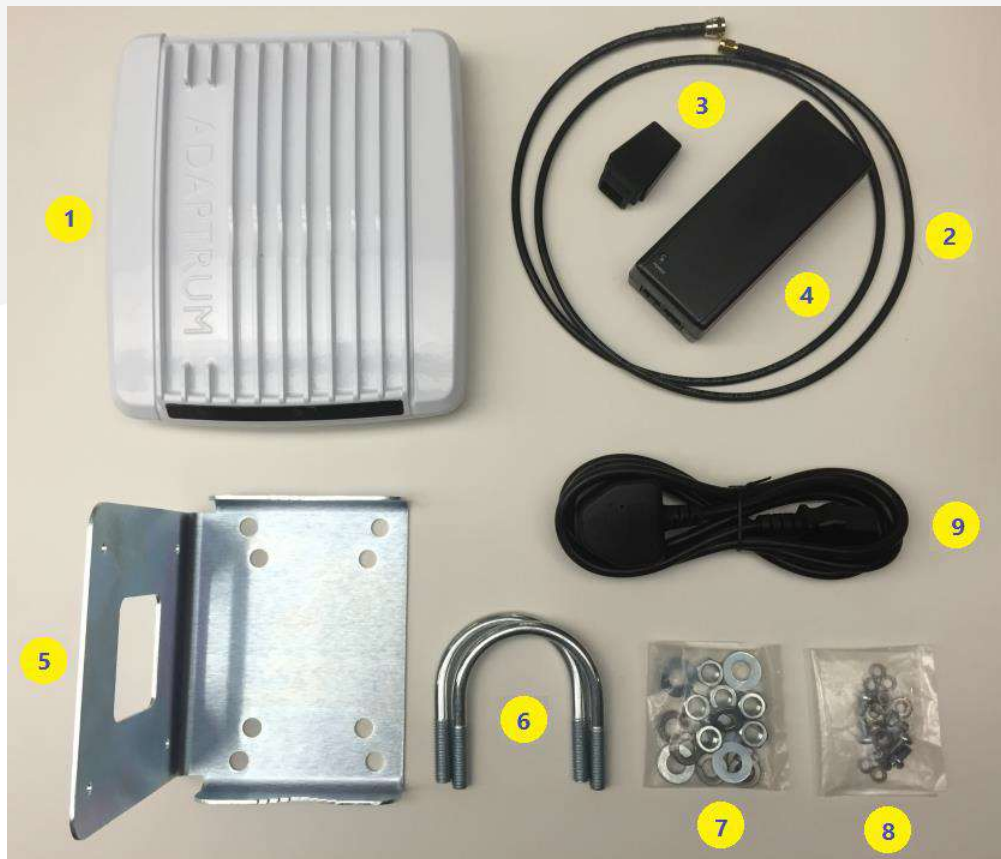|			
18 Mbps	Channel Expansion	8" x 8" x 1.5"	3.5 lbs
Spectrum Scan	POE	Rugged	6/7/8 MHz UHF

ARC 2.0 KIT

1. ACRS 2.0 unit ("BASE" or "CLIENT" per label on rear)
2. ACRS-to-antenna cable (only with receipt of LP45F antenna)
3. Ethernet cable weather-resistant boot
4. PoE
5. ACRS mounting bracket
6. U-bolts (2)
7. Bracket-to-pole mounting hardware (6 each nuts, split washers, flat washers)
8. ACRS-to-bracket mounting hardware (6 each Philips head screws, split washers, flat washers)
9. International power cord
10. contents sheet
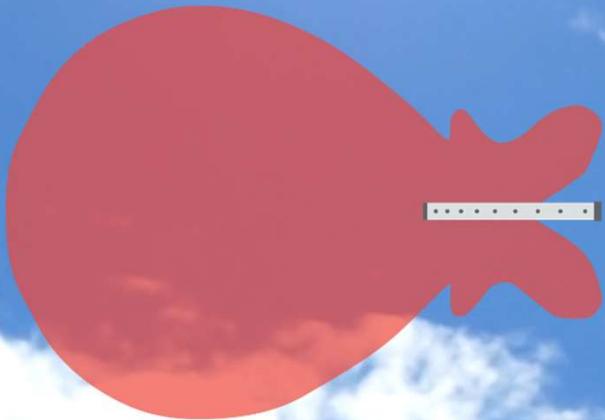
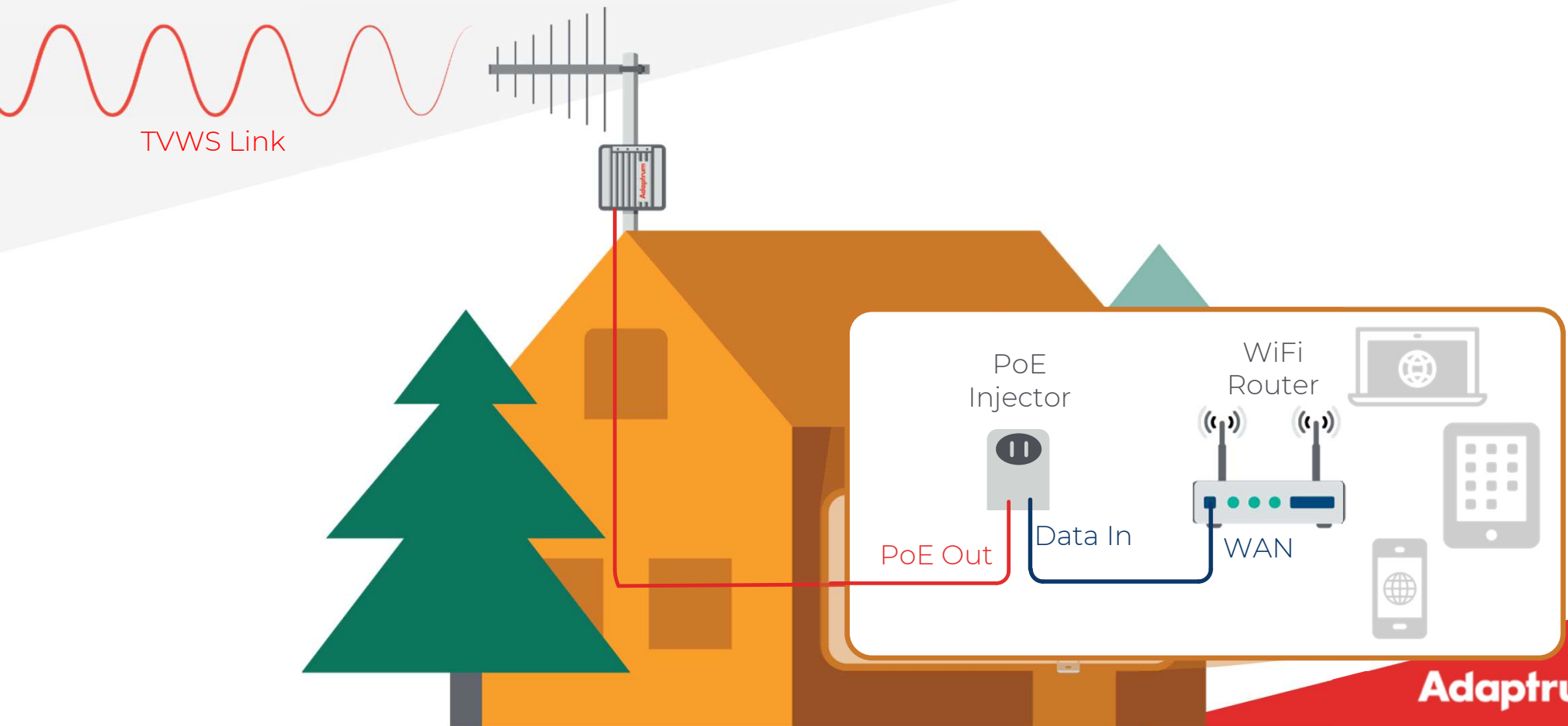# Client Antenna Easy to point high-gain yaggi

11 dBi

65° H-BW

- Industry Leading Long-Range Non-Line-of-Sight Performance
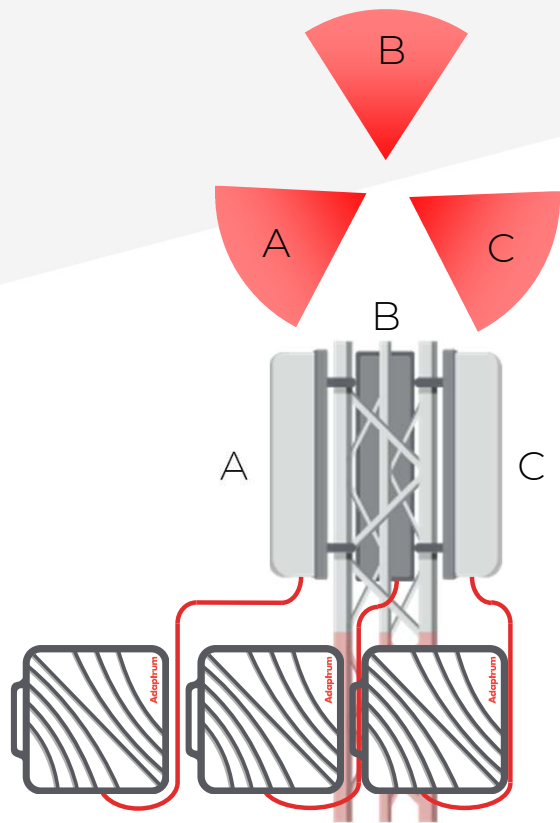- Rural Broadband Solution
- Built-in spectrum sensing

Typical Fixed Wireless Client Deployment

TVWS Outside / WiFi Inside

TVWS Link

PoE Injector

WiFi Router

PoE Out

Data In

WAN

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ACRS2: Point to Multi-Point

B

A   C

B

A   C

Non-LOS TVWS
over the air link

20 to 35 Mbps
per sector

3 x ACRS2-B1000 Base Station at
Tower site
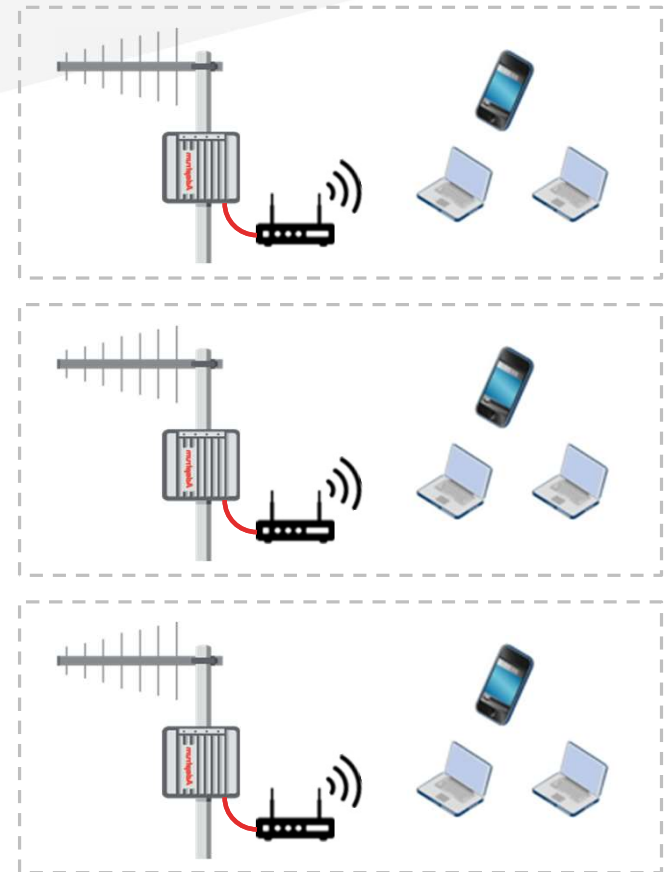
ACRS 2.0 CPE connects to an external Wifi router

©2021 Adaptrum. Confidential

Adaptrum

Adaptrum Network Management System

Configure, Monitor and Manage Network wide TVWS Devices

Adaptrum Device Manager

Brower based GUI running on the device

Radio Network Channel Planning

- **Patented Agile Sensing technology**
  - Real-time spectrum sensing & analysis gives instant visibility of the radio spectrum
  - ACRS radios measure channel background noise and interference level in a matter of seconds
  - Scan the complete UHF TV band (470 MHz to 800 MHz)
  - Choose the best channel(s) for operation

- **Multiday and Overnight Spectrum Scan**
  - Optimize network channel planning across conditions that change over time
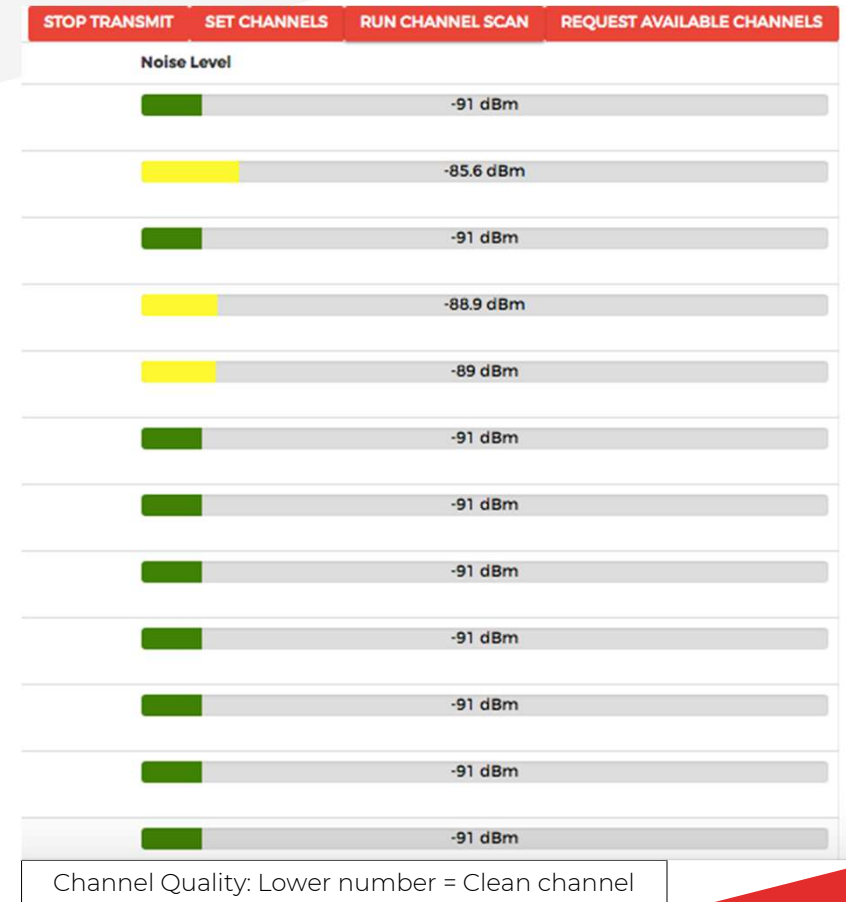
STOP TRANSMIT	SET CHANNELS	RUN CHANNEL SCAN	REQUEST AVAILABLE CHANNELS

Noise Level

-91 dBm

-85.6 dBm

-91 dBm

-88.9 dBm

-89 dBm

-91 dBm

-91 dBm

-91 dBm

-91 dBm

-91 dBm

-91 dBm

-91 dBm

Channel Quality: Lower number = Clean channel

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Going forward

Adaptrum TVWS equipment

Generation 2

ACRS 2

Designed for rural

Generation 3

ACRS 2.1

Scaling for speed

Generation 4

TVWS ASIC

Next generation

- For ITU Region 1 Adaptrum supports 8Mhz channels, channel expansion to 10MHz, 470-694MHz. (Chipset supports 6,7,8 Mhz channel plans depending on ITU region)
- Range capability : Verified deployments LOS > 20km and NLOS/nLOS up to 10km (*terrain & clutter dependent)
- Power consumption 20W (ready for low power outdoor deployments)
- PAWS database compliant & implemented in multiple countries in North America, Europe, Africa and Latin America

• Single channel with channel expansion to 10Mhz (regulator dependent) • Modulation QPSK to 64 QAM depending on range and clutter • Network sync	• Channel expansion to 20MHz (regulator dependent) and channel aggregation • Improvements in modulation, network sync, network management platform	• Chip based devices with improved economics • Multi-standard (802.22 & 802.11af) • Enabling Multi-band AP & Mobile systems • Enhanced capabilities to support IoT

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Adaptrum Projects
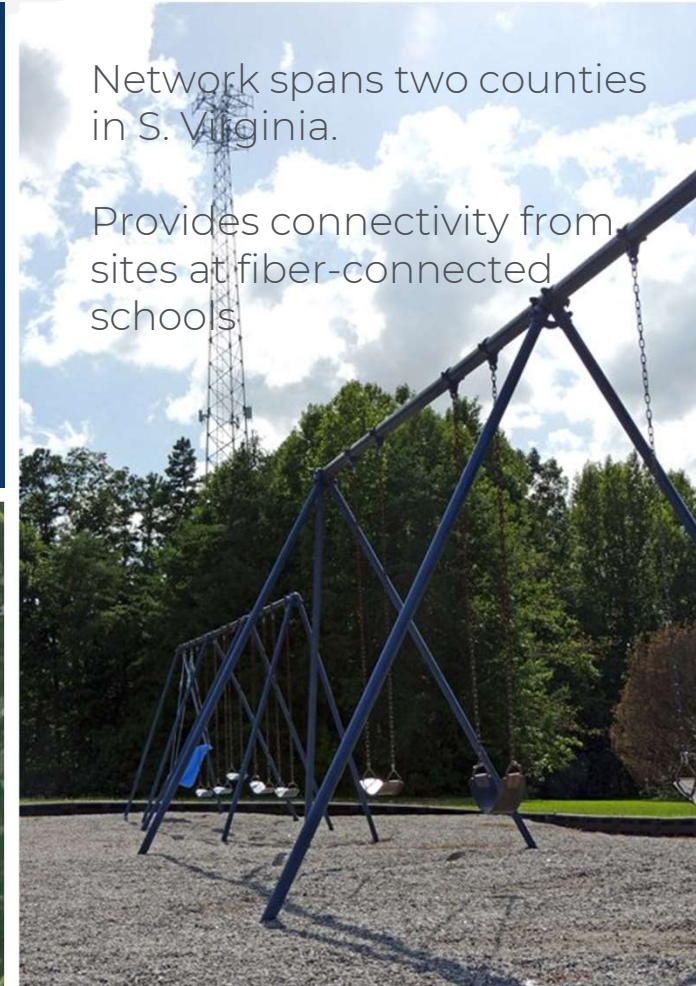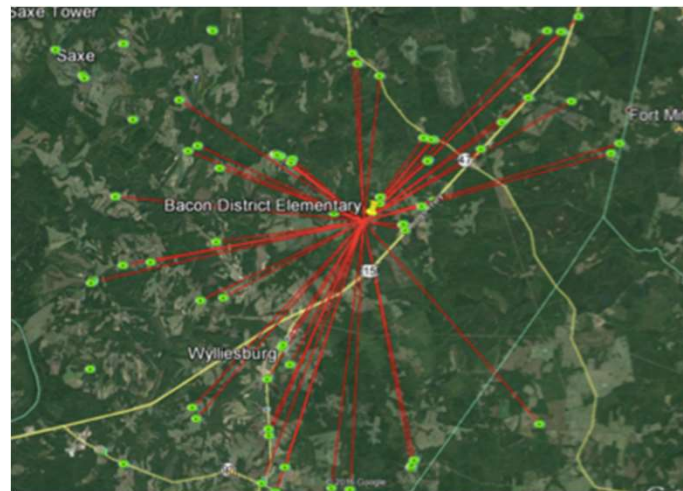
Virginia, USA

Mid-Atlantic BROADBAND

Closing the homework gap in rural Virginia with <u>largest</u> US TV White Space project

On-track to connect 1000 student homes, at no cost to families

Network spans two counties in S. Virginia.

Provides connectivity from sites at fiber-connected schools

Maine, USA

Axiom

Closing the digital divide in rural Maine

Remote rural communities
Heavy trees and foliage

Close to 100 radio deployed to date

1st commercial user to use channel expansion to increase capacity in installed network

Microsoft

Microsoft Affordable Access Grant Recipient

Only US company

Community Broadband - Namibia

World largest TVWS deployment by geographic area

Network Extension via Relay
Reaching 9,424km²

Aguadas, Colombia

Microsoft

ANE
Agencia Nacional del Espectro

Pilot project connecting
Rio Arriba school

15 miles
away from
Aguadas, Caldas

Pending regulations will
allow expansion into
countrywide projects

Colombian
President skyping
with Rio Arriba
school over TV
White Space

Arran, Scotland

BROADWAYPARTNERS

Deploying TVWS to provide internet service in remote/rural "not spot" areas of the UK

First commercial TVWS Network in UK

Adaptrum ACRS2.0 1st Radio to receive ETSI compliance certification

Jamaica – First Caribbean Deployment

Adaptrum

Kenya

Solar powered TV White Space network used to deliver broadband access to schools and cyber cafe.

MICROSOFT A KEY TECHNOLOGY/BUSINESS PARTNER IN IoT MARKET

Microsoft FarmBeats with TVWS connectivity introduced by Bill Gates

Business Partner Ferraris Inc. will be introducing Adaptrum's product .

ferraris@ferrarispower.com

www.ferrarispower.com