Maximizing FM Coverage – Advances in Technology & Design

August 2013

ABU Webinar

Featuring GatesAir's

Rich Redmond
Chief Product Officer

Maximizing FM Coverage – Advances in Technology & Design

Richard Redmond, Vice President, Transmission, Test & Measurement

August, 2013

Harris Broadcast

Deliver the moment™

Agenda

Harris Broadcast
Deliver the moment

- FM Radio is everywhere – well almost
- Limitations of FM coverage
- Use of Single Frequency networks
- Advances in Network design
- Advances in Program transport and network timing
- Advances in FM transmission solutions
- Summary

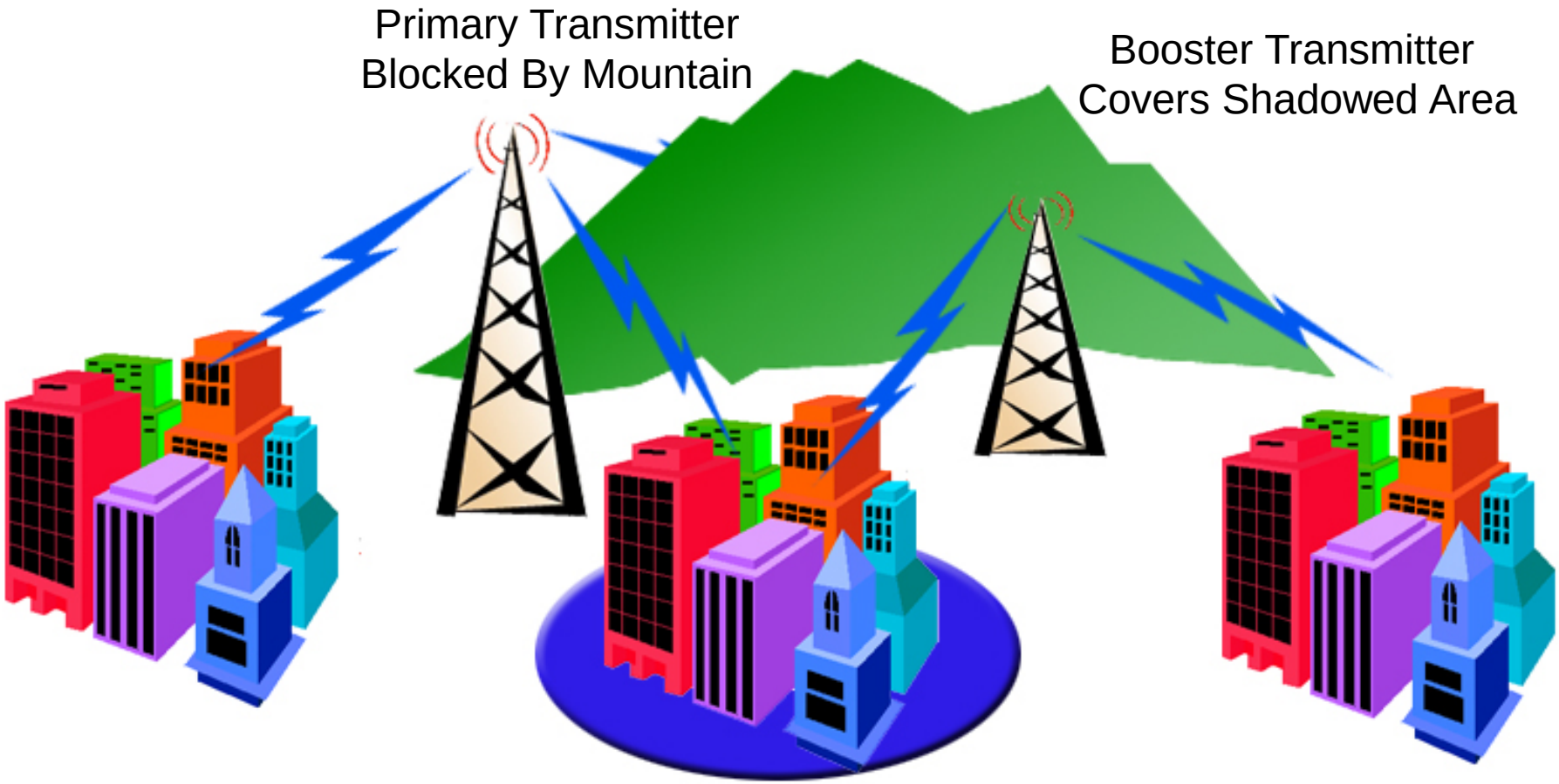
Limitations of FM Coverage

Harris Broadcast
Deliver the moment

- FM is Line of Sight overage
  - Obstructions such as terrain and dense large urban buildings can impact or block coverage
- Limited spectrum and costly licensing make adding additional frequencies a limited option for improved coverage
- Options for reliable SFN FM operation have been limited in the past
  - Typically only working well with a lot of terrain shielding
- Real world propagation often does not match predicted coverage
- Advanced SFN networks could be a solution

Fill Critical Coverage Gaps

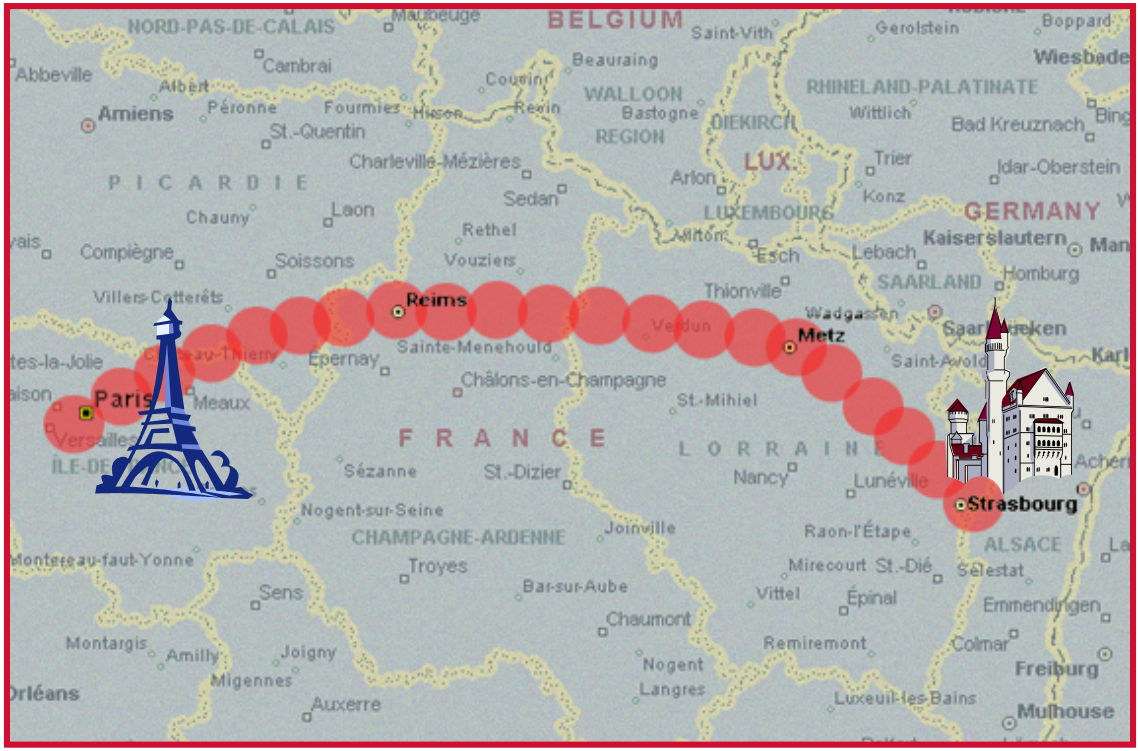
Harris Broadcast
Deliver the moment



Interference in Overlap Area
Controlled by SynchroCast

Cover a Travel Corridor

Harris Broadcast
Deliver the moment



- Listeners enjoy seamless reception as they travel
- Conserves frequencies in regional networks

What Are the Issues?

Harris Broadcast
Deliver the moment

- Overlap of RF coverage patterns can aggravate self interference
  - When terrain does not block the signal
- Transmitter frequencies are nominally the same, but not absolutely identical
  - Phase differences in the carrier frequencies generated by the exciters cause interference
- STL path delay differs
  - Additional phase interference problems, potentially even worse

MaxxCasting

Next Generation Single Frequency Networking Solution

What is MaxxCasting™?

Harris Broadcast
Deliver the moment

- Historically, broadcasters have used single booster sites with relatively high antenna heights to fill in areas where their main signal is blocked by terrain.
- While the single site, tall tower booster does fill in the terrain blocked area, it can often create interference with the main signal in areas that are covered by both the main and booster signals.
- Geo-Broadcast Solutions ("GBS") has developed the MaxxCasting System that combines radio and cellular technology to enable FM Broadcasters using boosters to enhance their signals by reducing multipath interference between the main and booster transmissions through the use of a cluster of low to the ground, high power, highly directionalized synchrocast booster sites.
- GBS is working in partnership with Harris Corporation and NPR Labs to provide the MaxxCasting design and related equipment for broadcasters to improve existing booster problems.
- The use of multiple boosters to broadcast the same content as the main is permitted by the FCC.
- GBS has filed for a patent on the MaxxCasting System.

GEO BROADCAST SOLUTIONS MAXXCASTING

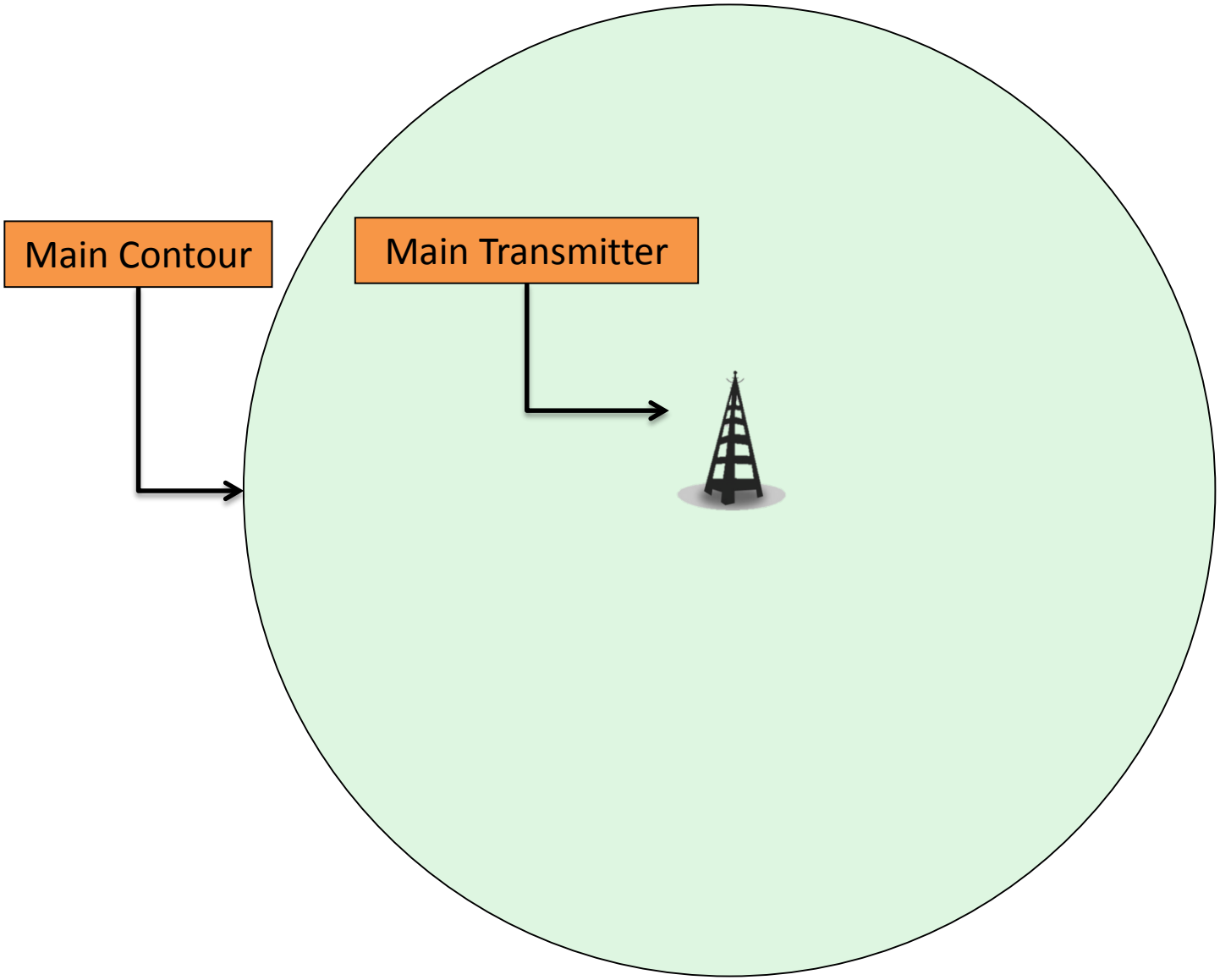
Background

Harris Broadcast
Deliver the moment

- Legacy SFN systems (boosters) resulted in unsatisfactory performance
    - Distorted audio (multipath)
    - Weak coverage
    - Interference to primary transmitter's signal
  - Some were problematic and were turned off
- Maxxcasting is an FM booster system, but that is where similarity ends…
- New technologies for repeater networks to resolve performance issues
  - Research into parameters that determine multipath interference
  - Advanced geographic tools to intelligently design repeater networks
- Multiple lower-power, lower-height transmitters
  - Placed strategically for desired zone
  - Spaced optimally to provide coverage fill-in (major roadways, building penetration)
- Frequency and modulation synchronized with primary transmitter using Harris Synchrocast® and Flexiva™ transmission and distributions solutions

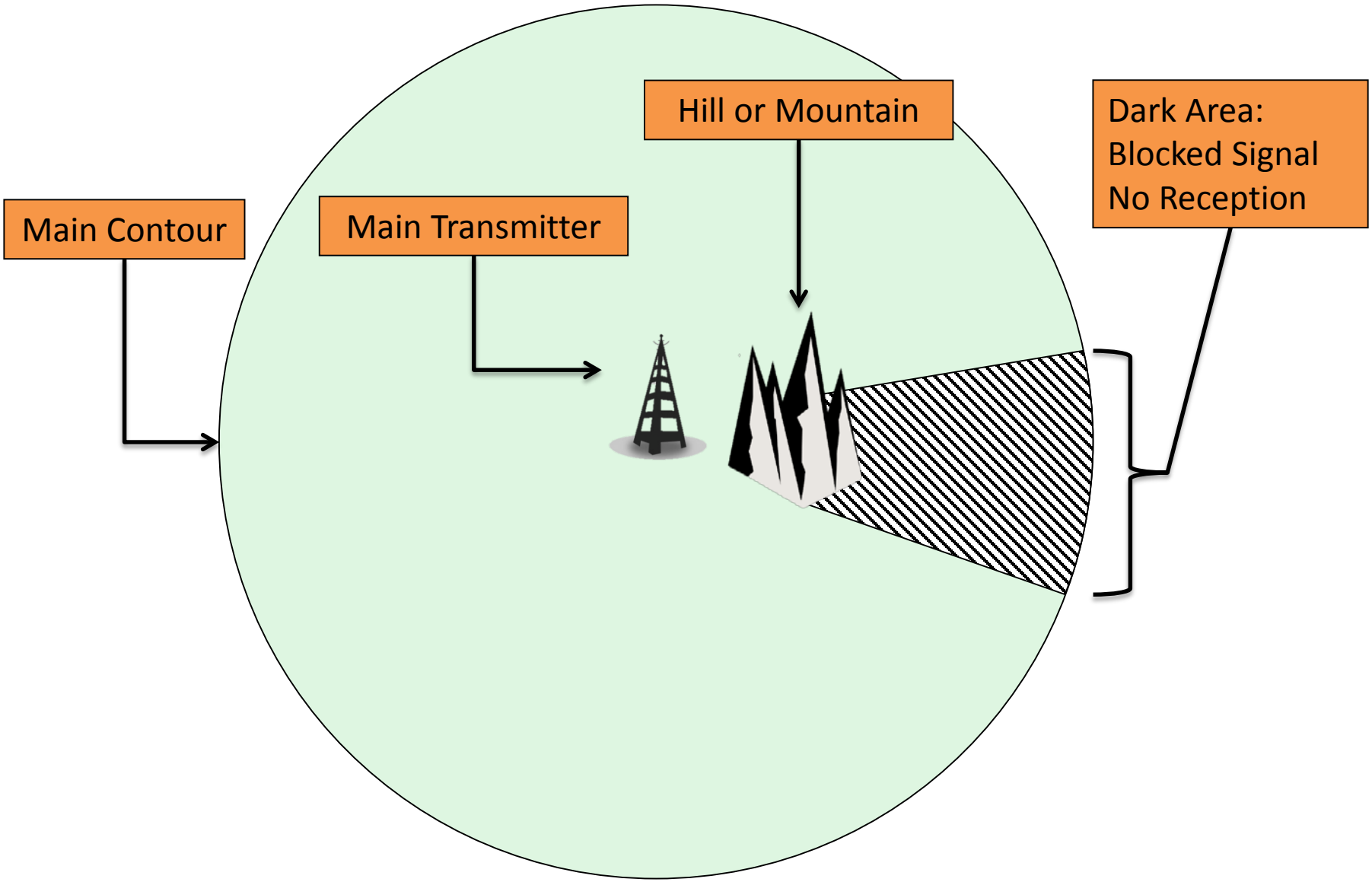
View from Above: Typical FM Station

Harris Broadcast
Deliver the moment



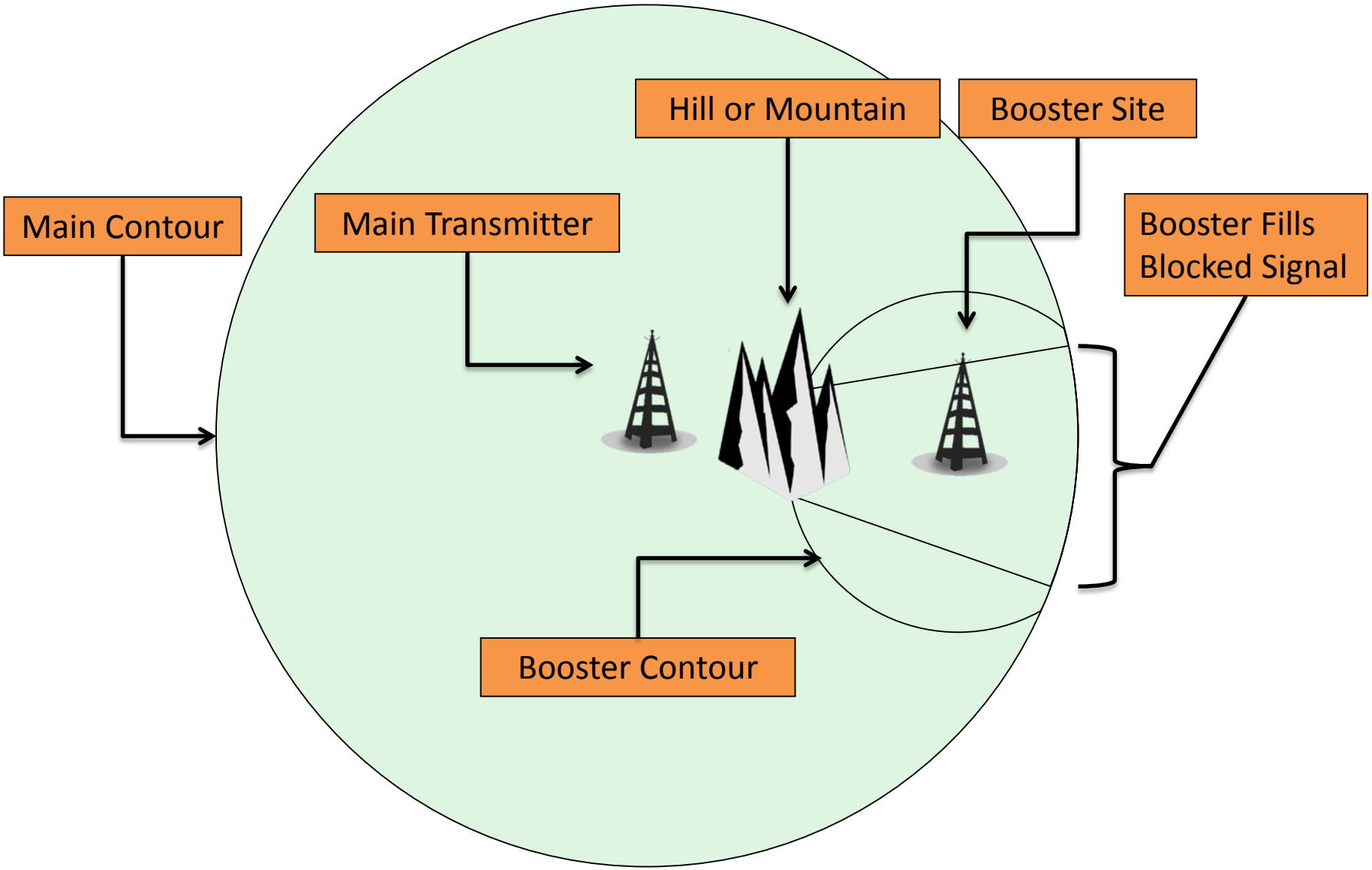
Partially Blocked Signal

Harris Broadcast
Deliver the moment



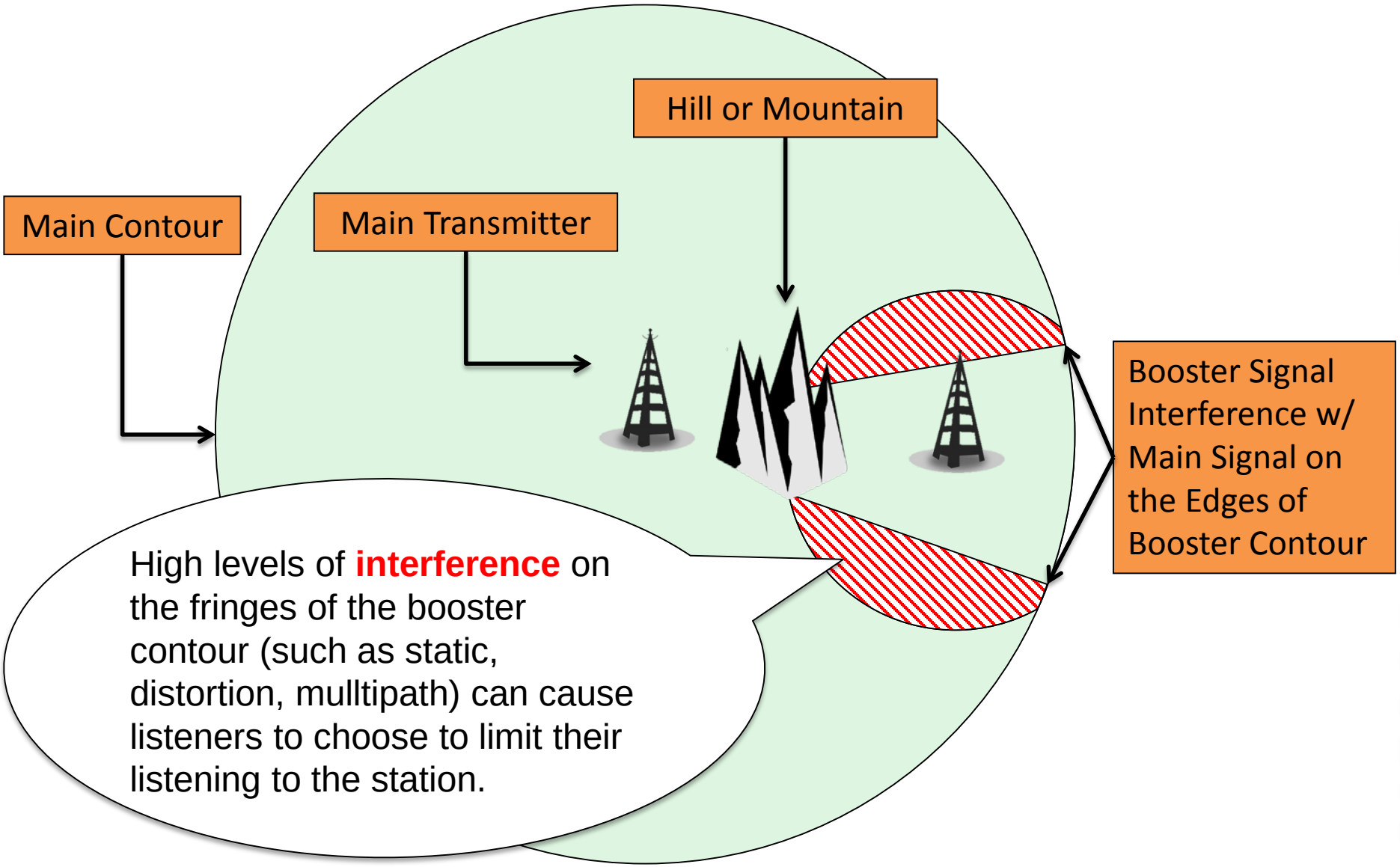
Traditional Booster (One Site)

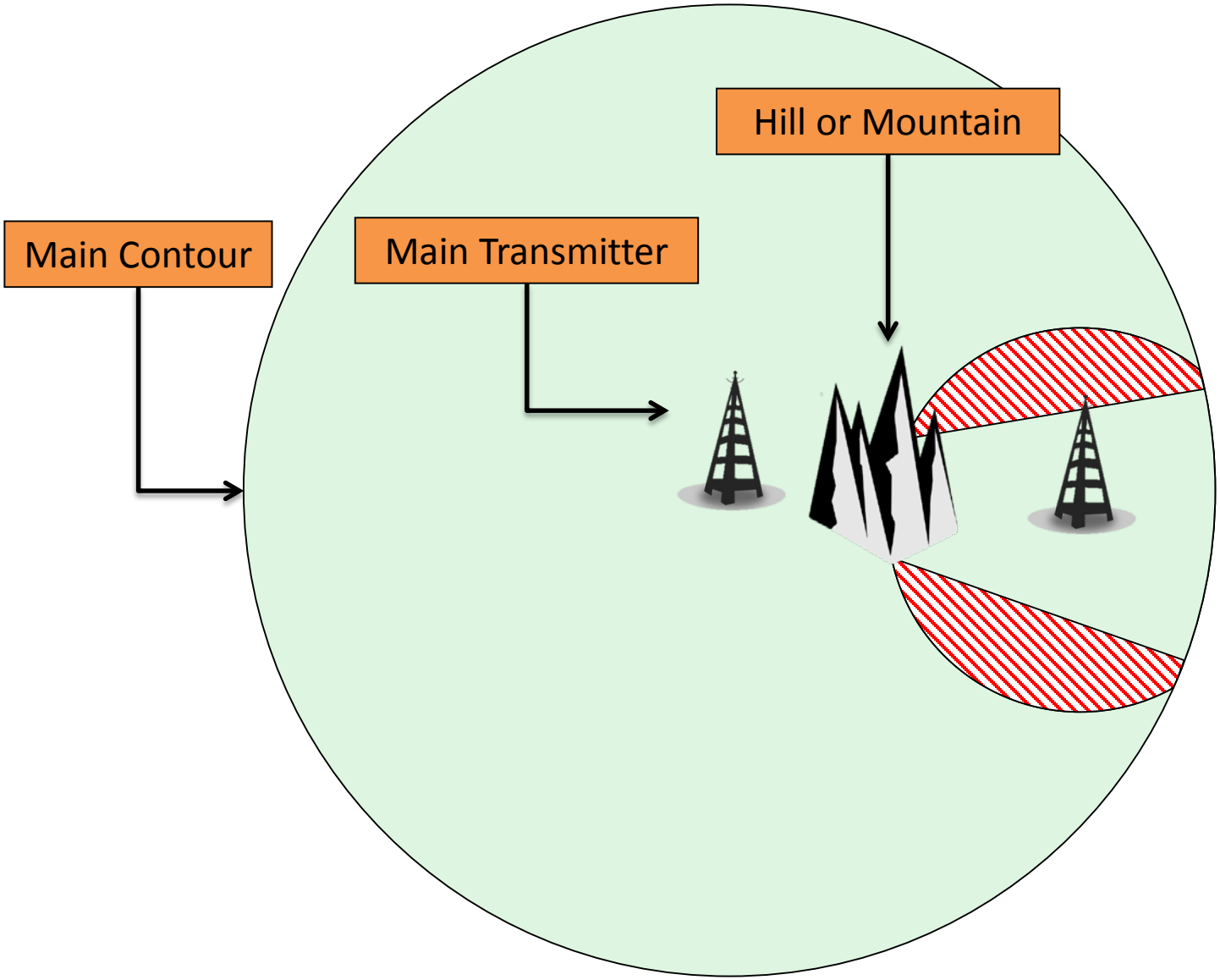
Harris Broadcast
Deliver the moment



Problem: Interference w/ Main Signal

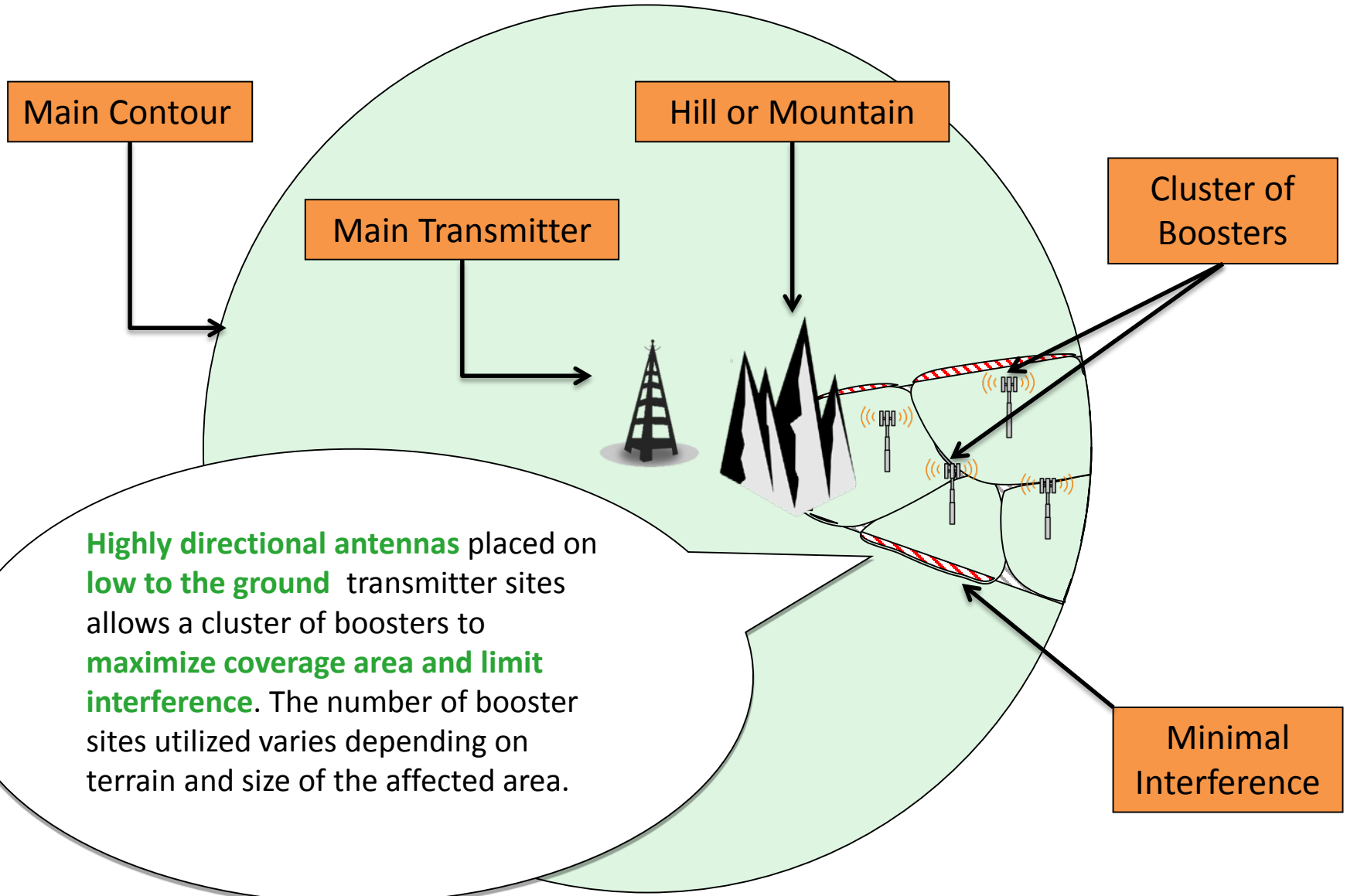
Harris Broadcast
Deliver the moment




Hill or Mountain
Main Contour
Main Transmitter

MaxxCasting

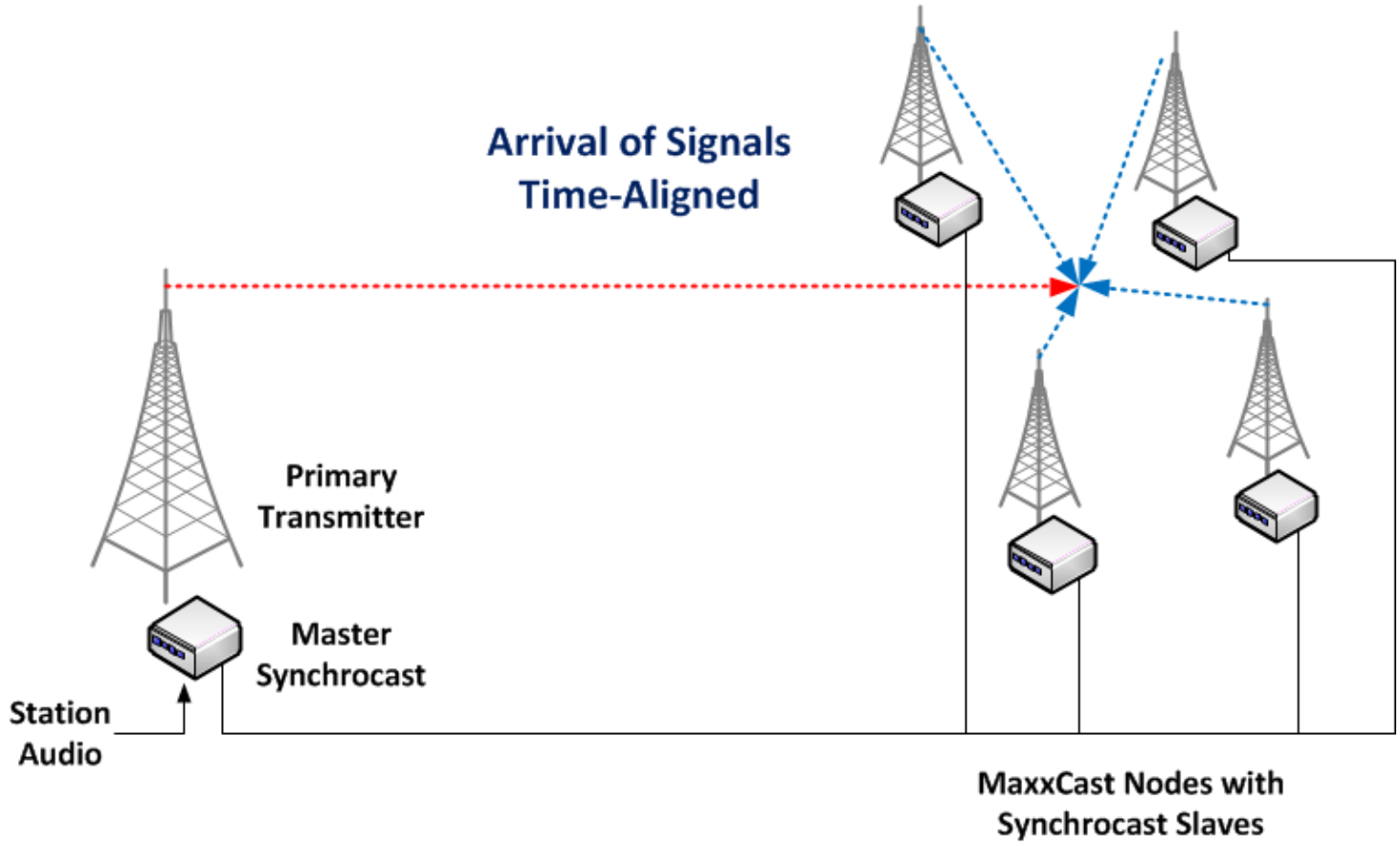
Harris Broadcast
Deliver the moment™



Highly directional antennas placed on **low to the ground** transmitter sites allows a cluster of boosters to **maximize coverage area and limit interference**. The number of booster sites utilized varies depending on terrain and size of the affected area.

Harris Broadcast Synchrocast®

Harris Broadcast
Deliver the moment



Sounds interesting but

Harris Broadcast
Deliver the moment

- What is different than previous approaches
  - Complete solutions
    - Network planning tools
    - Receiver performance evaluation
    - Listener testing
  - Case study

NPR Labs' Role

Harris Broadcast
Deliver the moment

- Design parameters
  - RF Lab simulations of primary transmitter and MaxxCast repeater signals
    - Both mobile (Rayleigh) fading and fixed signals
    - Process audio with professional broadcast hardware
    - Received with standard consumer car and home radios

NPR Labs' Role

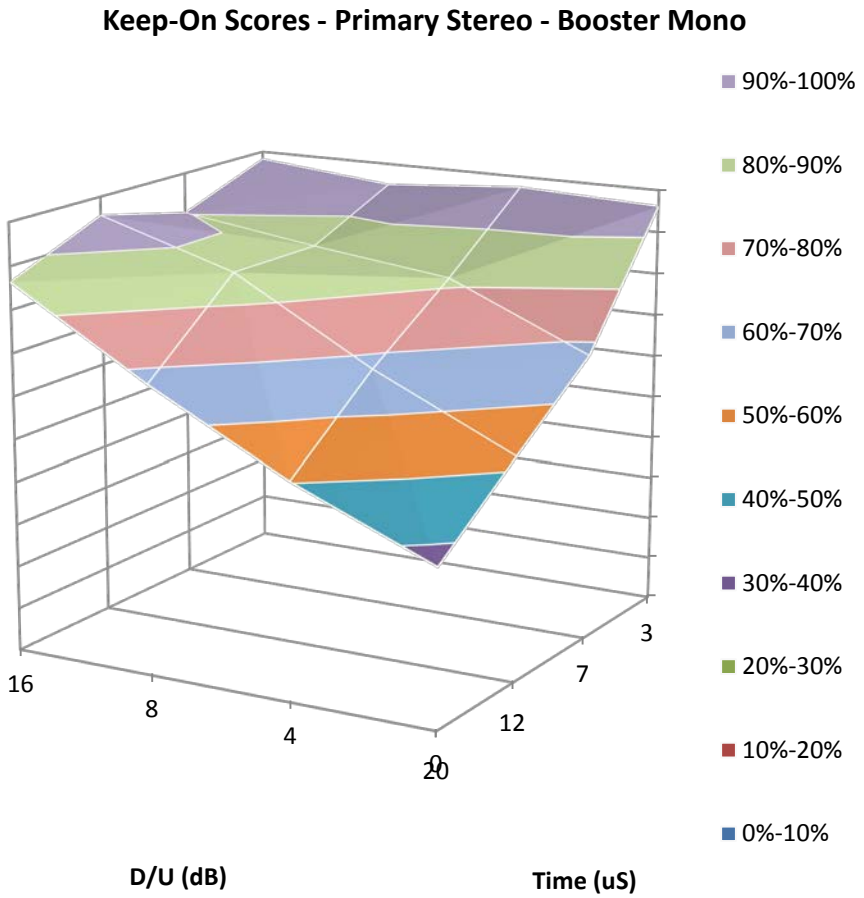
Harris Broadcast
Deliver the moment

- Listener tests
  - Measure consumers' opinions of MaxxCast design parameters
  - Conducted at Towson University, designed and supervised by Dr. Ellyn Sheffield
  - Listener keep-on, mean opinion scores
  - 19,000 data points

Design Parameters

Harris Broadcast
Deliver the moment

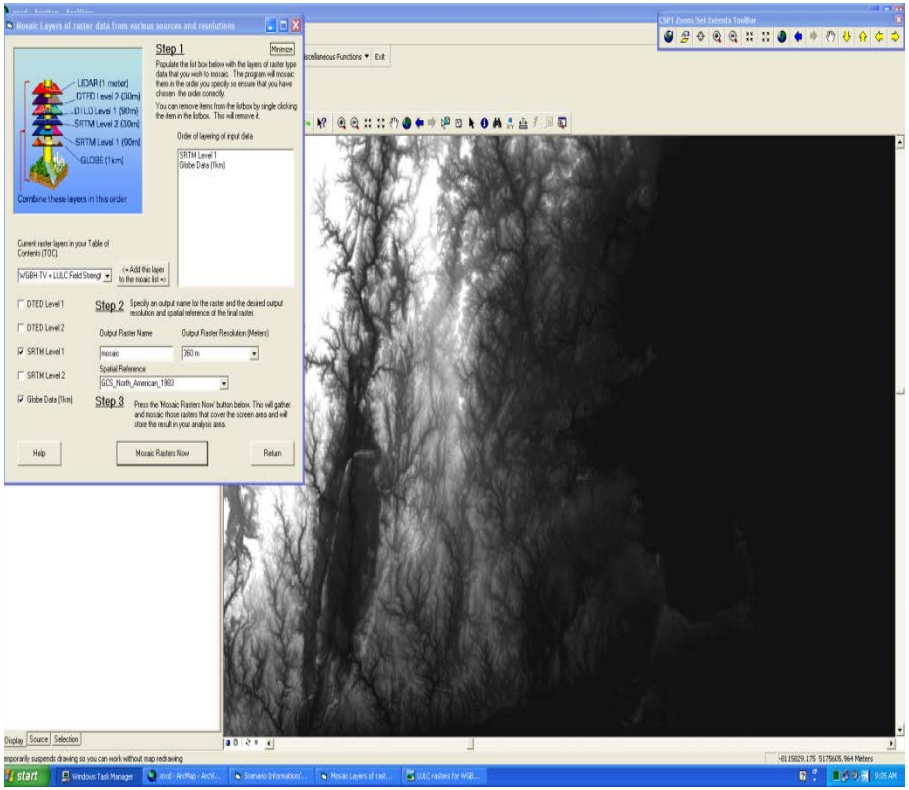
- Listeners evaluated
  - mono and stereo modes
  - Speech, music, voiceover
  - Time-of-arrival between signals
  - RF ratios between signals
  - Compiled as tables, then surface charts



Advanced RF Design Tool

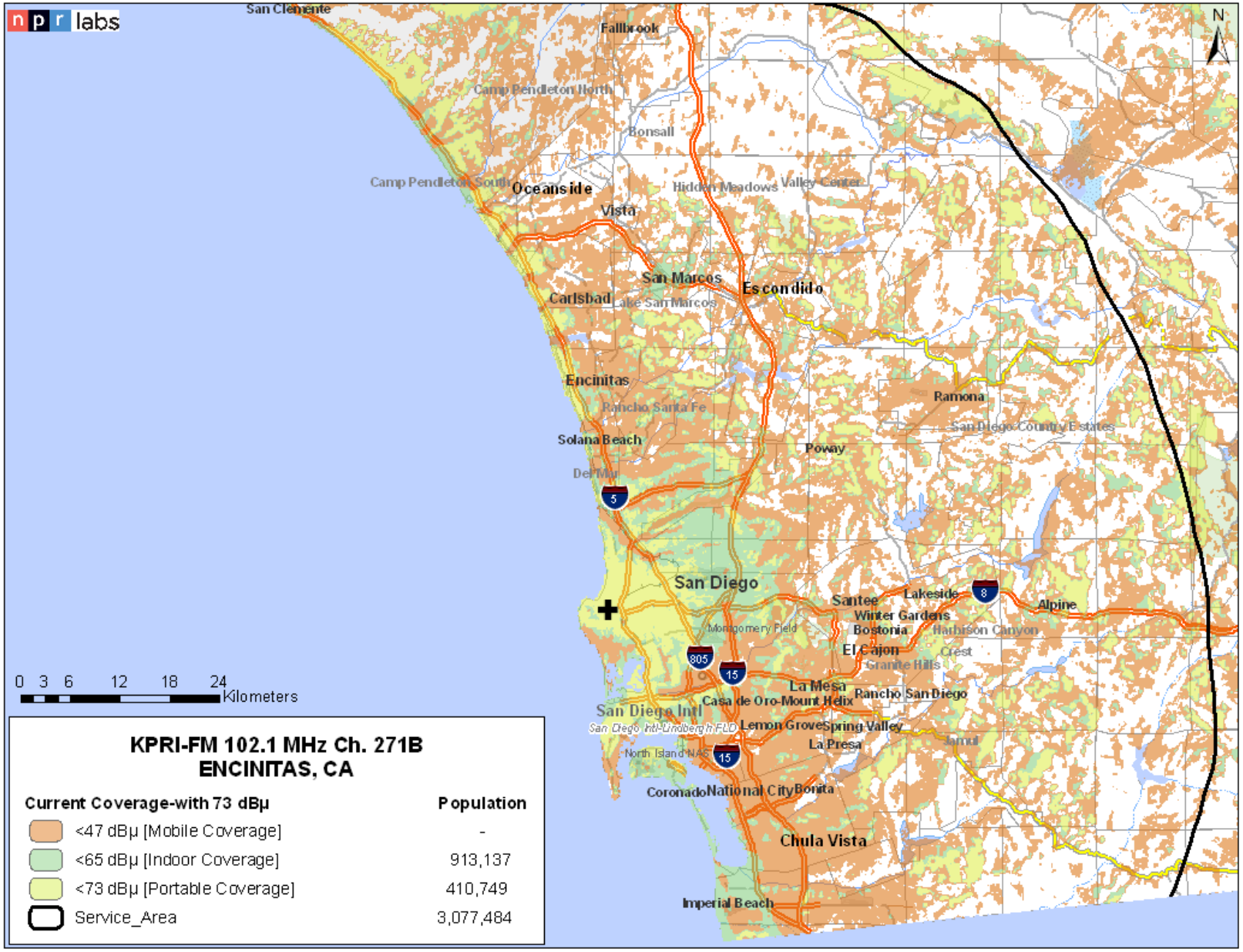
Harris Broadcast
Deliver the moment

- Terrain-sensitive analysis of field strength
- High-resolution Shuttle Radar Topography – city block level
- Able to consider signals from multiple MaxxCast transmitters (nodes)
- Population counts with US 2010 Census data



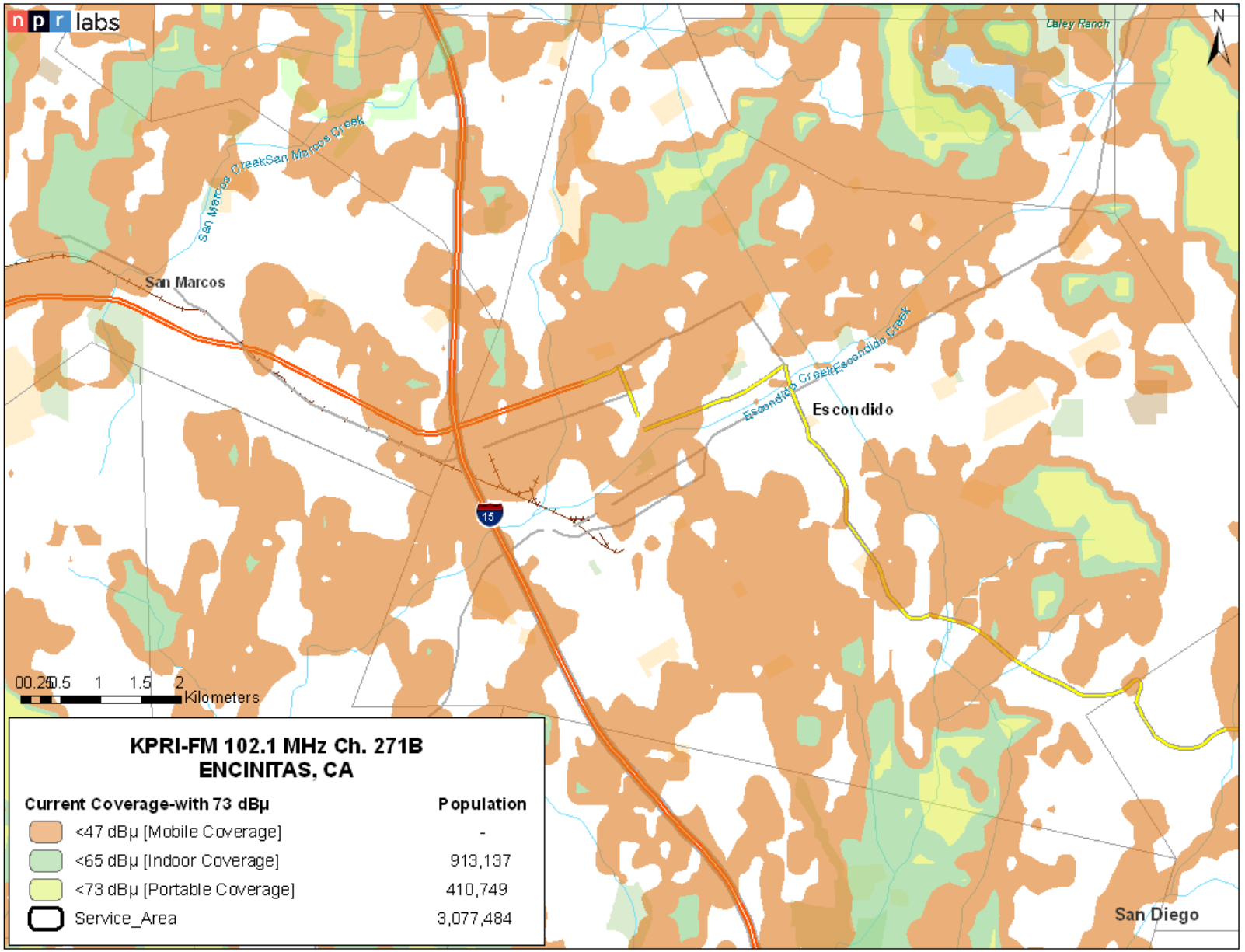
Current Coverage

Harris Broadcast
Deliver the moment



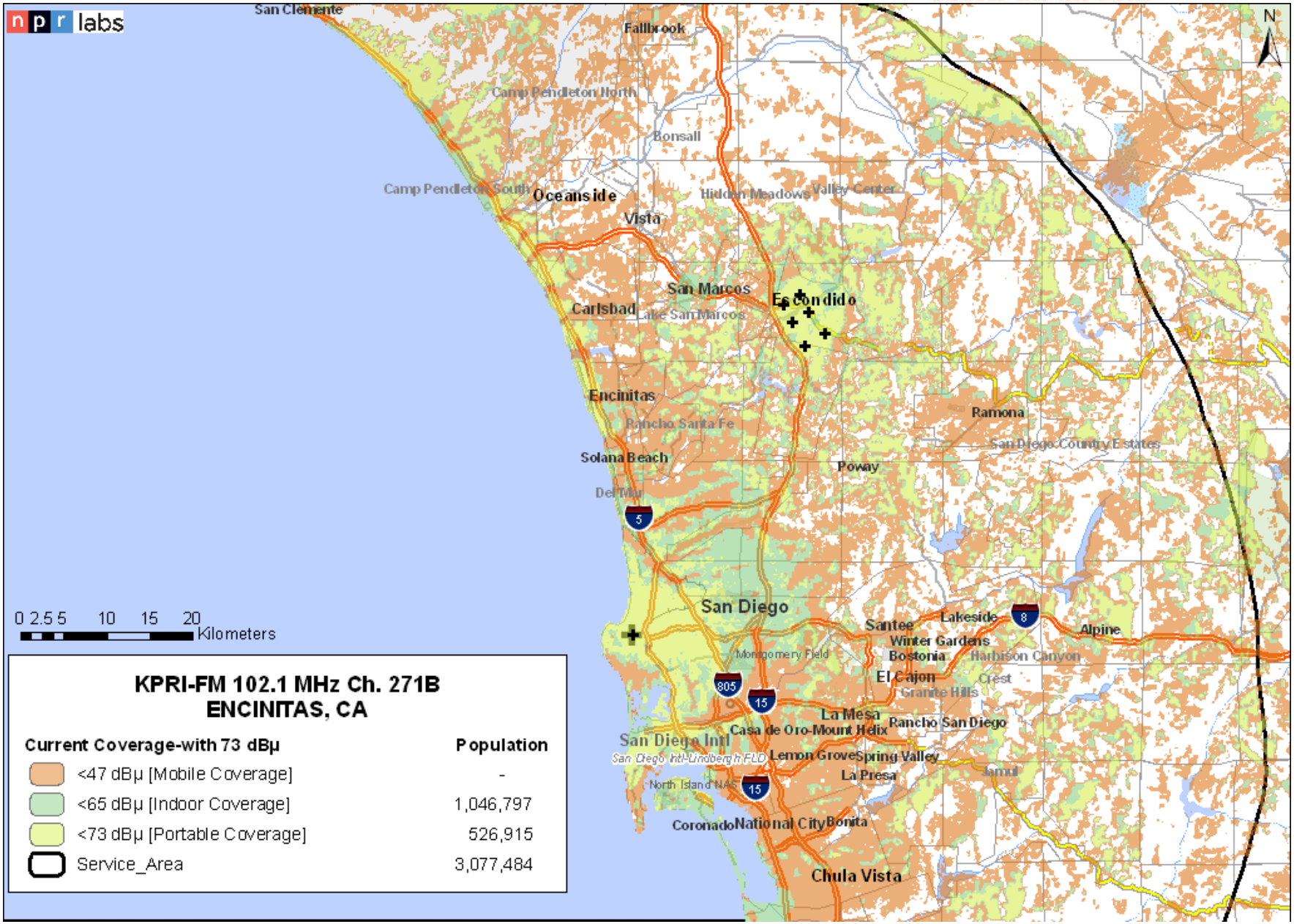
Escondido Coverage

Harris Broadcast
Deliver the moment



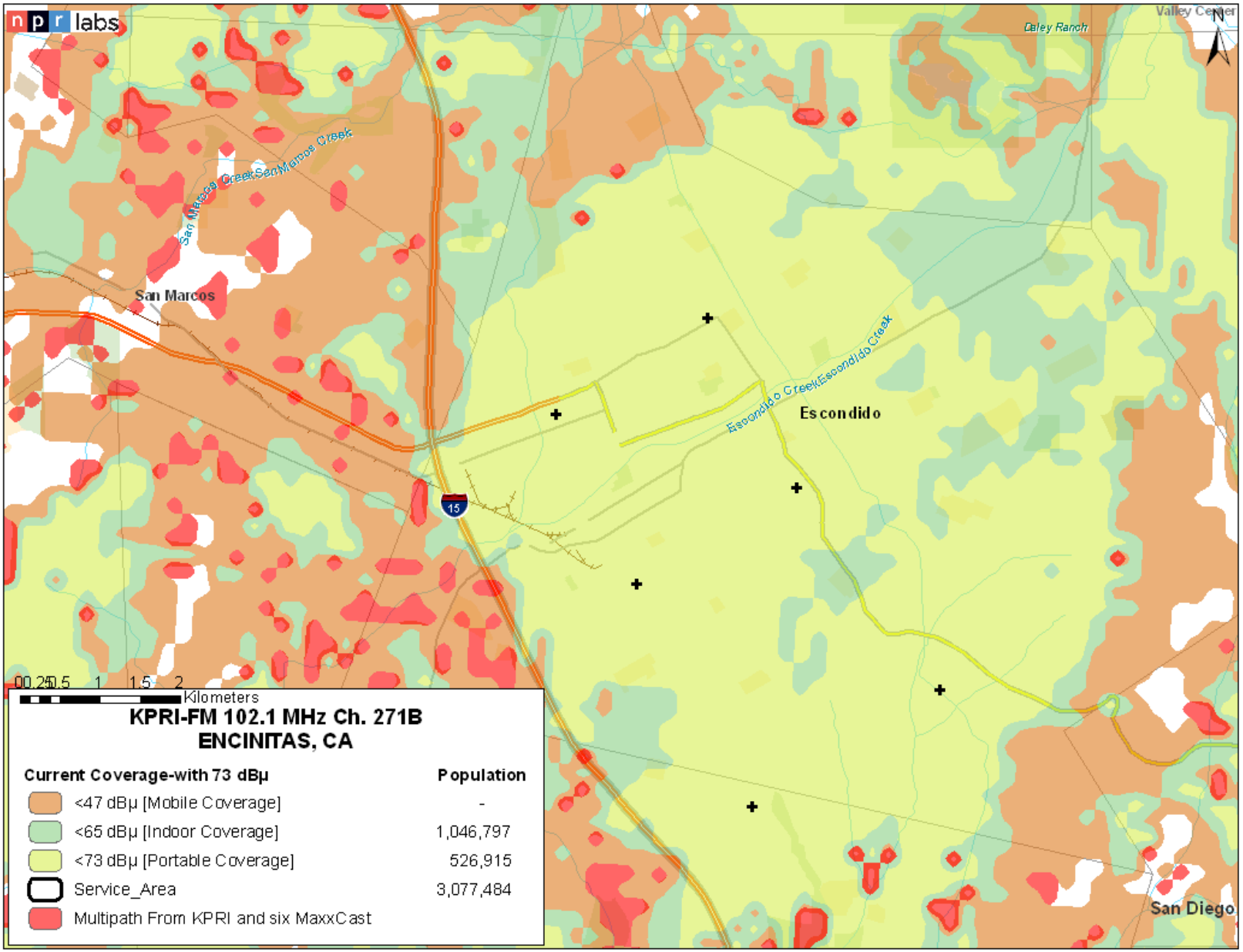
6-Node Maxxcast Network Added

Harris Broadcast
Deliver the moment



Escondido Coverage 6-Node MaxxCast

Harris Broadcast
Deliver the moment



KPRI(FM), Population Example

Harris Broadcast
Deliver the moment

	Indoor Service (65 dBu @ 2m)	Portable Service (74 dBu @ 2m)
Present Station	913.137	410,749
With Escondido MaxxCast	1,046,797	526,915
change	133,660 (+14%)	116,166 (+28%)

Notes:
MaxxCast population counted after deduction for interference
2010 U.S. Census

Networking Advances

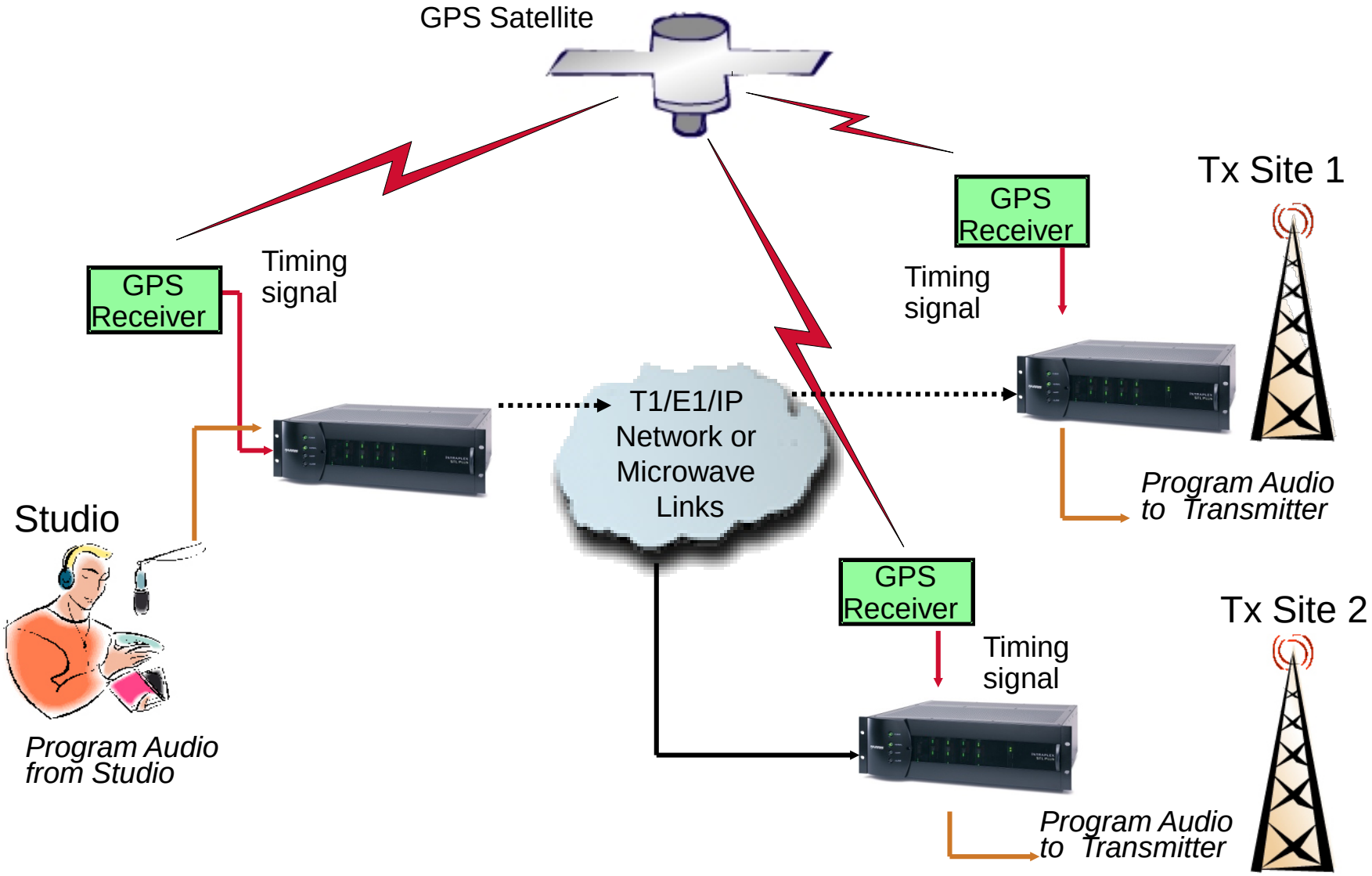
The SynchroCast Solution

Harris Broadcast
Deliver the moment

1. Use digital STL links: T1, E1, or IP
2. Synchronize transmitter frequency **and phase** by locking all sites to a common GPS clock
3. Equalize the delay on each STL path
4. Adjust the delay to optimize the system:
   - Provide cleanest coverage in prime areas
   - Move remaining interference to unpopulated or secondary areas
   - Automatically readjust the delay if actual network delay changes because of rerouting

SynchroCast System

Harris Broadcast
Deliver the moment



Delay Optimization

Harris Broadcast
Deliver the moment

- Delay can be adjusted at each transmitter to provide optimal coverage in desired area
- Delay difference of 3.3525 µs moves the equal delay point 1 km
- The SynchroCast system allows the user to select delay settings in 0.1 µs increments
- Delay accuracy is to within 0.25 µs, allowing the delay equalization point to be controlled to an accuracy of approximately 75 meters.

Dynamic Delay Control

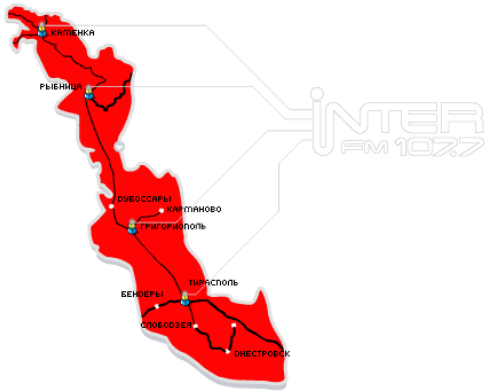
Harris Broadcast
Deliver the moment

- Once the optimum delay to each Tx site is established:
  - If the actual delay changes for any reason (such as a re-routing of the transmission path) SynchroCast will automatically adjust the amount of added delay to maintain the precise total amount desired
  - And, SynchroCast does this HITLESSLY, meaning there is no disruption to the on-air audio signal during the period of adjustment
- Only SynchroCast provides hitless dynamic delay control, ensuring maximum broadcast quality!

Representative SynchroCast® Users

Harris Broadcast
Deliver the moment

Moldova



Interdnestrcom

France

sanef groupe

Greece

SKAI / Melodia
Arrena Radio
Planet Radiofinikes 99.5

North America

Amaturo Group
So California Public Radio
Simmons Media
Aurora Media
Univision Radio
Wilks Broadcasting
Journal Broadcasting
CBS Radio
Entravision

Migration to IP Networks

Harris Broadcast
Deliver the moment

- Ongoing transition of the core WAN network from PDH (Plesiochronous Digital Hierarchy) to PSN (Packet Switched Network) which provides for the following benefits:
  - Converged network for all applications
  - Scalability for application bandwidth
  - Dynamic routing capability
  - Operational cost reduction
- PSN has jitter and delay

Simulcasting over IP Networks

Harris Broadcast
Deliver the moment

- A simulcasting system using an IP network must perform the following functions:
  - Encoding and decoding of real-time program audio
  - Transport of program audio over IP via a process of packetization
  - Sending a GPS referenced timing marker from the studio site to the transmitter site
  - Decoding of timer marker and measurement of delay
  - Establishment and maintenance of a programmable STL delay across a dynamic IP network

SynchroCast Performance

Harris Broadcast
Deliver the moment

- Target delay accuracy under static network conditions is maintained to +/- 200 nS
- In our lab, using a public IP network, crossing two service providers, significant delay changes (> 1 mS) occur several times a day
- Quality of the RF simulcasting is a function of the quality of the underlying network

Networking Conclusions

Harris Broadcast
Deliver the moment

- Same frequency networks (simulcasting) can provide advantages in increased coverage area
- Effectiveness depends on accurate synchronization of the carrier frequencies and broadcast audio
- Audio transport is migrating towards IP based networks
- IP offer the possibility of a highly flexible, low cost, converged network for many service types
- Emulated services, such as CES, allows audio circuits to be bridged between locations by providing a pseudo wire tunnel across an IP network
- Using GPS, it is possible to measure STL delay and use this information to set a programmable jitter buffer delay in the CES gateway to reach a target delay
- Jitter buffer delay changes should be smooth and hitless so as to result in no noticeable disturbance of the audio program
- An IP based simulcasting system should be constantly and automatically measuring STL delay and correcting for any changes in network delay
- Using the above methods, effective simulcasting over IP networks is possible

Transmitter Advances

Next Generation Transmission

Harris Broadcast
Deliver the moment

- Advanced SFN networks need transmission solutions designed to accommodate systems needs as an integral parts of the product
  - Ultra Stable direct to channel digital FM exciter
  - Integrated GPS receiver for SFN operation
  - Digital Audio Processing
  - Integration to Syncrocast system
  - Compact footprint
  - Superior power density
  - Low maintenance

Flexiva (FAX) – Low Power

Harris Broadcast
Deliver the moment

FAX 50W / 150W
(2RU)

FAX 300W / 500W / 1K
(3RU)

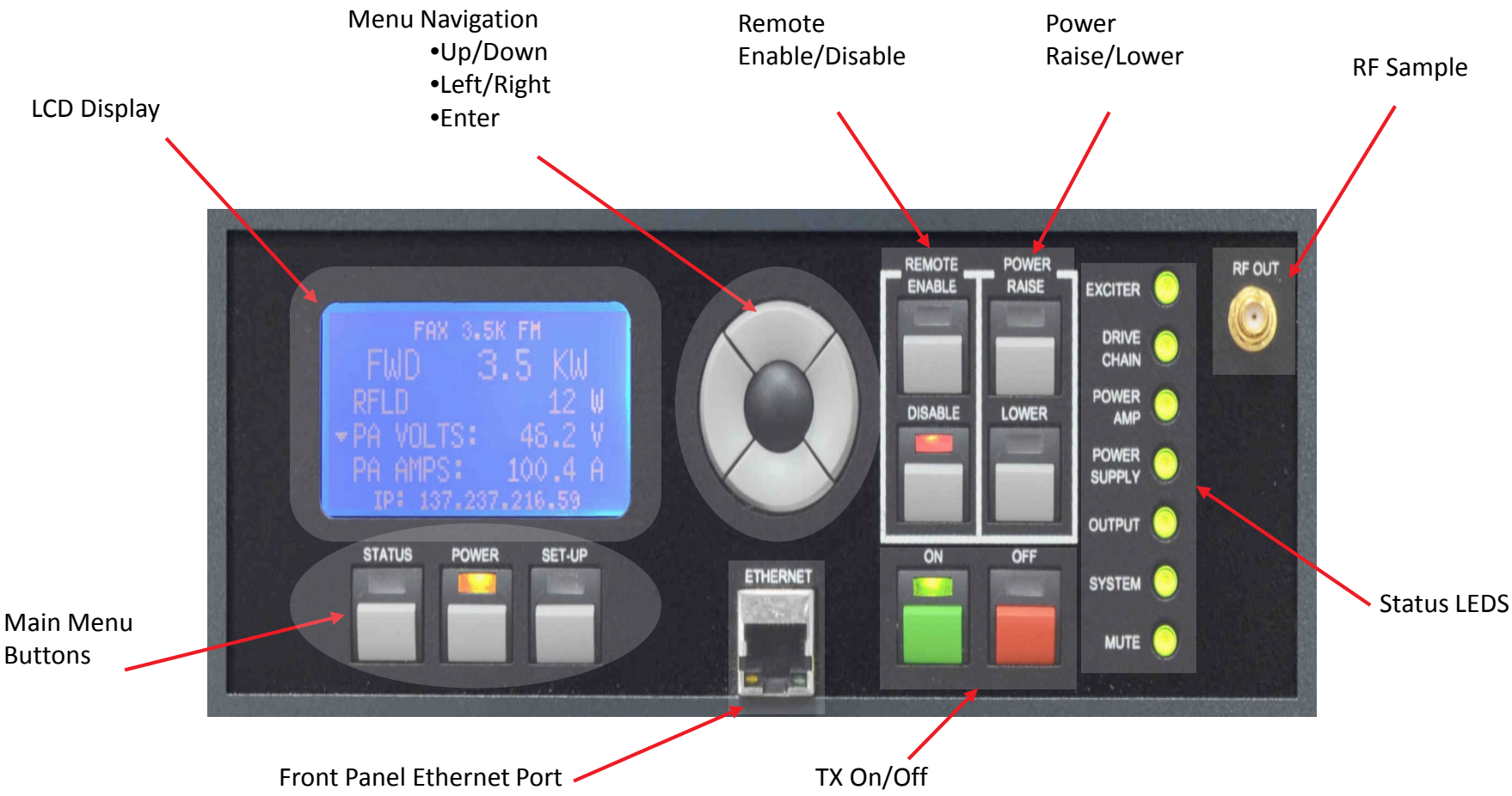
FAX 2K / 3K / 3.5K
(4RU)

FAX Low Power (50W – 3.5kW)

Flexiva (FAX) – Low Power 50W – 3.5kW

Harris Broadcast
Deliver the moment

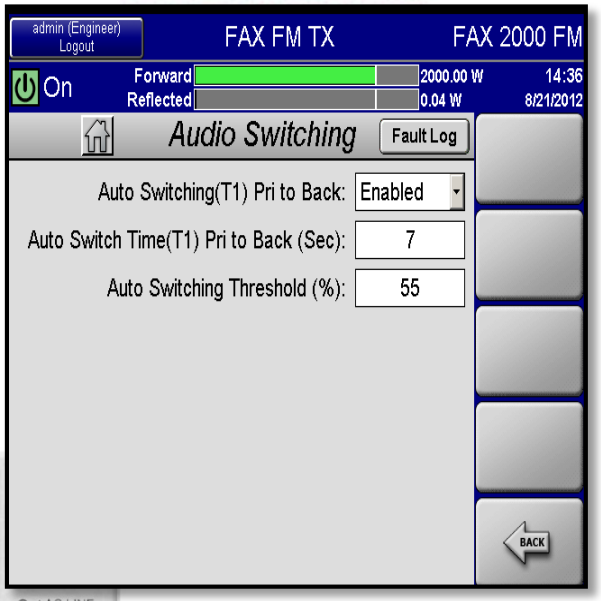
- Front Panel User Interface

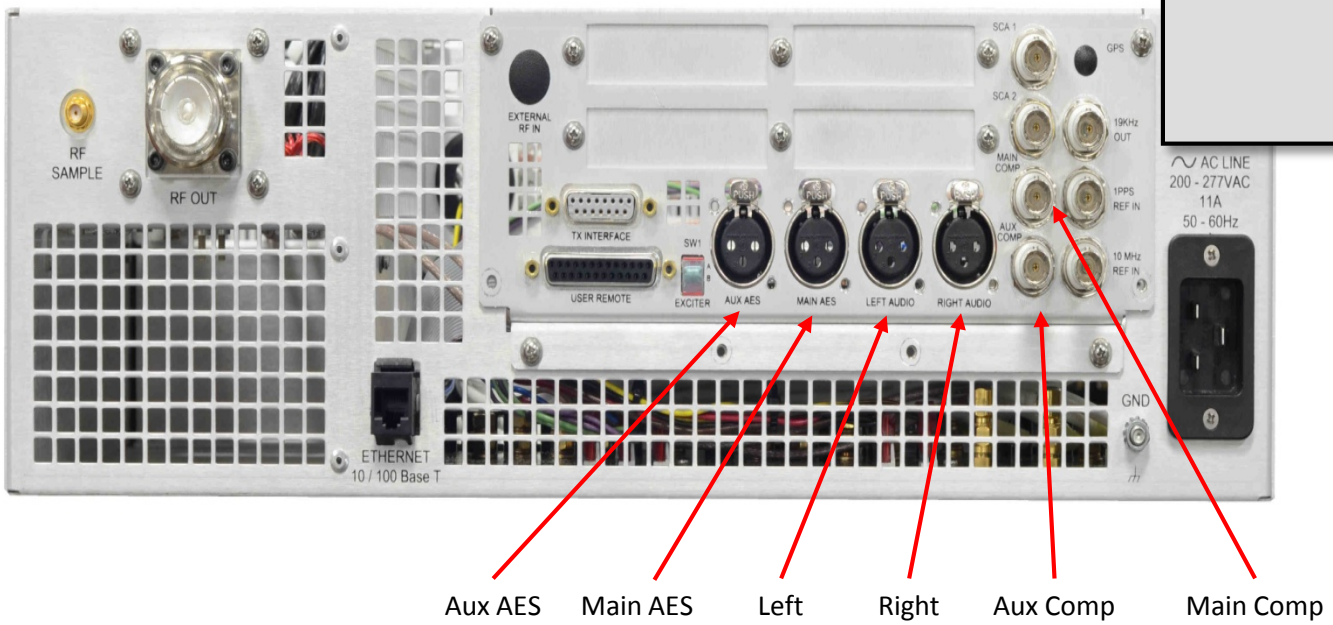


Flexiva (FAX) – Low Power 50W – 3.5kW

Harris Broadcast
Deliver the moment

- Multiple Audio Inputs
  - AES (2), Composite (2), Analog L/R
  - Auto Switching





Aux AES Main AES Left Right Aux Comp Main Comp

Flexiva (FAX) – Low Power 50W – 3.5kW

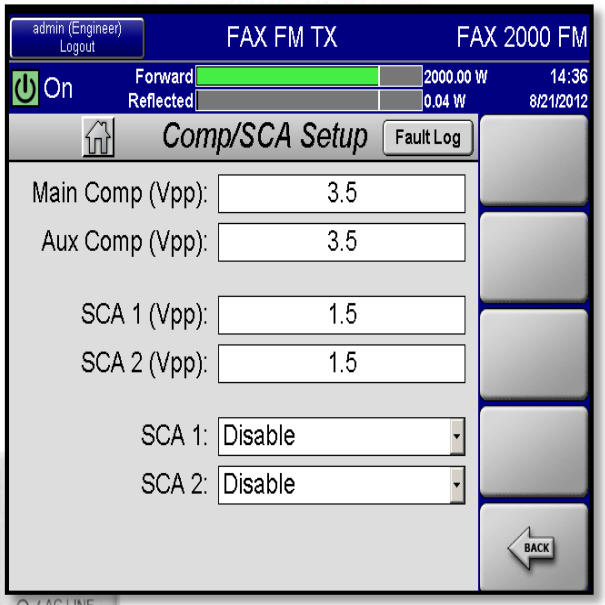
Harris Broadcast
Deliver the moment

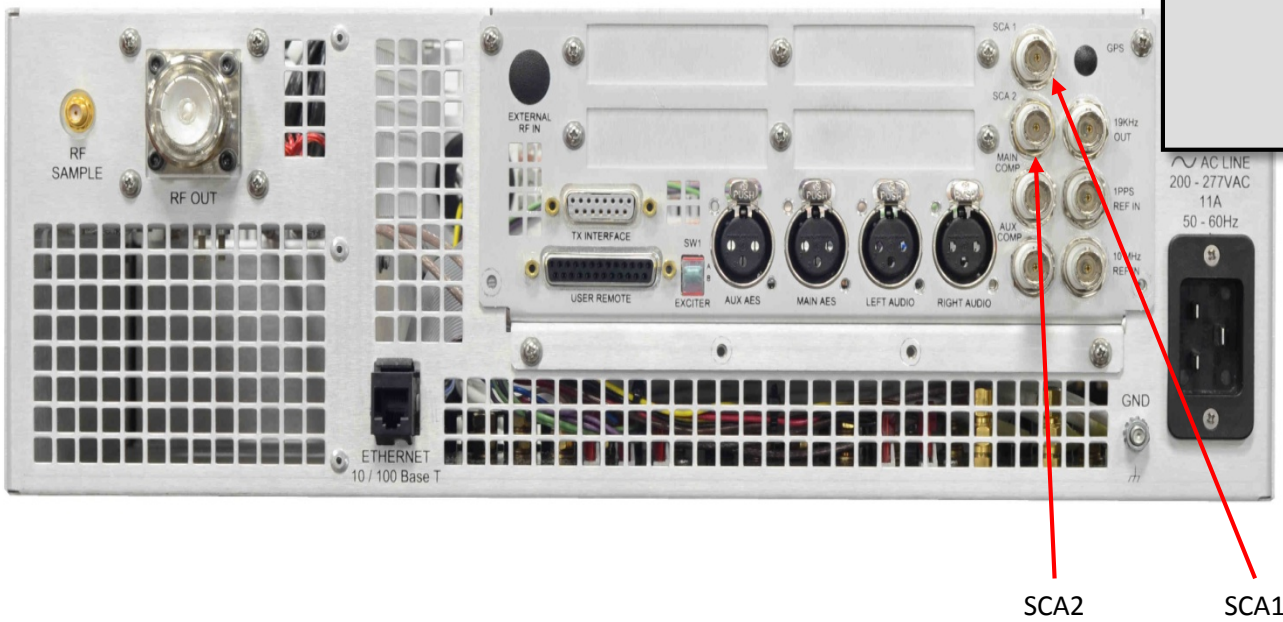
- Timing Reference
  - 10MHz Input/Output Selectable
  - 1PPS Input/Output Selectable
  - Optional GPS Receiver

Flexiva (FAX) – Low Power 50W – 3.5kW

Harris Broadcast
Deliver the moment

- Multiple SCA Inputs
  - SCA1 and SCA2
  - Can be utilized for external RDS Input



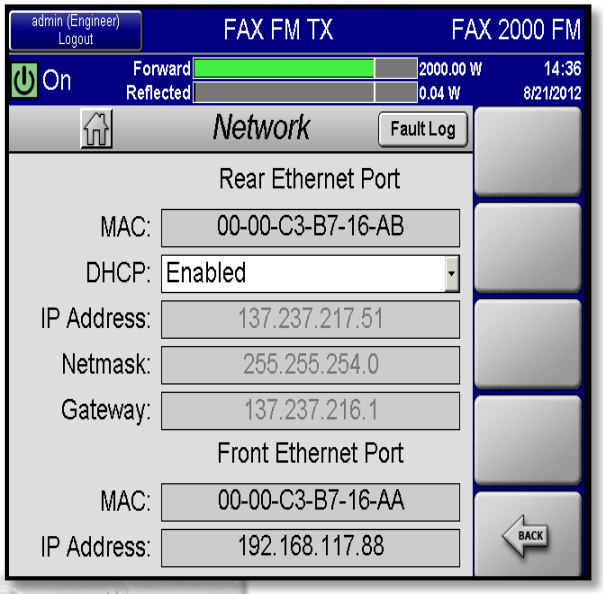


SCA2 SCA1

Flexiva (FAX) – Low Power 50W – 3.5kW

Harris Broadcast
Deliver the moment

- Ethernet Port
  - DHCP or Fixed IP Support
  - Remote WEB GUI access
  - Password Protected



Ethernet

Flexiva (FAX) – WEB Interface

Harris Broadcast
Deliver the moment

Feature-rich and intuitive *Advanced Graphical User Interface* allows Flexiva to be controlled from anywhere in the world via the World-Wide-Web

Front panel RJ45 allows instant access with a PC for detailed diagnostics, control and monitoring

Works with any PC based browser or Smartphone
Remote alarms are generated automatically in the event of a fault and are sent via SNMP or E-Mail with the connection to a network.

Flexiva (FAX) – Low Power 50W – 3.5kW

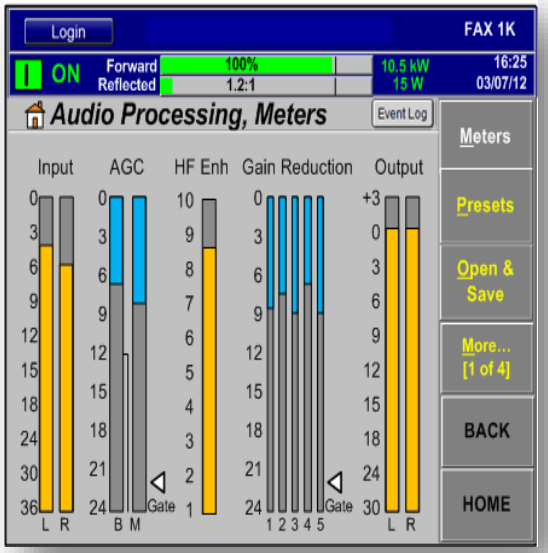
Harris Broadcast
Deliver the moment

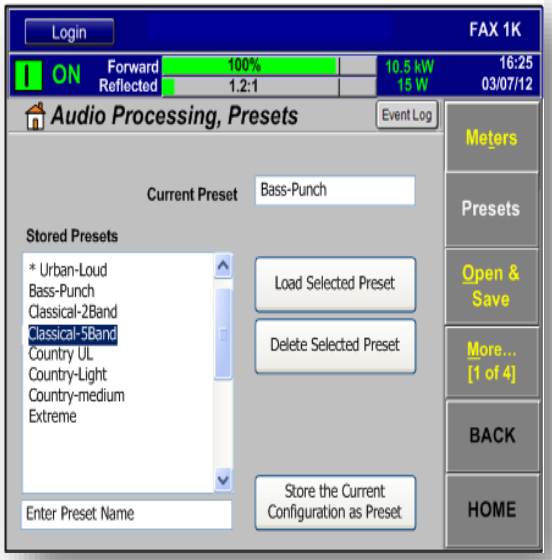
- FAX Low Power (Options)
  - Internal Orban 5500 Processor
  - Internal GPS Receiver
  - FM Receiver (Translator)
  - HD Radio /DRM+ Exgine Card
  - IP Audio/USB Playback Card
  - Dynamic RBDS/RDS Encoder Card

Flexiva (FAX) – Low Power 50W – 3.5kW

Harris Broadcast
Deliver the moment

- Orban 5500 Internal Processor
  - 5 band processor with dual band window-gated AGC
  - Built in presets for easy setup and operation
  - World class audio performance at a budget friendly price





Flexiva (FAX)

Harris Broadcast
Deliver the moment

- High Overall Efficiency
  - Lower Cost of Ownership
- Latest LDMOS FET Technology
  - Increases Efficiency
  - Reduces physical size
- Compact Size and Weight
  - Reduces installation and shipping costs
- High End Audio Performance
  - Built in Stereo Generator
  - Optional Internal Orban Audio Processor
- Comprehensive Feature Set
  - Multiple Audio Inputs with auto switching and silence sense
  - N+1 and Dual Drive Support

Flexiva (FAX)

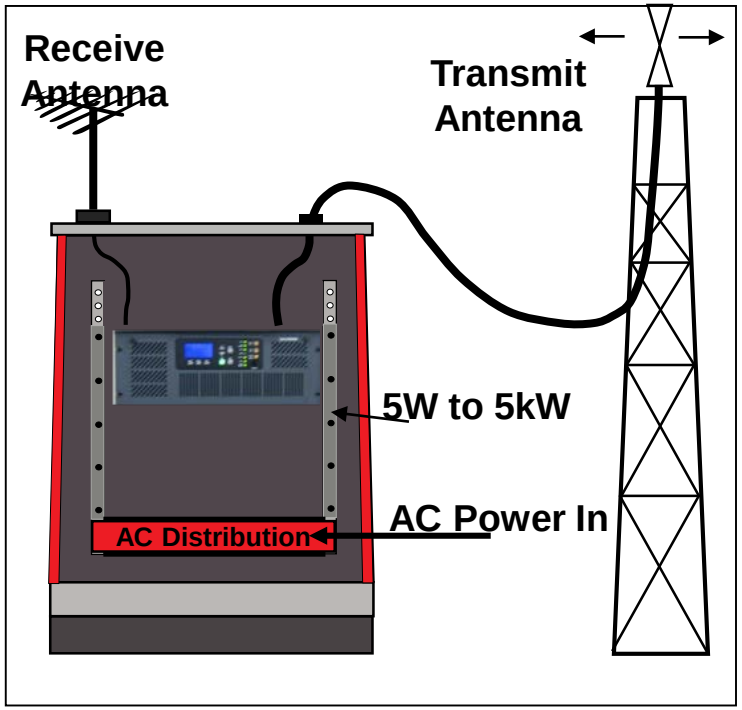
Harris Broadcast
Deliver the moment

- Accessibility
  - Easy to use local user interface
  - Advanced WEB GUI (No FLASH Required)
  - SNMP Support
- Serviceability
  - Hot-Pluggable PS Modules 300W – 3.5kW
  - Easy access to all modules (PA, PS, Modulator)
  - Front Panel and WEB interface with Fault Logging
- Compatibility
  - HD Radio
  - DRM+
- Reliability
  - Ruggedized LDMOS Devices
  - High Efficiency Power Supplies

Outdoor enclosures simplify site construction

Harris Broadcast
Deliver the moment

- Outdoor shelter
- Reduces site costs
- Fast deployment
- Up to 5kw site complete with cooling, GPS and Syncrocast equipment in small foot print
- Ideal for base of Mobile phone tower or rooftop



Summary

Harris Broadcast
Deliver the moment

- New technology enables the maximization of existing spectrum
  - Provides greater reach and new revenue opportunities
  - Available today
- Advances in network design and user research provide unique insight
- First and only totally integrated solution approach to increase coverage
  - Design, transport and timing, transmission solution
  - Leverage IP networks
  - Transmitters designed form the ground up for SFN operation
- Special Credit and Thanks
  - Chuck Alexander – Director Audio Products Harris Broadcast
  - Tim Anderson – Strategic Markets Manager – Radio Harris Broadcast
  - Chris Devine – Founder – Geo Broadcast Solutions
  - John Kean Senior - Technologist NPR Labs – National Public Radio

Maximizing FM Coverage – Advances in Technology & Design

Richard Redmond, Vice President, Transmission, Test & Measurement

August, 2013

Harris Broadcast

Deliver the moment™