Monterey Bay
ECONOMIC PARTNERSHIP
BROADBAND INITIATIVE

# CITIZENS BROADBAND RADIO SERVICE (CBRS) IN CALIFORNIA'S CENTRAL COAST

*February 2024*

## About MBEP:

**Monterey Bay Economic Partnership (MBEP)** is a regional member-supported nonprofit organization consisting of public, private, and civic entities located throughout Monterey, San Benito, and Santa Cruz counties. Founded in 2015, our mission is to improve the economic health and quality of life in the region.

## About the Author:

**David Witkowski** is an author, advisor, and strategist focused on the intersection between technology and public policy. He served in the U.S. Coast Guard and obtained his electrical engineering degree from University of California. In 2007 he founded **Oku Solutions**, an engineering consulting firm based in Northern California. David is a CBRS Certified Professional Installer (Certificate: GOOG-000613). David also serves as Senior Advisor on Broadband for Monterey Bay Economic Partnership.

## Acknowledgments:

We appreciate the following individuals for their significant contributions to this white paper: MBEP Member Surfnet Communications, specifically **Ken Nye**, Chief Operating Officer, for providing insights on RF field measurements; **Andrew Clegg**, Spectrum Engineering Lead at Google for contributing expertise on SAS and ESC operations; **Ameer Othman**, MBEP Director of Economic Development and Broadband Equity; **Jessica Gilden**, MBEP Marketing & Communications Manager, and MBEP President & CEO, **Tahra Goraya**.

# EXECUTIVE SUMMARY OF CBRS IN CALIFORNIA'S CENTRAL COAST

Citizens Broadband Radio Service (CBRS) offers significant potential for improved wireless connectivity in California's Central Coast, but challenges exist due to the region's unique characteristics.

## Key findings:

- CBRS operates in the 3.5 GHz band, offering shared spectrum access with three tiers: Incumbent Access, Priority Access License (PAL), and General Authorized Access (GAA).
- Environmental Sensing Capability (ESC) networks are crucial for detecting incumbent users and preventing interference.
- Dynamic Protection Areas (DPAs) restrict CBRS operations in areas where incumbents have priority, like near military bases.
- Exclusion zones around grandfathered Fixed Satellite Service (FSS) stations limit CBRS channel availability in certain areas.

## Challenges for California's Central Coast:

- **DPAs and potential shutdowns:** The presence of military and other incumbents can lead to unexpected service disruptions due to DPA activations.
- **Limited channel availability in FSS zones:** FSS protection areas reduce the number of usable CBRS channels, impacting network capacity.

## Recommendations:

- Carefully consider the risks and limitations of CBRS before deploying it for critical applications, including home broadband to unserved and underserved populations.
- Explore alternative solutions or mitigation strategies, such as purchasing CBRS PAL licenses, or using non-CBRS technologies, to address challenges.
- Continued collaboration among stakeholders is needed to improve CBRS reliability and make it a viable option for the Central Coast.
- Future changes to CBRS regulations could make the technology more viable.

# CITIZENS BROADBAND RADIO SERVICE (CBRS) IN CALIFORNIA'S CENTRAL COAST

## INTRODUCTION

The Citizens Broadband Radio Service (CBRS) represents a significant advancement in wireless communication technology. This white paper aims to explore the application and special considerations of CBRS along the West Coast of the United States, focusing on the challenges and opportunities presented by Dynamic Protection Areas (DPAs), Environmental Sensing Capability (ESC), and the presence of exclusion zones near grandfathered Fixed Satellite Service (FSS) stations.

## BACKGROUND OF CBRS

### Development and Technical Specifications

The Citizens Broadband Radio Service (CBRS) represents a significant advancement in wireless communication technology. This white paper aims to explore the application and special considerations of CBRS along the West Coast of the United States, focusing on the challenges and opportunities presented by Dynamic Protection Areas (DPAs), Environmental Sensing Capability (ESC), and the presence of exclusion zones near grandfathered Fixed Satellite Service (FSS) stations.

### Regulatory Framework

The FCC, in collaboration with the National Telecommunications and Information Administration (NTIA) and the Wireless Innovation Forum, has created a framework for the management and operation of CBRS. This framework includes the establishment of Spectrum Access Systems (SAS), Environmental Sensing Capability (ESC) networks, and Priority Access Licenses (PALs), ensuring that the spectrum is used efficiently and without interference to incumbent users, such as military radar systems and satellite stations.

Like Wi-Fi, CBRS uses a shared spectrum model, but unlike Wi-Fi it is not strictly unlicensed. CBRS is licensed-by-rule, meaning that CBRS spectrum users are coordinated by the SAS. For purposes of grant applications via the NTIA, CBRS is categorized as Tech Code 72. In December 2023, the NTIA clarified that Tech Code 72 technologies are eligible for funding under the Broadband Equity, Access, and Deployment (BEAD) program.

# CBRS ACCESS TIERS

## Incumbent Access

The Incumbent Access tier represents the highest priority in the CBRS band. This tier includes federal and non-federal incumbents, such as military radar systems and fixed satellite stations, who have been using the 3.5 GHz band prior to the introduction of CBRS. Incumbents are afforded the highest level of protection from interference by other CBRS users. The Spectrum Access System (SAS) ensures that these incumbent users have uninterrupted access to the spectrum and dynamically manages CBRS devices to avoid any interference with incumbent operations. This tier is not subject to auction and remains protected as per existing usage rights.

## Priority Access License (PAL)

The PAL tier is the middle layer in the CBRS framework, offering a more predictable and interference-protected spectrum access compared to the GAA tier. PALs are acquired through competitive bidding and are geographically and spectrally limited. Each PAL consists of a 10 MHz channel within the 3550-3650 MHz band. Licensees can hold up to four PALs in a given license area, and these licenses are valid for a 10-year term. The SAS manages PALs to protect them from harmful interference from GAA users, while also ensuring they do not disrupt incumbent users. PALs are particularly attractive to entities that require more reliable access to the spectrum than GAA can provide but do not have incumbent status.

## General Authorized Access (GAA)

The GAA tier is the most accessible level of the CBRS spectrum, allowing open and flexible use of the band. GAA users can utilize any portion of the 3550-3700 MHz band not assigned to incumbents or PAL holders. This tier operates on a shared basis, with users having no exclusive rights to the spectrum. Access is granted on a first-come, first-served basis, managed by the SAS to prevent interference with higher-tier users. GAA is ideal for a wide range of applications, including small cell deployments, fixed wireless broadband, and private LTE networks, offering a low-barrier entry point for utilizing the CBRS band.

# CBRS SYSTEM COMPONENTS

## Spectrum Access System

The Spectrum Access System (SAS) is a sophisticated and dynamic spectrum management system, crucial to the operation of the Citizens Broadband Radio Service (CBRS) in the 3.5 GHz band. It serves as an advanced, automated frequency coordinator, tasked with efficiently allocating spectrum among CBRS users, known as Citizen Broadband Service Devices (CBSDs). The SAS ensures that these devices operate without causing harmful interference to incumbent users, such as military radars and satellite services. It dynamically assigns and adjusts spectrum access rights, based on real-time conditions and the need to protect higher-priority users. This system is pivotal in maximizing the efficient use of the CBRS band, supporting a diverse range of applications from small cell deployments to fixed wireless broadband, while maintaining a harmonious coexistence with traditional spectrum users.

## Citizen Broadband Service Device

A Citizen Broadband Service Device (CBSD) is the equipment that provides wireless connectivity to end-user devices, similar to cellular base stations or Wi-Fi access points. They come in various types, including small cells for indoor use, larger base stations for outdoor coverage, and fixed wireless terminals. CBSDs are controlled and managed by a Spectrum Access System (SAS), which dynamically assigns them spectrum and power levels to optimize network performance and prevent interference with other CBSDs and protected incumbent users in the band.

## CBRS User Equipment

CBRS User Equipment (UE) refers to any device that connects to, and communicates through, a CBSD. UEs can range from smartphones, tablets, and laptops to hotspots, fixed-wireless endpoints, and specialized equipment like Internet of Things (IoT) sensors.

# CBRS OPERATIONAL CONSIDERATIONS

## Environmental Sensing Capability (ESC)

ESC networks are crucial for detecting the presence of incumbent radar signals within the CBRS band. Along the West Coast, the deployment and operation of ESC sensors must account for the region's varied terrain and coastal environment, ensuring accurate and reliable detection of incumbent users to prevent harmful interference.

## Dynamic Protection Areas (DPAs)

DPAs are geographic areas along the coast where CBRS operations may be restricted to protect incumbent spectrum users, primarily the U.S. Navy and their partner agencies. CBRS network operators, even those with priority use (PAL) licensing, may encounter cases where the military wants incumbent access to CBRS spectrum. This requires real-time management of spectrum access and the ability to dynamically adjust operations based on the activation of DPAs or detection of incumbent activity.

Areas subject to DPA control are known as "DPA Neighborhoods" and have different sizes based on the power profile of the CBRS equipment. As seen in Figure 1, these areas extend far inland from the California coast.

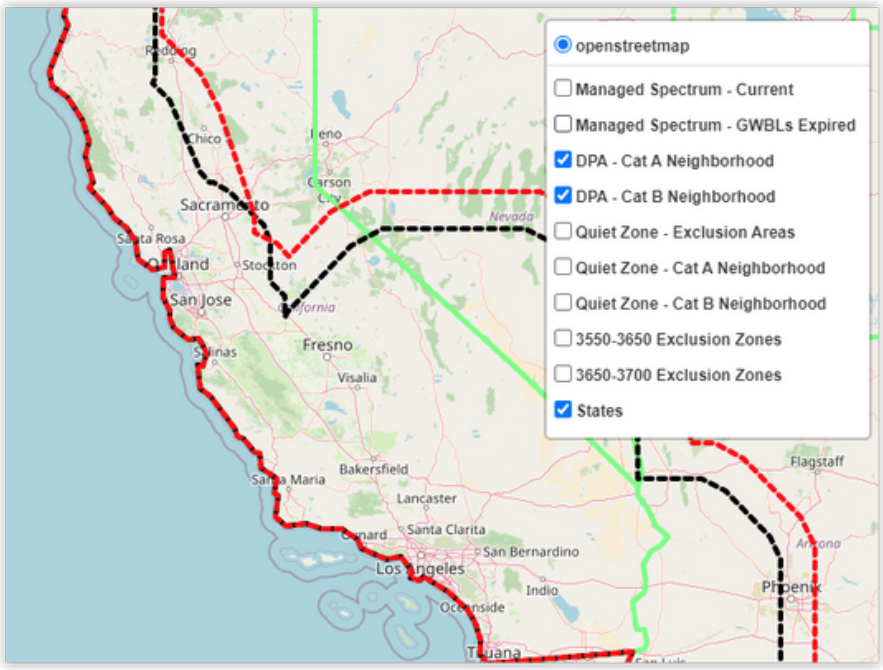


*Figure 1 - DPA Cat A (black) & DPA Cat B (red) Neighborhoods are areas where incumbents can block spectrum*

## Types of DPAs

Environmental DPAs (E-DPAs) occur when an ESC detects RF energy in the CBRS band, and the ESC determines that the detected RF energy indicates that an incumbent (e.g., military) user is operating in the area. Each SAS provider deploys and maintains their own ESC networks. Because ESCs are automated systems, they can and do suffer from false positive detections where stray RF energy registers as incumbent use.

Priority DPAs (P-DPAs) occur when an incumbent user (e.g., the military) tells the SAS that it intends to use the CBRS spectrum in a certain area, for a specified period of time. P-DPAs might be scheduled well in advance, or they may occur with no notice.

Due to the classified nature of some military operations, incumbents may not want to disclose their activity via registered P-DPA events. In those cases, the ESCs will detect military usage of the spectrum, resulting in sudden and unexpected shutdowns of CBRS spectrum via the SAS.

### Exclusion Zones and Grandfathered Fixed Satellite Service Stations

Exclusion zones are areas near grandfathered satellite earth stations where CBRS operations are limited or prohibited. CBRS network operators must be aware of these zones and design their networks to avoid interference with these incumbent services. This can involve complex coordination with satellite station licensees and operators.

## CBRS DEPLOYMENT ON THE WEST COAST

The West Coast of the United States, with its unique geographical and economic landscape, presents distinct challenges and opportunities for CBRS deployment. The region's diverse topography, varying population densities, and the presence of critical infrastructure require tailored approaches to CBRS network deployment and management.

### Impact of U.S Military Presence and Activities on CBRS

During World War II and the Cold War, the coastal areas of the San Francisco Bay Area, Monterey Bay, and Silicon Valley played a pivotal role in establishing the United States as a military superpower. This role was multifaceted, involving technological innovation, military operations, and signals intelligence.

Despite the demilitarization of the economy in the 1990s, the coastal areas of California, including the San Francisco Bay Area, Monterey Bay, and Silicon Valley, and the coastal waters of California remain an active area of operation for the U.S. military. In response to rising tensions in the Pacific region, the U.S. Navy is working to maintain readiness, resulting in increased activity along the California coast. This has potentially negative implications for CBRS use in coastal communities.

## Spectrum Restrictions near Grandfathered Satellite Earth Stations

In order to create the spectrum allocation for CBRS, the FCC negotiated an agreement with Fixed Satellite Service (FSS) users of what is now the CBRS band. On March 10, 2005, the FCC adopted a Report and Order and Memorandum Opinion and Order that provides rules for terrestrial operations in the 3650-3700 MHz band. CBRS users are required, under Section 90.1331(a) of the FCC rules, to protect the operations of certain grandfathered satellite earth stations that were using this band prior to December 1, 2000. This is codified in CBRS standards and methods under WINNF-TR-5003 Section 3.2 Inband FSS Protection Methods, and requires that "No CBRS operations allowed [in the 3650-3700 MHz band] within 150 km of the coordinates of [a] grandfathered FSS site".

There are several grandfathered FSS sites in Northern California, and areas subject to FSS protection can only access ten of the fifteen CBRS channels. Northern California's FSS protection area includes all of Santa Cruz County, and portions of northwest Monterey County.

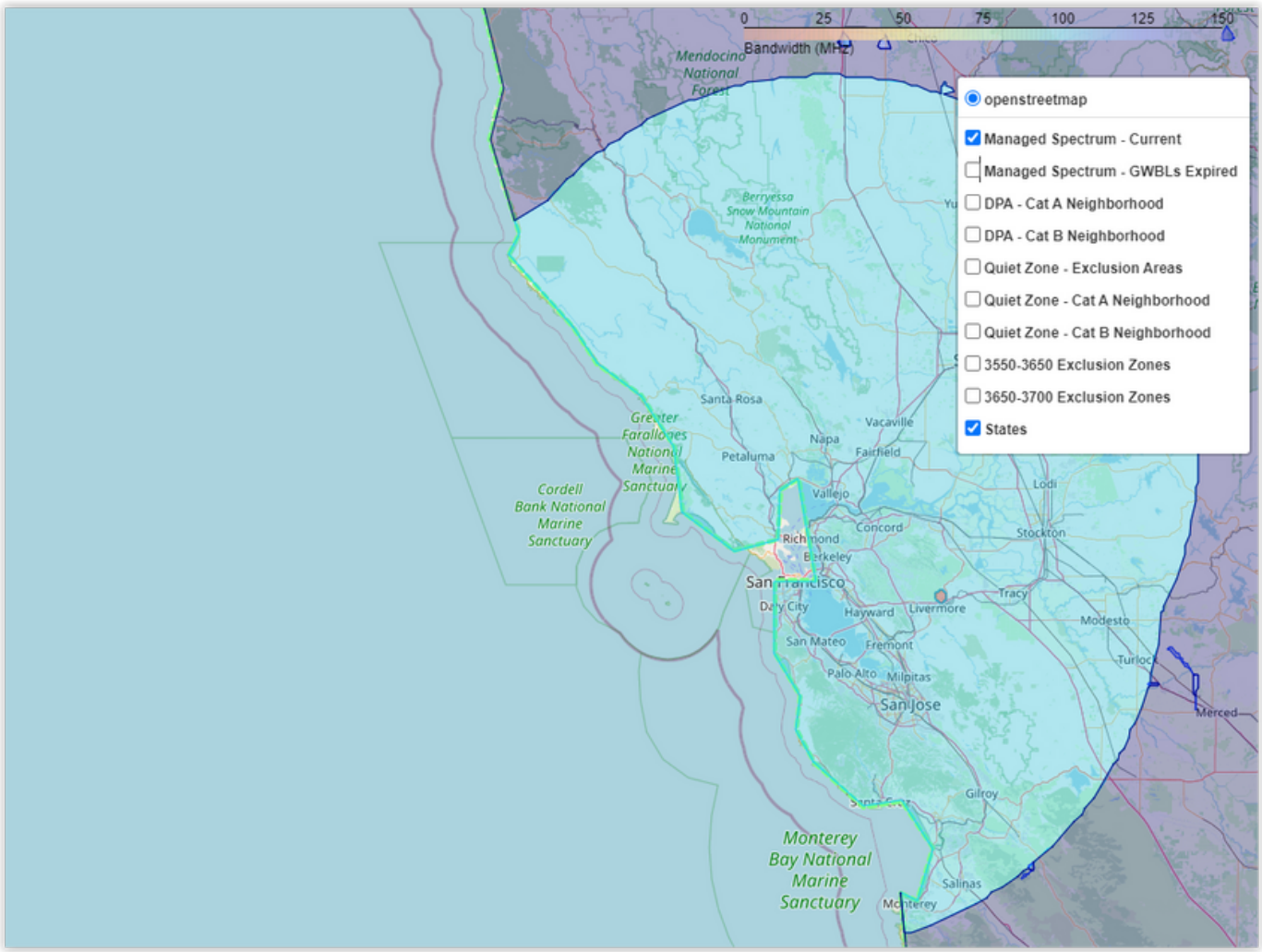


*Figure 2 - FSS Protection Zones in Northern California reduce the number of available CBRS channels*

## Risks to GAA Operations in FSS Protection Areas

By definition, there are seven CBRS channels available for PAL users between 3550-3650 MHz. Outside of FSS Protection Areas, there are eight CBRS channels reserved for GAA users. Inside the FSS Protection Areas, the number of channels reserved for GAA users drops to three. This creates a risk for network operators planning to use GAA channels. The risk can be mitigated by purchasing PAL licenses, but this requires making an up-front financial investment that may not be possible for some network operators.

## Case Study: CBRS DPA Events Affecting a Wireless ISP

Some wireless ISPs implementing CBRS in the coastal zone have reported issues with DPA events causing their subscribers to go offline. In December 2023 we received detailed reports from Surfnet Communications of DPA events in the San Luis Obispo area, at sites from Arroyo Grande to Templeton. In each case, the SAS suspended spectrum grants based on DPA events.

CBRS Status List

| CBSD | LUID | Grant State | Authorized Grants | Time Elapsed In State | EIR Req / |
|---|---|---|---|---|---|
| HighGrove450-CBRS [AP] | AP | Authorized | 3 / 3 | 22 days, 05:05:48 | 42 / |
| SusanMahler - [0a-00-3e-be-ba-ac] | 002 | Authorized | 3 / 3 | 22 days, 05:04:33 | 49 / |
| SandraKilpatrick - [0a-00-3e-be-bb-1b] | 003 | **Suspended** | **2 / 3** | 00:05:58 | **49** |
| RexSwan - [0a-00-3e-be-ba-f7] | 004 | Authorized | 3 / 3 | 13 days, 21:41:49 | 49 / |
| DanaShaw - [0a-00-3e-be-ba-c6] | 005 | **Suspended** | **2 / 3** | 00:05:58 | N |
| WilliamGibbs - [0a-00-3e-be-af-bb] | 006 | Authorized | 3 / 3 | 22 days, 05:04:31 | 49 / |
| DebBrown - [0a-00-3e-bd-97-1f] | 007 | Authorized | 3 / 3 | 22 days, 05:04:31 | 49 / |
| Gary Willis - [0a-00-3e-be-a5-d1] | 008 | Authorized | 3 / 3 | 22 days, 05:04:33 | 49 / |

Clear Statistics

cnMaestro Notifications

Hi,

You are currently subscribed to receive Critical, Major Alarm notifications. This email shows the newest alarms. They have been raised within the last 1 minute.

CRITICAL

1

Notification Details

| Type Time | Tower/Site | Name Type | IP Address Source Device | Message |
|---|---|---|---|---|
| CRITICAL 00:34 (UTC +00:00) | | PoleBarn450i PMP 450i | 172.25.3.56 null | One or more grants suspended |

*Figure 3 - Sample CBRS DPA Events, 05-Dec-2023, Courtesy of Surfnet Communications*

Further investigation showed that these DPAs affected 120-degree directional sector antennas facing approximately west. The DPAs were sudden, which led to speculation that they were E-DPAs. As previously discussed, DPA events can be caused by ESC sensing or intentional shutdown by incumbents, but it's almost impossible to know what happened because of the military nature of these operations. Regardless of what caused this outage, the end result was that subscribers lost internet access for the duration of the DPA event. In verbal conversations with Surfnet Communications,they stated that this is not the first time they have dealt with DPA shutdowns of their sites.

## Case Study: Co-Channel Interference Affecting a Wireless ISP

Surfnet Communications reported poor performance on certain CBRS channels in the area around Loma Prieta Mountain. On January 17th 2024, we found instances of in-band RF spurious noise at levels that sometimes exceeded the CBRS signal itself. The pattern of these noise bursts indicates incoherent sources, possibly switch-mode noise from high-current power sources. This type of noise is unusual for mid-band frequencies, but it could be due to frequency mixing (possibly passive intermodulation) from interaction of a high frequency RF source with a lower frequency noise source across a non-linear physical interface.

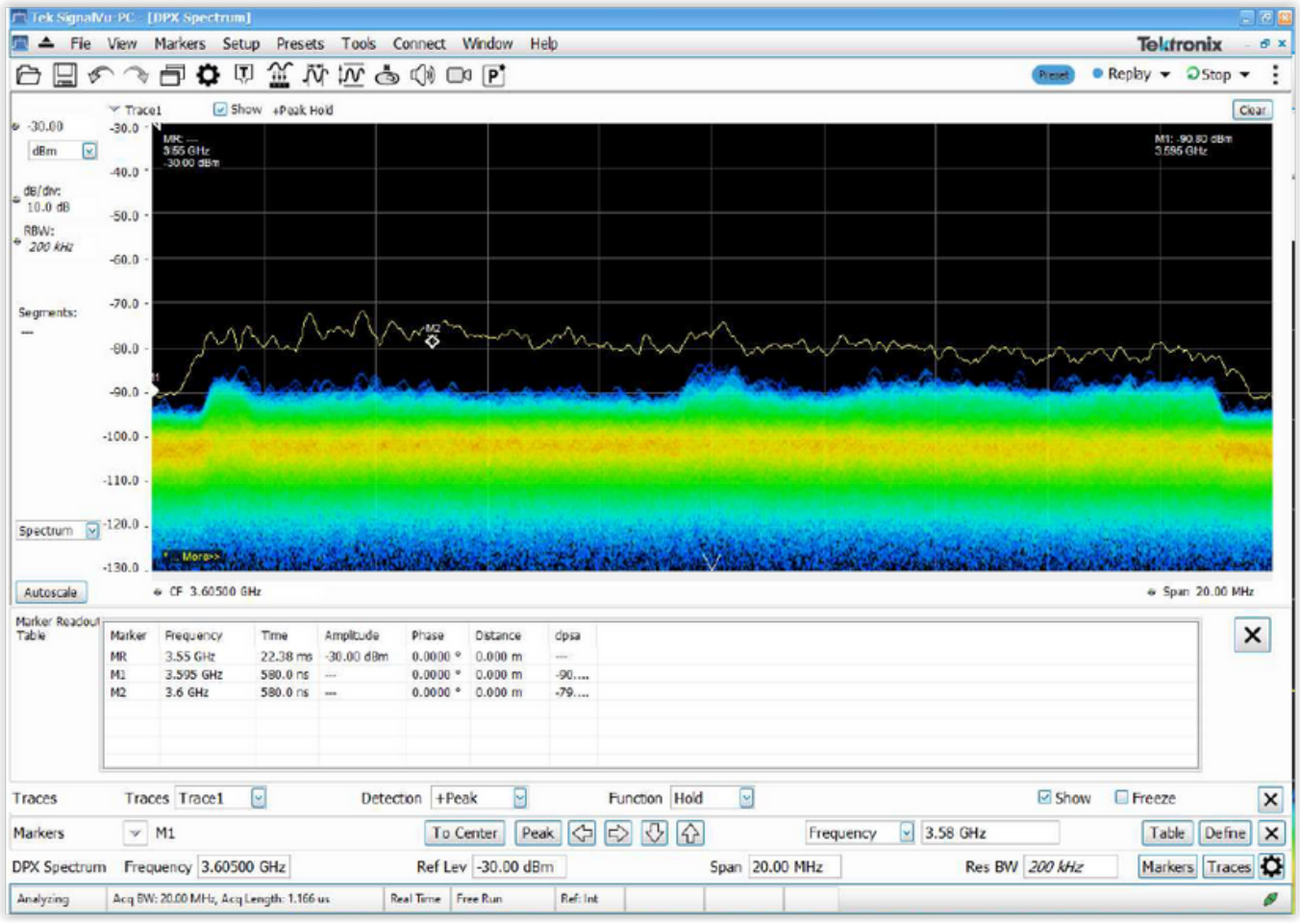


*Figure 4 - Spurious Noise on a 20 MHz CBRS Channel, Cf = 3605 MHz*

# CONCLUSIONS & RECOMMENDATIONS

The use of CBRS in the Central Coast region offers opportunities for enhanced wireless connectivity to unserved/underserved residents, and can potentially leverage innovations in spectrum sharing. However, CBRS also requires careful consideration of the region's unique challenges, including:

- Engineering around the possibility of P-DPA events due to incumbent use;
- The potential for possible unexpected shutdowns due to E-DPA events;
- Engineering around possible performance issues caused by limited channel availability within the regional FSS Protection Area.

In our opinion, the proximity of the Central Coast region to both an FSS Protection Area, and the Pacific Ocean where the U.S. Navy may operate at unexpected times, cautioning against use of CBRS as a reliable and high-performance technology for delivering broadband to unserved/underserved households in and around the San Francisco Bay Area, including the Monterey Bay region. Similar issues exist in Southern California, ranging from Santa Barbara to San Diego, but we do not cover those areas in this paper.

Being within an FSS Protection Area reduces the number of available CBRS channels. Local governments or their ISP partners could mitigate this issue by purchasing PAL licenses. If the local government or their ISP partner chooses to use GAA channels, and another provider purchases PAL licenses in their area, the government/ISP could be restricted to the remaining three GAA channels, which would severely reduce the information capacity of the network.

As a new technology, CBRS is evolving. There are proposed changes to the standard, SAS methods, ESC algorithms, and DPA equations that could make CBRS a workable choice for delivering broadband to unserved/underserved residents. For the time being, we recommend against it. Continued collaboration between regulatory bodies, industry stakeholders, and technology providers will be needed to make CBRS viable for the Central Coast region.

# ADDENDUM:

## CBRS BASELINE STANDARDS FOR INITIAL CERTIFICATION RELEASE 1, WINNFORUM

The CBRS Baseline Standards Release 1, created by the Wireless Innovation Forum, addresses the requirements of **47 CFR Part 96** and aims to develop an ecosystem of interoperable Spectrum Access System (SAS) and CBRS device technologies. Here's a summary of the key documents and specifications:

01 **SAS to CBSD Technical Specification (WINNF-TS-0016)**
Versions range from 1.0.0 to 1.2.7, with earlier versions being deprecated over time. This specification details the technical requirements for the interface between the Spectrum Access System and the CBRS Device (CBSD).

02 **CBRS PKI Certificate Policy (WINNF-TS-0022)**
Versions range from 1.0.0 to 1.5.0. This document outlines the policy for Public Key Infrastructure (PKI) certificates in the CBRS, essential for ensuring secure communications within the network.

03 **WG4 SAS Test and Certification Specification (WINNF-TS-0061)**
Versions range from 1.0.0 to 1.5.1. It specifies the testing and certification requirements for SAS, ensuring compliance and interoperability of different SAS implementations.

04 **CBRS Communications Security Technical Specification (WINNF-TS-0065)**
Versions range from 1.0.0 to 1.3.0. This specification focuses on the security aspects of communications within the CBRS network.

05 **CBRS Operational Security Technical Specification (WINNF-TS-0071)**
Version 1.0.0. It outlines the operational security requirements for the CBRS, ensuring the integrity and security of the network operations.

06 **SAS-SAS Protocol Technical Specification (WINNF-TS-0096)**
Versions range from 1.0.0 to 1.4.0. This document details the protocol for communication between different SAS providers, crucial for coordinated spectrum management.

07 **CBRS Operational and Functional Requirements (WINNF-TS-0112)**
Versions range from 1.0.0 to 1.9.1. It defines the operational and functional requirements for CBRS, providing a comprehensive framework for system implementation.

08 **CBRS CBSD Test Specification (WINNF-TS-0122)**
Versions 1.0.0 to 1.0.2. This specification outlines the testing requirements for CBRS Devices, ensuring they meet the necessary standards for operation within the CBRS band.

09 **Operations for Citizens Broadband Radio Service (CBRS) (WINNF-TS-0245)**
Versions 1.0.0 to 1.2.0. It includes technical specifications for the operation of the CBRS, particularly focusing on the Priority Access License (PAL) database.

10 **CPI Accreditation Standard (WINNF-TS-0247)**
Versions 1.0.0 to 1.6.0. This standard sets the criteria for Certified Professional Installer (CPI) accreditation, ensuring quality and compliance in CBRS installations.