Best Practices for Collaborative GAA Coexistence

October 2024

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1 Introduction

In the past, a key barrier to deploying private cellular networks was the expense of obtaining the licensed spectrum that those networks were designed to use. The advent of CBRS and its shared spectrum licensing model has removed that barrier. General Authorized Access (GAA) users can now deploy private cellular networks that deliver superior voice and data services without incurring the cost of spectrum licenses.

There is a tradeoff for this spectrum access – your private network shares the spectrum with other GAA users. As the number of GAA networks increases, your network is increasingly likely to experience interference on the CBRS channels it uses. Likewise, interference can also come from users of the adjacent C-Band and AMBIT bands. This interference can cause deterioration in the performance of your network, reducing the capacity and coverage provided to your users. To help address this problem, the OnGo Alliance has developed a coexistence framework that helps GAA users minimize interference between their networks. Combined with good network design, the potential impact of interference can be kept to a minimum, and your network can operate at its full potential.

This document is intended to provide you the tools you need to understand interference, how to avoid it, how to detect it and how to work with other GAA networks to minimize the interference your network receives and the interference it causes with other networks. It consists of three major topics:

- Sections 2 and 3: Introductory Material. This provides a basic overview of OnGo and CBRS, and a brief overview of the major types of interference that OnGo networks have to deal with. If you already know about OnGo and interference in 5GS networks, you can skip over these sections.
- Sections 4 and 5: Designing to Minimize Interference. These sections cover the basic principles of network design and operation to minimize interference – both the interference your network receives, and the interference your network creates. It also describes the kind of monitoring you should perform to detect interference and identify the source, when and if interference occurs.
- Sections 6 and 7: GAA Coexistence Framework. These sections describe the process for working with your SAS Administrator to reduce interference. This framework allows interfering networks to collaborate and coordinate to reduce that interference. We include a number of template forms in section 7, listing the information the SAS Administrator will need to facilitate the process.

If you want to learn more about the GAA Coexistence Framework, the full definition is in the Collaborative GAA Coexistence Technical Specification, OnGo-TS-2003, which can be found on our website, here.

2 Intro to OnGo and CBRS

This section provides background information about OnGo and the CBRS band. If you already know what OnGo is, skip to the next section.

OnGo networks are networks deployed in the CBRS Band that use 3GPP technologies – both the 4th generation LTE and 5th generation 5GS (also known as NR). The OnGo Alliance was formed to support and promote deployment of OnGo networks by defining how 3GPP networks operate in the CBRS Band.

Who's Who in OnGo

OnGo is the result of work by many organizations:

- The FCC – The Federal Communications Commission defined the part 96 regulations that opened access to the CBRS band.
- WInnForum – The Wireless Innovation Forum defined the requirements for CBRS- compliant physical devices.
- OnGo Alliance (OnGoA) – The OnGo Alliance defines the requirements for OnGo technologies in the 3.5 GHz band and certifies OnGo-compliant equipment. (The OnGo Alliance was previously known as the CBRS Alliance.)
- 3GPP – The 3rd Generation Partnership Project standards body represents the community of 3GPP equipment manufacturers and service providers, and defines the LTE and 5GS NR standards.

2.1 CBRS

In April 2015 the Federal Communications Commission (FCC) formally established the Citizens Broadband Radio Service (CBRS) to address current and future needs for wireless spectrum. Previously reserved solely for military and other government-approved uses, the CBRS band opens up 150 MHz of spectrum at 3.5 GHz band so that private organizations can share this spectrum with incumbent users. The OnGo Alliance created OnGo to promote the use of LTE and 5GS in the 3.5 GHz band, although other technologies can also make use of the band. The FCC partitioned 150 MHz of the 3.5 GHz band into 15 x 10 MHz channels. Access to the channels is dynamic and controlled by dedicated spectrum-management services known as Spectrum Access Systems (SAS).

2.2 PAL vs. GAA

Users who operate in the CBRS band have different priority levels. Top priority lies with the Tier 1 incumbent users such as the federal government, fixed satellite users, and grandfathered wireless users. Next in priority are Tier 2, or Priority Access License (PAL), users. These are licensed users who acquired spectrum licenses through an FCC auction. PAL users must not cause harmful interference to Tier 1 users. Third priority is given to Tier 3 General Authorized Access (GAA) users who deploy “lightly-licensed” devices. GAA users must not cause harmful interference to the higher-tier users.

The FCC auctioned PALs on a per-county basis, with sublicensing permitted. Of the 15 channels in the CBRS band, the FCC allocates seven for PAL licensees. Any spectrum not used by PAL holders or the protected incumbents can be used by GAA users. By default, GAA users are not afforded any interference protection from each other, but the OnGo Alliance has defined a coexistence framework that SAS Administrators can provide to help minimize interference.

2.3 CBSDs

Access Points are termed Citizens Broadband Radio Service Devices (CBSDs) in CBRS. CBSDs come in many types – fully integrated small-cells, distributed radio heads, or antenna clusters. CBRS defines a CBSD as a logical entity that radiates RF power, has antenna characteristics and is geolocated. CBSDs come in two classes, defined by their output power and range. Category A devices must emit less than one watt of power per 10 MHz channel. Category B devices, typically used outdoors, may emit up to 50 watts per 10 MHz channel. In an OnGo network, the 5GS gNodeBs (gNBs – base stations) are closely associated with CBSDs and are often in the same physical package.

Table 1: CBSD category summary.

Device Type	Maximum EIRP	Limitations
Category A CBSD	30 dBm (1W)	• Outdoor antenna height limited to six meters Height Above Average Terrain (HAAT). • If operation exceeds antenna height or max Category A power limits, the device is subject to Category B limitations.
Category B CBSD	47 dBm (50W)	• Limited to outdoor operation. • Must be professionally installed.

2.4 EUDs

In CBRS, End User Devices (EUDs) are the user-facing element. These devices can be either mobile or fixed and their power can't exceed 23 dBm/10 MHz (200 mW). EUDs may operate with permission from a CBSD. In an OnGo 5GS network, the EUDs are generally 5GS User Equipment (UE) devices.

2.5 SAS

All CBSDs must register with an FCC-certified Spectrum Access System (SAS) and obtain a channel grant from the SAS before transmitting in the CBRS band. To prevent interference with incumbent systems, the SAS allocates the spectrum to individual CBSDs and PAL license holders. To coordinate the CBRS band's usage, the SAS Administrators maintain a database of CBSDs and incumbent devices to calculate the aggregate interference.

For a SAS to grant access to channels in the lower 100 MHz of the CBRS band, the SAS must have access to an Environmental Sensing Capability (ESC). The ESC is a network of sensors used to detect federal frequency use in the 3550–3650 MHz band where U.S. Navy radar systems can operate, primarily along the Pacific, Atlantic and Gulf coasts. The ESC informs the SAS of radar operations so that the SAS can prevent any CBRS interference with the naval operations by suspending/terminating existing grants and/or rejecting any new grants in that location for those channels. The SASes use a combination of tools to create realistic propagation model to predict potential interference with incumbent systems, and can provide guidance to CBSDs via operating parameters to CBSDs so as to avoid potential interference.

A new CBSD requests access to a range of frequencies from the SAS, and, based on the location of the CBSD, its category, and its antenna characteristics, the SAS grants access to one or more CBRS channels. When higher-priority users need channel access, the SAS can direct the CBSDs to reduce their output power, stop using currently allocated channels, or shut down entirely to avoid interference with PAL users or incumbent systems.

Several FCC-certified SAS systems are deployed across the country. These systems are operated by various companies that share information among each other. Before a CBRS user deploys a CBSD, they need to subscribe to a SAS service from an FCC-certified SAS Administrator. Under Part 96 rules, a SAS does not guarantee interference protection among GAA users. However, WInnForum, the OnGo Alliance, and other standards bodies have developed a coexistence framework for GAA users to help manage GAA operations.

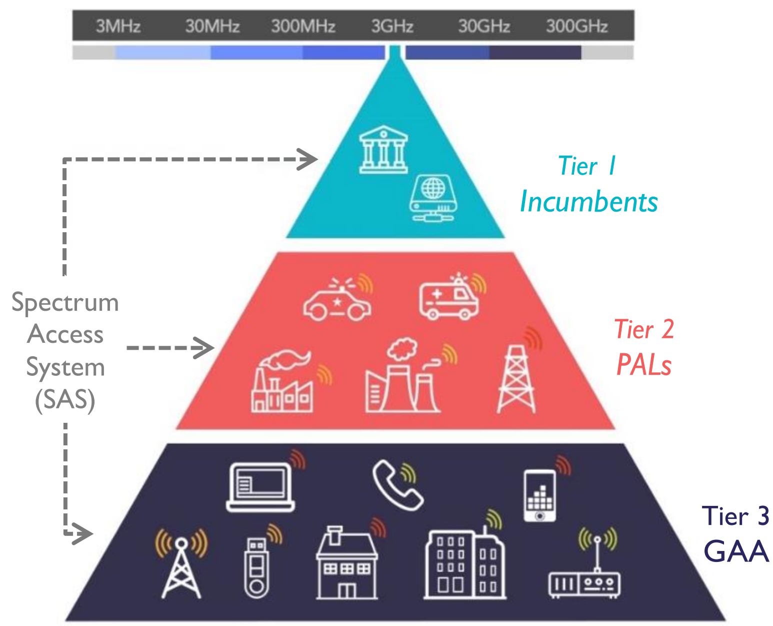

Figure 1: SAS prioritization of CBRS Access Tiers

2.6 CBRS 2.0

In the summer of 2024, the rules for the CBRS band were modified, resulting in CBRS 2.0. Most significantly, the protection areas for incumbent users were made much smaller, freeing up additional spectrum for use by PAL and GAA users along the coasts. In addition, the frequency CBSDs were required to check in with the SAS, termed the "heartbeat," was made more flexible, with the SAS Administrators able to decrease the frequency to a minimum of once per day, rather than once every five minutes. Also included in CBRS 2.0 is the coexistence framework defined by the OnGo Alliance, described below.

3 Interference in OnGo

3GPP networks are designed to minimize interference with other 3GPP networks, but interference between 3GPP networks is still possible. And while the PAL users of the CBRS band are protected from interference, GAA users are not. This section describes the types of interference an OnGo network may experience, and the effects of that interference.

3.1 Types of Interference

There are several types of interference that GAA users need to worry about.

3.1.1 Co-Channel Interference

This is interference from other GAA users that are using the same 10 MHz channels as your network. These are typically from other networks operating nearby or in the same physical area as your network.

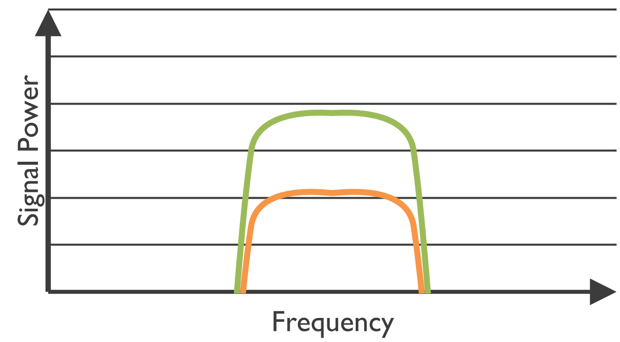

Figure 2: Co-Channel Interference Example

3.1.2 TDD Interference

OnGo networks use Time-Division Duplexing (TDD). In a TDD scheme, the CBSD (base station) transmits at certain times, while the EUDs (devices) transmit at other times. The 3GPP defines a number of different TDD patterns, allocating some for downlink (when the CBSD transmits), and others to uplink (when the EUDs transmit). As the CBSDs typically transmit at higher power than the EUDs, transmissions from CBSDs can drown out the transmissions from nearby EUDs of a different network using the same or adjacent channels but different TDD patterns.

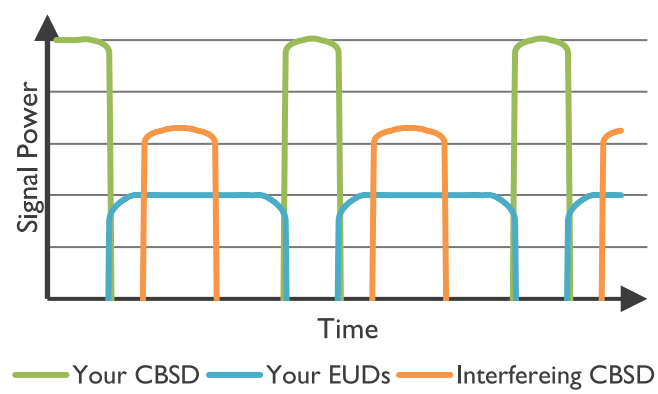

Figure 3: TDD Interference Example

3.1.3 Adjacent-Band Interference

Transmitters in other bands can interfere with CBRS. For the CBRS case the biggest concern are transmitters operating in the C-band and AMBIT bands, which are just above and below the CBRS band, respectively. Transmitters in that band can operate at much higher power levels, and their emission can “leak” into the CBRS band, causing interference on the upper and lower channels.

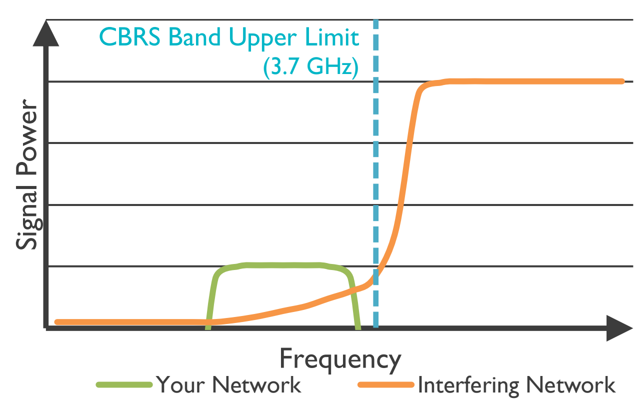

Figure 4: Adjacent Band Interference Example

3.1.4 Unauthorized Transmitters

Access to the CBRS band is only available to systems that have been granted access by a SAS (or are one of the incumbents that the SAS is protecting). There may be some systems that try and use the band that have not been authorized by a SAS. These unauthorized transmitters can interfere with an OnGo network. This shouldn't happen often, as such transmitters will be in trouble with the FCC, but they can happen.

3.1.5 Identifier Collisions

LTE and 5GS networks use a number of numbers to identify different components of the system. These numeric identifiers need to be unique. When multiple networks use the same identifiers, it can cause significant disruptions, ranging from reduced performance to complete denial-of-service. The OnGo Alliance administers an identifier management program to help ensure that these don't happen.

3.1.6 Other Sources of Interference

There are other forms of interference that OnGo networks can experience. This includes devices that emit noise in the band, either unintentionally or due to a malfunction in the device.

3.2 Effects of Interference

LTE and 5GS networks are designed to minimize the impact of interference and can automatically adjust themselves to respond to problems as they arise. This means that interference rarely causes an OnGo network to completely fail. Instead, interference tends to cause one of two effects.

3.2.1 Reduced Bandwidth

When interference is present, an OnGo network will adjust how data is encoded to compensate for the interfering signal. This results in reduced available bandwidth on the network. This reduction in available bandwidth can even effect devices that aren't having any interference problems themselves, as the network has to allocate additional network resources to the devices that are being directly impacted.

3.2.2 Reduced Coverage Area

When a device (EUD) is out near the edge of the coverage area of a base station (CBSD), the power level it receives is reduced. Interfering signals can more easily drown out the signals from the base station, as well as the signal from the device. The net result is that interference can cause the coverage area of a network to shrink. Devices out at the edge of the network will have reduced performance, or suffer a denial-of-service, unable to connect to the network at all.

3.3 Measuring Interference

For 3GPP networks, the most common way to quantify interference and describe the quality of radio channel's signal is using Signal-to-Interference plus Noise Ratio (SINR), expressed as dB. A high SINR measurement means the channel is good, a low (negative) SINR measurement indicates a poor channel with lots of interference.

4 Design Optimization to Minimize Interference

Establishing and maintaining an optimized network reduces your exposure to interference from other networks, reduces the interference your network causes to others, and maximizes the quality of services within your intended service area. Optimization focuses first on deployment configuration to provide a sufficient and clean radio environment. This is followed by parameter optimization to satisfy accessibility, retainability, mobility, integrity, and availability requirements.

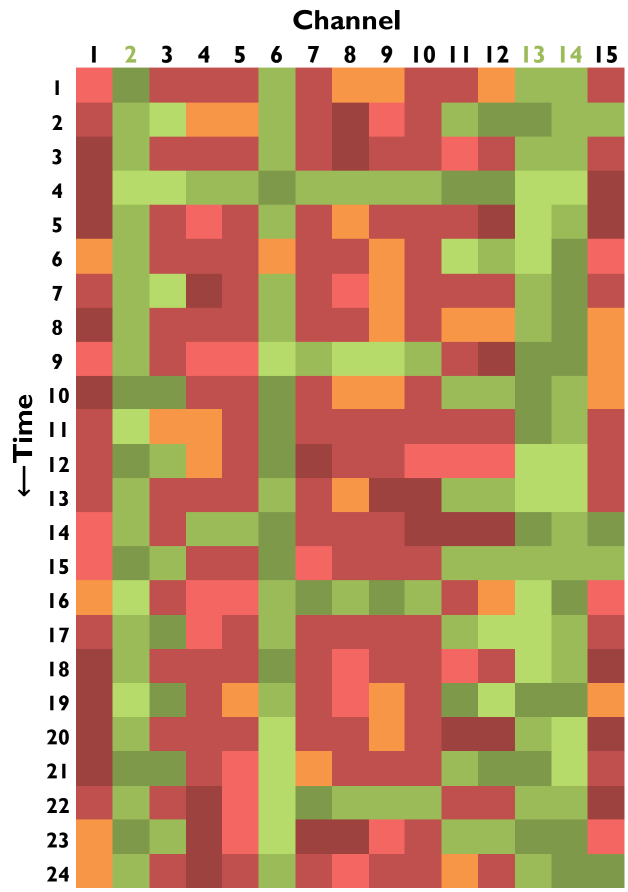

Figure 5: An Example Channel Map

4.1 Identifying Optimum Channels

Selecting the channels with the best quality for your network is an important part of network optimization and yields the best results on networks that maintain optimal deployment and parameter configurations. This involves measuring the channel quality at planned CBSD locations, and throughout the planned service area. The best information on channel quality comes from direct observations of power levels and utilization within your service area. Spectrum monitoring, spectrum analyzers, CBSD measurements, RAN measurements and channel quality measurements are sources that provide this information. Spectrum Inquiry and SAS channel guidance are some additional sources of channel quality information. These measurements should be made at multiple places in your networks intended coverage area. Measurements can be taken at a single time but measuring for a few minutes or hours can give additional insight to choose optimum channels during network design. Persistent and ongoing measurement after deployment will allow you to continue to select the best channels as channel quality changes over time.

4.2 Characterizing Adjacent CBRS Networks

External interference often comes from other sources that provide coverage beyond their intended service areas into the service area of your network. This is especially harmful at the edges of your coverage area, creating coverage holes and overlap. This makes it a good idea to record information about how the CBRS networks that you can see in your network's coverage are configured. Similar information should be collected for other LTE or 5GS networks in the area. Some of this information can be acquired from the SAS, but the best information on interference relationships comes from direct observations of those networks. The following aspects of how those networks are configured are especially worth noting:

- Where are their antennas/CBSDs located?

- What channels are they using? At what power levels?
- What Network Identifiers are the OnGo networks using? Of particular note are any other networks using the CBRS SHNI (PLMN-ID 315-010), what Tracking Area Codes (TACs) they are using, and what eNodeB/gNodeB IDs they are using.
- What Physical Cell (PCI) identifiers are all the other LTE and 5GS networks in the area (not just the networks in the CBRS band) using?
- What TDD configuration are the other CBRS networks using?

While direct measurement is the best way to characterize LTE and 5GS networks in your coverage area, there are other ways to get this information – websites such as http://www.cellmapper.net or http://www.antennasearch.com provide open databases with much of the information you need, though with less accuracy and reliability.

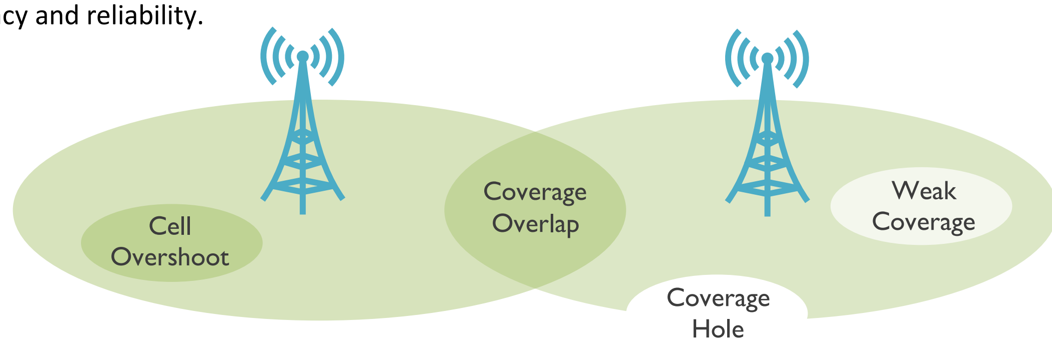

Figure 6: Coverage Scenarios for Adjacent Networks

4.3 Network Configuration Optimization

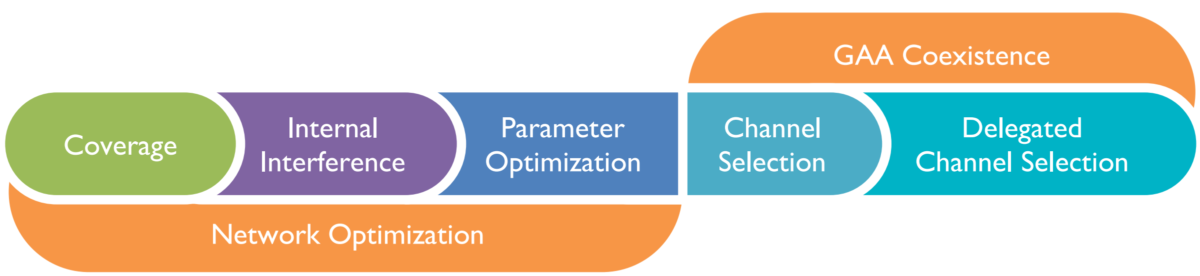

Figure 7: Network Optimization and GAA Coexistence Domains

The biggest concerns when optimizing your network for coexistence are:

4.3.1 Selecting the Optimum Channels

Based on the measurements made of the available channels, you can identify which channels will work best in your coverage area. Your CBSDs can configure their request for grants from the SAS to be limited to only those channels that have the best coverage. Should the SAS not grant access to those channels, a fallback set can be used. If too few or no good channels are available, we have established a Collaborative GAA Coexistence framework to allow you and other OnGo network operators to coordinate with the SAS Administrators to improve coexistence. (See section 6 GAA Coexistence, below.)

Design Optimization

When spectrum utilization is light, it is relatively straightforward to select channels for the CBSDs in your network by using received power measurements of the CBRS channels in your service area and choosing the best that satisfy your requirements for number of channels, channel bandwidths, channel contiguousness, signal-to-interference levels, and utilization as well as common frequency and frequency reuse criteria.

When spectrum utilization is high, channel reselection requires more persistent measurement to respond quickly to changing channel quality.

If you have multiple services with different SINR requirements and channels with different power and utilization, align your channel choices with your service requirements accordingly. If there are no channels of sufficient quality available, look for sources of external interference – a coexistent network may not be optimized accounting for your network.

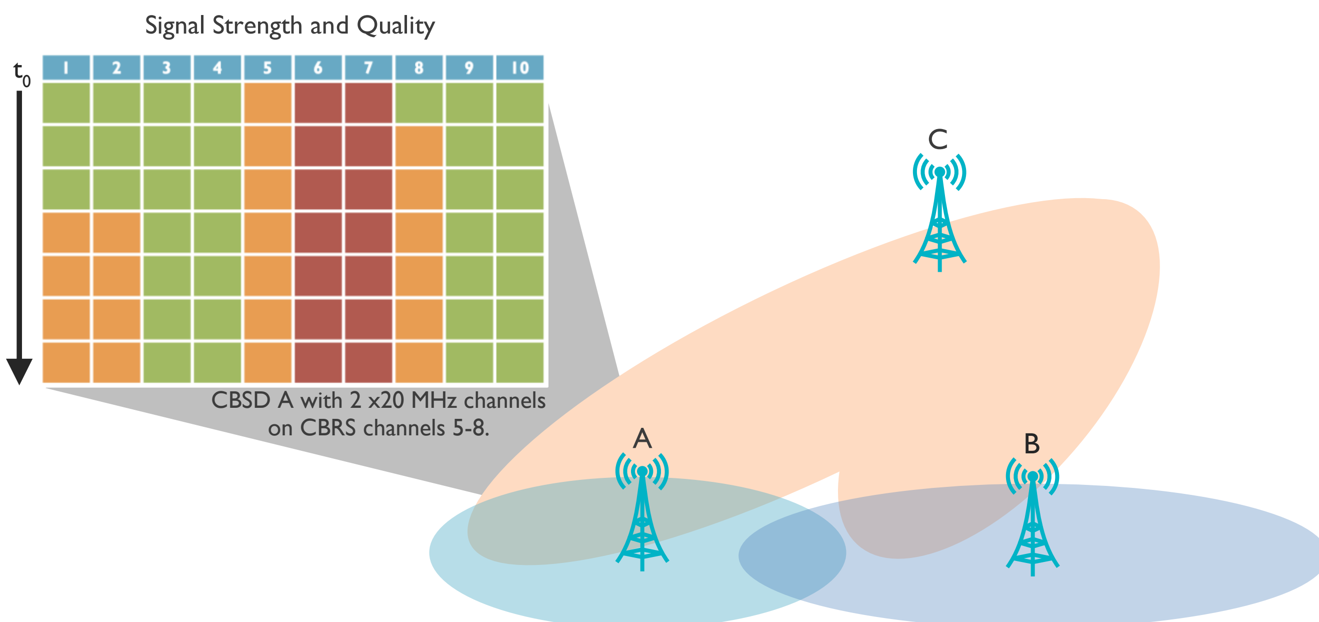

Figure 8: Channel Strength and Quality from CBSD A Over Time

One additional consideration is how the channels your network uses are organized. OnGo networks can support a variety of channel sizes and channel combinations, with different base stations and devices supporting different combinations. 10 MHz channels and 20 MHz channel support (1 or 2 adjacent CBRS channels) are common, with support for 40 MHz channels being added in 5GS. In addition, combinations of multiple sets of channels are allowed via Carrier Aggregation (CA). In the CBRS band, multiple 10, 20, or 40 MHz channels can be combined, contiguously and non-contiguously to increase the overall aggregate bandwidth.

4.3.2 Delegated Channel Selection

Some networks lack the resources or ability to detect, identify, and characterize channel quality and interferers across all CBRS channels. Such networks can delegate channel selection to their SAS Administrator who uses its knowledge of CBRS networks and topologies in your area, predicted interference relationships, and current state of channel allocations to select the best channels for your network devices. The SAS Administrator can also leverage reported channel quality and interference relationship information from coexistent networks to refine the channel allocation for your network. It is important that you provide the SAS Administrator with information about your network including which devices must use the same channels and which devices are part of a spectrum reuse group.

4.3.3 TDD Optimization

Selecting a TDD configuration (the pattern of uplink and downlink time slots) your network uses that matches the other networks in your area is a key way to reduce interference. Even if the pattern in use does not match your desired uplink vs. downlink allocation, using the same pattern as nearby networks using the same CBRS channel may provide better overall performance than using your preferred pattern.

In addition to using the right pattern, you will need to ensure that your network is time-synchronized with those other networks.

4.3.4 Network Identifier Optimization

In order for your network to operate smoothly, it needs to have the proper identifiers configured for that network. Most importantly is the PLMN-ID that identifies the network. A PLMN-ID has been allocated for use in CBRS networks – the CBRS SHNI (315-010). For OnGo networks, using this PLMN-ID creates an additional wrinkle in that certain other identifiers need to be managed to make sure there are no collisions. The OnGo Alliance has an identifier management program to ensure that the identifiers you use from us will not cause any collisions – see our Identifier Whitepaper, which can be found here. In addition to this, you'll want to make sure that some of the other identifiers you use do not collide with those used by other networks in the area:

- Tracking Area Codes (TACs). LTE and 5GS networks are divided up into geographic tracking areas – collections of base stations (CBSDs) that are used to track devices as they move around the coverage area. These aren't strictly managed by the OnGo Alliance. While these codes do not strictly have to be unique, it is a good idea to have the TACs in your network be different from the TACs used by other OnGo networks in your area – especially from those that use the CBRS SHNI as their PLMN-ID.
- Physical Cell Identifier (PCI). LTE and 5GS base stations use the PCI to identify their network cells to other base stations in their area, as part of the measurement and optimization mechanisms built into LTE and 5GS networks. It is important that each PCI in an area is unique, otherwise these mechanisms will not function properly and can end up degrading the performance of multiple networks.

4.3.5 Physical Configuration Optimization

Your network needs to provide a signal of sufficient strength and quality that allows users to access and utilize services at required performance levels. Areas in the intended service footprint where the signal strength is below a minimum level will result in coverage holes that lead to access failures and dropped connections. Areas where the signal strength is strong enough to access the network, but is still low, will lead to poor service quality. Overlap in coverage between CBSD is necessary to support mobility but must be optimized: inadequate coverage overlap leads to handover issues, while excessive overlap increases internal interference and affects service quality. In some cases, cell coverage can significantly overshoot its intended location causing interference in another cell or creating a coverage island with significant handover failures and dropped connections.

An optimized radio network is now limited only by sources of external interference and the availability of channels with sufficient quality to avoid that interference. Optimization efforts include changes to physical network attributes such as number and location of CBSDs, antenna models, electrical and mechanical tilt, azimuth, height, and transmit power. Optimization also includes changes to parameters such as thresholds and timers related to signal strength and quality that control network access, retention, and handovers.

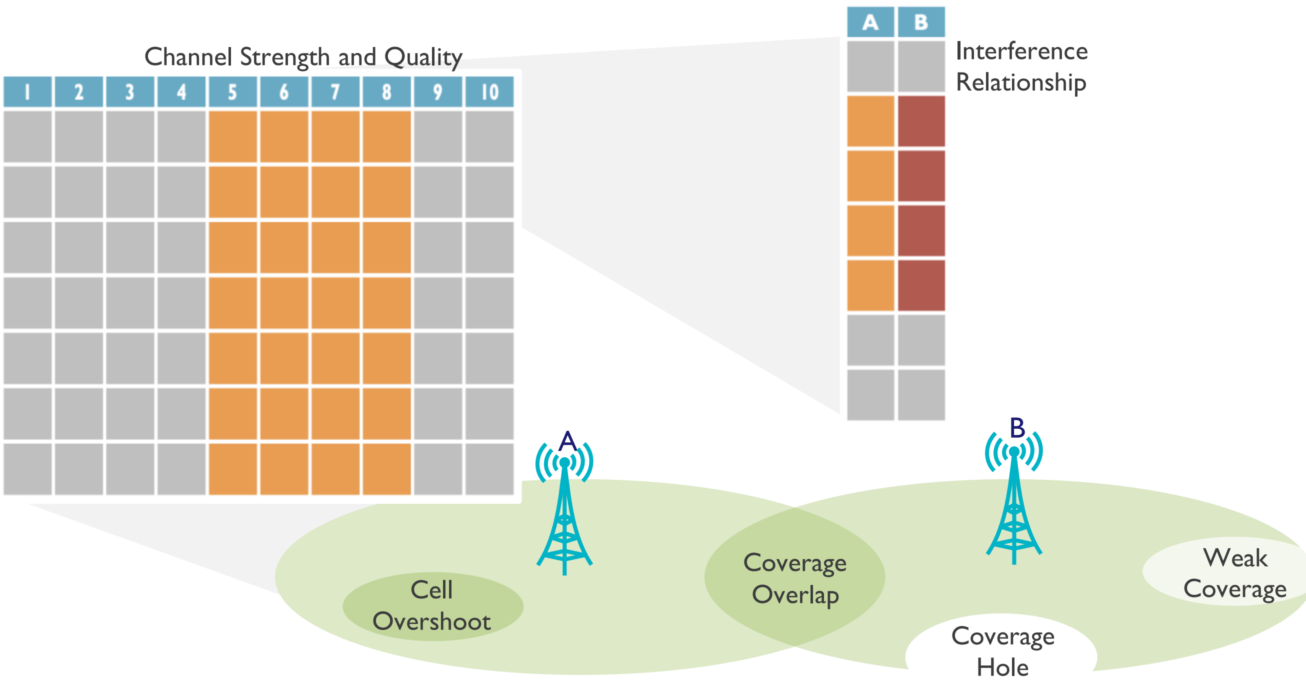

Figure 9: Locating Areas with Channel Issues and Identifying Internal Interference

4.4 Being a Good Neighbor

One thing to keep in mind when optimizing a network design is that you don't want to interfere with other users of the CBRS band in the area. The good news is that optimizing your network design and configuration to reduce the interference caused by nearby networks also means that your network is going to cause minimal interference with those same nearby networks. It's also a good practice to not consume more of the band than you need: don't take up more channels than you need, and don't transmit at higher power levels than are necessary.

5 Maintaining Your Network

The radio environment of your network can change over time. Additional GAA CBRS networks may appear or disappear, and physical changes to the environment (new construction, vegetation, changes to facilities, and the like) can also impact the radio environment. Monitoring of your network's performance and the environment can help you identify and resolve problems caused by these changes before they become serious.

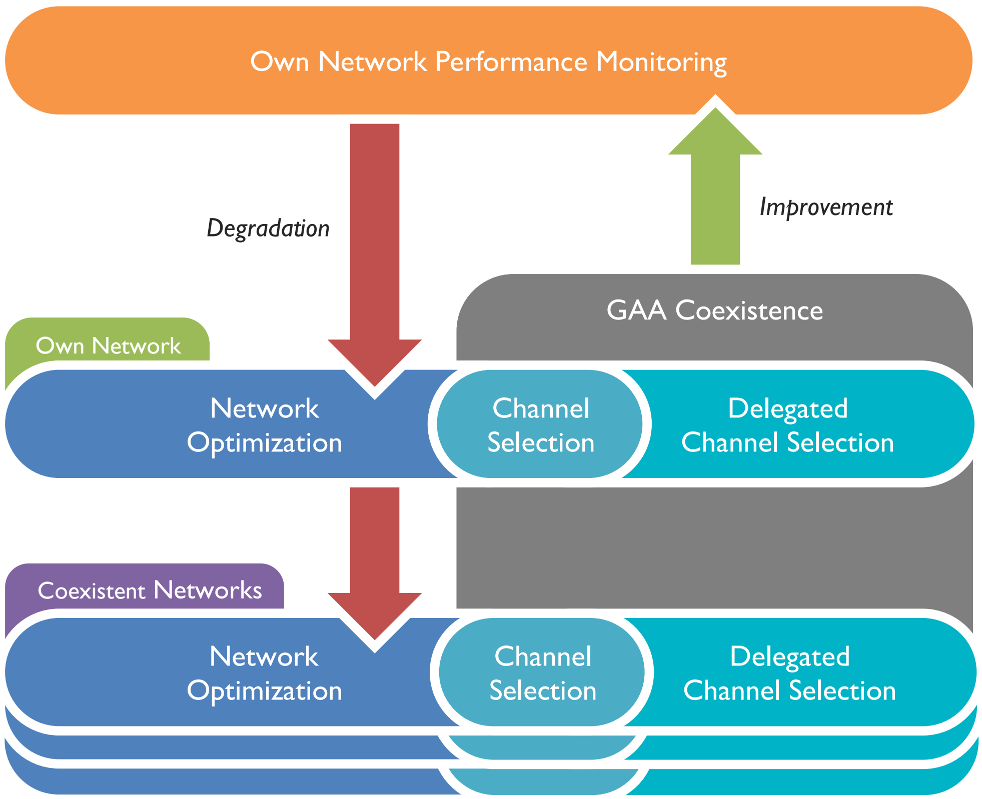

Figure 10: Performance Monitoring and Interference Resolution Relationships

It is therefore important to monitor your network's performance regularly to ensure that the services it delivers continues to meet the needs of the enterprise. Performance issues often manifest as increased call setup and connection failures, dropped calls and connections, handover failures, packet corruption, packet loss, latency, jitter, and so on. Insufficient coverage, excessive interference, or suboptimal parameter configuration often are underlying causes.

5.1 Performance Monitoring

Your network management system, end user complaints, and field observations are important sources of information about the performance of the radio network and the quality of the radio environment.

5.1.1 Network Management System

Network management systems provide statistics, event tracking, and recordings to detect, identify, and troubleshoot performance issues experienced by the CBSDs and EUDs that belong to your network. This information helps you to monitor trends in network performance, understand where users experience performance issues in your service area, and identify possible underlying causes.

5.1.2 End User Complaints

Additionally, reports of poor service from end users often alert you to important performance issues and areas that are not immediately apparent from trends in performance management data. These reports often help to direct efforts at collecting or leveraging detailed measurements for troubleshooting. For these reasons, it is important that end users have a channel through which to report the issues they experience. If an issue is reported by a single user, the issue could be with the user’s device or an indication of an issue impacting performance to many. If multiple users have reported a similar issue in same area, this would be a better indication of an issue not associated with a single user.

5.1.3 Channel Monitoring

Lastly, persistent monitoring or directed collection of the radio environment provides insight into the quality of the radio environment and to contributing factors. This information confirms the deterioration of channel quality, identifies channels of better quality to support your service requirements, and determines sources of interference, which allows you to directly address interference coming from your own network, coexistent networks, and unknown sources.

Made on a persistent basis, these measurements can indicate whether other channels have improved in quality or have developed better quality than those currently in use. This information allows you to respond to deterioration in the channels you currently use or to take advantage of improvement in other channels while maximizing your access to and selection within all GAA channels available.

5.2 Responding to Changes

Responding to changes in the environment involves adjusting your network design to account for these changes. In a lightly loaded spectral environment, simply changing channels may solve interference problems. As spectrum congestion increases, solutions can also require adjusting your TDD configuration, the identifiers your network uses, and adjusting a CBSDs physical location, antenna positioning and the like.

As GAA spectrum utilization increases, you will find that the performance achieved from optimization of deployment configuration, parameter configuration, and channel selection is limited by the optimization state of other networks that coexist in the same spectrum. Identifying and characterizing the interference relationships with coexistent networks facilitates collaboration between CBSD Users to resolve issues and to share GAA spectrum efficiently. In the next section, we discuss how networks can coexist with each other to reduce interference and improve the performance of networks using the CBRS band.

6 GAA Coexistence

As discussed above, interference can originate from within your own network, from the coexistent networks of other CBSD Users, and from unauthorized sources operating in the CBRS spectrum. In some situations, especially as utilization of the CBRS spectrum increases, CBRS networks will be unable to resolve external interference issues despite radio network optimization, channel selection, and collaboration with coexistent networks. To address this situation, the OnGo Alliance has published the Collaborative GAA Coexistence Technical Specification, TS-2003, for developing a frequency plan that minimizes interference among GAA deployments in an area of reported and unresolvable interference. The core of the Coexistence system is the creation of a GAA Coordination Area (GCA) Frequency Plan by the SAS Administrator, which allocates channels for participating networks in the most efficient manner possible. In addition to the GCA Frequency Plan, the SAS Administrator can help broker communication between network operators, and the coexistent network may be willing to optimize their network to improve their own performance and mitigate the degradation caused to yours.

6.1 GCA Frequency Plan

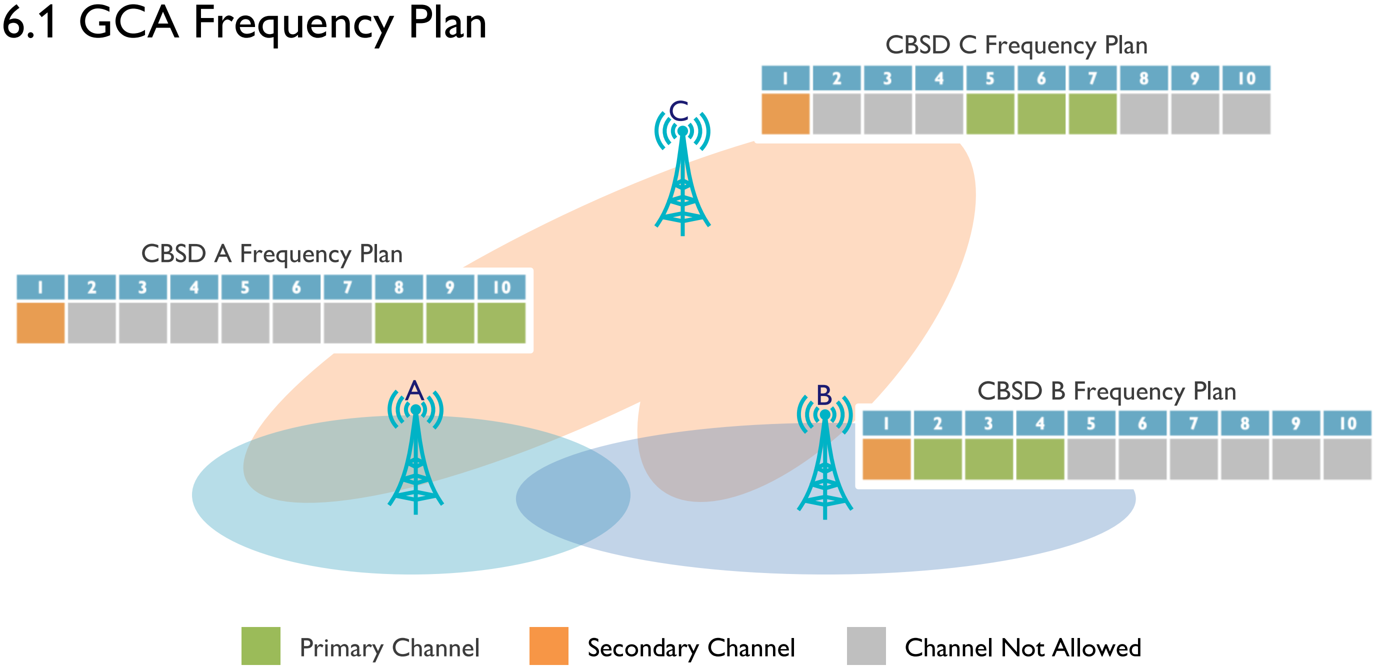

Figure 11: Illustration of a GCA Frequency Plan with Primary and Secondary Channels

The GCA Frequency Plan defines the set of primary and secondary GAA channels where each CBSD is allowed to operate. Primary GAA channels are a set of channels allocated to a CBSD that is not allocated to any other CBSDs in the area where it may cause interference. Secondary GAA channels are channels other than primary GAA channels that a CBSD can use if it does not interfere with the Primary GAA channel of another CBSD in the area.

6.2 GCA Frequency Plan Creation Process

The basic process is for implementing a GCA Frequency Plan is shown below, and described in more detail following:

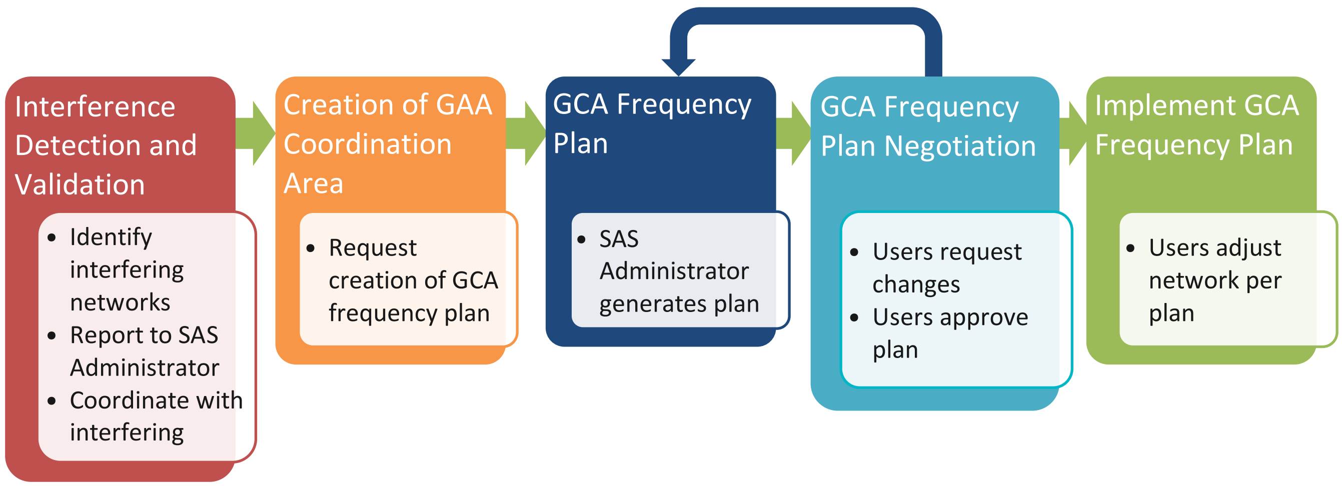

Figure 12: Process Flow for Generating and Deploying a GCA Frequency Plan

6.2.1 Identify Interfering Networks

Identifying and characterizing networks that are causing interference is the necessary first step in addressing interference issues and developing a GCA Frequency Plan. This involves identifying and understanding the sources of external interference on the GAA channels otherwise available for your network. This information can be used to document and support discussion with those network operators to address and resolve the interference they cause, which your Managing SAS Administrator can help to broker. This information is also valuable for your SAS Administrator to improve your channel allocation when you have delegated that authority to them, to initiate a GCA Frequency Plan with your SAS Administrator, and to assist in the development of a GCA Frequency Plan.

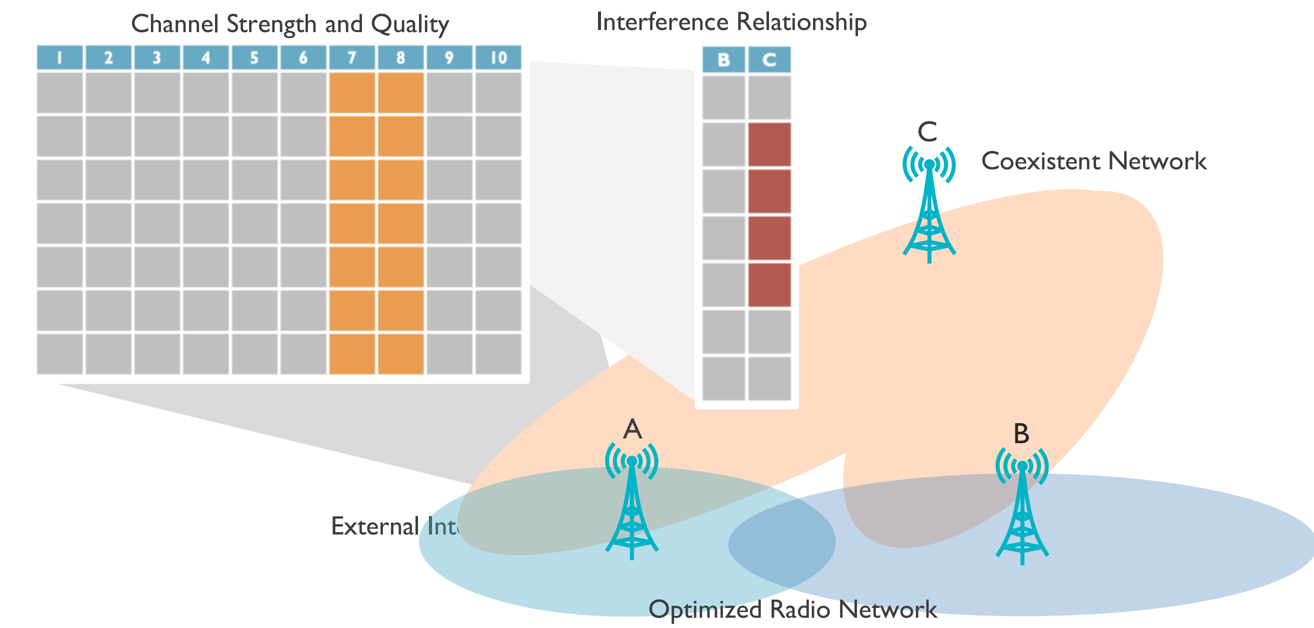

Figure 13: Identifying Interference from a Coexistent Network

6.2.2 Report Information to SAS Administrator

Section 7.1 provides a template that can be used to report CBSD and frequencies experiencing interference, network frequency requirements, and description of interference including spectrum scan and identification of interfering devices. CBSD Users are encouraged to provide channel quality and interference relationship information from measurements to their Managing SAS Administrator to further assist in the creation of the GCA frequency plan.

6.2.3 Coordinate with Interfering Networks

Your SAS Administrator can assist in establishing a dialog with the operators of other networks that interfere with yours. It will be helpful to have this evidence available along with some description of your network, including its location, and the extent of interference from each source identified. To develop and assess the feasibility of solutions beyond channel reselection, the affected CBSD User might benefit by providing relevant network topology information that the other CBSD User can use to mitigate interference caused.

In cases where the source of interference arises from the CBSD of another CBSD User, evidence of interference performance limitation, and performance requirements should be provided to motivate collaboration before resorting to GCA Frequency Plan creation and enforcement. Even when involved parties are unable to deconflict the interference relationship, this set of information describing the extent of the interference relationship, the service requirements, and the impact of the interference relationship can prove useful to the SAS Administrator in developing the GCA Frequency Plan.

If you are able to work with the interfering network operator(s) to resolve the problem without creating a GCA Frequency plan – great!

6.2.4 Request GCA Frequency Plan

Any CBSD User can initiate the creation of a GCA Frequency Plan by reporting interference to its managing SAS Administrator along with collected evidence of the interference condition. The more info you can provide, the better the SAS Administrator will be able to respond. Section 9 provides a template for what you should submit to the SAS Administrator. Documentation of the discussions you have had with the operators of interfering networks should also be provided.

6.2.5 SAS Administrator Generates GCA Frequency Plan

Based on the information provided, the SAS Administrator will generate a GCA Frequency Plan. This can involve discussions with the other SAS Administrators, operators of other CBRS networks in the area, and coordination with any nearby PALs users. The GCA Frequency Plan is provided to all impacted users, and includes basic statistics about the proposed plan, including (but not limited to):

- The GCA Frequency Plan
- The current state of the spectrum and of channel allocation to CBSD Users.
- Average number of primary channels allocated per CBSD.
- Average number of secondary channels per CBSD not having an estimated interference dependency on the primary channel of another CBSD User.
- The secondary channels of a CBSD not having an estimated interference dependency on the primary channel of another CBSD of another CBSD User.
- Average signal-to-interference level across all CBSD per primary channel.
- Average signal-to-interference level across all CBSD per secondary channel.

A couple of things to keep in mind:

- The SAS Administrators are limited in what they are allowed to communicate due to confidentiality requirements mandated by the FCC.
- The SAS does not directly allocate the channels per the GCA Frequency Plan. It only says which channels are available to each CBSD as primary channels and which as secondary channels.

6.2.6 Users Approve GCA Frequency Plan

For the GCA Frequency Plan to go into effect, it must be approved by all CBSD Users involved. Users can request changes to the plan, if such changes are needed for them to agree to participate. Once approved by CBSD Users, the SAS Administrators maintain the integrity of the plan by denying requests for channels that are not consistent with it.

6.2.7 Users Adjust Network per GCA Frequency Plan

Once all users have approved the GCA Frequency Plan they can then adjust their network configuration to implement the plan. If you have not delegated channel selection to the SAS for your network, you will need to adjust your network configuration manually per the plan.

6.3 Reporting Unauthorized Networks

If interference arises from sources not authorized by a SAS to operate in the CBRS spectrum, they can and should be reported to the FCC for investigation and enforcement. Providing as much information as possible about the interferer is needed to ensure that the FCC is able to respond appropriately. This includes the channels and frequencies involved and any identifying information that you can provide.

This information should also be provided to your managing SAS Administrator. This allows them to account for it in the development of a GCA frequency plan, and aid in reporting to the FCC.

7 GCA Frequency Plan Request Form

In order to generate a GCA Frequency Plan, the SAS Administrator needs as much information about the interference your network is experience as possible. This section provides a template for reporting that information. While you don't strictly have to follow this template, it's a useful guide. The more information you can provide, the better.

7.1 Interference Report Form

This is the primary form for generating a GCA Frequency plan. It is also useful for reporting information about unauthorized users to the FCC for investigation.

Summary						
[REQUIRED] **Reporter / Contact Information**		**Name**	**Company**	**Email**	**Phone Number(s)**	
[REQUIRED] **Devices experiencing interference** (CBSD IDs, FCC ID, or Serial Numbers)		Please list the CBSDs and the frequencies for those CBSDs that are experiencing interference, one per line. Please do **NOT** put CBSD IDs of devices that you suspect are causing interference in this section. If in your investigation you suspect or have determined another operator and/or CBSD causing the interference, please feel free to provide that information in the section below, Description of Interference.				
		CBSD ID or FCC ID / Serial Number	**Frequencies (Lower - Upper)**	**Principal Subordinate SFG (CCG) group**	**Spectrum Reuse (ICG) group**	**Device / Deployment notes** (Ex. CPE, eNB, gNB)
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
[REQUIRED] **Time period of interference**		**Start Date/Time**	**End Date/Time**			
[REQUIRED] **Total bandwidth desired**		**Bandwidth**	**Preferred Frequency**	**TDD Configuration**		
[OPTIONAL] **Description of interference**		Please provide any additional description or findings from your investigation that you can share. If you have spectrum scans for the CBSDs experiencing interference that can be shared, please include them in separate page or attach them to your ticket.				

Table 2: Example interference report template

7.2 Contact Information

Contact information enables the SAS Administrator to follow up with the relevant personnel for your network. With express approval from the CBSD User, the SAS Administrator is able to provide this information with the interfering network(s) to facilitate discussions to resolve the issue.

CONTACT INFORMATION		
Name:		
Company:		
Email:		
Phone Numbers:		
Approval for SAS Administrator to share report with CBSD Users of interfering networks:		Yes/No

Table 3: Contact Information Attributes

7.3 Network Information

Information about how your network is configured, and the network resources impacted by interference is important to resolving interference-related performance issues. This includes a description of your overall network, and the configuration of the CBSDs in your network.

7.3.1 Network Topology Information

The network object identifies the network according to its technology identifiers, provides a summary of network size and location, describes its minimum requirements of the radio environment, and describes its CBSDs. These attributes support discussion with other CBSD Users to resolve identified interference issues.

NETWORK TOPOLOGY Information			
Network Identity Attributes		**MCC:**	
		MNC:	
		CSG-ID/CBRS NID:	
Network Summary	**Device Counts**	**Number of Category A CBSDs:**	
		Number of Category B CBSDs:	
		Number of UEs:	
	Service Area Attributes	**Area of Network Coverage (Approximate center point latitude/longitude + radius, bounding lat/long coordinates, KML file, etc.)**	
	Minimum Requirements	**Needed Spectrum Bandwidth:**	
		RSRP:	
		RSRQ:	
		RSSI:	
		SINR:	
CBSD List		**CBSD Information Objects:** (see below)	

Table 4: Network Object Attributes

7.3.2 CBSD Information

The CBSD object describes the CBSDs used within your network, along with the relevant information about how those CBSDs are configured. You should already have much of this information on hand, as this is the information that the CPI needed to register your network with your SAS Administrator. You should also provide additional information, such as the identifiers used by the CBSD, and its LTE/5GS configuration.

CBSD Information Object		
CBRS Identity Attributes	**FCC ID:**	
	Manufacturer Serial #:	
	Sector ID:	
	TP ID:	
Network Identity Attributes	**MCC:**	
	MNC:	
	CSG ID:	
	eNB/gNB ID:	
	Cell ID:	
	PCI:	
Transmission Point Attributes	**Longitude:**	
	Latitude:	
	HAAT:	
	Azimuth:	
	Beamwidth:	
	Tilt:	
Frequency Attributes	**Start Frequency:**	
	Stop Frequency:	
	Bandwidth:	
	SFG / CCG:	
	SRG / ICG:	
	TDD Configuration:	
	Transmit Power:	
Interference Attributes	**Is Interfered:**	
	Start DateTime:	
	Stop DateTime:	
Minimum Requirements	**RSRP:**	
	RSRQ:	
	RSSI:	
	SINR:	
Preferred/Desired Frequency Attributes	**Start Frequency:**	
	Stop Frequency:	
	Bandwidth:	
	SFG / CCG:	
	SRG / ICG:	
	TDD Configuration:	
	Transmit Power:	

Table 5: CBSD object attributes

7.4 Channel Information

Information about the channel state and quality is needed by the SAS Administrator, as it helps the SAS Administrator identify the availability and suitability of channels for the interacting networks, and coordinate possible changes with the operator of the interfering network.

CHANNEL Information Object			
MEASUREMENT Attributes	**Time Attributes**	**Start DateTime:**	
		Stop DateTime:	
		Measurement Duration:	
		Measurement Interval:	
	Location Attributes	**Measuring Device Description:**	
		Measuring Device ID:	
		Longitude:	
		Latitude:	
		Altitude:	
CHANNEL Attributes	**Frequency Attributes**	**Start frequency:**	
		Stop frequency:	
	Power Attributes	**Received power:**	
		Noise power:	
		Duration:	
		Interval:	
		Occupancy:	
		Acceptability:	
		Min. reduction required:	

Table 6: Channel object attributes

7.5 Signal Information

The elements in this section describe the signals that are observed in the environment, providing information and evidence of actual or potential interferers. This provides SAS Administrators with valuable information to refine their models that underpin GCA Frequency Plans.

SIGNAL Information Object			
MEASUREMENT Attributes	Time Attributes	Start DateTime:	
		Stop DateTime:	
		Measurement duration:	
		Measurement interval:	
	Location Attributes	Measuring Device description:	
		Measuring Device ID:	
		Longitude:	
		Latitude:	
		Altitude:	
SIGNAL Attributes	Frequency Attributes	Start frequency:	
		Center frequency:	
		Stop frequency:	
		Bandwidth:	
	Time Attributes	First observance:	
		Last observance:	
		Frequency of observation:	
	Power Attributes	Received power:	
	Protocol Attributes	Air Interface:	
		Modulation:	
Emitter Attributes	Protocol Attributes	TDD Configuration:	
	Identity Attributes	MCC:	
		MNC:	
		CSG ID:	
		eNB/gNB ID:	
		PCI:	
	Location Attributes	Longitude:	
		Latitude:	
		Altitude:	
		Horizontal Uncertainty:	
		Vertical Uncertainty:	
		Azimuth:	
	Signal Metrics	RSRP:	
		RSRQ:	
		SINR:	
		Pathloss:	
	User Metrics	Active Users:	
	CCE Metrics	Available CCE:	
	Interferer Downlink Metrics	Cell DL data rate:	
		DL MCS:	
		DL PRB utilization:	
		DL spatial multiplexing:	
	Interferer Uplink Metrics	Cell UL data rate:	
		UL MCS:	
		UL PRB utilization:	
		UL retransmission:	

Table 7: Signal object attributes (1 per interfering signal/channel)

8 References

[1] OnGo TS-2003 “Collaborative GAA Coexistence Technical Specification”, December 5, 2023, version 5.0.0

[2] “OnGo Private LTE Deployment Guide”, January 2022, version 2.1.0

[3] “OnGo Private 5G Deployment Guide”, April 2022, version 1.0.0

[4] “OnGo Neutral Host Network Deployment Guide”, November 2021, version 1.0.2

9 Definition and Abbreviations

9.1 Definitions

Term	Definition
CBSD User	The registered entity that has operational responsibility for the CBSD [WINNF-TS-0112, V1.9.1, section 2.1] (May be a network operator or an enterprise)
Delegated Channel Selection	Mechanism where a CBRS network relies on the SAS to directly assign which channels to use.
GCA Frequency Plan	A scheme for allocating channels to participating GAA users in an area to minimize interference between their networks.
OnGo Alliance	Industry standards organization focused on the use of 3GPP networks (LTE and 5GS) in the CBRS band.
WInnForum	The Wireless Innovation Forum, organization responsible for developing specifications for the CBRS band.

9.2 Abbreviations

Term	Definition
3GPP	3rd Generation Partnership Project
5GS	Fifth Generation System
CBRS	Citizens Band Radio Service
CBSD	Citizens Band Radio Service Device, a Base Station
CCE	Control Channel Element
CCG	Common Channel Group
CPI	Certified Professional Installer
CPE	Customer Premises Equipment
CSG-ID	Closed Subscriber Group Identifier, LTE, used to transmit CBRS NID for networks using the CBRS SHNI.
dBm	dB milliwatts
DL	Downlink
eNB	Evolved Node B, an LTE base station/CBSD
ESC	Environmental Sensing Capability
EUD	End User Device, CBRS term for mobile devices, an LTE or 5GS UE
FCC	Federal Communications Commission
FCC ID	FCC Identifier, a unique identifier assigned to produced that have been authorized by the FCC.
GAA	General Authorized Access, the lowest tier of access to the CBRS band
GCA	GAA Coexistence Area
gNB	Next Generation Node B, a 5GS base station/CBSD

HAAT	Height Above Average Terrain
ICG	Interference Coordination Group
LTE	Long Term Evolution, the 3GPP's 4th Generation Standard
MHz	Megahertz
MCC	Mobile Country Code, 3-Digit component of PLMN-ID, assigned by ITU
MCS	Modulation Coding Scheme
MNC	Mobile Network Code, 3-Digit (in US) component of the PLMN-ID, assigned by US IMSI Administrator
NR	New Radio, the air interface of the 5GS
PAL	Priority Access License, the second tier of access to the CBRS band
PCI	Physical Cell Identifier, locally unique identifier for individual cells of a 3GPP network, used a part of the self-optimization systems of 3GPP networks.
PLMN ID	Public Land Mobile Network Identifier, used to identify 3GPP (and other) networks.
PRB	Physical Resource Block
RAN	Radio Access Network
RSRP	Reference Signal Received Power, a measure of received signal power
RSRQ	Reference Signal Received Quality, a measure of received signal quality
RSSI	Received Signal Strength Indicator, a measure of received signal power
SAS	Spectrum Access System
SFG	Single Frequency Group
SINR	Signal-to-Interference-Plus-Noise Ratio, a standard measurement of signal quality
SRG	Spectrum Re-use Group
TAC	Tracking Area Codes
TDD	Time Division Duplexing, where uplink and downlink signals use the same channel, operating at different times.
TP ID	Transmit Point ID
UE	User Equipment, the mobile device in a 3GPP network, an EUD
UL	Uplink