Application Note

XIRRUS®

Auto Channel

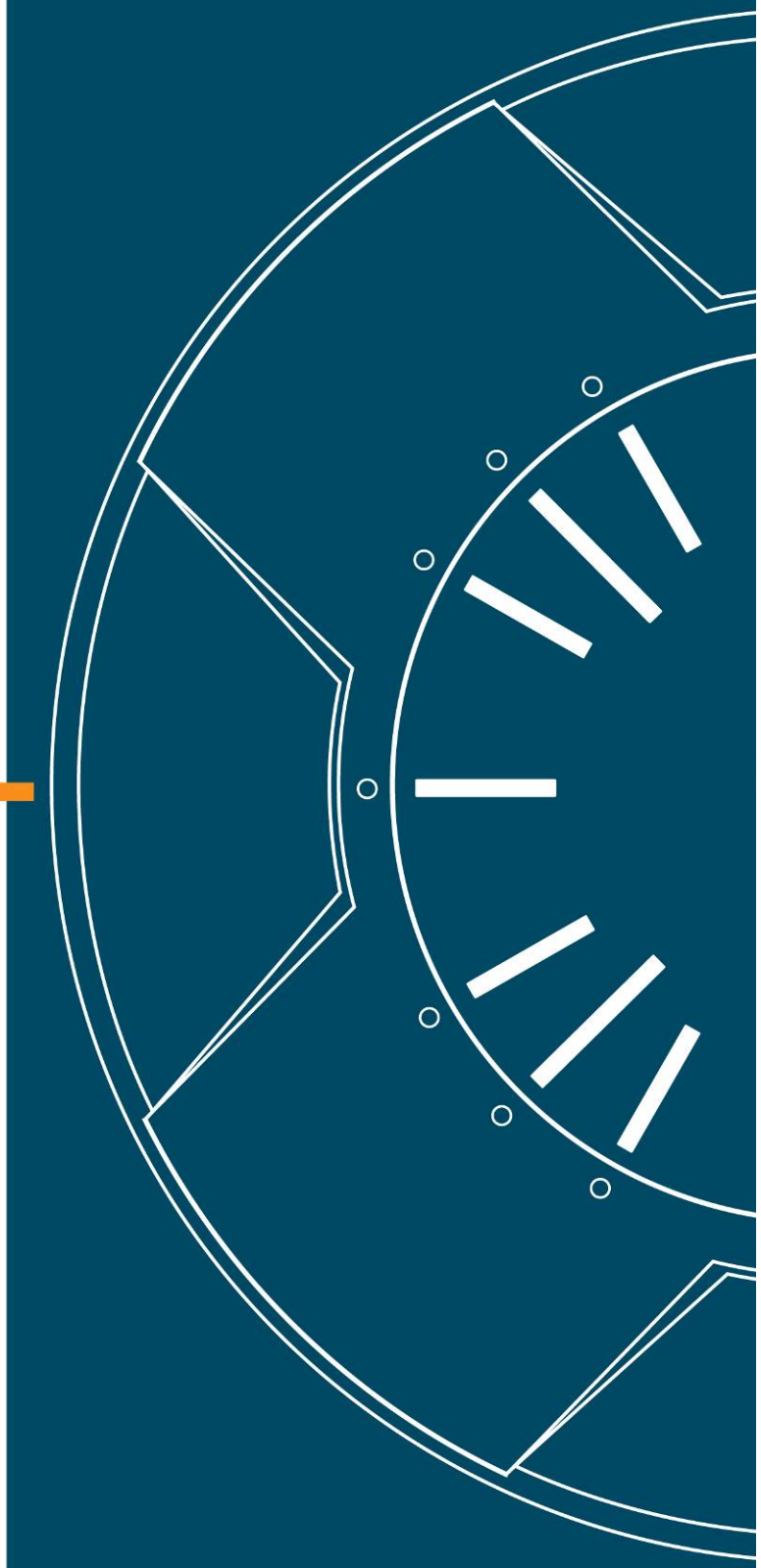


Table of Contents

Background 3
Description 3
Benefits 3
Theory of Operation 4
Interaction with Other Features 6
Configuration 7
Tips and Recommendations 11

Background

Wi-Fi systems operate on a set number of channels. Each channel represents a slice of RF spectrum to which a given radio is tuned and sends/receives data. When planning a Wi-Fi network, appropriately assigning channels to radios within the network is a key part of the process.

Wi-Fi is effectively a half-duplex communication medium, meaning that only one device can send information over the air on a specific channel at any one time. When deploying multiple Wi-Fi access points (AP's), one must ensure radios in close proximity to each other are not tuned to the same channels. If this occurs, multiple clients may attempt to communicate at the same time over the same channel frequency. This results in multiple radios (APs) effectively forming a single large virtual cell where only one client can communicate at a time, even though there are multiple radios available. The overall result is increased contention, additional transmission deferrals,, and ultimately reduced network performance.

Description

To optimize Wi-Fi network performance and operation, a channel plan must be correctly done when multiple radios are deployed. While channel planning can be done manually, it is tedious at best. The Xirrus Wi-Fi Array supports an Auto Channel assignment feature that simplifies and increases the accuracy of the plan. Auto Channel assignment is performed by scanning the surrounding area for RF activity on all channels, then automatically selecting and setting channels on the Array to the best channels available. This function is typically executed when initially installing Arrays in a new location and may optionally be configured to execute periodically to account for changes in the RF environment over time.

Benefits

The benefits of automatic channel assignment in the Xirrus Wi-Fi Array are as follows:

- Eliminates tenuous manual channel planning.
- Optimizes a Wi-Fi network for best overall performance.
- Allows the Array to come up for the first time and not interfere with existing equipment that may be already running, thereby limiting co-channel interference.
- More accurately tunes the RF characteristics of a Wi-Fi installation than manual configuration since the radios themselves are scanning the environment from their physical location.
- Scheduled Auto Channel allows dynamic adjustment and tuning in response to environmental changes at designated time intervals.

Theory of Operation

When using Auto Channel assignment, radios in the same Array and between multiple Arrays are automatically set to different channels that have enough frequency spread between them so they do not interfere with each other. As an example, refer to Figure 1. In this case, radios A1 on Array 1 and A3 on Array 2 are facing each other but set to Channels 40 and 60.

Auto Channel derives an optimal channel plan by first evaluating the external RF environment around the Array and then determining appropriate channel assignments for the internal radios (IAPs). When running Auto Channel, all radios on the Array tune to the same channel for a period of 250msec. All radios listen for RF signals from any source arriving on this channel, whether Wi-Fi or otherwise. Radios whose antennas are oriented towards another radio operating on this channel will receive substantially more signal than those not so oriented. This information is recorded and will be used to determine a 'signal score'. All radios are then tuned to the next channel, and this process continues until all channels are examined– up to 14 different channels for radios operating in the 2.4GHz band (802.11b/g/n), and up to 26 different channels for radios operating in the 5GHz band (802.11a/n). The signal strength of valid 802.11 traffic and non-802.11 interference, as well as noise floor and signal-to-noise ratio (SNR), are all taken into consideration.

When all specified channels have been scanned, channel usage information is tabulated into a spectrum usage matrix. All information in the matrix is then compared with the Array's 'Channel Allocation Map' which offers millions of potential channel configurations to maximize optimize channel allocation. Spacing between physically adjacent radios within the Array itself is also taken into consideration. Based on these calculations, the most advantageous channel assignments are applied to the Arrays directional radios/antennas.

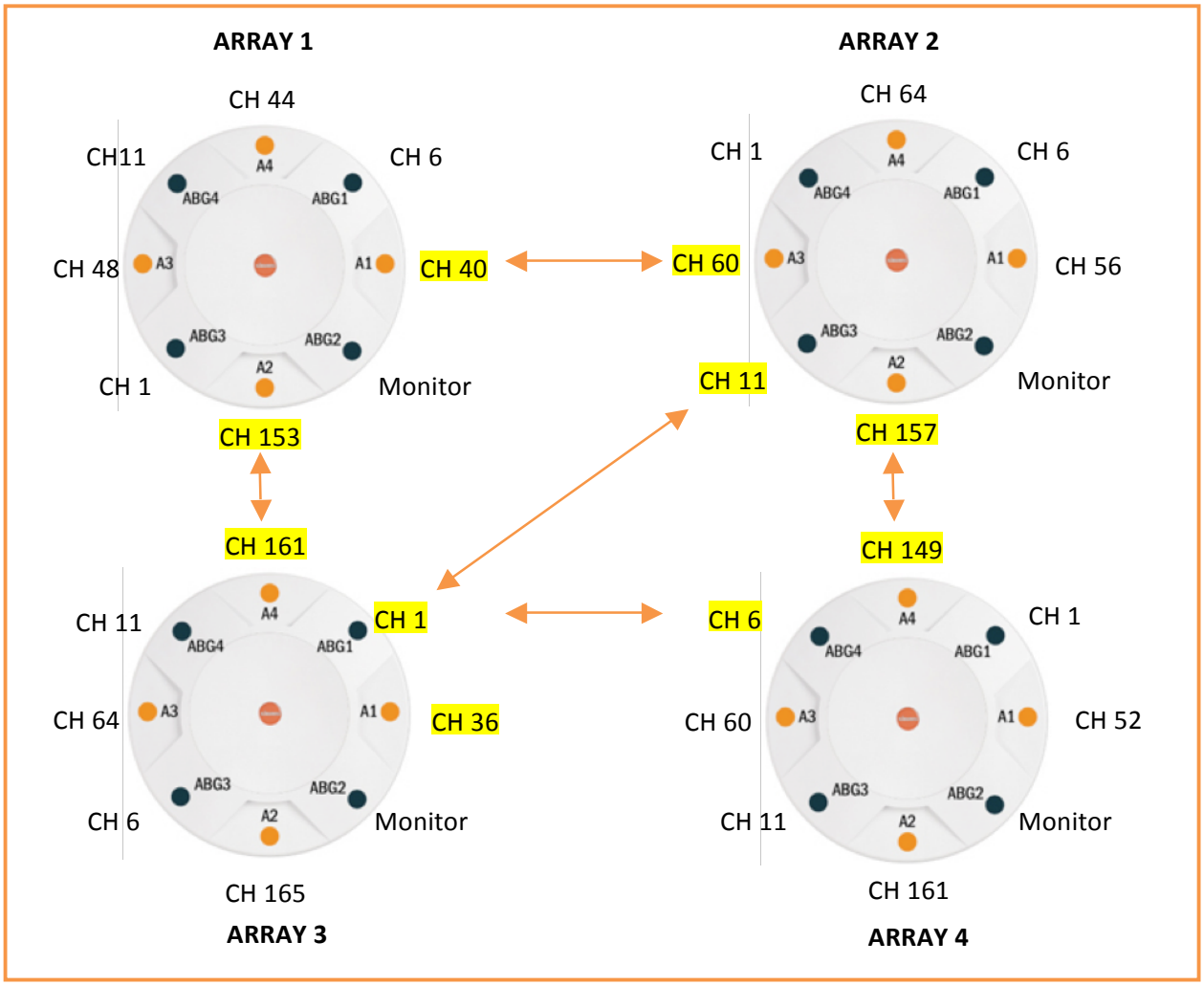


Figure 1: Example of optimum channel settings

Auto Channel can be set on a Wi-Fi Array to start manually on-demand or automatically on startup or per a schedule. The entire Auto Channel process takes about 40 seconds to complete. During this time, radios share equal time between supporting Wi-Fi clients and running the Auto Channel scan. In this way, Auto Channel does not significantly disrupt associated stations. At the end of the Auto Channel process, if Array radios must be reassigned to a new channel, connected stations are informed via 802.11h packets that the channel change is about to occur. The channel change only temporarily impacts stations. In most cases, they will reconnect to the same or a different radio on a new channel within several hundred milliseconds.

Two Arrays within RF range of each other should never run Auto Channel at the same time. Therefore when one Array is running Auto Channel, all other Arrays in range are alerted via the Information Elements in its beacons. If multiple Arrays are configured to run Auto Channel at the same time, they will automatically negotiate between themselves and pick an order in which to run. Only one Array will run Auto Channel at a given time to prevent race conditions in setting channels and to avoid a faulty channel plan.

When Auto Channel completes, the new IAP channel list is set and automatically saved. Once set, the option is available to lock channel settings so that they will not be changed again by another Auto Channel operation unless explicitly unlocked.

Interaction with Other Features

Operation of Auto Channel on the Wi-Fi Array may interact with other features as follows:

- The country code must be set on the Array prior to using Auto Channel (see Configuration Step 1). This will prevent selection of channels that are not allowed in the country of operation.
- When Auto Channel is set, it will automatically configure IAP channel settings. It will override any channel settings made in IAP Settings.
- Channels used for an active WDS link should not be changed as this will break the wireless backhaul connection. If you are using a WDS link between two Arrays, set the radio channel for the WDS radios to Lock since the radios on both side of the link need to remain on the same channel. In the Figure 2, radio a4 is locked on channel 136. The Array will automatically not include radios assigned to WDS in the Auto Channel process.

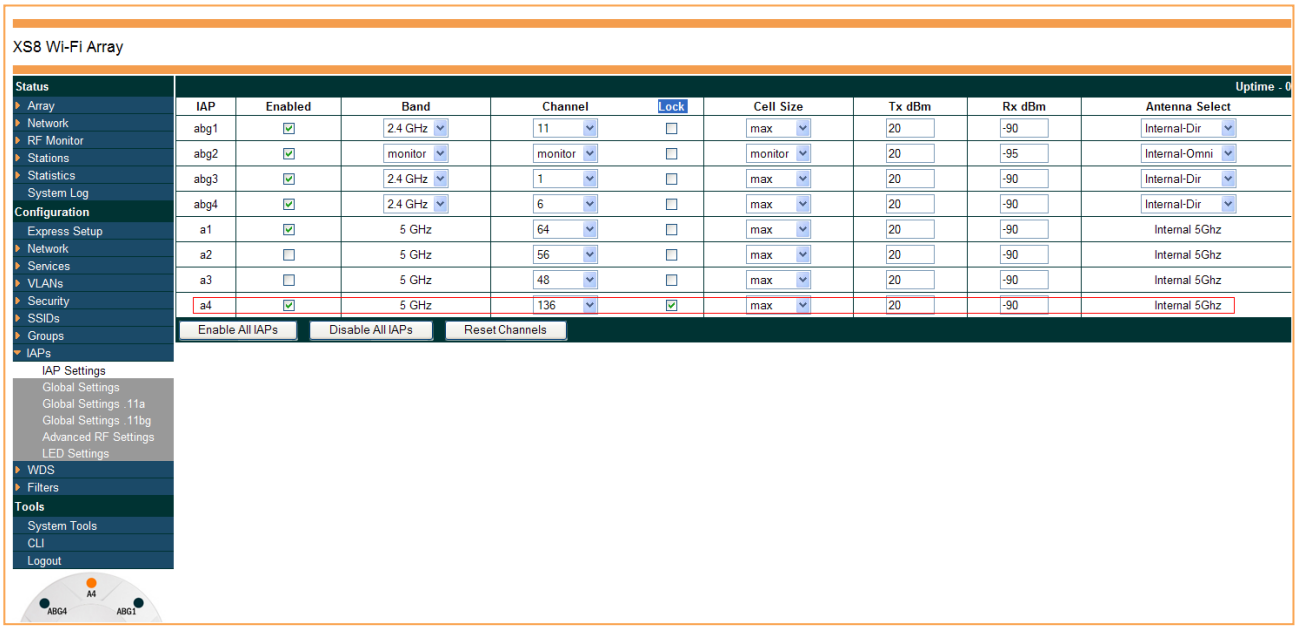


Figure 2: IAP Settings

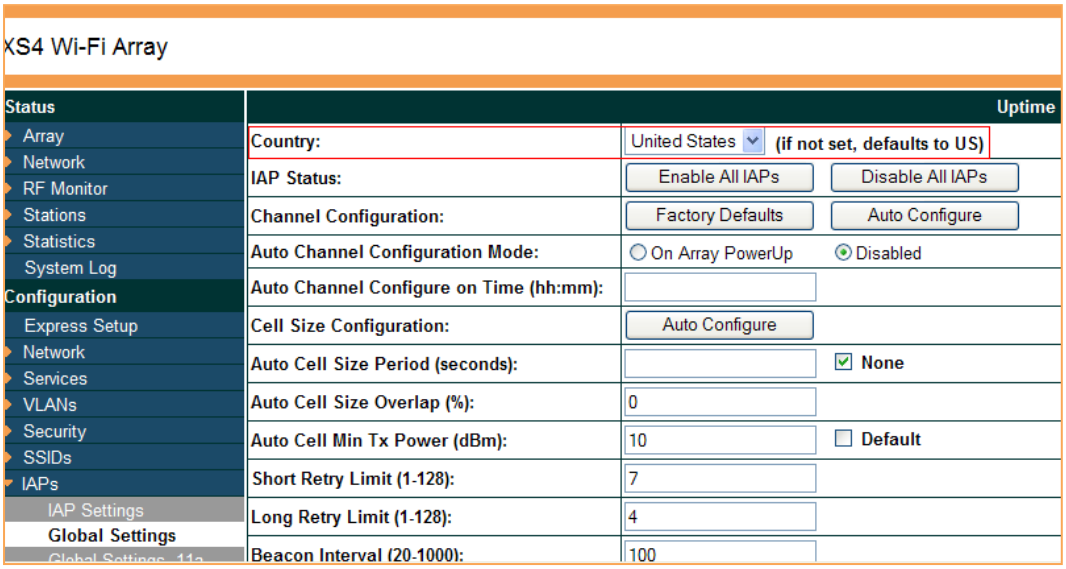
Configuration

Auto Channel configuration is a simple process no matter the method used (WMI or CLI) and only requires a few steps.

Note: *This application note is based on ArrayOS version 3.4 and later.*

Auto Channel Configuration Using the Web Management Interface (WMI)

1. Ensure that the country of operation has been set on all Arrays. If the country has not been set, the Array will default to a limited set of channels that are available globally in all countries. This default list will significantly limit the options available for your channel plan.
    a. The country code selection can be made on the IAP Global Settings screen.



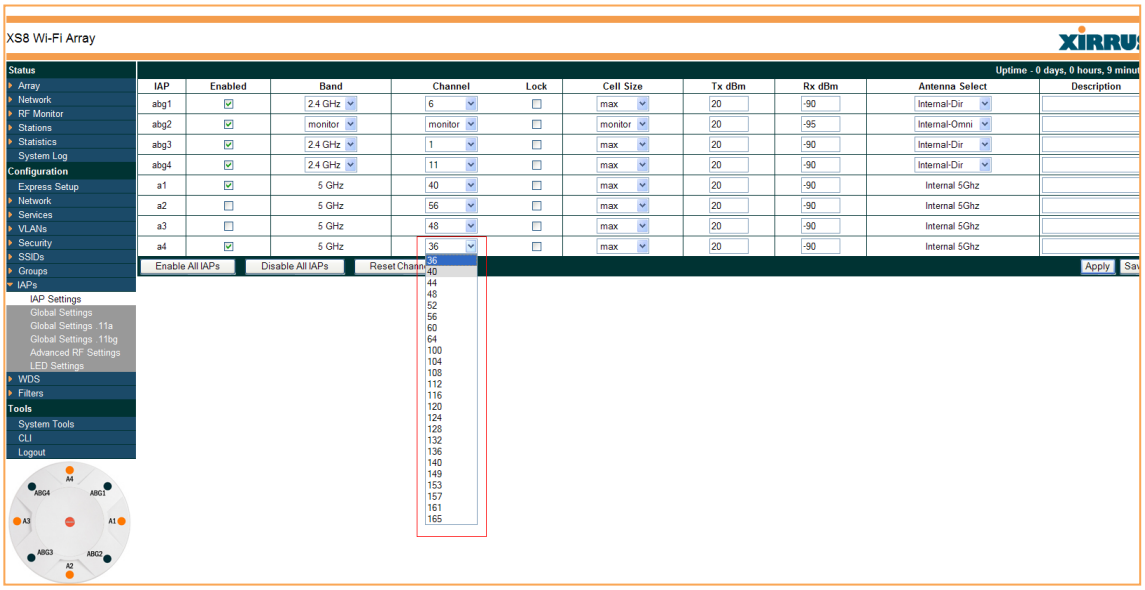
2. Determine the appropriate channel list for operation in your network.

    a. For operation in the United States, this will typically be:
        i. 802.11b/g channels 1, 6, and 11. These 3 channels do not overlap with each other in the 2.4GHz spectrum.
        ii. 802.11a channels 36 through 64 and 149 through 165. Most laptop clients typically support the 13 channels in these two ranges. An additional 11 channels (100-140) are available with the Wi-Fi Array, but are not supported by many clients. It is recommended to use these for WDS connections if required.
        iii. For Public Safety operation only, channels 191 and 195. Operation on these channels in the 4.9GHz requires a license and is reserved for emergency use. These channels are only available by enabling Public Safety in IAP Advanced RF settings.

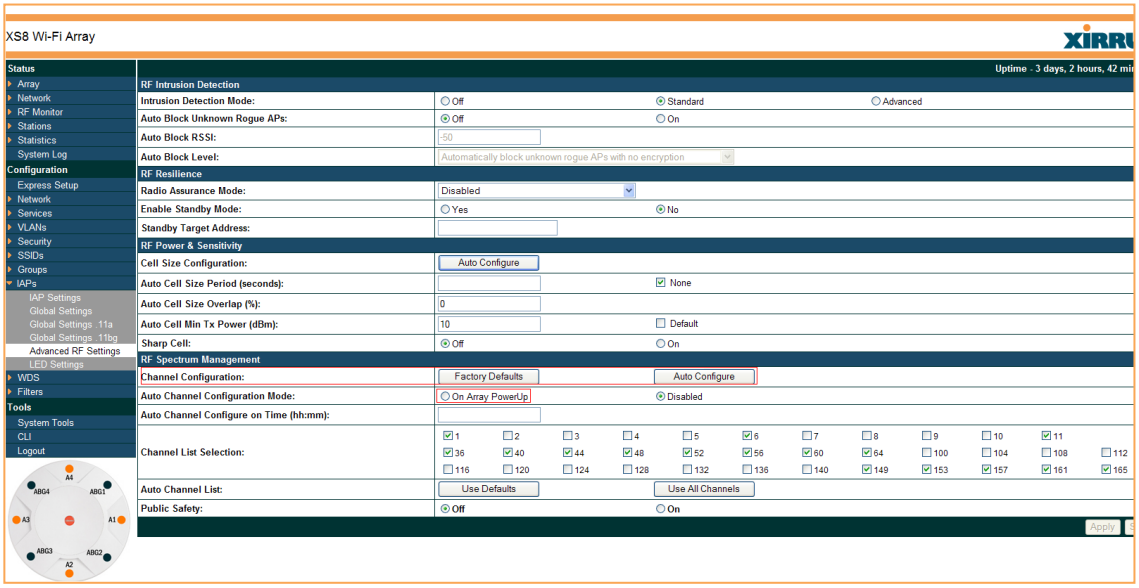
b. Operation in other countries will add or remove channels to the list as required by that region.

3. Set the channel list that will be available on the Array for Auto Channel configuration.
   a. Go to Advanced RF Settings and set the list under Channel List Selection. If running Public Safety channels, set Public Safety to On. You must have a license to run the Public Safety channels.

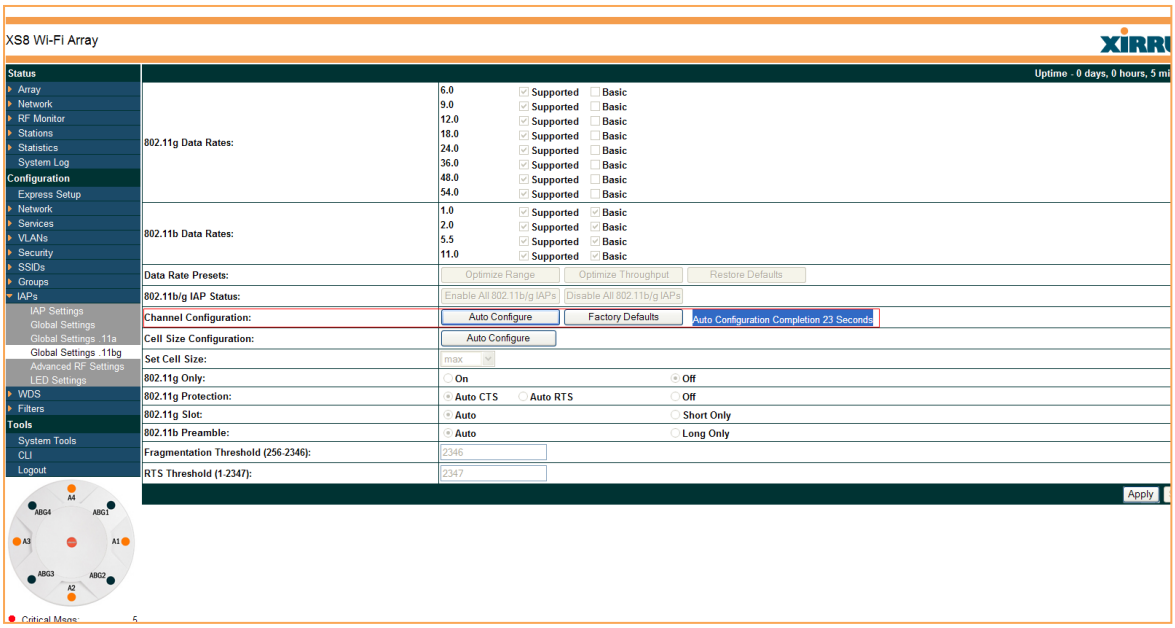
4. Lock the channels on radios that should not be set by Auto Channel.
   a. Go to IAPs / IAP Settings and select Lock on any radios that should not participate in Auto Channel.



5. Start Auto Channel.
   a. To run Auto Channel, select Channel Configuration / Auto Configure under Advanced RF Settings / RF Spectrum Management or per band under IAPs / Global Settings .11a and .11bg.



6. After selecting Auto Configure, the Auto Channel configuration will commence, taking about 40 seconds to complete. The time remaining in the operation will be displayed on the window.



7. After the Auto Channel operation is complete, the best channels of operation will be set on each enabled radio that did not have its channel locked. Save the configuration by clicking the Save button. Radios that have had their channels set automatically will show the word “Auto” in the Channel column on the IAPs screen.

8. If desired, set Auto Channel to run at boot-up by selecting On Array PowerUp for Auto Channel Configuration Mode in Advanced RF Settings. This setting is useful if the Array will be set up in a remote location or deployed in temporary environments. In most permanent

installations however, maintaining the same channel plan across power cycles is sufficient.

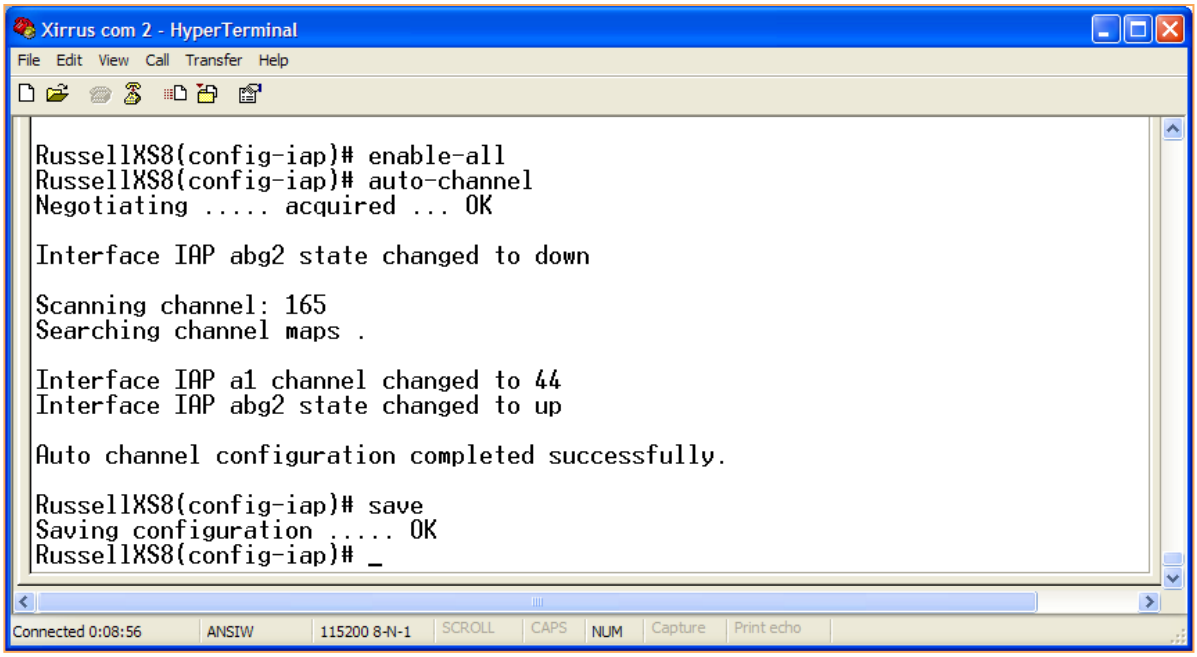
9. If desired, set a time for Auto Channel to run automatically each day by entering a time in the Auto Channel Configure on Time box. This setting is useful if the Array is deployed in a frequently changing RF environment, for example movement of furniture, equipment, etc. or dynamic changes in the presence or operation of other RF devices in the area. If making this setting on multiple Arrays, stagger the time that each starts by 5 minutes.

   Note: *Arrays in RF proximity of each other should not run Auto Channel at the same time. Arrays will detect if other Arrays are running Auto Channel and back off automatically, but they should not be scheduled to execute at the same time.*

Auto Channel Configuration Using the Command Line Interface (CLI)

Auto Channel configuration is done under the IAP settings area of the CLI.

1. XS8# configure
2. XS8(config)# interface iap
3. XS8(config-iap)# enable-all
4. XS8(config-iap)# auto-channel
5. Save



Tips and Recommendations

When should Auto Channel be run?

Auto Channel should be run whenever one or more Arrays are installed for the first time or otherwise brought on-line. Following the initial run, Auto Channel should be configured to run periodically with the frequency dependent upon the environment. Auto Channel should be run more frequently when there are significant changes to the RF environment, such as:

- Wi-Fi network operation and changes from neighboring Wi-Fi users
- Significant addition or movement of furniture, equipment, walls, people, etc.
- New or changing interference sources such as microwave ovens, cordless phones, etc.

How should Auto Channel be run for the first time in a multi-Array installation?

Following initial installation, run Auto Channel manually starting with all Arrays powered on but radios off. Start Auto Channel on one Array first. After completion, start Auto Channel on the next Array, but never run it on two Arrays at the same time. In this way, the entire Array network will automatically assign channels in an optimized plan without overlapping each other.

How should Auto Channel be configured to run on a periodic schedule?

Typically set Auto Channel to run during off hours so as to minimize the impact on users. However users will maintain connection to the network during Auto Channel operation. A schedule of once per week should be sufficient for most environments. Scheduling can be set in the CLI (command line) or WMI (web interface) using the format: dd:hh:mm.

What channels should I include for Auto Channel operation?

The channel list is dependent on both local restrictions (country of operation) and likely client support. The current 5GHz band supports 24 channels, however not all clients also support all these channels. Including channels that clients cannot associate to will waste available Wi-Fi capacity. Configure channel options to meet the needs of the local environment. Setting the country code on the Array will set a common default channel list for Auto Channel.

How will Auto Channel impact WDS (Wi-Fi bridging) links?

If any radios are assigned to a WDS link, set the channels on those radios to Lock so that it will continue to match the channel of its WDS radio link partner. Auto Channel will automatically exclude WDS radios from its operation.

How will running Auto Channel impact an Array with associated clients?

In most cases, running Auto Channel and switching channels following its operation will be invisible to users (switching channels is a common roaming process). Time sensitive applications such as voice may be marginally impacted.