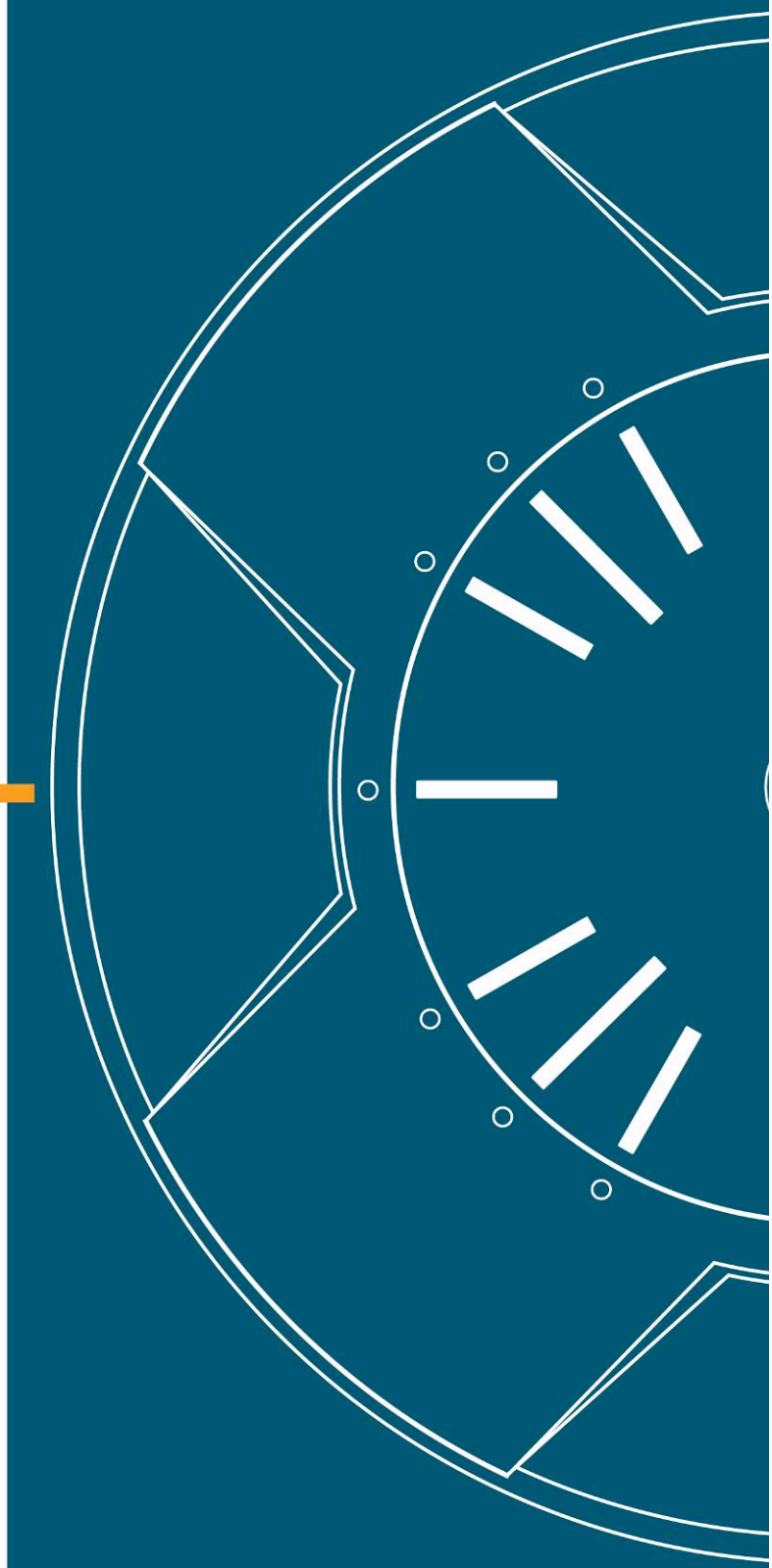
Application Note

XIRRUS®

Auto Cell



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Background

Radio Frequency (RF) is a dynamic medium for communication. Many factors can affect its reliability and overall performance, such as changes to the physical environment, neighboring Wi-Fi networks and component failures. For a successful Wi-Fi deployment, solutions must be designed that cannot only monitor the RF environment, but have the ability to dynamically adjust to changing conditions.

Points to consider when designing an enterprise class Wi-Fi solution**:**

- Flooding an area with cheap APs may seem like a good coverage plan, however co-channel interference can quickly becomes a problem.
  - Interference range is typically 2 times greater than operational range.
  - Interference is a 2 way street, impacting you and your neighbors.
- Changes in the RF environment are dynamic and require constant monitoring; continual manual 'tweaking' is not realistic.
- Device failures must be compensated for dynamically and quickly.

To handle the increasing performance expectations and requirements for Wi-Fi network deployments, a higher level of RF intelligence is needed than is typically found in traditional APs. Wi-Fi access devices must not only be able to monitor the RF environment, but adjust RF power levels to compensate for changes in the environment, system failures and support seamless roaming.

Description

The Xirrus Wi-Fi Array provides the highest performance of any Wi-Fi device in the industry with up to 2Gbps of data capacity (802.11n). This high performance is made possible by many advanced and/or patented features; one of these is Auto Cell. Auto Cell is an automatic, self-tuning mechanism that balances cell size between Arrays to guarantee coverage while limiting the RF energy that could extend beyond the organizational boundary.

Auto Cell uses communication between Arrays to dynamically set radio power so that complete coverage is provided to all areas, yet at the minimum power level required. This helps to minimize potential interference with neighboring networks. Additionally, Arrays running Auto Cell automatically detect and compensate for coverage gaps caused by system interruptions.

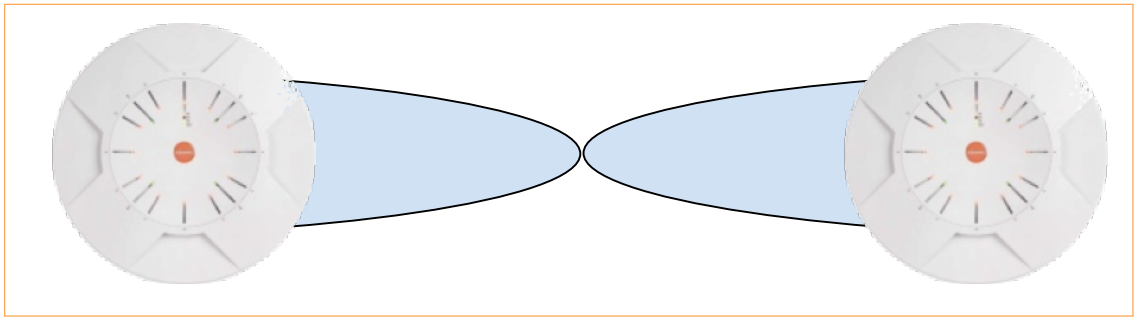


Figure 1: Auto Cell Coverage Balance

Several Auto Cell parameters can be defined including minimum cell size, scheduled RF assessment/adjustment, and the ability to define a coverage overlap percentage for roaming.

Without Auto Cell

Networks are commonly designed with either an abundance of APs to prevent coverage gaps if one were to fail, or designed for minimum coverage with failed APs needing manual replacement to restore 100% coverage.

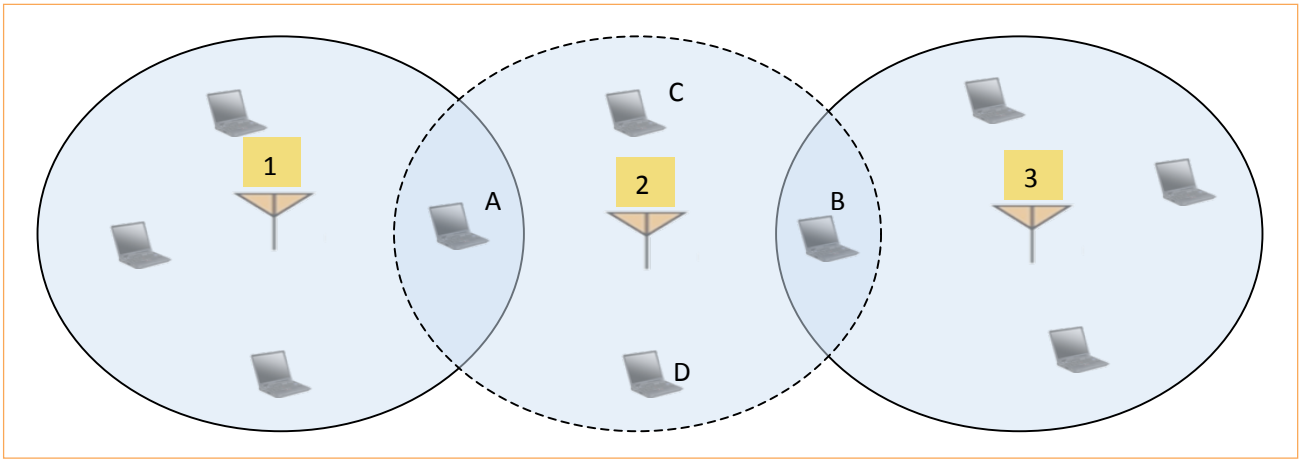


Figure 2: Typical Coverage without Auto Cell

- If all radios are operating, clients A and B (cell #2) could potentially experience interference from neighboring APs.
  - Weak interference could result in corrupted packets.
  - Strong co-channel interference could cause clients in adjacent cells (1 and 3) to defer communication while clients in cell 2 are transmitting. This is often called “virtual cell merging” and overall throughput is greatly reduced.
- Clients C and D could lose all connectivity in the event AP #2 were to fail.

With Auto Cell

Radios automatically adjust and balance coverage between Wi-Fi Arrays.

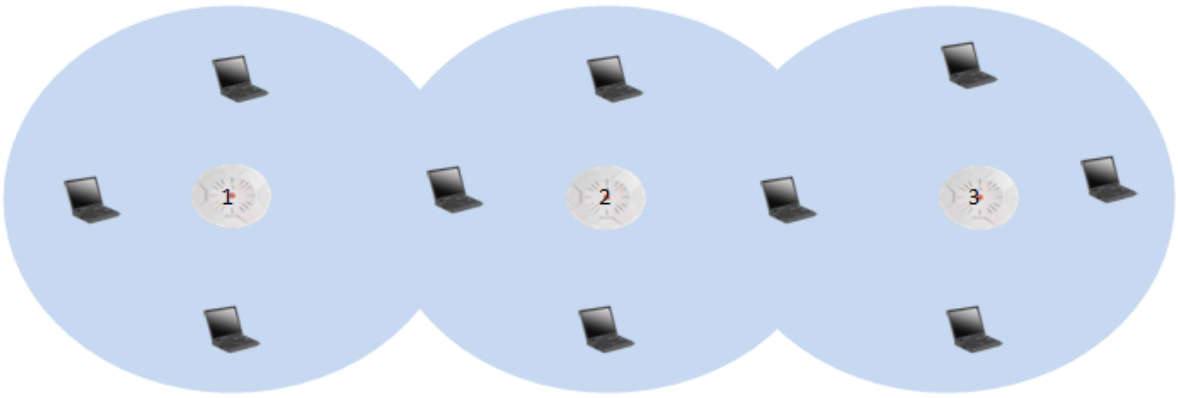


Figure 3: Coverage with All Arrays in Operation

All cells operate on separate channels to avoid co-channel interference. A 15% overlap between cells is provided in the example in Figure 3 for seamless roaming.

In case of Array failure (Array 2 in Figure 4), Arrays 1 and 3 automatically increase radio power (larger cells size) to compensate for the down Array. As a result of the Array's directional antennas, only those radios on sectors facing the failed Array are required to adjust power. Additionally, cell overlap is retained to support seamless roaming.

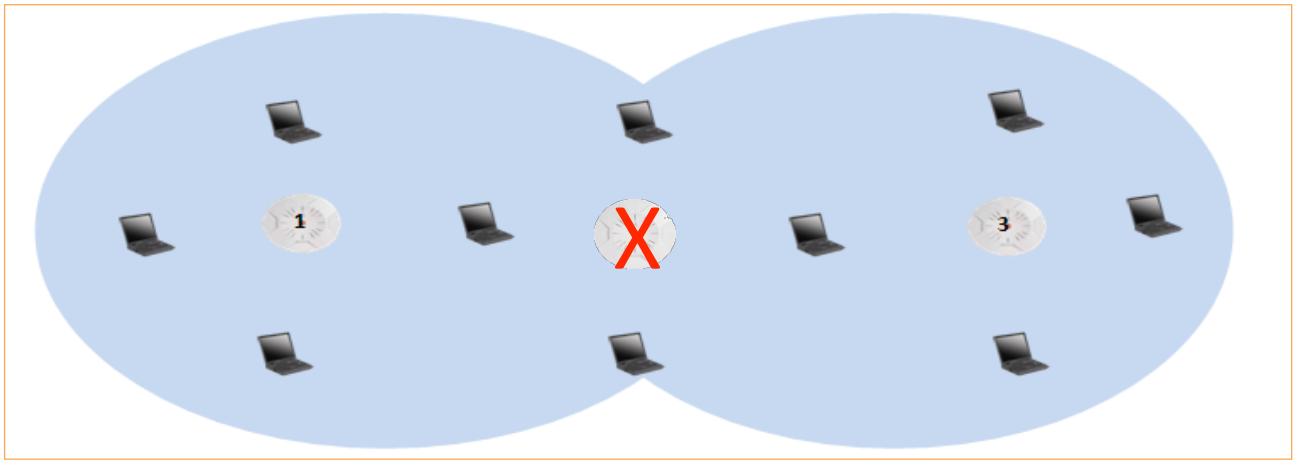


Figure 4: With Auto Cell – Self-Adapting Coverage Solution

- Array radios balance power levels between themselves to guarantee client coverage, but without the potential of interfering with other cells.
- In the event of a failure in this example, Arrays 1 and 3 automatically detect the loss of energy from Array 2 and raise their own radio power levels to compensate for the loss. Clients who were on Array 2 then re-associate to the other Arrays.

Benefits

Auto Cell technology is designed to intelligently control the amount of RF energy by allowing the Arrays to exchange received energy information and adjust transmit levels accordingly. Auto Cell provides the following benefits to a Wi-Fi Array deployment:

- Automatic cell size adjustment fills coverage gaps caused by device failures.
- Self-tuning sector sizes reduce interference with adjacent Arrays.
- Automatic cell size adjustments ensure proper coverage and minimize coverage gaps in an Array network.
- Automatic tuning adjusts cell sizes to cover gaps caused by changes in physical environments (partitions, walls, furniture, etc.).
- Adjusts based on individual IAPs, eliminates cascading RF adjustments.
- Allows ability to set overlap area (0-100%) to support seamless roaming.
- Allows scheduled intervals for RF tuning.

Theory of Operation

Auto Cell technology is one of several Advanced RF Management features in the Xirrus Wi-Fi Array. It is designed to dynamically control radio power to balance the coverage between multiple Wi-Fi Arrays. At the most basic level, Arrays exchange signal strength information. Based on this information, each Array then adjusts its transmit power to provide the level of coverage and resiliency required.

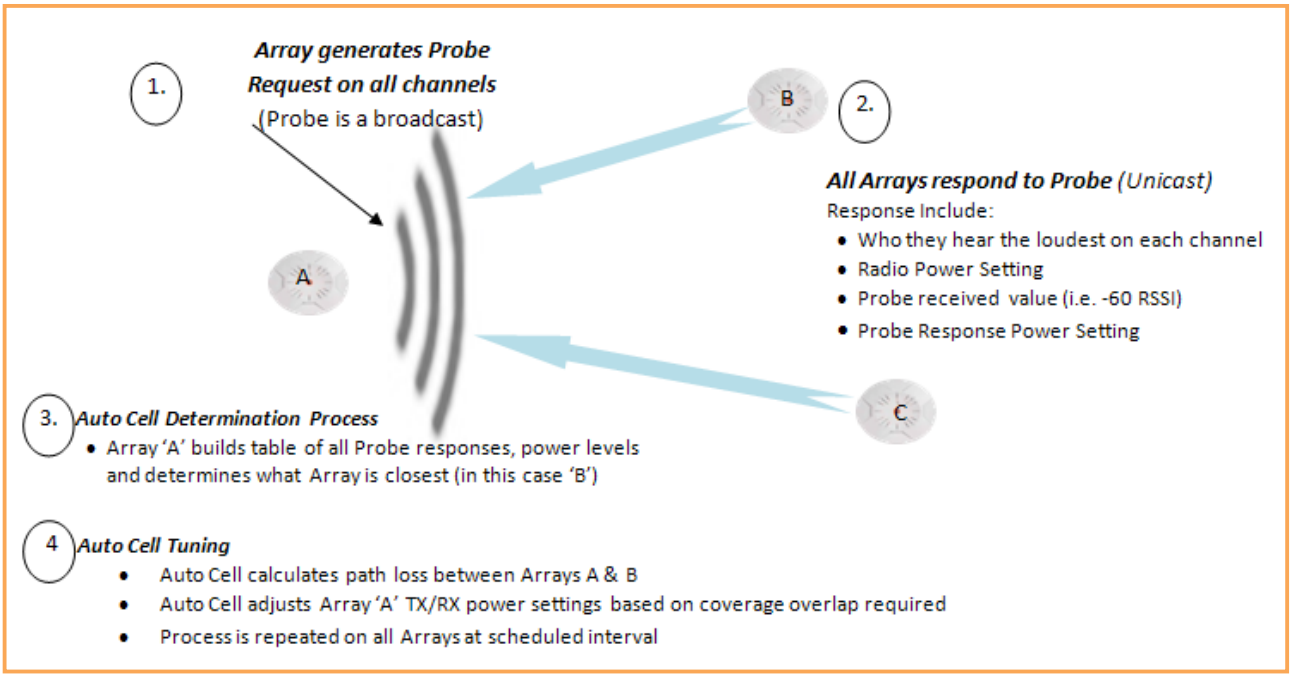


Figure 5: Auto Cell Process

Following is a more detailed description of the Auto Cell process as shown in Figure 5:

1. Every Array transmits a broadcast probe request on every channel every 250 msec and at full power.

2. Arrays hearing a probe request on an operating channel reply with a probe response.
    a. If the probe request came from a Wi-Fi Array, the probe response will be transmitted at max power.
    b. The probe response will contain an additional information element (IE) containing:
        i. The max power setting of the radio (power probe response was transmitted).
        ii. The current power level setting of the radio.
        iii. Who this Array hears the 'loudest' (highest RSSI):
            1. The 'loudest' Array's MAC address.
            2. The RSSI at which the loudest Array's probe response was heard.
            3. The TX power at which the loudest Array's probe response was sent.

3. As the initial Array receives probe responses, it performs the following functions:
    a. Tracks by channel which Array it has heard the loudest probe response.
        i. All radios include this information when responding to probes from other Arrays.

   b. Data is updated every 10 seconds.
   c. Checks to see if a probe response indicates that another Array hears this Array's probe responses loudest (highest RSSI) on this channel.

4. If Array receives a probe response from another Array indicating that it hears this Array's probe the loudest (highest RSSI) on a channel, then:
   a. The path loss between the Arrays is calculated from the information in the probe response IE's.
      i. Including the TX power and RSSI of the probe request/probe response transaction in both directions.
   b. Then, based on the overlap value (0% to 100%), the power of the radio operating on this channel is adjusted as follows:
      i. For an overlap of 0%, the power is adjusted so that the remote Array (that hears loudest) hears at -90dBm RSSI.
      ii. For an overlap of 100%, the power is adjusted so that the Array (that hears loudest) hears at -70dBm RSSI.
      iii. There is an adjustable minimum TX power (default is 10dbm) to maintain a minimum cell size.
   c. If a probe response is not received on a particular channel (indicating that no other Array hears this Array the loudest), the operating radio on that channel will be set to Max power.

The Auto Cell interval is set in seconds and adds only minimal traffic load. The interval sets the maximum amount of time before a failure could be detected and dynamically corrected. Sixty seconds in the minimum interval that can be set.

Note: *The Auto Cell process occurs on all Arrays, all IAPs (channels), and both directions simultaneously.*

Interaction with Other Features

Auto Cell is designed to work with other advanced RF services and optimize performance of these features. Operational interaction and dependencies on other Array features are as follows:

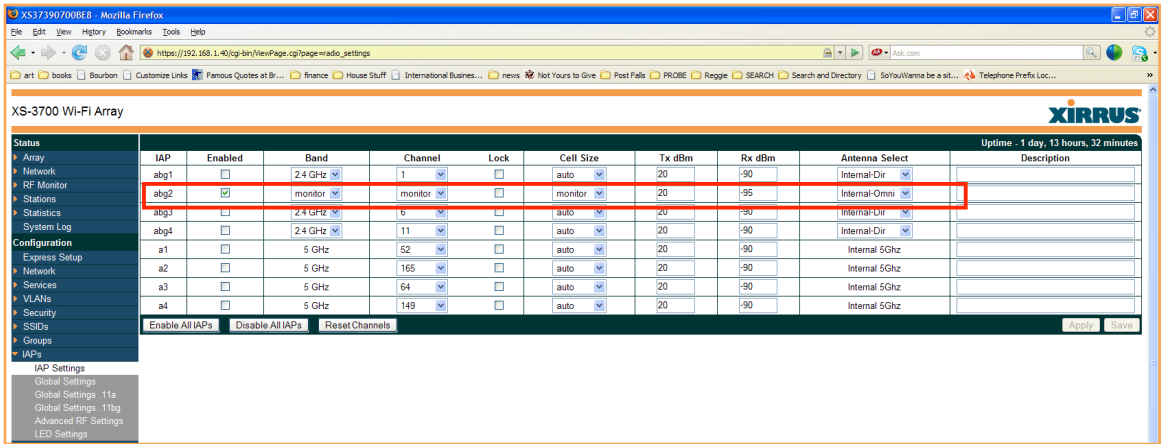
- Auto Cell uses the abg2 monitor radio. This IAP must be in monitor mode for Auto Cell to operate.
- Intrusion Detection mode must be set to Standard for Auto Cell to operate. Setting to 'Advanced' Intrusion Detection mode will disable Auto Cell.
- IAP cell sizes must be set to 'Auto. If manually set to other sizes (Small, Medium, Manual, etc.), Auto Cell will be disabled on those IAPs. A mixed environment, with some IAPs set to Auto and some set to fixed cell sizes, is possible and may be advisable in some environments.
- All other Array RF management functions, such as Auto Channel and Sharp Cell, are not impacted by Auto Cell and can work in conjunction.

Configuration

Auto Cell configuration is a simple process no matter the method used (WMI, CLI or XMS).

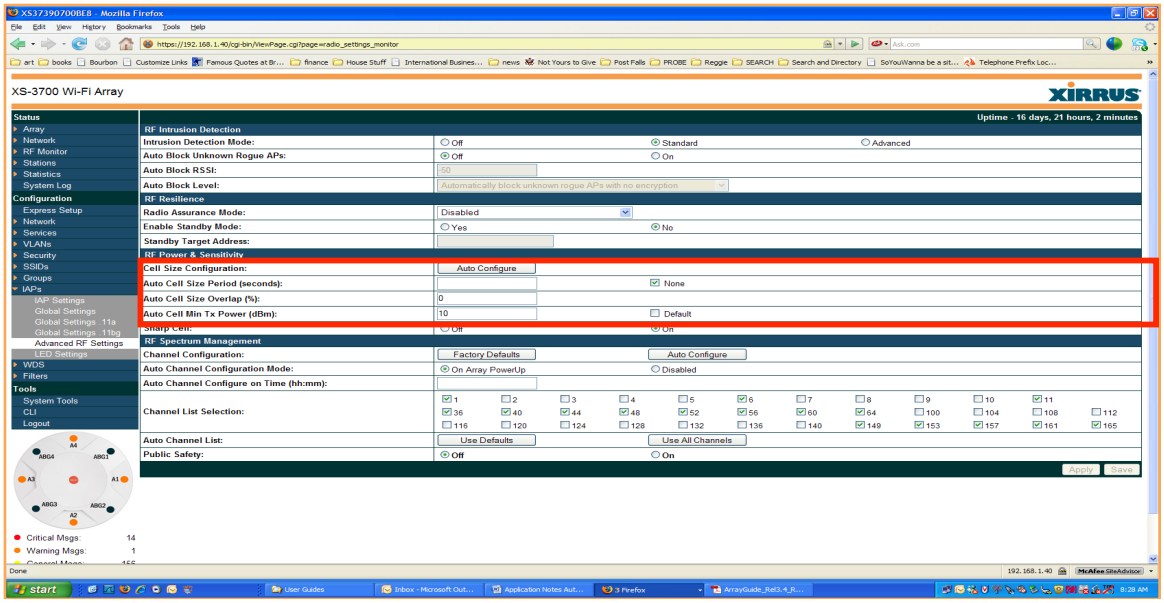
Auto Cell Configuration Using the Web Management Interface (WMI)

1. The first step is to confirm the abg2 radio is in monitor mode; this is required for Auto Cell operation. Go to the IAP Settings screen, confirm abg2 is enabled and Band is set to monitor.



2. Next, in the IAP Settings screen, set all IAPs (that will use Auto Cell) to Auto.

3. Next go to the IAPs / Advanced RF Settings screen. Confirm Intrusion Detection Mode is NOT set to Advanced. Auto Cell will be disabled if this is set to Advanced.



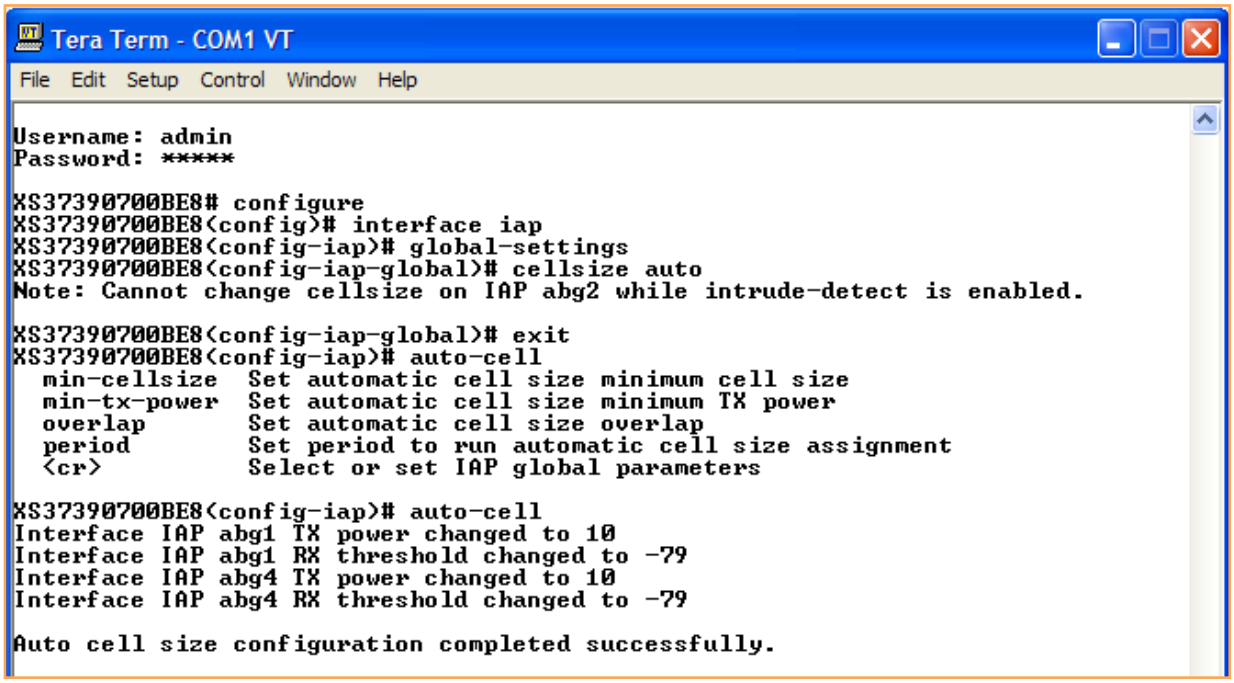
4. Next configure Auto Cell on the Advanced RF Settings screen. The settings are as follows:
    a. The Auto Cell Size Period field allows you to set up Auto Cell configuration to run periodically and to readjust cell sizes based on current conditions. Enter a value, in seconds to specify how often Auto Cell will run.
    b. The Auto Cell Size Overlap (%) field identifies the percentage of cell overlap allowed between Arrays. For 100% overlap, the power is adjusted such that neighboring Arrays will hear each other at -70dBm. For 0% overlap, that number is -90dBm.
    c. The Auto Cell Min Tx Power (dBm) field allows administrators to set a minimum transmit power that the Array will assign to a radio when adjusting cell sizes. The default is 10 dBm which is between a small and medium cell size.
    d. The Auto Configure button runs the configuration process based on parameters set in the previous steps. Select this button to run the Auto Cell process.

Auto Cell Configuration Using the Command Line Interface (CLI)

1. Confirm abg2 is enabled and set to monitor mode: configure / interface IAP / abg2 / show. If incorrect, make the following changes:
    a. Enable abg2: (config-iap-abg2)# enable.
    b. Set Monitor Mode: (config-iap-abg2)# monitor.

2. Configure Cell Size: configure / interface IAP / global-settings / cellsize.

3. Define Auto Cell Parameters: configure / interface IAP / auto-cell.
    a. Minimum Cell Size: Administrator can define minimum cell size based on standard cell sizes. Options include Large, Medium and Small.
        i. Command example: (config-iap-a1)# cellsize large.
    b. Minimum Transmit Power: Administrator can define minimum cell size based on dBm value. Default is 10dBm and can be set to a specific dBm value.
        i. Command example: (config-iap)# auto-cell min-tx-power -10.
    c. Cell Overlap: Administrator can set cell overlap between Arrays. At 100% overlap, the power is set so neighboring Arrays will hear each other at -70dBm. At 0% overlap, that number is -90dBm (enter a value between 0-100).
        i. Command example: (config-iap)# auto-cell overlap 100.
    d. Cell Period: Administrator can set configuration to run periodically and to readjust cell sizes based on current conditions. Enter a value in seconds (86400 seconds = 1 day).
        i. Command example: (config-iap)# auto-cell period 300.



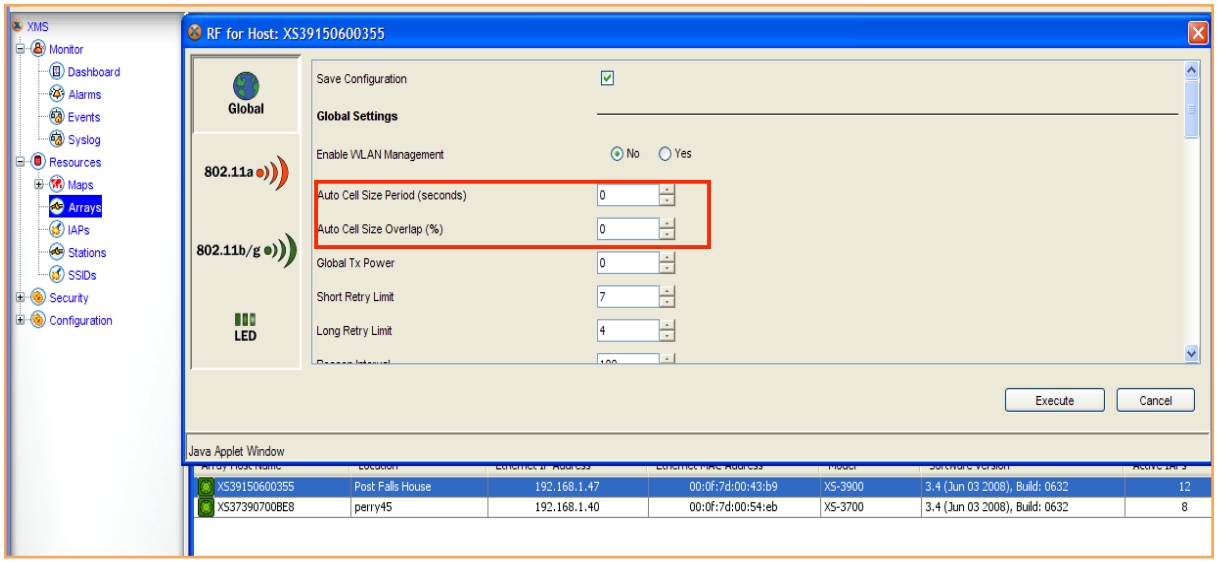
4. Enable Auto Cell: Once parameters are set, type “auto-cell” (from configure / iap) to launch Auto Cell configuration.

Auto Cell Configuration Using the Xirrus Management System (XMS)

The XMS can be used to configure Auto Cell on a single Array via the following procedure:

1. For a single Array configuration, go to Resources / Arrays and find the Array to be configured.

2. Right click the mouse on the Array to open the menu, and then select Configure and then RF. The following window will appear.



3. In the Global window, set the Auto Cell Period (interval) and the Auto Cell Size Overlap (%).
    a. Auto Cell Period: Enter value in seconds (86400 seconds = 1 day)
    b. Auto Cell Size Overlap: Enter a value between 0-100 (100% overlap = -70dBm Array-to-Array and 0% overlap = -90dBm)
4. The XMS can also be used to create a policy to configure Auto Cell on multiple Arrays.
5. Under Configuration, select RF.
6. In the RF window, select Add New Policy.
7. An identical window will be displayed as above. Configure the parameters required then execute the policy on one or more Arrays.

Application Example

Auto Cell balances power output to ensure complete RF coverage. Continual monitoring allows for the re-tuning if the RF environment changes. The following sequence demonstrates the operation of Auto Cell when radio failure is identified.

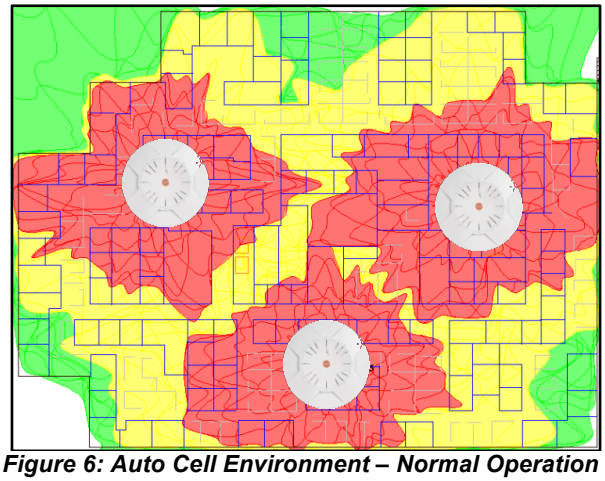


Figure 6: Auto Cell Environment – Normal Operation

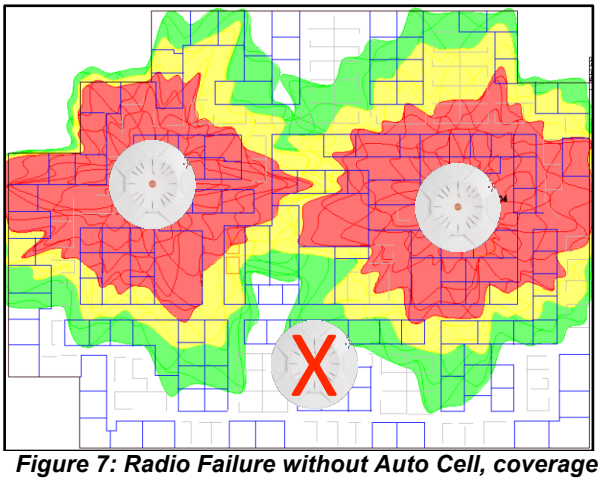


Figure 7: Radio Failure without Auto Cell, coverage gaps

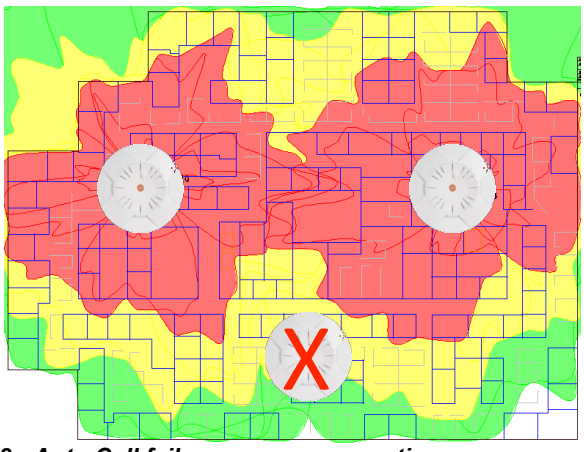


Figure 8: Auto Cell failure recovery operation, coverage restored

Tips and Recommendations

When should Auto Cell be enabled?

In any multi-Array environment where network up time is critical.

When is Auto Cell not recommended?

In single Array deployments, enabling Auto Cell will have no effect. In addition, environments where specific RF boundary requirements demand manual tuning of cell sizes due to specific requirements may be better served without Auto Cell.

How should Auto Cell be configured in multi-floor environments?

If coverage is dependent upon clients associating with Arrays located on floors other than where the clients are located, than site surveys must be performed with Auto Cell enabled. Auto Cell tuning of Arrays on a single floor will impact floor to floor coverage and must be considered during the survey.

Should all IAPs (radios) be set to Auto Cell?

Typically yes, however there is no requirement for all radios in a single Array to participate in Auto Cell. In some cases manual settings for some radios are preferred when it is desirable to limit Array coverage in a specific direction. As an example, for security purposes, an Array's RF settings for radios directed at a public parking lot may be manually set (reduced power) while radios directed towards the internal areas of the building would use Auto Cell for dynamic coverage tuning.

How does Auto cell and Auto Channel interoperate? Which should be executed first?

The Auto Cell and Auto Channel (see Auto Channel Application Note) features of the Wi-Fi Array compliment each other and are designed to be used together. Auto Channel should be run first and will serve to reduce co-channel interference between radios, whether Arrays or other vendor's APs. After Auto Channel completes, Auto Cell can be used to tune coverage for the environment.

Will Auto Cell work with other vendors' APs?

No, this solution is limited to Wi-Fi Arrays.

How often should I set Auto Cell Tuning Intervals?

A setting of 5 minutes is recommended. This will provide limited delay if a failure occurs and Auto Cell must re-balance the coverage.

To what percentage should I set the Auto Cell overlap?

Xirrus recommends an overlap value of 15% to provide seamless roaming.