

# Guidelines for IBM High Rate Wireless LAN Cell Planning<sup>1</sup>

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## Introduction

This document is written for end user's, Value Added Resellers (VARs), or anyone who is designing the layout for an IBM High Rate Wireless LAN for a specific building or facility. It will give a set of guidelines to assist in determining the number of Access Points (APs) required and the optimal layout of those APs.

The method described is the floor plan analysis method which provides an easy way to plan a wireless network in situations where:

- You do not (yet) have the wireless LAN system components procured or available.
- You wish to prepare a site verification "off-site."
- You are calculating the rough budget required to build a wireless network.

**IMPORTANT NOTE:** Although this procedure will provide a rough estimate of the number and placement of access points, you are advised to always perform a live survey using a single AP and the High Rate Wireless LAN diagnostic tools as described in the client user's guide, *prior* to purchasing the complete number of APs and prior to mounting them in the locations determined using this floor-plan analysis method.

## About the Floor-Plan Analysis

In the floor plan analysis method, the range of the APs in the specific target environment will be estimated. Circles will then be drawn on a floor plan of the environment to approximate the coverage of each of the APs. The diameter of these circles is related to the average range of the wireless LAN radio in the specific type of environment. Although the actual shape of the wireless cells will have a more irregular shape than the circles used in the floor-plan analysis method, this method will still provide an easy and fairly reliable means to quickly determine the radio characteristics of the target area.

The floor plan analysis method is a 3 step procedure:

1. Obtain a to scale copy of the original floor-plan of the target area.
2. Determine the wireless point-to-point distance that applies to the building or network under survey.
3. Color up the floor plan to mark the wireless coverage area(s).

### What you need:

- A detailed floor plan.
- A set of pencils or other drawing tools.
- A compass.

## Determine the Point-to-Point Distance

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The maximum range of the IBM High Rate Wireless LAN product (as measured from point-to-point), is determined by the following factors:

- The User-defined parameter: “Distance between Access Points.”
- The physical environment of the location where the wireless LAN equipment will be installed.

The procedure to determine the point-to-point distance for your network is summarized as follows:

1. Evaluate the key criteria for your network to determine the appropriate value for “Distance between Access Points.”
2. Identify the type and nature of construction materials used throughout the premises, to determine the type of radio environment where the wireless LAN will be installed.
3. Use Table 1 on page 3 to determine the point-to-point distance value that corresponds with the two criteria listed above.
4. Convert the point-to-point distance(s) to a value in inches that matches the scale of your floor plan.
5. Write the result down on your floor plan worksheet.

The results from step 2 will be used as the radius of the circles you will draw on the floor-plan to picture the wireless cells. In most office buildings, you will see that multiple “radio environments” will apply. If this is the case in your situation, determine the point-to-point distance for each of the environment type that applies.

## Distance between Access Points

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In networking environments where you have either data intensive users, or a large number of users in a small area, you may wish to balance the throughput performance versus the cost of investments.

- **Large Distance Between APs**, provides a maximum wireless coverage with a minimum number of access points. This option which is typically used for single-cell networks and point-to-point links, will also provide an efficient and cost effective solution for most networks that include multiple wireless cells. Note that this is the default setting for IBM High Rate Wireless LAN Access Points and PC Cards.
- **Medium Distance between APs** can be selected for environments where wireless stations experience slow network response times even though the quality of radio communications is rated as excellent. The slow response times might be experienced in areas where:
  - A high number of wireless stations are located close to one another, causing other stations to defer data transmissions.
  - A number of wireless stations engaged in heavy network traffic are causing other stations to defer data transmissions.
- **Small Distance between APs** should be selected only when you are designing a wireless infrastructure where the total cost of hardware investments is less critical than the maximum data throughput per cell. By definition, a High Density (small distance between APs) network will include the highest concentration of access points.

In medium or high density (Small Distance between APs) networks, you will typically add more access points to distribute the wireless workload. However placing access points closer to one another requires you to adjust the deferral behavior of the access points to allow maximum throughput performance<sup>1</sup>. The default option for IBM Wireless LANs is Large Distance between APs, which was designed to build wireless networks with overlapping radio cells where the Signal to Noise Ratio (SNR) may vary between Acceptable, Good or Excellent. The settings “Medium” or “Small” Distance between APs are often used in multiple channel networks, that provide a excellent quality of radio communications throughout the entire wireless coverage area.

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<sup>1</sup> The deferral behavior is controlled via the Distance between APs parameter of the access point. For more information, please consult the High Rate Wireless LAN User’s Guide.

## Type of Radio Environment

Subject to the type and nature of building materials, IBM Wireless LAN radio signals may either pass obstacles in the radio signal path, or be absorbed or reflected by the RF barriers. According to the number and severity of RF barriers in the radio signal path, wireless networking environments can be classified as one (or a combination) of the following type of radio environments:

- **Open**                      No physical obstruction in the signal path
- **Semi-open**                Shoulder-height partitions of wood or synthetic material
- **Closed**                     Floor to ceiling walls of brick and plaster

Metal for example, is a high severity barrier. Environments with metal constructions or large metal objects, such as elevator shafts or machinery, require extra attention when performing a floor plan analysis. The table below lists the Point-to-Point distances in various environments.

*Table 1: Horizontal Point-to-Point distance in various environments in meters (feet)*

Environment	Large Distance b/w APs		Medium Distance b/w APs		Small Distance b/w APs	
	Reliable	Probable	Reliable	Probable	Reliable	Probable
Open	200(600)	290(950)	100	140	50	70
Semi-open	40(120)	75(250)	20	40	10	20
Closed	20(60)	30(90)	10	15	5	8

Determine which environment represents your building. Then use the reliable values to make your floor plan.

**Important Note:** Range for the IBM Wireless LAN family depends on many factors and can vary greatly depending on the environment. The numbers provided here are only a guideline, not a guarantee. The actual range you experience may be less than stated.

## Color up the Floor Plan

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Now you have determined the wireless point-to-point distance, you can use a pair of compasses to draw circles on the floor plan, representing the wireless coverage area of the IBM Wireless LAN. Set the width of the legs of your compasses, to the converted scale of the point-to-point distance you determined in the preceding steps. When drawing the circles, please note the following:

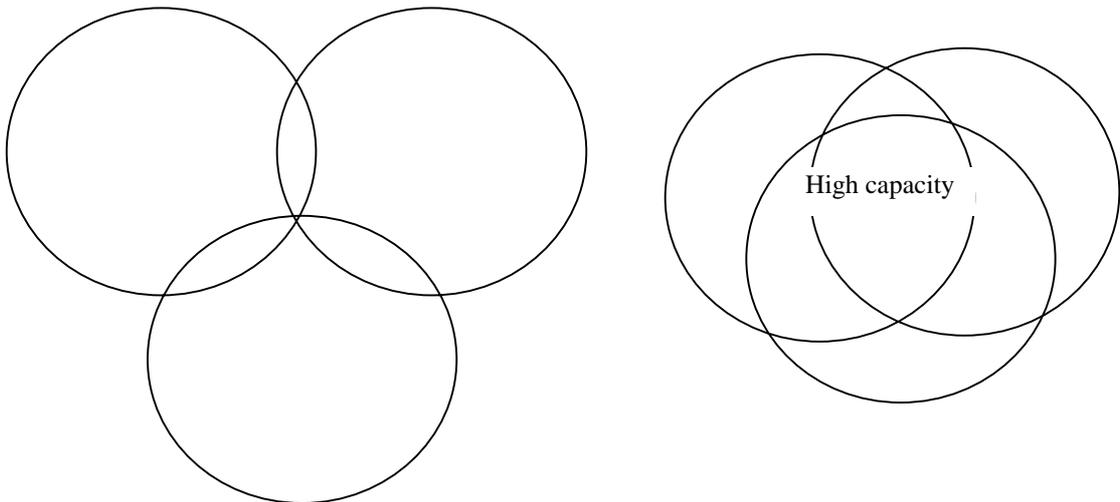
- If the location includes multiple types of construction materials, for example a combination of shoulder-height partitions and floor-to-ceiling brick walls, you may need to draw the circles in a “bulls-eye” type pattern, where each ring identifies the range associated with the type of RF obstacle(s).
- To allow mobile stations to roam between various locations, the station should be able to detect other access points prior to leaving the coverage area.
- To avoid out of range situations, design your network in such a way that the wireless coverage areas of individual access points overlap one another slightly.

## How much overlap do you need?

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For most office environments, you can use a “Normal Density” pattern as pictured in the left portion of Figure 1. This type of density pattern provides satisfactory results in normal density networks, where mobile stations roam at pedestrian speed.

*Figure 1: Creating a high density area*



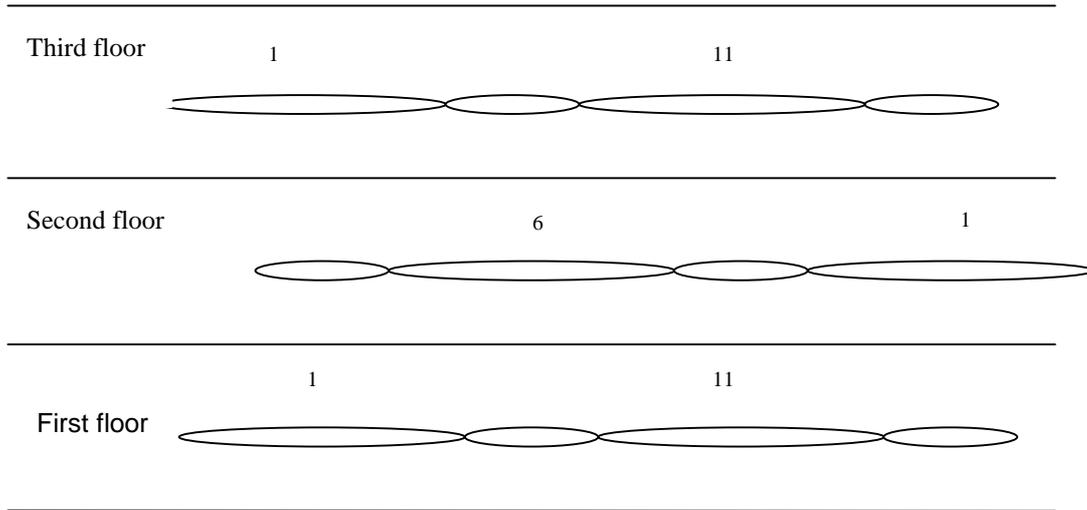
Increasing the overlap of wireless cells as pictured in the right side of Figure 1, enables you to create a high capacity network, where numerous mobile wireless stations can engage in heavy traffic loads, or roam at velocities higher than pedestrian speed. If each of the wireless cells is assigned a distinct operating frequency, this type of network enables you to triple the average throughput capacity in a specific environment.

## Using Vertical Overlap

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If you are designing a network in a multi-story building you are advised not to position access points on top of one another. You will leverage far more cost/throughput efficiency when you would alternate placement of access points across the various floors, in combination with smart radio channel allocation.

Figure 2: IBM Wireless LAN in multi-floor building



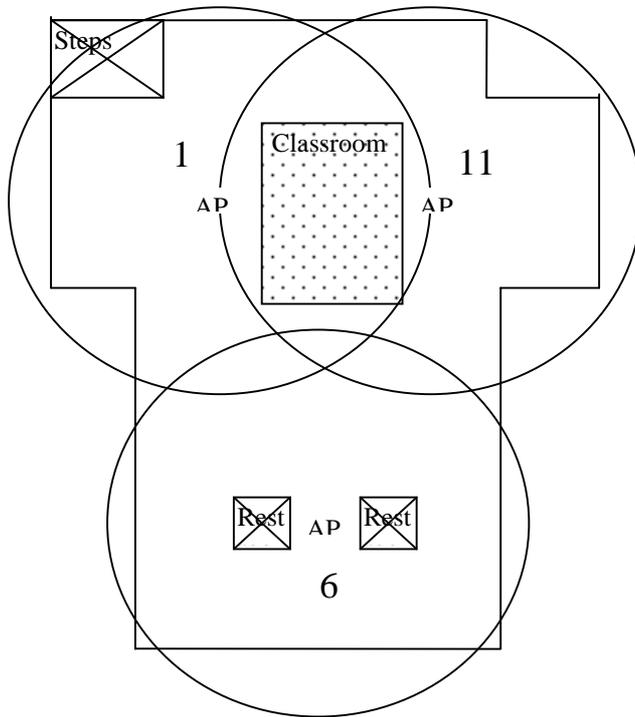
In this way access points with the same frequency cannot hear each other, so they don't take each others bandwidth. In multi-story buildings, you can also identify the vertical point-to-point distance, to determine the range of access points across multiple floors.

Table 2: Vertical Coverage (in multiple-story buildings)

Environment	Large Distance b/w APs		Medium Distance b/w APs		Small Distance b/w APs	
	Reliable	Probable	Reliable	Probable	Reliable	Probable
Thin	8(25)	12(37)	4	6	-	-
Thick	4(13)	6(20)	2	3	-	-

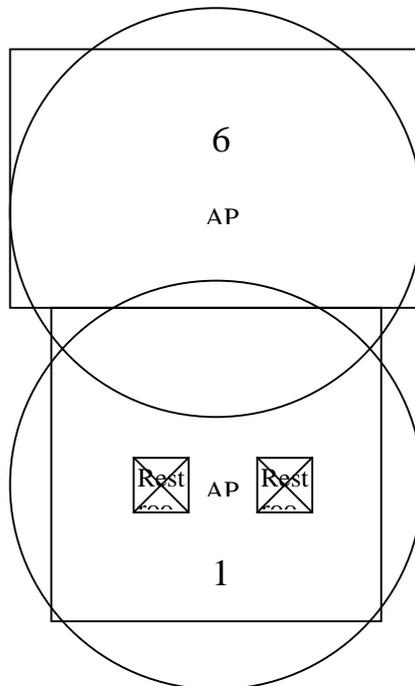
Mark the rooms on the floor-plan that need no coverage (in the example below, the stairs are marked with an X indicating no coverage necessary). Mark the rooms where you need a high capacity (i.e. a classroom) with dots. For these areas you will need 2 to 3 cells to overlap each other so that you have a higher capacity. Start drawing circles at the high capacity places. Use a pair of compasses to draw the circles on your floor-plan that will represent the wireless cells. Set the middle of the compasses at the position where you want to place the Access Point. Set the width of the compasses feet according to the cell radius as determined in previous step. Be sure to take floors above and below into account. Remember, don't put the access points on top of each other as stated above. Fill the rest of the maps with circles to complete the coverage. The cell radius is just an estimate of the coverage, so it doesn't matter if half a room just falls outside a circle. See the example below:

Figure 3: First floor



On floor 1 are three access points using three different frequencies. The numbers represent the frequency channels. The dots in the middle represent a high density area.

Figure 4 Floor 2



On floor 2 are two APs with frequencies offset from floor 1. When all circles are drawn, this will indicate the number of access points that must be procured.

<sup>1</sup>Original content from Lucent Orinoco™