IBM High Rate Wireless LAN: Interference[1]

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This document describes sources of interference that may affect the performance of your IBM Wireless LAN systems. Whether interference causes system problems is primarily determined by the:

- The type of device causing interference and the frequencies at which it radiates radio energy.
- The location of the device causing interference in relation to the signal paths of your IBM Wireless LAN devices.

This document will help you identify potential sources of interference. The guidelines included here will help you eliminate or minimize the negative effects of the interference on your IBM Wireless LAN system performance.

Types of Interference

There are two types of interference, which may occur in the Industrial, Scientific and Medical (ISM) frequency band, where the IBM Wireless LAN components operate:

- Narrow band interference
- Wide band interference

"Narrow" and "Wide" are relative measures; the reference is the 16 MHz bandwidth (at -30 dBm points in the spectrum) of the IBM Wireless LAN system.

Narrow Band Interference

Narrow band signals contain high levels of radio energy in a frequency range that is smaller than the receiver bandwidth of the IBM Wireless LAN system. Narrow band signals do not disrupt communication on an IBM Wireless LAN system, because they have a processing gain that will cause interference up to a Signal-to-Interference Ratio of only 10 dB. Most sources of interference described in this document, will be narrow band when considered in relation to Wireless LAN Direct Sequence Spread Spectrum (DSSS) systems.

A DSSS receiver receives energy over a range of frequencies corresponding to the spread bandwidth. The de-spreading performed by DSSS receivers collects energy from the components of the signal at different frequencies and recovers the wanted information by adding them constructively; this is known as “processing gain.”

A portion of the total receiver bandwidth may be occupied by a narrow band interference signal. The received narrow band signal will be "spread" by the DSSS receiver (i.e. the interfering signal will only be sensed as the receiver transiently tunes to that particular narrow frequency). The effective interference depends on the power ratio between the wanted signal and the interference signal and on the processing gain of the receiver.

However, with strong interference signals the receiver amplifier circuits may be overloaded by the interfering signal and subsequent signal processing has little effect. This is directly dependent upon the amplitude of the overload and how quickly the overloaded circuits can recover to their normal operating conditions.

Wide Band Interference

Wide band interference exceeds the receiver bandwidth of affected systems and makes data reception, as well as interference avoidance, difficult or impossible. The most prevalent source of wide band interference is the domestic microwave oven, which operates in the 2.4 GHz (2400 MHz) band. The microwave energy is spread in both time and frequency. The typical microwave oven operates at 50 pulses per second and usually sweeps through the frequencies between 2400 and 2450 MHz, although most of the energy is normally present at frequencies near 2450 MHz.

DSSS systems, because of their wide bandwidth, may have difficulty obtaining a free area of the spectrum during periods of heavy interference. When wide band interference cannot be avoided, the DSSS receiver suffers degradation during the time that the microwave energy is present within the receiver's operating bandwidth. Given the pulsed operation of the microwave oven, more than one message transmitted by a DSSS system may be affected and may have to be retransmitted.

Continuous wide band interference of sufficient strength will jam the IBM Wireless LAN System, but if the interfering device operates intermittently, the system will be able to complete some of its transmissions successfully. However, the user will notice some performance degradation.

Potential Sources of Interference

Potential sources of interference for IBM Wireless LAN systems may be one or more of the following devices:

- Microwave ovens
- Elevator motors
- Copier machines
- Theft protection equipment (retail)
- Cordless telephones

When these interference sources are present in the wireless networking environment, consider one or more of the options listed below to eliminate or minimize the negative effects of interference:

- Move the interfering device away from the signal paths of your Wireless LAN devices.
- Investigate whether the interfering device can be adjusted to minimize, change the frequency of, or completely eliminate the emitted signal.
- Reconfigure your Wireless LAN devices to operate on another frequency sub-channel.

When it becomes necessary to adjust the frequency channel of your Wireless LAN devices, you will only need to change the frequency channel in the access points. In IEEE 802.11b infrastructure environments, client stations will automatically adopt the channel of the access points.

In exceptional cases where relocating devices and/or adjusting frequency channels does not resolve the negative effects of interference, you may need to consider using a combination of wired and wireless LAN segments in the locations where the interference truly impacts wireless performance.

Note: See also "If the Wireless LAN is the Source of Interference" on page 5.

Microwave Ovens

Band:	2.4 GHz where the maximum radiation from the ovens occurs around 2450 MHz. The emitted radiation sweeps from 2400 to 2450 MHz and remains stable for a short period at 2450 MHz.
Bandwidth:	May vary with different products and manufacturers.
Power:	Not an intended transmitter.

	The radiation cycle of the oven is about 10 milliseconds. Interference occurs only while the oven is on. Product variation is such that no uniform levels of emission can be identified.
Environment:	Cafeterias, kitchens, vending areas, etc.

Expected Effects:

The Wireless LAN will communicate effectively in most environments, except where the oven is very close to a Wireless LAN station:

- **Hardly Affected** – Wireless LANs operating around 2480 MHz are hardly affected because of the difference in frequency between the two systems. Noticeable effects only occur when the oven is within a few meters of a Wireless LAN station.
- **Moderately Affected**– Wireless LANs operating around 2430 MHz are less severely affected by ovens than Wireless LANs operating at 2460 MHz.
- **Strongly Affected**– Wireless LANs operating around 2460 MHz are affected strongly if the distance from the receiving Wireless LAN station to the oven is considerably less than the distance to the transmitting Wireless LAN station. In general, a separation of 30 meters in open space between a Wireless LAN station and a oven will reduce the interference experienced by the Wireless LAN station to very low levels. Walls help to reduce interference; a solid brick wall between the oven and the Wireless LAN station allows the safe distance to be reduced to 10 meters.

Corrective Action

- Keep Microwave ovens away from any Wireless LAN station - 20 meters is sufficient, but less can give acceptable results depending on local conditions, such as operating frequency and walls.
- If you experience interference, do not use a microwave oven while your network is very busy and heavily loaded.

Theft Detection Devices

Band:	▪ 915 MHz, possible range 902-928 MHz. ▪ 2.4 GHz, possible range 2.400 - 2.435 GHz. ▪ 2.4 GHz, possible range 2.465 - 2.4835 GHz.
Power:	:75 mW e.i.r.p.
Environment:	Retail.

Theft detection devices use a small portion of the available ISM bandwidth. Often a theft detection device can be tuned (in 100 KHz steps) to determine which part of the band is being used

Expected Effects:

- **Hardly Affected** - When they operate in the same band, depending on the location of Wireless LAN antennas and the theft detection devices. You should investigate whether tuning the radio channel of the theft detection device is possible, or you can select another operating channel for your IBM Wireless LAN System.
- **Not Affected** - When the theft protection system operates in the 915 MHz band, the radio channels are so far apart that they do not interfere with one another. When the theft protection system operates in the 2.4 GHz band, Wireless LAN performance will neither be affected when the operating frequency of the system is adjusted or when you reconfigure your IBM Wireless LAN System to operate at another frequency channel.

Cordless Telephones

Cordless phones or cellular phones exist in a variety of types and technologies. These devices are subject of local radio regulations, and they often use dedicated radio channels:

- In Europe, cell-phones (also referenced as GSM phones) use the 915 MHz and/or 1800 MHz band
- In the US, cellular phones use the 810-956 MHz, the 824-849 MHz, the 869-894 MHz, the 1429-1501 MHz, and the 1850-1990 MHz bands.

Another popular type of cordless phone is the indoor wireless handset for home-use.

- DECT technology phones use the 1880-1900 MHz band
- U.S. wireless phones use the 46-47 MHz, the 900 MHz and the 2.4 GHz bands

Expected Effects:

- The location of Wireless LAN antennas, cordless handsets, and base units determines whether interference can occur and, if so, whether it can be resolved. Wireless LAN systems may exhibit reduced performance, and cordless phones may exhibit reduced line quality and losses of connection.

Corrective Action:

Keep cordless telephones (especially the base units) away from any Wireless LAN station. A separation of 20 meters is sufficient, but less can give acceptable results depending on local conditions, such as operating frequency and walls.

Unlicensed Citizen Band and FRS Radio Devices

Unlicensed Citizen band and FRS band devices that are used for personal communications from vehicles and homes often use a dedicated radio band that is different from the Wireless LAN radio band. As such, these devices do not interfere with Wireless LAN networks.

Other Wireless Equipment

Wireless is popular, but not just in networking and communications environments. In the home and professional marketplace, you will see a wide variety of other wireless devices, such as:

- Remote controls for TV sets, VCRs, garage doors, light switches, etc.
- Wireless keyboards and mouse devices for computers.
- Wireless audio headsets or speaker systems.

Most of these devices are based on either infrared or radio technology.

- Infrared systems will never interfere with Wireless LAN radio technology.
- Radio-based systems may interfere depending on the type of radio technology and/or operating frequency used.

Expected Effects:

You can determine if interference is caused by such devices by running the IBM Wireless LAN Manager Client radio diagnostics. Watch the behavior of your Wireless LAN system while you switch the suspect device(s) off and on.

Corrective Action:

If interference occurs, you should move the transmitting/receiving antennas of the interfering device away from the signal paths of your IBM Wireless LAN System. You can also consult the user documentation that came with the suspect device to determine whether the device can be adjusted to a different operating frequency.

If the Wireless LAN is the Source of Interference

The IBM Wireless LAN System has been designed to operate in any type of physical environment using the license-free radio band assigned to wireless Industrial, Scientific and Medical (ISM) applications.

Although the ISM band allows unlicensed usage of the band, local radio regulations, defined by national governments or institutions, may restrict use of this band to specific users only or may distinguish between "primary" and "secondary " users.

In the USA, the Federal Communications Commission (FCC) has identified a number of primary users. In situations where Wireless LAN communications interfere with devices operated by primary users, the FCC regulations require the Wireless LAN user to stop the interference either by reorienting the Wireless LAN antennas and/or equipment or by disabling the Wireless LAN network completely.

A list of primary users in the USA is available from the FCC.

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