YRH Spectrum

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YRH

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Unlicensed Bands...Can also be a nightmare

The appeal of unlicensed ISM systems is that they offer quick and inexpensive solutions to transmission and access problems encountered by wireless LAN operators or cellular carriers that may require temporary rapidly deployed microwave links. However, the lack of collaboration and coordination between users of the unlicensed bands is quickly making the installation of spread spectrum systems a nightmare. Indeed, the rising level of RF noise within the unlicensed bands implies that a rigorous engineering study must be done to maximize the chances of a interference-free operation of these systems.

The use of microwave frequencies assigned for the Industrial, Scientific and Medical (ISM) and Unlicensed National Information Infrastructure (NUII) applications is becoming increasingly popular for telecommunications applications (WiMax, WiFi, Bluetooth, micro-wave). Indeed many systems, which operation is based on the spread spectrum technology (such as 802.11 and soon the 802.16), are or will be available in the unlicensed bands of 2.4 GHz and 5 GHz.

A bit of history…

The idea of a spread-spectrum system was patented on June 10, 1941, an original idea of Hollywood actress Hedy Lamarr and classical composer George Antheil. Referred to as 'secret communication system' it was first constituted of 88 player-piano keys, matching the 88 frequencies used. It synchronized the transmitter and receiver frequency hopping sequence with perforated paper rolls, ordering the frequency hopping sequence and duration.

In 1950, engineers De Rosa and Rogoff proposed a direct sequence spread spectrum system (DSSS) and introduced the processing gain equation and noise-multiplexing concept. In 1957 Engineers of Sylvania Electronic Systems Division replaced the perforated paper roller and its mechanisms with an early electronic computer processor and electronic circuit designed by engineers at the Sylvania Electronic Systems company. This technology was then used by the American military for over 20 years.

Regulations

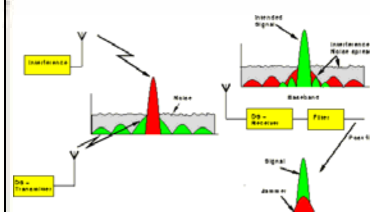
Since 1985 the Federal Communication Commission (FCC) of the United-States modified its regulation to allow the commercial use of spread spectrum system. Initially, the two methods of spread spectrum mostly used were the Frequency-Hopping (FHSS) and the direct sequence (DSSS). Systems using Orthogonal Frequency Division Multiplexing (OFDM) are now becoming very popular.

Industry Canada (IC) describes the current standards concerning use of unlicensed frequencies in RSS 210. Canadian guidelines are based on similar regulations enacted in the USA by the FCC. The main points of these guidelines are as follows:

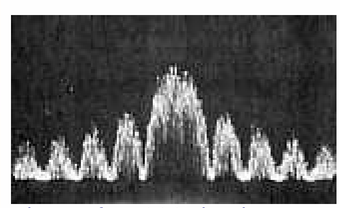
Freq. (MHz)	Transmitter Power (watts)	EIRP (watts)
2400 to 2483.5	1	➢ 4 ➢ 200 in outlying regions
5150 to 5250	Built-in antenna	0.2 Indoors equipment only
5725 to 5825	1	➢ 4 ➢ 200 in outlying regions

Canadian Regulation

FHSS and DSSS



DSSS radios use a larger portion of the available bandwidth than FHSS radios. DSSS radios use a scheme where each data bit is "chipped" using a pseudo-random binary code (chipping code) at a rate much higher than the data bit rate. The transmitted signal having the aspect of white noise is restituting the original data when multiplied by the same chipping code. The continuous repetition of this code adds redundancy to the transmitted signal, allowing data recovery even when channel disturbances occur. Higher chipping rates produce wider spreading width, increasing the processing gain and the system robustness.



Picture of a DSSS signal spectrum

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"The devices that are license-exempt are radio equipment that, in regards to the law on telecommunication, exempt from the obligation to operate under the conditions of a radio license within specific frequency bands, but still are required to be in conformity with the Industry Canada applicable policies, procedures and standards. The devices that are license-exempt can not ask for the protection from other radio systems and can not cause any detrimental interference to radio services authorized by a license."

Popularity Complex

The popularity of the systems deployed in the unlicensed band is due to their relatively low cost and ease of installation and operation. This popularity translated into unchecked and uncoordinated growth, especially in urban areas. This in turn has created operating problems due to interference.

The main aspect that needs to be addressed before deploying a spread spectrum system operating in the unlicensed frequency band is noise immunity. Several different sources of interference can affect the performance of these systems:

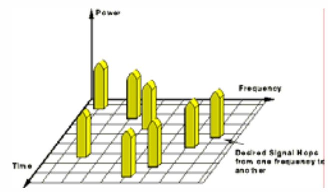
1. Interference from narrow-band systems operating within the frequency spread of the system.
2. Co-channel interference with non-orthogonal spreading code (Insufficient Eb/No).
3. Interference from adjacent channels.
4. Intermodulation interference.
5. Proximity to microwave ovens for the 2.4 GHz frequency band.
6. The increasing number of spread spectrum unlicensed private networks spread out on a relatively small urban area increases the noise floor level.

All these potential interference sources need to be addressed in the planning and design stages of the spread-spectrum system operating within the unlicensed frequency band. All of them can degrade the signal-to-noise ratio and can even render the system inoperable. The signal-to-noise ratio needs to be evaluated and optimized for each planned link.

Reduced regulation = More Engineering and Planning

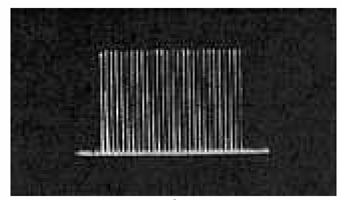
- *Training on microwave link design methods with Pathloss planning tool.*
- *Reflection and propagation studies and microwave path surveys.*
- *Propagation and reliability studies.*
- *Interference studies and RF noise measurements at selected locations.*
- *Optimal network configuration (WiFi, WiMax)*
- *Antenna sweeps and alignment.*

Contact us for more information!

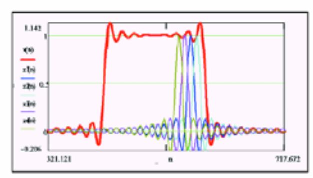


FHSS use a narrow frequency band that is switched several times per second within a larger frequency band. The receiver follows the same sequence of frequency hops as the transmitter.

The FHSS signal offers a good immunity against conventional radio interference, however in presence of wideband interference like DSSS signals, it may not be able to find any clean frequencies to hop to. The spectral efficiency is generally lower with FHSS, however its simplicity often means cheaper devices for lower throughput applications.



FHSS Spectrum image



OFDM Signal

To a certain extent OFDM is a special case of FHSS, but instead of hopping between multiple frequencies, they are designated as sub-carriers and all transmitted simultaneously.

The sub-carriers are selected to be orthogonals, meaning that they are spectrally spaced to avoid interference with each other, even when their impulse responses spectrum overlap. Higher spectrum efficiency is achieved while maintaining a good immunity to conventional radio interference and achieving strong multipath robustness.

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