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BreezeACCESS® VL

Dynamic Frequency Selection (DFS+)

For Radar Avoidance

Introduction

In some regions, it is important to ensure that wireless access equipment does not interfere with certain radar systems in the 5 GHz band. In case radar is being detected, the wireless access network should move automatically to a frequency that does not interfere with the radar system.

The DFS algorithm of BreezeACCESS VL is designed to detect and avoid operation in channels with radar activity. The implantation complies with ETSI EN 301 893 V0.r (2003-04).

Radar Avoidance Mechanism

The country dependent set of parameters used by the BreezeACCESS VL (selected Sub Band) includes also an indication whether DFS (Dynamic Frequency Selection) should be used.

To simplify the installation process as well as the system management, the DFS mechanism is fully controlled by the Access Unit. When the DFS mechanism is enabled, the AU monitors the spectrum continuously, searching for signals with a specific pattern indication radar activity. Upon detecting radar activity, the AU immediately informs the SU, stops transmitting on this frequency and starts looking for another radar-free frequency.

The set of viable frequencies is configurable and may include either all the frequency in the selected Sub Band (Country Code dependent) or a subset of these frequencies. The AU maintains a continuously updated database of all applicable frequencies, where each frequency is marked as Radar Free, Radar Detected or Adjacent to Radar. The AU attempts to check a new frequency only if it is marked as Radar Free. If a radar activity was detected on a certain frequency, it will be marked in the database as a Radar Detected frequency. The AU will not attempt to check for radar activity in frequencies marked as Radar Detected. A certain time after detecting radar activity on a frequency, it will be removed from the list of Radar Detected frequencies and will be marked as Radar Free. This time, during which the frequency will remain marked in the database as either

Radar Detected or Adjacent to Radar after detecting radar activity, is defined by the configurable Channel Avoidance Period parameter. If radar activity was detected on a certain frequency, adjacent channels should not be used as well, according to the bandwidth. For example, if the bandwidth is 20 MHz, then if radar activity was detected in 5500 MHz, frequencies 5490 MHz and 5510 MHz should not be used as well. These frequencies are marked in the database as Adjacent to Radar, and will be treated the same as Radar Detected frequencies.

After detecting radar activity, the AU selects randomly one of the frequencies marked as Radar Free and checks whether there is currently any radar activity on this frequency. A configurable Channel Check Time parameter defines the time allocated for checking whether there is a radar activity on a new frequency. During this time the AU does not transmit in order to avoid transmissions on a potentially radar occupied channel. If no radar is detected on the new frequency, the AU starts operating on this frequency. Otherwise, the frequency will be marked as Radar Detected (and adjacent channels will be marked as Adjacent to Radar), and the AU will check radar activity on another randomly selected Radar Free frequency.

Before ceasing transmission on a frequency where radar signals had been detected, the AU sends special disassociation messages to its associated SUs. These messages include special elements stating that radar was detected, the new frequency the AU intends to check, and the time period in which the AU will be unavailable due to checking for radars on the new frequency (Channel Check Time). The SUs are also informed by the AU whether they should wait for this AU, as defined by the configurable SU Waiting Option. The waiting time is the Channel Check Period plus 5 seconds. During this time each SU searches for the current AU in the defined frequencies subset. If the AU was not found within the waiting time, or if a waiting request was not included in the message, the SU starts immediately searching for any AU, using the Best AU mechanism if applicable. SUs always scan in passive mode (searching for beacons) in order not to transmit on a potentially radar occupied channel. It is not transmitting unless associated to an AU. The SU Waiting Option is typically enabled to increase the probability that an SU will always be served by the same AU. This facilitates increased stability as well as more effective planning and network management.

DFS+ for Frequency Reuse

Typically, operators prefer to preserve the original frequency planning and to avoid moving to a new channel unless they are sure that there is a continuous radar activity in the original channel. It should be noted that detection of radar activity does not necessarily indicate a continuous radar activity in the channel. The DFS+ channel reuse algorithm enables returning to the original channel under certain conditions that indicate low radar activity on the channel.

The conditions are that radar was detected in this channel not more than N times (Maximum Number of Detections in Assessment Period) during the last T hours (Radar Activity Assessment Period). When the Channel Reuse Option is enabled, then by the end of the Channel Avoidance Period the unit will attempt returning to the original frequency, provide these conditions are met.

DFS Related Trap

The following DFS related traps are available to support network management when the DFS option is enabled:

- **Radar Detected Trap:** Indicating that radar has been detected on the current frequency.
- **New Frequency Trap:** Indicating the new frequency after detecting radar on the previous one.
- **No Free Channel Trap:** Indicating that all channels are currently marked as either Radar Detected or Adjacent To Radar. The AU will wait until one or more frequencies will become Radar Free.

Radar Signals Detection

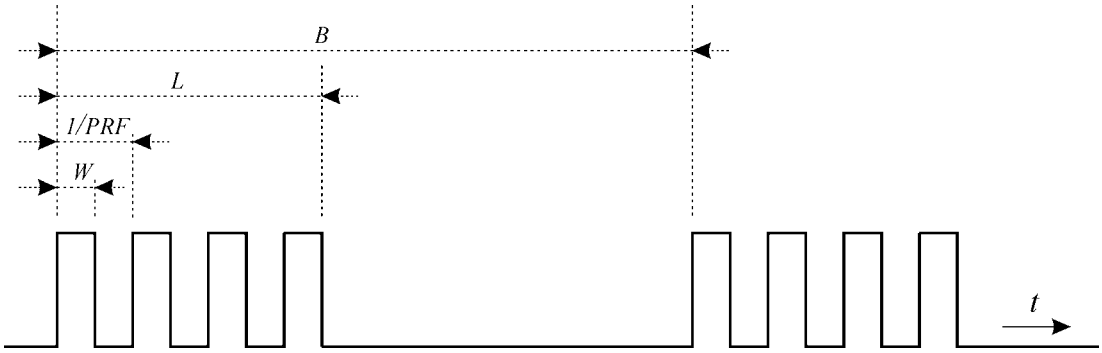
Radar Signal Definitions

A conventional radar signal is a short burst of pulses of a high frequency signal. Radar burst are repetitive, and the time interval between consecutive burst is called Sweep Time. The sweep time is the result of the radars slow rotation, up to 60 seconds cycle time.

Each burst consists of several pulses separated by a time interval called Period, which is anywhere from 250 microseconds to 20 milliseconds.

The Pulses Repetition Frequency (PRF) is defined as 1/Period, and its measurement units are Pulses Per Second (PPS).

The width of each pulse can be 2 microseconds or less.



Legend:

B: Sweep Time

L: Burst Duration

1/PRF: Period

W: Pulse Width

Radar Detection Algorithm in BreezeACCESS VL

The radar detection algorithm is based on identifying pulse detection events by the modem, logging these event, going over the events list and examining if it matches a pattern of radar signal burst. A match is decided upon meeting the following criteria:

1. There is sufficient number of logged events, occurring in a fixed periodicity (same PRF). The minimum number of events required for a decision on radar activity is defined by the Minimum Pulses to Detect parameter.
2. The logged events (pulses) Width and PRF match the characteristics of a radar signal.
3. There were not too many events that do not comply with the periodicity demand.

Events are examined only under the timing boundaries of one burst length. The algorithm examines only a single burst.

The algorithm includes filters to remove undesired data points, to reduce the probability of false alarms. It filters pulses that are more than 20 microseconds (assumed to be interferences caused by adjacent channels) and pulses that vary in their pulse width from the average.

The algorithm discards bursts of a large number of PHY errors in a short period. It also discard samples that have too many pulses between two consecutive valid pulses for a given PRF.