
# Contention Based Protocol

# Redline Communications AN-100U Wireless Broadband System

## Part 90 – Private Land mobile Radio Services

## Sub-Part Z – 3650 MHz Wireless Broadband Services

Revision 1
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# 1 Introduction

## 1.1 Purpose

This document constitutes a submission for equipment certification purposes for the Redline Communications RedMax AN-100U system transmitters in the 3650-3700 MHz band, subject to the rules and requirements of CFR 47 Part 90, Sub-part Z. It specifically describes the methodology used to meet the requirement that each transmitter employ a contention based protocol (CBP).

## 1.2 Requirement

Paragraph (o) of section 90.203 in sub-part Z identifies that applications for certification must describe the methodology used to meet the CBP requirement on each transmitter.

*Section 90.7 defines the CBP as follows: "A protocol that allows multiple users to share the same spectrum by defining the events that must occur when two or more transmitters attempt to simultaneously access the same channel and establishing rules by which a transmitter provides reasonable opportunities for other transmitters to operate. Such a protocol may consist of procedures for initiating new transmissions, procedures for determining the state of the channel (available or unavailable), and procedures for managing retransmissions in the event of a busy channel."*

# 2 The Redline RedMax System

## 2.1 System configuration

The Redline RedMax wireless broadband system that would be deployed in the 3650 – 3700MHz band comprises devices identified as sector controllers (called the AN-100U) and devices identified as subscriber units. The AN-100U Sector controllers are usually deployed with sectorial antennas covering an area that can be populated with a number of subscriber units. This is a typical Point to Multipoint configuration and the number of subscriber stations can range from one to many tens of units. In this arrangement, the subscriber stations are under the control of the sector controller which will allocate transmission resources to subscriber stations as the need to pass traffic arises. For the purposes of this document, an active sector under the control of a sector controller is considered a network. Once a subscriber station has been accepted into the network then its transmission time and bandwidth resources are scheduled in terms of receiving data from the sector controller (downlink) and when it may respond with transmissions in an uplink direction. However there has to be an opportunity for new subscriber stations to join the network and this aspect will be described further.

## 2.2 *Standards based*

The Redline AN-100U wireless broadband system is based on the IEEE 802.16 2004 air interface standard, which is the standard worldwide for the 3650 – 3700MHz band.

## 2.3 *Distributed Functionality*

Section 90.203 identifies a requirement that each transmitter employ a CBP. In the Redline AN-100U system, the CBP functionality is a distributed implementation between the sector controller and the subscriber stations as a network function rather than specifically in each transmitting station. Neither of these stations would operate as a stand-alone transmitter.

# 3 Network Entry

## 3.1 *Introduction*

The CBP definition states the need to define "….. the events that must occur when two or more transmitters attempt to simultaneously access the same channel and establishing rules by which a transmitter provides reasonable opportunities for other transmitters to operate.". This situation will occur when new subscriber stations attempt to

join the network and the following sections describe the process that occurs in the Redline RedMax wireless broadband system.4.1. Definitions and Abbreviation.

## 3.2 *General Description*

Within a given frequency channel and BS antenna sector, all SS's receive the same transmission, or parts thereof. The BS is the only transmitter operating in this direction, so it transmits without having to coordinate with other stations, except for the overall time division duplexing (TDD) that may divide time into uplink and downlink transmission periods.

- The downlink is generally broadcast. In cases where the DLMAP does not explicitly indicate that a portion of the downlink subframe is for a specific SS, all SS's capable of listening to that portion of the downlink subframe shall listen. The SS's check the CID's in the received PDU's and retain only those PDU's addressed to them.
- Subscriber stations share the uplink to the BS on a demand basis. Depending on the class of service utilized, the SS may be issued continuing rights to transmit, or the right to transmit may be granted by the BS after receipt of a request from the user.
- SS's entering the network implement a:
    - Listening Period - synchronization with DL/UL
    - Ranging Period – Contention Based session
    - Scheduled management message session that completes registration, authentication and service flow creation.
- Any SS rejected during Registration/Authentication CANNOT pass contention based staged.
- A SS that cannot synchronize cannot proceed to the contention interval to start ranging.
- So unauthorized SS cannot cannibalize bandwidth or influence 802.16, network functionality.

## 3.3 *GPS (global positioning system)*

To promote co-existence with other base stations from within the operator's same network, or from co-located networks belonging to other operators, the AN-100U employs GPS (global positioning system) that ensures synchronization of all base stations.

## 3.4 Network Entry Contention based Ranging and Automatic Parameters Adjustments

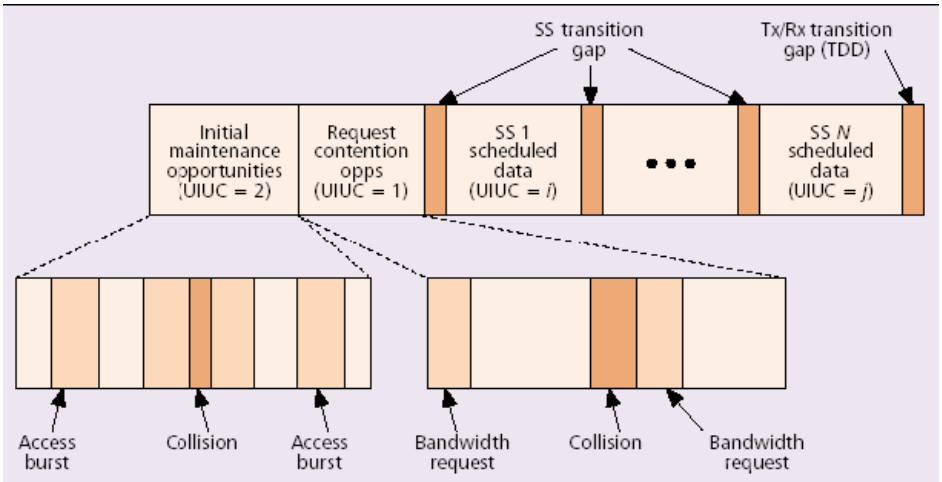


**Figure 1 Uplink Intervals**

The BS controls assignments on the uplink channel through the UL-MAP messages and determines which mini-slots are subject to contentions or collisions. Collisions may occur during Initial Ranging and Request intervals defined by their respective IEs. The potential occurrence of collisions in Request Intervals is dependent on the CID in the respective IE. The mandatory method of contention resolution, supported by the standard, is based on a truncated binary exponential backoff, with the initial backoff window and the maximum backoff window controlled by the BS.

The values are specified as part of the UCD message and represent a power-of-two value. For example, a value of 4 indicates a window between 0 and 15; a value of 10 indicates a window between 0 and 1023.

This retry process continues until the maximum number (i.e., Request Retries for bandwidth requests and Contention Ranging Retries for initial ranging) of retries has been reached. At this time, for bandwidth requests, the PDU shall be discarded. Note that the maximum number of retries is independent of the initial and maximum backoff windows that are defined by the BS.

When an SS has information to send and wants to enter the contention resolution process, it sets its internal backoff window equal to the Request (or Ranging for initial ranging) Backoff Start defined in the UCD message referenced by the UCD Count in the UL-MAP message currently in effect. The SS shall randomly select a number within its backoff window. This random value indicates the number of contention transmission opportunities that the SS shall defer before transmitting. An SS shall consider only contention transmission opportunities for which this transmission would have been eligible. These are defined by Request IEs (or Initial Ranging IEs for initial ranging) in the UL-MAP messages. Note that each IE may consist of multiple contention transmission opportunities.

First, an SS shall synchronize to the downlink and learn the uplink channel characteristics through the UCD MAC management message. At this point, the SS shall scan the UL-MAP message to find an Initial Ranging Interval. The BS shall allocate an Initial Ranging Interval consisting of one or more transmission opportunities.

Ranging adjusts each SS's timing offset such that it appears to be collocated with the BS. The SS shall set its initial timing offset to the amount of internal fixed delay equivalent to collocating the SS next to the BS. This amount includes delays introduced through a particular implementation and shall include the downlink PHY interleaving latency, if any.

**The BS has much flexibility in controlling the contention resolution on both Ranging and BW Request**. At one extreme, the BS may choose to set up the Request (or Ranging) Backoff Start and Request (or Ranging) Backoff End to emulate an Ethernet-style backoff with its associated simplicity and distributed nature as well as its fairness and efficiency issues. This would be done by setting Request (or Ranging) Backoff Start = 0 and Request (or Ranging) Backoff End = 10 in the UCD message. At the other end, the BS may make the Request (or Ranging) Backoff Start and Request (or Ranging) Backoff End identical and frequently update these values in the UCD message so that all SS are using the same, and hopefully optimal, backoff window.

The IEEE 802.16 2004 standard includes functionality that can be invoked associated with determining the state of the operational channel. There is a specific "Channel measurement Report Request" (REP_REQ/RSP) MAC message defined that can request an SS to make and report measurements back to the BS associated with other users and potential interferers.

# 4 Glossary and References

## 4.1 Definitions and Abbreviations

**BS**: Base Station or Sector Controller.
**CBP:** An **unrestricted** contention-based protocol is one which can avoid co-frequency interference with devices using all other types of contention-based protocols. A **restricted** contention-based protocol is one that does not qualify as unrestricted.
**CID**: connection identifier.
**DL / Downlink**: The direction from the base station (BS) to the subscriber station (SS).
**Downlink channel descriptor (DCD)**: A MAC message that describes the PHY characteristics of a downlink channel.

**Downlink map (DL-MAP)**: A MAC message that defines burst start times for both time division multiplex and time division multiple access (TDMA) by a subscriber station (SS) on the downlink.

**IE**: information element
**PDU**: protocol data unit.
**SF**: Service Flow
**SS**: Subscriber Station Unit
**Time division duplex (TDD)**: A duplex scheme where uplink and downlink transmissions occur at different times but may share the same frequency.

**Time division multiple access (TDMA) burst**: A contiguous portion of the uplink or downlink using PHY parameters, determined by the Downlink Interval Usage Code (DIUC) or Uplink Interval Usage Code (UIUC), that remain constant for the duration of the burst. TDMA bursts are separated by preambles and are separated by gaps in transmission if subsequent bursts are from different transmitters.

**UL / Uplink**: The direction from a subscriber station (SS) to the base station (BS).

**Uplink map (UL-MAP)**: A set of information that defines the entire access for a scheduling interval.

**Uplink channel descriptor (UCD)**: A medium access control message that describes the PHY characteristics of an uplink.

**Uplink interval usage code (UIUC)**: An interval usage code specific to an uplink.

**Wi-Max Technology:** A Technology, which is based on IEEE Standard 802, avoids interference by synchronizing the timing of potentially competing transmissions so that the various transmitters (operating on the same frequency and do not overlap in time) are assigned to discrete time slots and do interfere with each other.

## 4.1 References

**[1]** IEEE P802.16-2004 Air Interface for Fixed Broadband Wireless Access Systems

**[2]** IEEE P802.16-2004/Cor1/D5 Corrigendum to IEEE Standard for Local and Metropolitan Area Networks - Part 16: Air Interface for Fixed Broadband Wireless Access Systems

# 5 Conclusions

The AN-100U is a Wi-Max Forum Certified wireless broadband system. Its contention handling algorithm, along with GPS, satisfies the requirement for "A protocol that allows multiple users to share the same spectrum by defining the events that must occur when two or more transmitters attempt to simultaneously access the same channel". It clearly identifies procedures for initiating new transmissions to allow multiple users to share the same spectrum. The in-built facilities in the air interface standard allow the state of a channel to be assessed and this information can be used by the network in a variety of ways, depending on the specific scenario to either avoid other users or to promote sharing of the spectrum.

AN-100U qualifies with the requirements of "**restricted"** contention-based protocol (CBP) and hence could be deployed in the lower 25 MHz in the frequency band 3650-3700 MHz.

# 6 Contacts

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