

RangeLAN2 Frequency Hopping Theory of Operation

GENERAL:

All of RangeLAN2 products comply with the Theory of Operation described below.

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Frequency Hopping :

RangeLAN2 protocols use a hopping sequence frequency set composed of 79 frequencies. This frequency set spans a tuning bandwidth from 2.402 GHz to 2.480 GHz, with 1 MHz spacing between frequencies. In theory, 79 hopping frequencies results in 79 orthogonal sequences being available. Two sequences are orthogonal to each other if both sequences occupy the same frequency once and only once during a cycle of 79 hops regardless of the starting phase between the two sequences. Out of the 79 possible orthogonal sequences, Proxim only allows the use of 15 sequences.

The RangeLAN2 hopping sequences used are defined below and are derived using a linear congruence method¹. This method takes advantage of the fact that the sequence length is a prime number (in this case 79). In addition to the orthogonality properties, the sequences are random and each frequency is occupied only once in each cycle, ensuring that all frequencies are used equally.

Operation:

In normal operation, a pair of stations that need to communicate with each other need to be synchronized to the same hopping sequence. In order to achieve synchronization, stations must first be configured to hop to the same sequence. Second, stations must listen to the channel long enough to acquire synchronization. Third, stations must contend for access to the media before being able to transmit. Given that conditions one and two are met, stations will attempt to contend for the media when they have data to transmit and asynchronously to the hopping sequence. At any one time, there is one and only one station transmitting on any hopping sequence network. A network consists of one master (or base) station responsible for maintaining the hopping timing and one or more stations synchronized to that master station.

Multiple networks can occupy the same geographical area as long as they use different sequences. The stations participating in the additional networks will be synchronized to their respective hopping sequences. When the additional networks are initially started, they start hopping asynchronously from any other network in the region. Therefore, the additional network, in addition to having different hopping sequences, the sequences have random phases with respect to each other. There is no synchronization between different hopping sequences.

- 1.- Different networks hop in independent orthogonal sequences.
- 2.- Different networks start hopping in a random phase with respect to each other.
- 3.- Stations have to acquire synchronization to the desired network before they can transmit.
- 4.- Only one station can transmit in each network at any one time.

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¹- E. L. Titlebaum, *IEEE Transactions on Aerospace and Electronic Systems*, July 1981, AES-17, No 4.

5.- When a station transmits data, it does so asynchronously (randomly) with respect to the hopping sequence. Over time, all frequencies will be used equally and no frequency will be given preference over others.

6.- There is no synchronization information of any kind passed between one network hopping on one sequence to another hopping on a different sequence. Their hopping patterns will be completely independent of each other.

Hopping Sequences:

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CH #1	24,46,58,23,40,56,08,38,57,22,42,64,10,32,60,16 44,76,27,53,29,71,18,28,75,06,50,66,04,39,78,07 47,79,12,51,62,11,52,77,55,13,31,65,26,35,67,05 49,59,09,30,54,14,43,70,01,37,72,15,03,33,74,20 36,61,19,45,73,25,41,69,21,34,68,17,48,63,02
CH #2	24,02,63,48,17,68,34,21,69,41,25,73,45,19,61,36 20,74,33,03,15,72,37,01,70,43,14,54,30,09,59,49 05,67,35,26,65,31,13,55,77,52,11,62,51,12,79,47 07,78,39,04,66,50,06,75,28,18,71,29,53,27,76,44 16,60,32,10,64,42,22,57,38,08,56,40,23,58,46
CH #3	24,55,46,13,58,31,23,65,40,26,56,35,08,67,38,05 57,49,22,59,42,09,64,30,10,54,32,14,60,43,16,70 44,01,76,37,27,72,53,15,29,03,71,33,18,74,28,20 75,36,06,61,50,19,66,45,04,73,39,25,78,41,07,69 47,21,79,34,12,68,51,17,62,48,11,63,52,02,77
CH #4	24,77,02,52,63,11,48,62,17,51,68,12,34,79,21,47 69,07,41,78,25,39,73,04,45,66,19,50,61,06,75,75 20,28,74,18,33,71,03,29,15,53,72,27,37,76,01,44 70,16,43,60,14,32,54,10,30,64,09,42,59,22,49,57 05,38,67,08,35,56,26,40,65,23,31,58,13,46,55
CH #5	24,65,38,09,60,37,71,36,04,69,51,02,31,08,59,32 01,29,20,66,41,12,63,13,56,49,10,70,53,74,50,25 79,48,55,40,05,64,43,27,33,06,73,47,17,77,23,67 42,14,76,03,75,45,07,68,52,58,35,22,54,44,15,28 19,78,34,11,46,26,57,30,16,72,18,61,39,21,62
CH #6	24,66,43,58,39,01,40,07,72,08,79,03,57,51,74,42 11,36,10,77,19,60,13,73,44,65,41,27,35,21,29,05 68,18,59,48,75,30,02,50,14,46,04,70,23,78,37,56 47,15,38,12,33,22,62,20,64,52,61,32,55,45,16,31 25,76,26,69,53,67,34,71,49,17,28,09,63,06,54
CH #7	24,78,03,64,13,69,18,54,23,79,20,60,26,68,06,70 08,62,19,76,05,63,04,72,22,77,25,29,09,46,07,33 10,31,21,28,14,40,12,36,16,35,17,50,01,38,11,45 27,49,02,39,15,42,55,41,71,30,58,47,74,32,65,34 75,43,56,51,61,44,67,48,66,37,57,52,73,53,59
CH #8	24,69,20,70,05,77,07,28,16,38,02,41,74,43,67,52 78,18,60,08,63,25,33,14,35,11,39,71,32,56,48,73

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	03,54,26,62,04,29,10,40,17,45,15,30,65,51,66,53 64,23,68,19,72,09,31,12,50,27,42,58,34,61,37,59 13,79,06,76,22,46,21,36,01,49,55,47,75,44,57
CH #9	24,54,06,63,09,28,17,49,71,34,67,53,69,26,76,25 31,16,45,55,32,61,52,64,20,62,22,33,12,38,15,47 56,37,78,23,70,04,46,14,50,02,30,75,48,59,18,68 05,29,21,35,27,41,65,44,73,13,60,19,77,10,36,11 42,74,51,57,03,79,08,72,07,40,01,39,58,43,66
CH #10	24,62,21,39,61,18,72,16,30,57,26,46,11,34,78,19 28,15,44,54,22,35,58,52,68,07,45,75,03,76,14,42 67,23,77,17,47,73,06,33,27,43,64,05,40,55,48,79 25,50,74,53,70,10,49,56,13,63,12,41,66,20,29,01 32,59,08,31,02,51,69,04,36,71,37,60,09,38,65
CH #11	24,29,55,03,46,71,13,33,58,18,31,74,23,28,65,20 40,75,26,36,56,06,35,61,08,50,67,19,38,66,05,45 57,04,49,73,22,39,59,25,42,78,09,41,64,07,30,69 10,47,54,21,32,79,14,34,60,12,43,68,16,51,70,17 44,62,01,48,76,11,37,63,27,52,72,02,53,77,15
CH #12	24,15,77,53,02,72,52,27,63,37,11,76,48,01,62,44 17,70,51,16,68,43,12,60,34,14,79,32,21,54,47,10 69,30,07,64,41,09,78,42,25,59,39,22,73,49,04,57 45,05,66,38,19,67,50,08,61,35,06,56,36,26,75,40 20,65,28,23,74,31,18,58,33,13,71,46,03,55,29
CH #13	24,73,37,67,51,75,32,58,41,15,49,11,50,16,40,21 33,09,77,04,76,08,68,20,54,13,78,53,57,48,61,43 65,47,71,42,02,45,01,35,12,28,10,46,25,72,05,62 06,60,23,69,03,59,52,66,44,56,34,74,30,55,39,27 38,17,36,14,31,07,29,22,63,19,70,26,79,18,64
CH #14	24,59,53,73,52,57,37,66,48,67,44,61,51,56,43,75 34,65,32,74,47,58,30,71,41,55,42,15,39,02,49,27 45,11,38,01,50,17,35,16,36,12,40,14,28,21,31,10 33,07,46,09,29,25,77,22,72,04,63,05,76,19,62,08 70,06,68,26,60,20,79,23,54,18,69,13,64,03,78
CH #15	24,78,03,64,13,69,18,54,23,79,20,60,26,68,06,70 08,62,19,76,05,63,04,72,22,77,25,29,09,46,07,33 10,31,21,28,14,40,12,36,16,35,17,50,01,38,11,45 27,49,02,39,15,42,55,41,71,30,58,47,74,32,65,34 75,43,56,51,61,44,67,48,66,37,57,52,73,53,59

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Revision History

Revision Number	Revision Date	Revised By	Changes Since Last Revision
1.0	April 28, 94	JuanG.	First Revision

Overview

This document describes RangeLAN2's Frequency Hopping Theory of Operation. The objective of this document is to provide enough information to satisfy regulatory requirements. It is not intended to be a detailed description of every aspect of the RangeLAN2 FH protocol.

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