

**MIMO stands for Multiple-Input Multiple-Output** that is not narrowly restricted to multiple streams operations, as evidenced in the proposed IEEE 802.11n specification<sup>1</sup>. In the Appendix A, “Modulation and Coding Schemes” of single stream are defined as MCS0-MCS7. Ralink's MIMO XR system is based on single-stream technology, utilizing both antennas for RX MRC and TX diversity in a time-sharing fashion, described in detail in a published white paper<sup>2</sup>. In summary, Ralink MIMO XR combines signals from both antennas using MRC algorithm on the receiver and uses selected beam algorithm based on statistic of received signal strength on the transmitter.

The classical MIMO concept started in 1984, with credit to Jack Winters; at that time multiple streams approach did not exist.

( [http://en.wikipedia.org/wiki/Multiple-input\\_multiple-output\\_communications#History\\_of\\_MIMO\\_in\\_radio\\_communications](http://en.wikipedia.org/wiki/Multiple-input_multiple-output_communications#History_of_MIMO_in_radio_communications) ). Jack Salz, of Bell Laboratories, published a paper<sup>3</sup> on MIMO in 1985, taking a cue from Winters' research, that Tx diversity and Rx MRC form the foundation of the classical MIMO implementation. In addition, in an IEEE paper<sup>4</sup> describing MIMO overview, it is quoted "Now, we consider the *use of diversity at both transmitter and receiver giving rise to a MIMO system*. For N TX and M RX antennas, we have the now famous capacity equation [1], [3], [21] .... ".

There are many other generally accepted MIMO viewpoints, e.g., Netgear's website (<http://www.netgear.com/products/details/WPN824.php> “What is MIMO?”)<sup>5</sup>. Dr. A. Paulraj of Stanford University stated, “The multiple antennas at each end of a MIMO link can be used in different modes such as transmit-receive diversity, beam-forming, antenna subset selection and spatial multiplexing... Different aspects of MIMO will find their unique niches in the plethora of products now entering the market.”

All of the references support Ralink's claims on the MIMO techniques used in the products. Overall, MIMO is divided into two classes: those who use MRC and transmit diversity to mitigate multi-path effects for longer range; others who take advantage of multi-path effects as in spatial multiplexing for higher throughput.

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<sup>1</sup> IEEE 802.11-05/1102r04, IEEE P802.11 Wireless LANs

<sup>2</sup> Ralink Technology, “MIMO technology primer: Understanding MRC-OFDM”, JAN, 2006

<sup>3</sup> Jack H. Winters, “Optimum Combining in Digital Mobile Radio with Cochannel Interference”, IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, VOL. 2, NO. 4, JULY 1984

<sup>4</sup> David Gesbert, Member, IEEE, Mansoor Shafi, Fellow, IEEE, Da-shan Shiu, Member, IEEE, Peter J. Smith, Member, IEEE, and Ayman Naguib, Senior Member, IEEE “From Theory to Practice: An Overview of MIMO Space-Time Coded Wireless Systems”, IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, VOL. 21, NO. 3, APRIL 2003

<sup>5</sup> Dr. A. Paulraj & Dr. Heath, “What is MIMO?”, Netgear web site