

MIMO technology and increased Spectral Efficiency: the next step in Wireless Networks

MIMO, Multiple Inputs Multiple Outputs, is a system that uses multiple transmitters and receivers to create additional paths or radio channels for the wireless transmission. Each path operates independently and the receiver recognizes this. The differences in the multipath create orthogonal communication channels. This requires a high-signal to noise ratio which uses sophisticated algorithms to separate the paths which overlap in time and frequency.

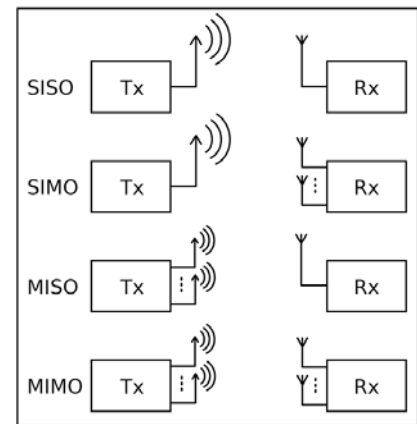
The key benefit of MIMO is that it offers significant increases in data throughput and link range without additional bandwidth or transmit power. It achieves this by higher spectral efficiency (more bits per second per hertz of bandwidth) and link reliability or diversity (reduced fade).

Spatial Multiplexing takes the high rate signal and breaks it down to lower rate streams within the same channel. These streams arrive at the receive antenna with different spatial patterns which allow them to be reconstructed and deliver more throughput and capacity using the same channels using that higher signal to noise ratio. This prevents the degradation of quality but significantly increase that throughput on the same spectrum.

Currently, SISO (Single Input Single Output) is the standard. MISO (Multiple Input Single Output) and SIMO (Single Input Multiple Output) can also be utilized but MIMO creates the most paths and is now becoming a critical component to Cellular, DAS and Wi-Fi systems. It promises to create additional capacity to handle the exponential growth of data and video traffic being offered to the network. The forecast for growth has dire implications for today's networks that cannot support the 30 to 50x capacity forecasted over the next 5 years.

Spatial multiplexing techniques makes the receivers very complex, and therefore it is typically combined with Orthogonal Frequency Division Multiplexing (OFDM) or with Orthogonal Frequency Division Multiple Access (OFDMA) modulation, where the problems created by multi-path channel are handled efficiently. The IEEE 802.16e standard incorporates MIMO-OFDMA. The IEEE 802.11n standard, released in October 2009, recommends MIMO-OFDM.

While the concept of Multiple Antenna's and Multiple Path's is



critical to any analysis a detailed understanding of how each manufacturer's actually engineer their solution is necessary to fully understand how much capacity can be gained and to determine ROI. For Instance, Tyco Electronics utilizes a distribution system that converts to IF while Corning/Mobile Access and Commscope/Andrew keep the signal at the RF level. They all utilize different ways of utilizing fiber optics and cabling (COAX OR CATV). These differences affect engineering of the cabling components and can make the difference between 1 or 2 cable paths. The implication of this is that time and cost are affected. Time to install and commission a system can take 30 to 40 % more time and even require new conduits. The effect of additional conduit, cable and labor can affect the system cost by 50% to 60%.

MIMO systems can be overlaid to existing systems but in general require a new discrete cabling and antenna deployment.

Some of the practical factors which will continue to drive the requirement for capacity and therefore MIMO include:

- Spectrum Scarcity-The carriers are trying to drive volume data traffic to wi-fi and BTS offloads which do not affect the amount of usable bandwidth in their licensed spectrum.
- Smartphone, tablet and device manufacturers continue to invest in the integration of MIMO in their small form factor devices by continuing research and the continued shrinking of component sizes. This will add to the requirement for MIMO in the network.
- Human behavior and the growth of video apps.

Today MIMO is generally seen as a 2x2 system. The market is forcing LTE technology to develop 4x4 and 8x8 systems. These systems will optimize the network and create increased throughput, capacity and coverage.

Spatial diversity contributes to signal quality and spatial multiplexing delivers such higher throughput and capacity that it is becoming both an economic and practical solution to the increasing demands on all wireless networks. MIMO is clearly a requirement to the continued network solution for high bandwidth requirements.