# MIMO USING OFDMA

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***Abstract* - Wireless communication is divided into mobile communications and fixed wireless communications. Each type of communication has huge demand according to customers need in the market. The demand of wireless communication is constantly growing day by day. The users of the wireless communication demands for higher data rates, good voice quality and higher network capacity restricted due to limited availability of radio frequency spectrum, Bandwidth, Channel Capacity, physical areas and transmission problems caused by various factors like fading and multipath distortion.**

**To improve the performance of fading channels, diversity techniques are used. In diversity technique, communication channel is supplied with multiple Transmitting and Receiving antennas which is known as MIMO. The signal is transmitted and received through multiple paths. Diversity techniques are used to overcome the fading problem and to improve the performance of the radio channel without increasing the transmitted power or bandwidth and improves the SNR . The current WLAN standards IEEE 802.11a and IEEE 802.11g are based on Orthogonal Frequency Division Multiplexing (OFDM). There are two types of OFDMA-MIMO system 1) Downlink MIMO: For the LTE (long term evolution) downlink (tower to device), a 2x2 configuration for MIMO is assumed as baseline configuration, i.e. 2 transmit antennas at the base station and 2 receive antennas at the terminal side. Configurations with 4 antennas are also being considered.
2) Uplink MIMO: Uplink,(from device to tower) LTE uses the DFTS-OFDMA (discrete Fourier transform spread orthogonal frequency division multiple access) scheme to generate a SC-FDMA(SinglecarrierFDMA) signal.**

**SC-FDMA is better for uplink because it has a better peak-to-average power ratio over OFDMA for uplink. LTE-enabled devices, in order to conserve battery life, typically don't have a strong and powerful signal going back to the tower, so a lot of the benefits of normal OFDMA would be lost with a weak signal. Despite the name, SC-FDMA is still a MIMO system. LTE uses a SC-FDMA 1×2 configuration, which means that for every one antenna on the transmitting device, there's two antennae on the base station for receiving. There signal detection is done by Spatial prewhitening for MED decoding and SIC (Successive Interference cancellation) . The capacity of a MIMO communication link depends not only on the fading statistics, as for a SISO link, but also on the spatial correlation of the channel. This results in a random capacity whose instant value depends on the corresponding instantaneous H matrix. An ensemble of H matrixes results for a given average SNR per RX antenna in a cumulative distribution function (cdf) of the capacity. In general, however, the complementary cdf is used because then, e.g., the 99% point denotes that for 99% of the instants of channel use the corresponding capacity can be achieved.**

**Hence there applications are High Throughput WiFi – 802.11n, MIMO in Mesh Network, MIMO in RFID,MIMO Enables the Digital Home.**

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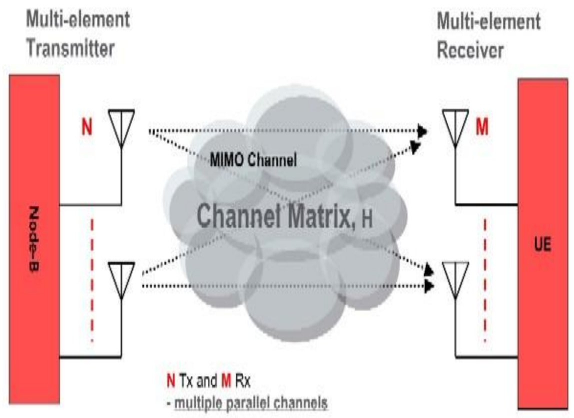
## 1 INTRODUCTION

MIMO channel model is introduced, based on these requirements, a wideband MIMO channel model is introduced, based on a geometric interpretation of the communication link, as an extension to the narrowband geometric MIMO interpretation. For various environments, the variations in the different paths between transmitter and receiver as function of time, location and frequency, generally called fading, can be represented by statistical distributions. For these cases, the geometrically based model is transferred to a stochastic channel model well as additive receiver noise. Most MIMO algorithms, however, are not introduced as wideband, but as narrowband techniques. Therefore, describes a narrowband signal model and its fading statistics. The narrowband model is shown to be a special case of the wideband model. An impairment that is specific for multi-antenna systems is spatial fading correlation.

Consider a wireless MIMO system, with $N_t$ transmit (TX) and $N_r$ receive (RX) antennas, that is operating in an environment with reflecting objects In such a scattering environment, during a transmission, reflections will occur and a transmitted signal that is launched by a given TX antenna arrives at a given RX antenna along a number of distinct paths. This effect is referred to as *multipath*. Because of movement of the user and/or movement of objects, each of these paths has its own time-varying angle of departure, path delay (i.e., excess delay), angle of arrival, and power. Due to constructive and destructive interference of the multipath components, the received signal can vary as a function of frequency, location and time. These variations are referred to as *fading*.




One of the potential application areas is that of Wireless Local Area Networks (WLANs). The current WLAN standards IEEE 802.11a and IEEE 802.11g are based on Orthogonal Frequency Division Multiplexing (OFDM). A high-data-rate extension of these standards could be based on SDM . This leads to the promising combination of the data rate enhancement of SDM with the relatively high spectral efficiency and the robustness against frequency-selective fading and narrowband interference of OFDM. An advantage of wireless LAN systems is that they are mainly deployed in indoor environments. These environments are typically characterized by richly scattered multipath.

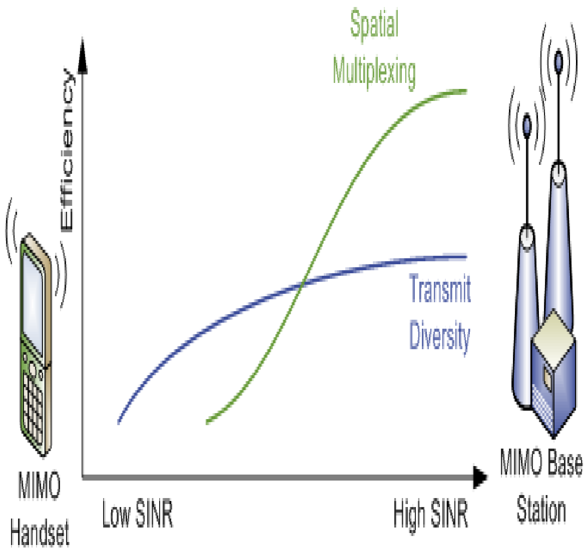
## 2.TYPES OF MIMO:

*1.Downlink MIMO:*

- For the LTE (long term evolution) downlink(tower to device), a 2x2 configuration for MIMO is assumed as baseline configuration, i.e. 2 transmit antennas at the base station and 2 receive antennas at the terminal side. Configurations with 4 antennas are also being considered.
- Different MIMO modes are envisaged. It has to be differentiated between spatial multiplexing and transmit diversity, and it depends on the channel condition which scheme to select.

**a). Spatial Multiplexing:** Spatial multiplexing requires MIMO antenna configuration. In spatial multiplexing, a high rate signal is split into multiple lower rate streams and each stream is transmitted from a different transmit antenna in the same frequency channel. If these signals arrive at the receiver antenna array with sufficiently different spatial signatures and the receiver has accurate CSI, it can separate these streams into (almost) parallel channels. Spatial multiplexing can also be used for simultaneous transmission to multiple receivers, known as space-division multiple access or multi-user MIMO, in which case CSI is required at the transmitter.

**b). Transmit diversity**: Diversity Coding techniques are used when there is no channel knowledge at the transmitter. In diversity methods, a single stream (unlike multiple streams in spatial multiplexing) is transmitted, but the signal is coded using techniques called space-time coding. The signal is emitted from each of the transmit antennas with full or near orthogonal coding. Diversity coding exploits the independent fading in the multiple antenna links to enhance signal diversity.


*2. Uplink MIMO*

Uplink,(from device to tower) LTE uses the DFTS-OFDMA (discrete Fourier transform spread orthogonal frequency division multiple access) scheme to generate a SC-FDMA(Single carrier FDMA) signal. SC-FDMA is

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better for uplink because it has a better peak-to-average power ratio over OFDMA for uplink. LTE-enabled devices, in order to conserve battery life, typically don't have a strong and powerful signal going back to the tower, so a lot of the benefits of normal OFDMA would be lost with a weak signal. Despite the name, SC-FDMA is still a MIMO system. LTE uses a SC-FDMA 1×2 configuration, which means that for every one antenna on the transmitting device, there's two antennae on the base station for receiving.

## 3.SIGNAL DETECTION

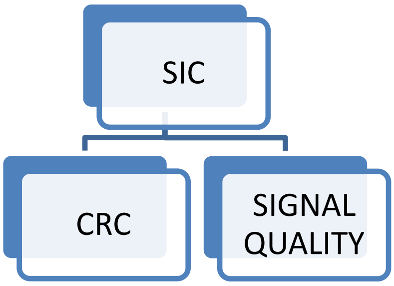
*1) Spatial prewhitening for MED decoding:* The joint detection of the data block b1[n,k] and b2[n,k] are treated as interference when detecting and decoding b1[n,k] so received signal is

$$r[n,k]=H1[n,k]\ t1[n,k] + v1[n,k]$$

where v1[n,k]= H2[n,k] t2[n,k] + w[n,k]

*2) SIC (Successive Interference cancellation):*

SIC has been proposed for the CDMA and single carrier system is used here for better performance .




## 4.Capacity

The capacity of a MIMO communication link depends not only on the fading statistics, as for a SISO link, but also on the spatial correlation of the channel. This results in a random capacity whose instant value depends on the corresponding instantaneous **H** matrix. An ensemble of **H** matrix results for a given average SNR per RX antenna in a cumulative distribution function (cdf) of the capacity. In general, however, the complementary cdf is used because then, e.g., the 99% point denotes that for 99% of the instants of channel use the corresponding capacity can be achieved. So, note that when the transmitter does not have channel knowledge, for any information or bit rate it chooses there is a nonzero probability that an instantaneous **H** is incapable of supporting it even when ideal channel coding for that chosen rate is employed.

## 5.APPLICATION:

*1.)High Throughput WiFi –802.11n*
Using the *rates up* to 600 Mbps through multiple antennas and signal processing

Target applications include: large files backup, HD streams, online interactive gaming, home entertainment, etc. Backwards compatible with 802.11a/b/g.

*2.) MIMO in Mesh Network*

- A collection of wireless mobile nodes that self-configure to form a network (data rate + range)
- No fixed infrastructure is required
- Any two nodes can communicate with each other
- High capacity link are useful for scalability and multimedia services.

*3.)Mobile- 802.16eTechnology Overview*

- A 2x2 MIMO Configuration in 802.16°
- Increasing spectral efficiency (bps/Hz)
- Downlink – higher capacity and user peak rates
- Uplink – higher capacity only
- Non line of site, up to 4-6 mbps per user for a few km
- 2.5 GHz (US) and 3.5 GHz licensed bands
- Channel bandwidth from 1.25 to 20 MHz
- QPSK, 16 QAM and 64 QAM modulation
- OFDMA access (orthogonal uplink)
- spatial diversity, spatial multiplexing using MIMO (2x2)

*4.)MIMO in RFID*

- Increasing read reliability using space diversity.
- Increasing read range and read throughput.
- Full channel information at the reader comes.

*5.)MIMO Enables the Digital Home*

- MIMO delivers whole home coverage with the speed and reliability to stream multimedia applications
- MIMO can reliably connect cabled video devices, computer networking devices, broadband connections, phone lines, music, storage devices, etc.
- MIMO is interoperable and can leverage the installed based of 802.11 wireless that is already deployed: computers, PDAs, handheld gaming devices, cameras, VoIP Phones, etc.

## 6. ADVANTAGES

- MIMO routers include faster speeds, greater distances between your paired devices, more simultaneous users, less signal fading and dead spots, and better resistance to interference.
- limited-bandwidth channels
- Superior Data Rates, Range and Reliability. The price point of under $100.00 should help this technology to be launched in a big way and gain supporters quickly.

## 7. DISADVANTAGES

- MIMO routers are more expensive than other routers, prices are expected to fall as the technology matures.

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- Distortion

## 8. FUTURE

3GPP
ADVANCE space time coding and channel matrix.

## 9. CONCLUSION

As answer to the demand for ever increasing data rates and augmented mobility, SDM OFDM provides an attractive and practical solution for future high-speed indoor wireless data communication networks. It combines the data-rate and spectral-efficiency enhancements of SDM with the relatively high spectral efficiency and the robustness against frequency-selective fading and narrowband interference of OFDM.

Specifically, the proposed coded-SDM detection scheme, based on a non-linear variant of the Minimum Mean Squared Error (MMSE) algorithm and named Per-Antenna-Coded Successive Interference Cancellation (PAC SIC) , was shown to perform close to the optimal performing Maximum Likelihood Detection with soft-decision output values (SOMLD). PAC SIC, however, has a much lower complexity than SOMLD as can be deduced from the complexity comparison of Subsection. This high performance and low complexity are achieved at the expense of a manageable latency. Through simulations and practical measurements it is shown that by SDM OFDM the data rate can be increased by a factor equal to the number of transmit (TX) antennas, while for many scenarios also the performance is increased with respect to standard OFDM. This performance gain is explained by the fact that, besides the exploitation of frequency diversity, also the spatial diversity is exploited.

Moreover, the inherent capability of coded SDM to fallback in coding rate, constellation scheme, and/or number of transmit antennas provides a means to deliver a good performance in a variety of scenarios. Altogether, these are strong advantages making the SDM OFDM combination an attractive solution for, e.g., next generation Wireless Local Area Networks (WLANs).

More detailed conclusions and results of this dissertation are presented in MIMO channel model (for indoor environments), evaluate and find efficient SDM detection techniques in terms of performance and complexity, evaluate these techniques in combination with OFDM, e.g., by performing simulations and making use of the proposed wideband MIMO channel model, verify the SDM OFDM combination in real-life channels by means of a test system. This also requires tackling of the non-idealities encountered in practical circumstances.

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