MIMO Technology Used in Wireless Communication

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Abstract

Future wireless systems are expected to support high data rates of 1 Gbit/s or more in a variety of scenarios. A key technology in order to achieve the required high spectral efficiency is the application of multiple input multiple output (MIMO) techniques, which exploit spatial diversity, array gain or spatial multiplexing gain. Another source of diversity - inherent to wireless systems- is that of the multiuser diversity. Multiuser (MU) MIMO algorithms combine both MIMO gains with multiuser diversity benefits. Although MU MIMO techniques have been extensively studied and were shown to provide considerable average cell throughput gains, they often prove inadequate to cope with intercell interference and can only offer poor cell edge performance

Introduction

MIMO (multiple input, multiple output) is an efficient transmission technology used in modern wireless communication. As the name implies, MIMO uses multiple antennas for transmission and reception. Combination of multiple transmission sources enhances higher data rate and system efficiency. Smart devices with wireless standard 802.11n support MIMO technology.

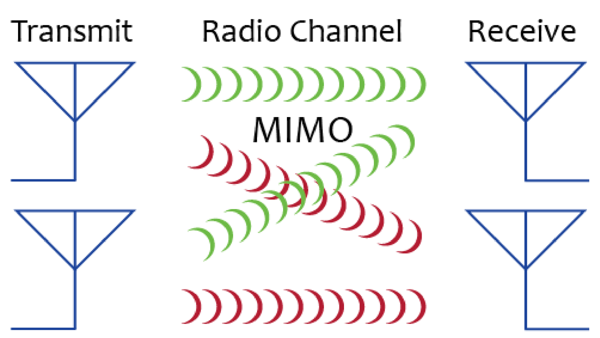

Figure 1: Basic MIMO Transmission

Diversity is one technique that is used to mitigate this effect.Time and frequency diversity are two types of diversity that are used. The use of multiple antennas adds a new type, space diversity.
In conventional signal transmission, one antenna send signal and another antenna pick up the signal at the receiving end. In a basis MIMO system more than one transmitting antennas and single or multiple receiving antennas used for signal transmission simultaneously.

MIMO in Wireless LAN

One of the common uses of MIMO technology today is wireless LAN. Wireless routers with multiples antenna become common nowadays. Data rate can be doubled or multiplied many times with effective use of MIMO technology in wireless routers and mobile devices. In order to have an efficient system, both transmitting and receiving devices must be compatible.

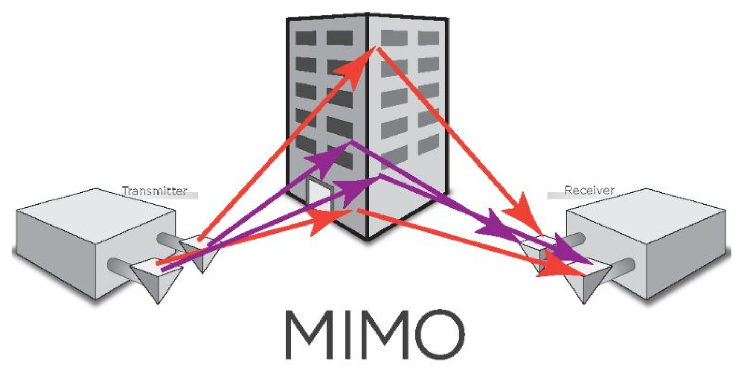

Figure 2: MIMO in Wireless LAN

MIMO in 5G and IOT

5G and Internet of Things requires massive data rate. MIMO technology with Beamforming is one of the significant transmission terminologies for super charged 5G networks and IoT. Transmission tower will be equipped with multiple antennas. It will locate a particular user at a specific location and will transmit to that user using multiple antennas simultaneously.

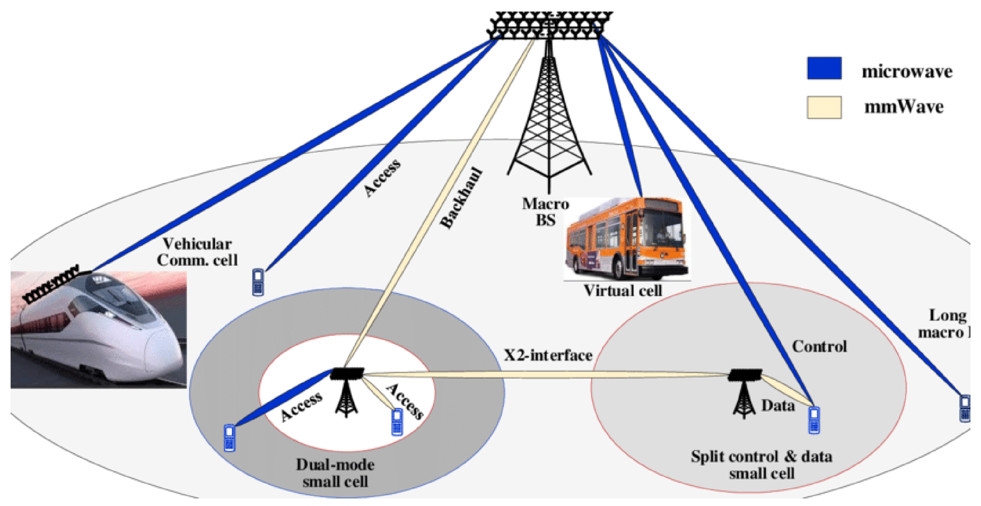

Figure 3: 5G Architecture Based On MIMO

Change in user location can be tracked and user will be handled by the antennas located at the specific direction of user. It enables network operators to offers an uninterrupted service effectively. MIMO can be used in Internet of Things, smart home, smart cities and connected car applications. The architecture is a multitier cellular HetNet composed of the macrocell and small cell.

How MU-MIMO works with wireless devices

MU-MIMO was created to support multiple users which are trying to access the wireless network at the same time. The nature of the 802.11 protocol is that users are served on a first-come, first-serve basis.
When multiple users begin accessing the router near the same time, congestion can be introduced as the router services the first user's request while the second waits. MU-MIMO helps by allowing multiple users to access router functions without the congestion.

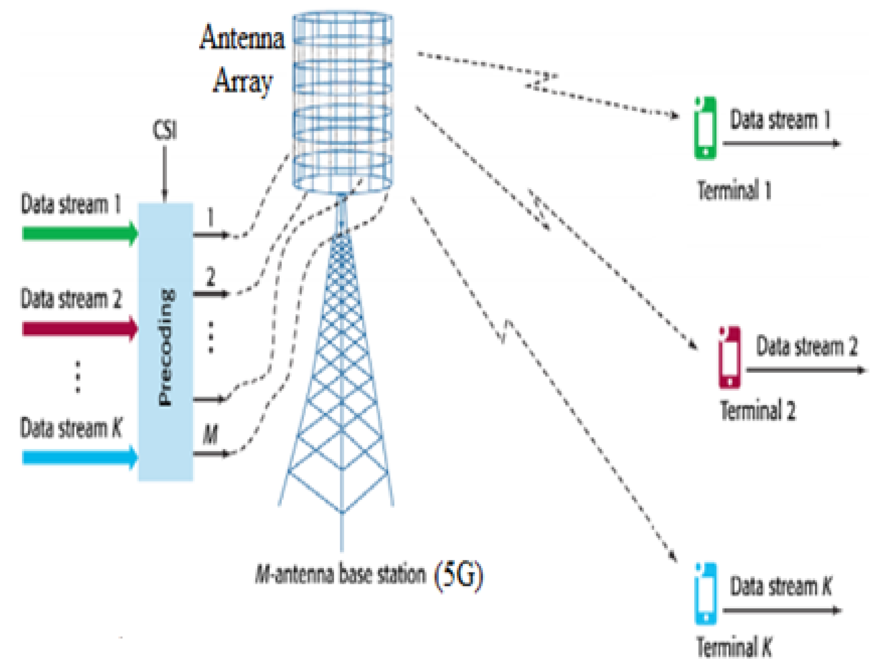

Figure 4: MU-MIMO in 5G System

Advantages & Disadvantages And References

ADVANTAGES

- Beam steering – MIMO offers the opportunity to electronically guide the directivity of the RF signal by controlling the signal propagating phase over multiple antennas.
- Beam steering can directionally focus the RF energy on a single user, ignoring the remaining space. It is also possible to track the user, reducing interference and boosting signal to noise wherever the user is located.
- Beam steering can solve the problem of RF multipath by discovering the best path and targeting RF energy toward that direction.
- MIMO can add data carrying capacity without requiring additional bandwidth through spatial multiplexing.

Figure 5: Advantage of Massive MIMO

DISADVANTAGES

- System requires higher level of signal processing at transmitter and receiver end.
- MIMO based systems cost higher compare to single antenna based system due to increased hardware and advanced software requirements.
- The hardware resources increase power requirements. Battery gets drain faster due to processing of complex and computationally intensive signal processing algorithms. This reduces battery lifetime of MIMO based devices.

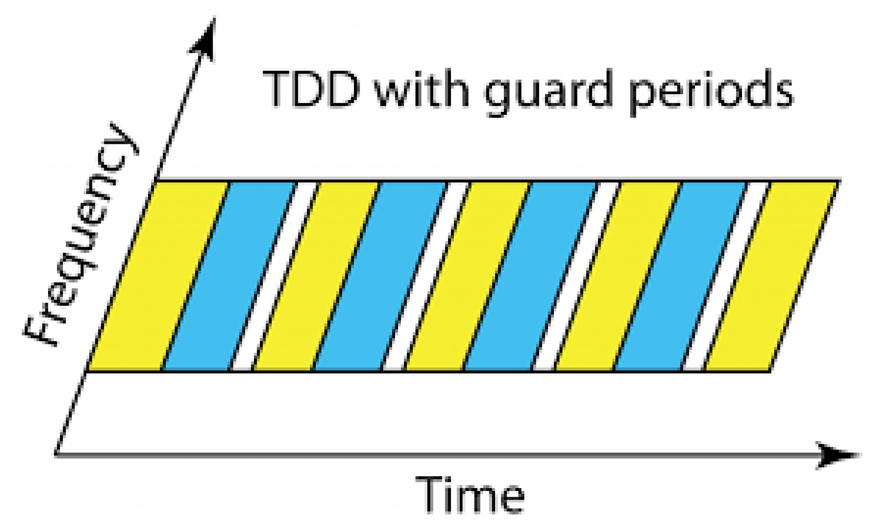

Figure 6: Disadvantage of Massive MIMO

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