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Adaptive Massive MIMO Based Wireless Backhaul for 5G Ultra Dense Networks

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ABSTRACT

To propose a Digitally Controlled Phase Shifter (DPSN) for adaptive massive MIMO to increase the data rate, this will also reduce the complexity. Macro cell BS can support Small cell BS which is typically different and limited to single user MIMO with multiple streams or multi user MIMO with single stream for each user. Using BPSK modulation, is the reason for efficient technique. Based on the proposed scheme, we further explore the fundamental issues of developing massive MIMO for wireless backhaul, and the associated challenges, further the benefits and features of the massive MIMO are also addressed.

Keywords: MIMO, Digitally Controlled Phase Shifter and BPSK Modulation.

1. INTRODUCTION

To recognize such an aggressive 5G variation, the extremely-dense network (UDN) has been considered as a promising method architecture to permit gigabit-per-2d person expertise, seamless insurance policy, and inexperienced communications Macrocell base station with significant insurance plan probably manipulate user scheduling and resource allocation, and aid high-mobility customers, while many ultra dense small-mobile phone BSs with much smaller coverage furnish excessive data rate for low-mobility customers. As a result of extremely-dense small-mobile phone BSs, higher frequency reuse can be accomplished, and power effectivity can also be multiplied extensively due to the reduced direction loss in small cells To allow UDN, a riskless, price-strong, Gigahertz bandwidth backhaul connecting the macrocell BS and the associated small-phone BSs is prerequisite. It has been established that backhaul with 1~10 GHz is required.

2. PROPOSED SYSTEM

To help multi-consumer and multi-movement, we recommend the DPSN-founded hybrid precoding/combining scheme as proven, which can effectively cut down the rate and complexity of the transceiver. Certainly, take into account the macrocell BS has Na Ma antennas but NBB Ma BB chains, the place Na Ma >> NBB Ma, at the same time every small-cellphone BS has Na Sm antennas but NBB Sm BB chains, the place Na Sm >> NBB Sm. The quantity of at the same time supported small-mobile phone BSs is okay. H_k OE CNaMa×NaSm with Na Ma > Na Sm denotes the massive Wave significant MIMO channel matrix related with the macrocell BS and the k^{th} small cell BS, and it can be expressed as follows in line with singular price decomposition

3. EXISTING SYSTEM

Conventional massive Wave multi-antenna techniques utilize a single RF chain and analog, phase shifters for precoding/combining as proven, but are confined to SU-MIMO with a single move. Full digital precoding in microwave massive MIMO, as shown, can at the same time help more than one single-antenna customers,(multi-user [MU]-MIMO), nevertheless it requires one particular RF chain to be connected to each antenna, which will also be unaffordable in massive Wave communications .Not too long ago, the hybrid precoding/combining scheme such as analog and digital precoding/combining, as shown , has been proposed for massive Wave significant MIMO with the lowered rate and complexity of the transceiver. However, brand new hybrid precoding/combining schemes are frequently restricted to SU-MIMO with more than one streams or MU-MIMO with a single circulate for each.

4. CHALLENGING CHANNEL ESTIMATION FOR MM-WAVE MASSIVE MIMO

As discussed earlier, mmWave massive MIMO may suffer from the prohibitively high overhead for channel estimation, and calibration error of RF chains as well as synchronization are also not trivial in TDD. Additionally, due to the much smaller number of BB chains than that of antennas, the effective dimensions that can be exploited for channel estimation will be substantially reduced although massive antennas are employed. Furthermore, channel estimation in the digital baseband should consider the characteristics of phase-shifter networks at both macrocell BS and small-cell BSs, which can make it more complex. Finally, due to the strong signal directivity of mmWave, reliable channel estimation requires sufficient received signal power, which means at least partial CSIT is necessary to ensure beamforming at the transmitter to match mmWave MIMO channels.

5. OVERVIEW OF EXISTING CHANNEL ESTIMATION SCHEMES

Wireless local area network (WLANs) (IEEE 802.11ad) relies on beamforming training to compensate the large path loss in 60 GHz. The specific training consists of three phases:

• Sector-level sweep is to select the best transmit and optionally receive antenna sector.

• Beam refinement is used for fine adjustment of beamforming.

• Beam tracking can adjust beamforming during data transmission.

In wireless personal area networks (WPANs) (IEEE 802.15.3c), a codebook is designed in scenarios of indoor communications with the small number of antennas, where the beamforming protocol is similar to that in IEEE 802. However, both of them only consider the analog beamforming (precoding). Proposed a hierarchical multi-resolution code book based channel estimation for hybrid precoding/ combining scheme. However, the proposed scheme may suffer from destructive interference between the path gains when multiple paths are summed up in the earlier stages of the proposed algorithm.

6. OTHER ISSUES OF CHANNEL ESTIMATION

There still remains some problems to be investigated further, such as the optimal beamforming/combining patterns in coarse channel estimation, training signals for AoA/AoD and path gains estimation, low-complexity high-accuracy CS-based channel estimation algorithms, effective channel feedback scheme, dynamic channel tracking to combat sudden blockage or slow channel changes. For instance, the microwave control link with only limited resource can be used to feedback the estimated parametric AoA/AoD, since the number of AoA/AoD is typically 3~5. Regarding the CS-based channel estimation algorithm, in addition to FRI theory, other CS approaches such as low-rank matrix reconstruction are expected to be tailored for mmWave massive MIMO with low complexity. Besides, the proposed channel estimation scheme (including the coarse channel estimation and the following estimation of AoA/AoD and path gains) is used to initially build the UDN backhaul link, where the latency can be negligible. Once the backhaul link is built, only the estimation of AoA/AoD and path gains is required to track the channels and then adjust the corresponding precoding/combining, where the training sequences and data can be multiplexing in the time domain, so the latency can also be negligible.

7. BLOCK DIAGRAM

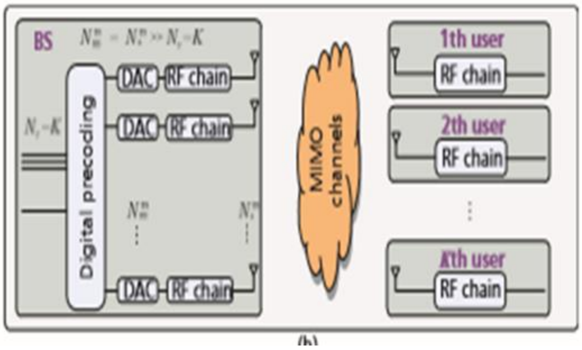


Fig 1.1 Proposed DPSN based hybrid precoding for 5G ultra dense Networks

8. FEASIBILITY AND CHALLENGES OF MASSIVE MIMO FOR WIRELESS BACKHAUL IN 5G UDN

In UDN, small cells are densely deployed in hotspots (e.g., office buildings, shopping malls, residential apartments) with high data rate to provide traffic offload from macro cells, since the large majority of traffic demand comes from these hotspots. Hence, the backhaul between the macrocell BS and the associated small-cell BSs should provide large bandwidth with reliable link transmission. Besides, power efficiency and deployment cost are also key considerations.

9. MMWAVE IS SUITABLE FOR WIRELESS BACKHAUL IN 5G UDN

Traditionally, mmWave is not used for RAN in existing cellular networks due to its high path loss and expensive electron components. However, massive Wave is especially suitable for backhaul in UDN due to the following reasons.

High-capacity and inexpensive: The large amount of underutilized mmWave including unlicensed V-band (57–67 GHz) and lightly licensed E-band (71–76 GHz and 81–86 GHz) (the specific regulation may vary from country to country) can provide potential gigahertz transmission bandwidth. For example, more than 1 Gb/s backhaul capacity can be supported over a 250 MHz channel in E-band
.

Immunity to interference: The transmission distance comfort zone for E-band is up to several kilometers due to rain attenuation, while that for V-band is about 500–700 m due to both the rain and oxygen attenuation. Due to high path loss, mmWave is suitable for UDN, where improved frequency reuse and reduced inter-cell interference are expected. It should be pointed out that rain attenuation is not a big issue for mmWave used in UDN. If we consider very heavy rainfall of 25 mm/hr, the rain attenuation is only around 2 dB in E-band if we consider the distance of a backhaul link is 200 m in typical urban UDN.

Small form factor: The small wavelength of mmWave implies that massive antennas can easily be equipped at both macro and small-cell BSs, which can improve the signal directivity and compensate severe path loss of mmWave to achieve larger coverage in turn. Hence, the compact mmWave backhaul equipment can easily be deployed with low-cost sites and short time.

10. CHANNEL CHARACTERISTICS

As discussed above, the massive MIMO-based backhaul is apt for the transceiver with a limited number of BB chains. Compared to microwave massive MIMO using full digital precoding, precoding/combining with the smaller number of BB chains than that of antenna elements can make mmWave massive MIMO suffer from a certain performance loss, which is largely dependent on the propagation condition of massive MIMO channels.

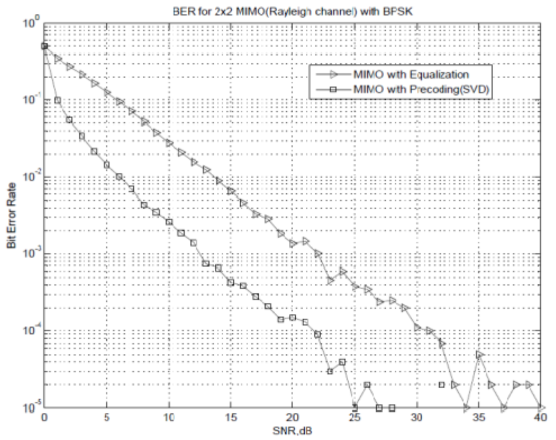
11. CHANNELS WITH SPATIAL SPARSITY

Extensive experiments have shown that mmWave massive MIMO channels exhibit the obviously spatial/angular sparsity due to its high path loss for non-line-of-sight (NLOS) signals, where only a small number of dominant multipath components (typically, 3~5 paths in realistic environments) consist of mmWave MIMO multipath channels. If we consider the widely used uniform linear array (ULA), the point-to-point massive MIMO channel can be modeled.

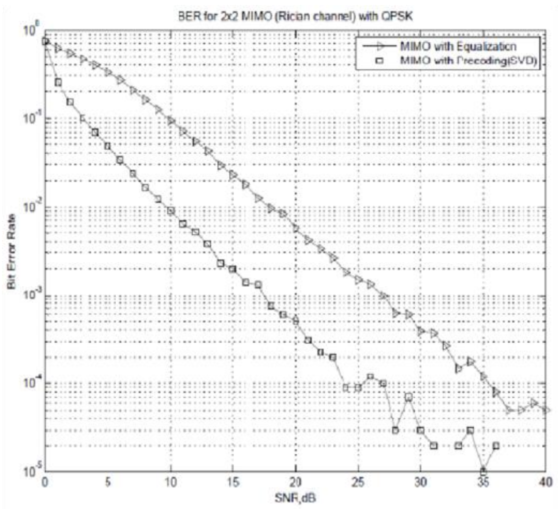
12. KEY ISSUES OF DESIGNING MASSIVE MIMO FOR 5G UDN BACKHAUL HYBRID PRECODING

In order to realize the reliable point-to-multipoint (P2MP) backhaul link, mmWave massive MIMO for UDN backhaul should exploit the flexible beamforming and spatial multiplexing to simultaneously support multiple small-cell BSs and provide multiple streams for each small-cell BS, which challenges conventional precoding/ combining schemes.

13. RESULTS



MIMO USING BPSK



MIMO USING QPSK

14. CONCLUSIONS

This article discusses a promising wireless backhaul based on mmWave massive MIMO for future 5G UDN. We have explored the fundamental issues of the implementation of mmWave massive MIMO for wireless backhaul. Especially, by leveraging the low-rank property of the massive MIMO channel matrix, we propose a DPSN-based hybrid pre coding/combining scheme and the associated CS-based channel estimation scheme. The proposed scheme can guarantee that the macrocell BS simultaneously supports multiple small-cell BSs with multiple streams for each small-cell BS. This is essentially different from conventional precoding/combining used for RAN. The proposed scheme can provide a viable approach to realize the desired P2MP backhaul topology and novel BDM-based scheduling, and it may also facilitate the in-band backhaul in mmWave. Additionally, some potential research directions to enable mmWave massive-MIMO-based wireless backhaul are highlighted, which may become active research topics in near future.

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