OAM-mMIMO: A Massive Capacity Scheme for 6G Wireless Backhaul Connectivity

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ABSTRACT

The massive capacity backhaul wireless connectivity is required for future 6G. But due to interference issues and the division of resources (Time/Frequency/Code) of wireless communication degrade the capacity achievement in case of the backhaul connection for future 6G wireless communication. Hence, the OAM technique is integrated with massive MIMO which is termed as OAM-mMIMO scheme. Moreover, the divergence of the OAM beam can be overcome by the proposed OAM-mMIMO scheme. In addition, the superiority of the proposed OAM-mMIMO scheme over the conventional schemes is evaluated by simulation results.

Ⅰ. INTRODUCTION

The sixth-generation (6G) wireless networks are expected to provide superior performance to conventional 5G wireless networks and also need to provide emerging services and applications [1]. Moreover, 6G will provide full dimensional wireless coverage to support full-vertical applications [1]. Furthermore, Mobile internet and internet of everything required high data rate transmission are two major factors of 6G wireless communication [1]. These major factor required massive capacity backhaul wireless connectivity to meet the requirements of 6G. That is why a suitable interference free and massive capacity solution is required. So, OAM is a suitable technique to provide capacity improvement and interference-free wireless transmission technique according to [2--3]. Moreover, integrating the OAM technique with MIMO can provide high channel capacity improvement as well as overcome the beam divergence issues of higher-order OAM beams [3].Thus OAM is integrating with mMIMO in this paper (Termed as OAM-mmIMO scheme) to achieve massive channel capacity improvement for 6G wireless backhaul connection compared to conventional schemes.

Ⅱ. SYSTEM MODEL

An OAM-mMIMO system in the case of LOS case is illustrated in Figure 1. The distance between Tx and Rx is d. Moreover, N (n=1,⋯, N) and M (1,⋯, M) is the number of UCAs at Tx and Rx side, and NT and MT are the total numbers of antenna elements. Furthermore, the Φ and Θ are the misalignment angle between Tx and Rx UCAs and elevation angles, respectively. λ is the wavelength of the signals. Besides, h denotes the channel matrix and μ is the Eigenvalues [4]. According to Figure 1, the signals are transmitted from transmitter by OAM-mMIMO multiplexing technique and perform MD and decoding at receiver end to extract the respective signal. The OAM-mMIMO multiplexing technique is shown in Table1.

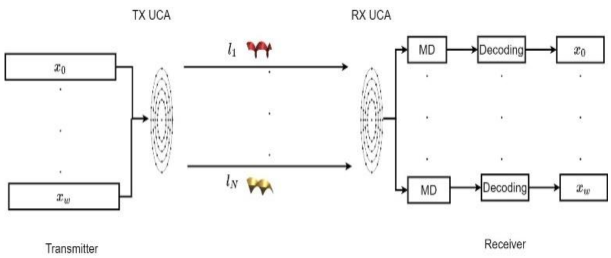

Fig. 1: System Model of the proposed OAM-mMIMO scheme.

Table. 2: OAM-mMIMO multiplexing.

UCA No.	Mode -2	Mode -1	Mode 0	Mode 1

UCA 4	**O**	**O**	**O**	**O**
.	.	.	.	.
UCA 1	**O**	**O**	**O**	**O**
UCA 4	**O**	**O**	**O**	**O**
UCA 3	**O**	**O**	**O**	**O**
UCA 2	**O**	**O**	**O**	**O**
UCA 1	**O**	**O**	**O**	**O**
UCA 0			**O**	

Ⅲ. CHANNEL CAPACITY ANALYSIS

The achievable channel capacity for the proposed OAM-mMIMO scheme is derived as below [2--4].

$C_1 = F\sum_{q=1}^{Q} log_2(1+\frac{\gamma}{N}\mu^2)$………(1)

Where ρ is the transmit SNR [4]. Furthermore, $F=N_T/N$ and $\gamma = \sum_{m=1}^{M}\sum_{n=1}^{N}\rho|h|^2$. Moreover, Q is the rank of the channel matrix. In addition, $Q \leq R=\min(M, N)$. Fullrank (Q = R) channel matrices with equal eigenvalues are obtained in this case [2--4].

Ⅳ. RESULT ANALYSIS

The result analysis analyzes and compares the channel capacities of the proposed OAM-mMIMO scheme and conventional OAM-MIMO and mMIMO based schemes. Parameter $d=10\lambda$, $\lambda=0.01$, $M_T=N_T=64$, $M=N=4$, $\Theta=0^o$, and $\phi=0^o$ [2--4]. Figure 2--3 depicted that the proposed OAM-mMIMO scheme provides significantly higher channel capacity than conventional schemes.

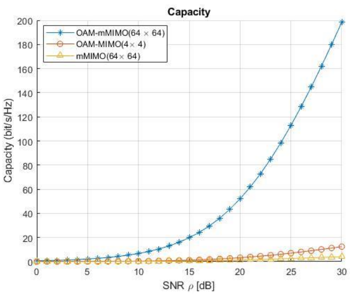

Fig. 2: Capacity with respect to ρ

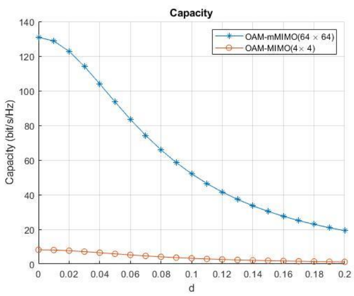

Fig. 3: Capacity with respect to normalized d

Because multiple sub-channels utilized by different OAM modes can carry multiple symbols towards the users simultaneously without any interference. Hence, in the case of OAM-mMIMO, multiple UCAs are transmitted massive data streams are transmitted simultaneously by utilizing the OAM-mMIMO multiplexing with less number of OAM modes to overcome the beam divergence issue. Thus, the capacity is improved to a great extent. Moreover, due to the higher distance, the proposed scheme outplayed the conventional OAM-MIMO scheme as well.

Ⅴ. CONCLUSION

The proposed OAM-mMIMO scheme for 6G backhaul wireless communication link can provide massive channel capacity compared to other conventional schemes. In addition, due to the higher distance between Tx and Rx UCA, the proposed scheme outplayed the existing scheme as well.

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