
Multi-user MIMO transmission scheme aiming to exploit transmit diversity benefit

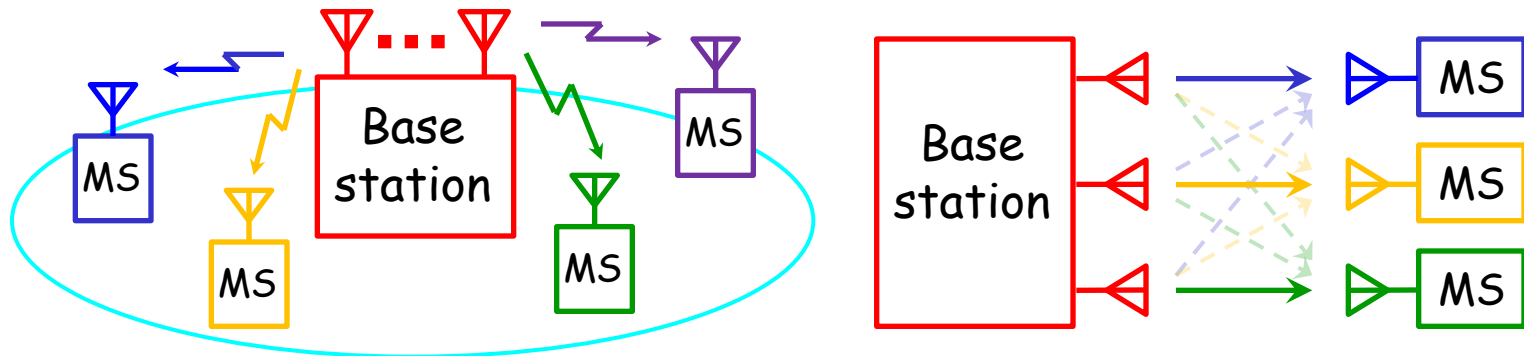
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Background

Recent years, there is a high demand for new technology in order to achieve **high spectral efficiency**.

MU-MIMO (Multi User-Multiple Input Multiple Output)

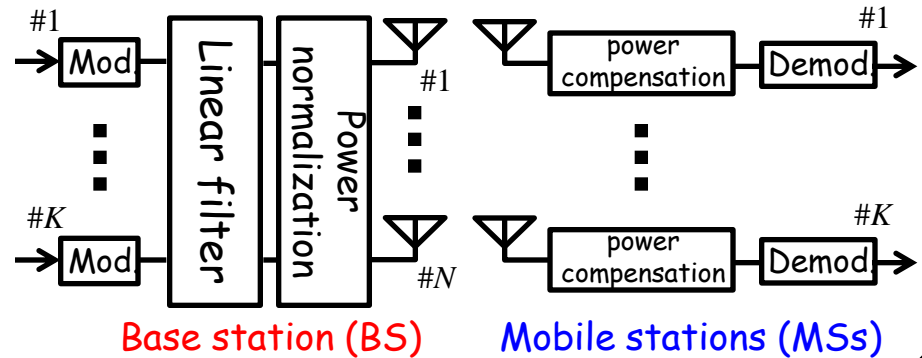


MU-MIMO makes it possible to realize simultaneous multi-user transmission by using plural transmit antennas at the base station while leaving a few antennas at the mobile stations.

⇒ **To realize high system capacity**

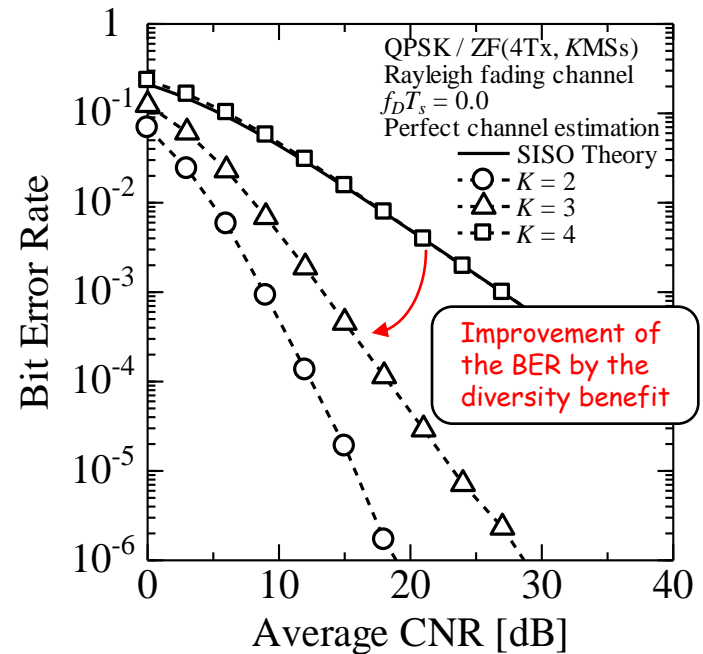
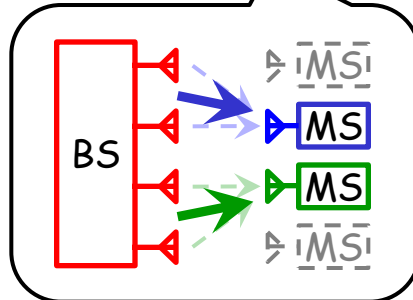
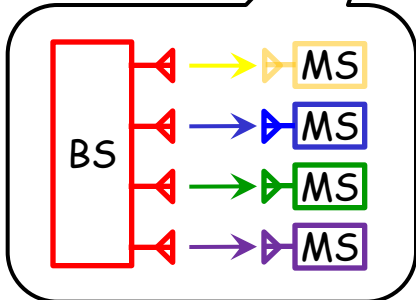
The concept of MU-MIMO

- To realize simultaneous multi-user transmission, orthogonality among MSs is essential.
- Orthogonality is created by precoding at BS



Basic characteristics of MU-MIMO

Number of antennas	BS = MS	BS > MS
Total transmission rate	○	△
Diversity benefit	×	○



Proposed MU-MIMO transmission scheme

Problem statement

MU-MIMO unfortunately fails to exploit the space diversity benefit in the case that the number of MSs is the same as that of the transmit antennas.

Number of antennas	BS = MS	BS > MS
Total transmission rate	○	△
Diversity benefit	×	○

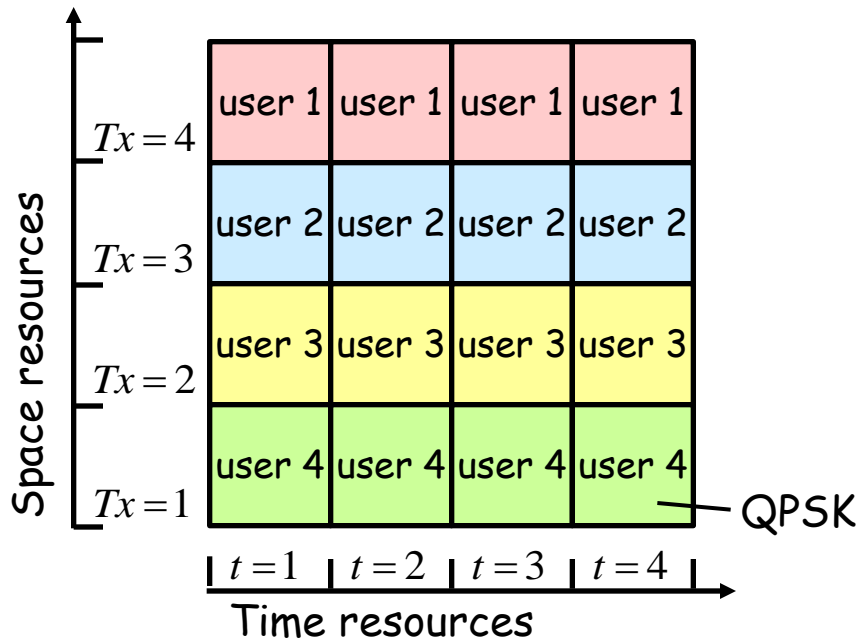
Target of this work

Proposed method

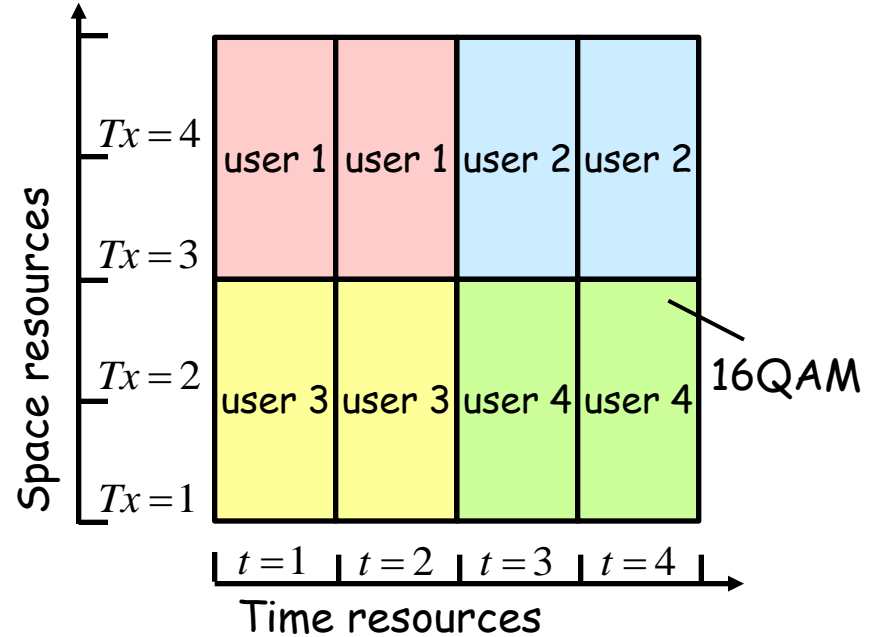
- The transmit diversity benefit is exploited by intentionally **decreasing the number of effective MSs in each time slot** while **the higher level modulation is adopted** for keeping the constant transmission rate.
- The BERs of possible combinations of the MSs are theoretically calculated by using the CSI and then **the combination with the best BER performance is adopted** for the actual multi-user transmission.

The effectiveness of the proposed scheme is demonstrated in comparison with the traditional MU-MIMO transmission by means of computer simulations.

Concept of the proposed scheme



(a) Traditional scheme



(b) Proposed scheme

The proposed scheme restricts the number of MSs to be simultaneously communicated in each time slot to exploit the transmit diversity benefit.

Advantage:

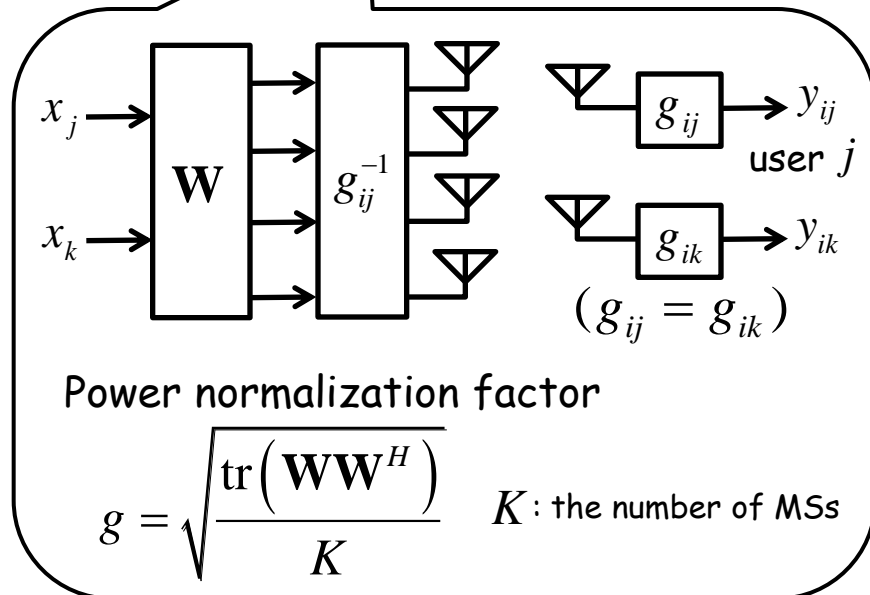
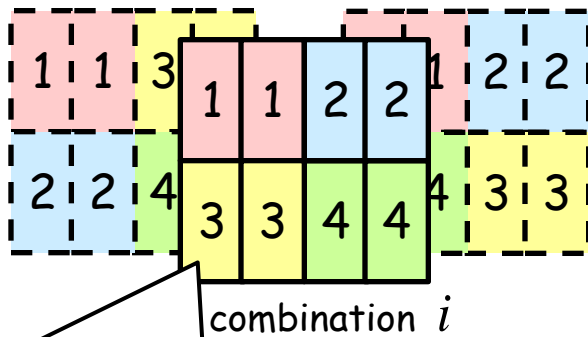
The space diversity benefit created by decreasing the effective MSs in each time slot is enhanced.

Disadvantage:

The power efficiency loss is caused by the use of the higher level modulation.

Multi-user selection method

In the proposed scheme, the BER of each combination of the MSs is theoretically calculated, and the combination with the best BER performance is used for actual transmission.



If 2bit per symbol is assumed as a transmission rate...

The BER of user j in the combination i

$$P_{bij} = \frac{3}{8} \text{erfc} \left(\sqrt{\frac{|s|^2}{10g_{ij}^2\sigma_n^2}} \right)$$

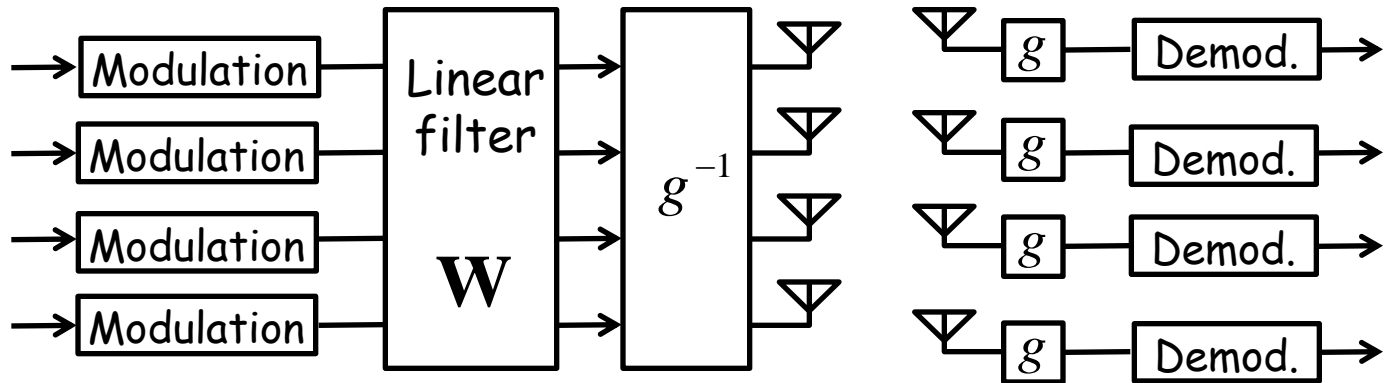
The BER of the combination i

$$\bar{P}_{bi} = \frac{1}{N} \sum_{j=1}^N P_{bij}$$

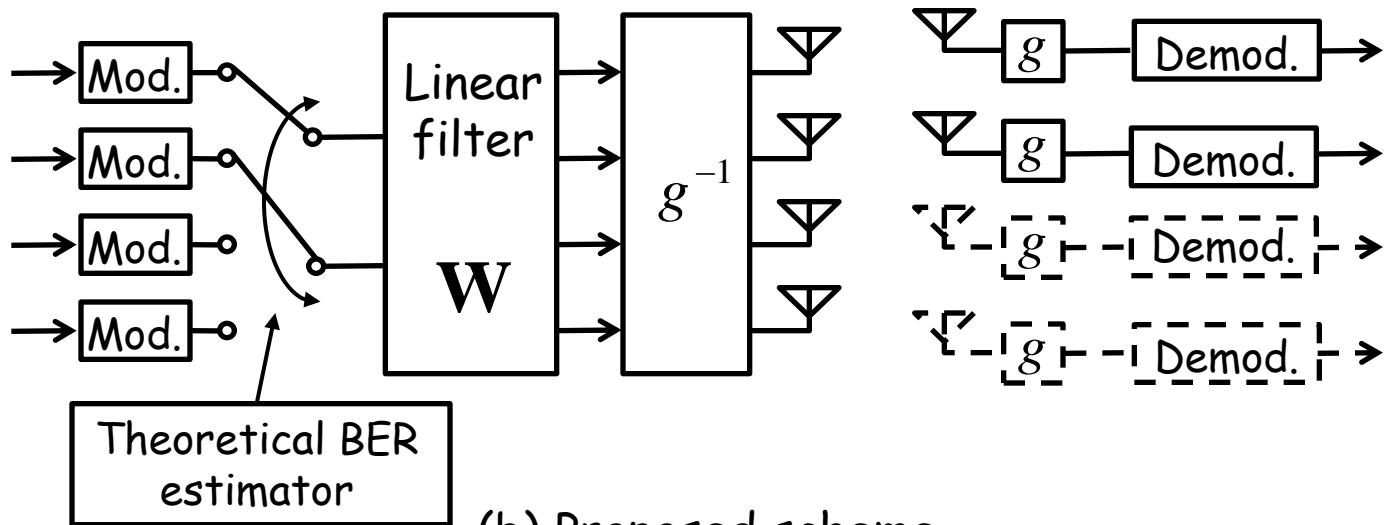
$|s|^2$: signal power
 σ_n^2 : noise power

The proposed multi-user selection method creates the multiuser diversity benefit in addition to the space diversity benefit exploited by decreasing in the number of effective MSs.

System configuration



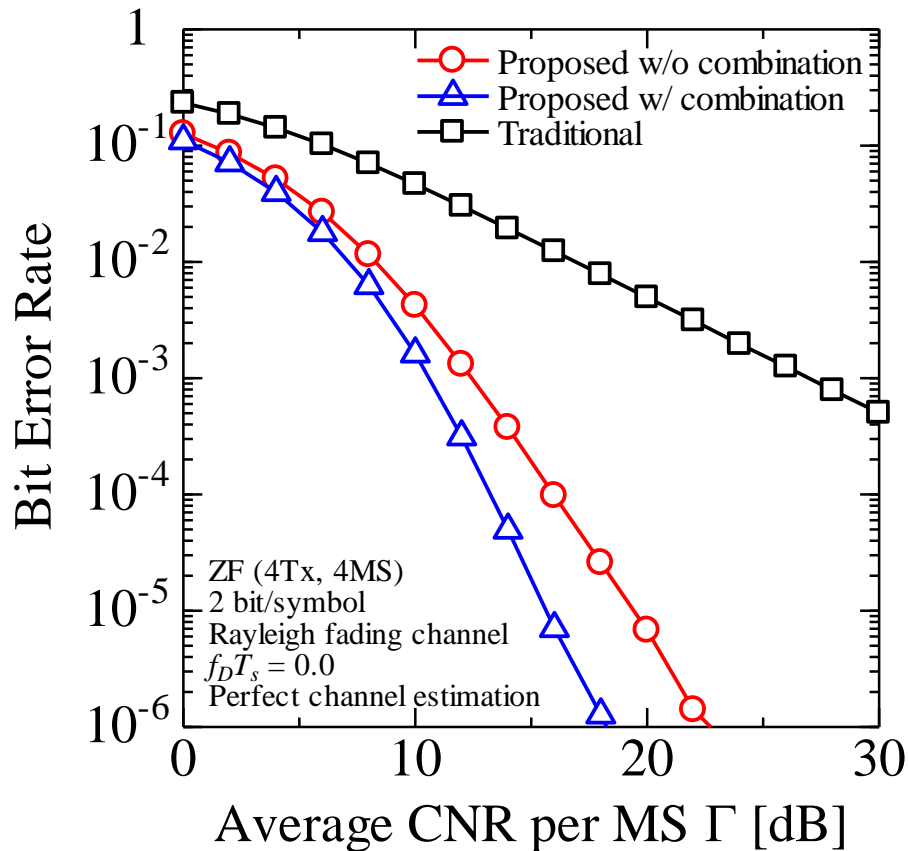
(a) Traditional scheme



(b) Proposed scheme

Numerical result ($T_x = 4$)

Since 2bit transmission at each MS is assumed, 16QAM and QPSK are adopted for the proposed scheme and traditional scheme, respectively.

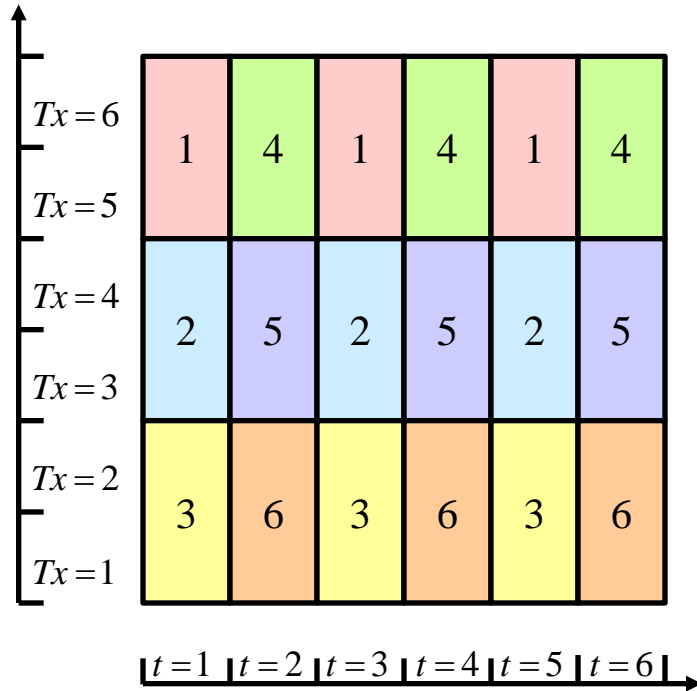


Proposed scheme provides far better BER performance than the traditional scheme.

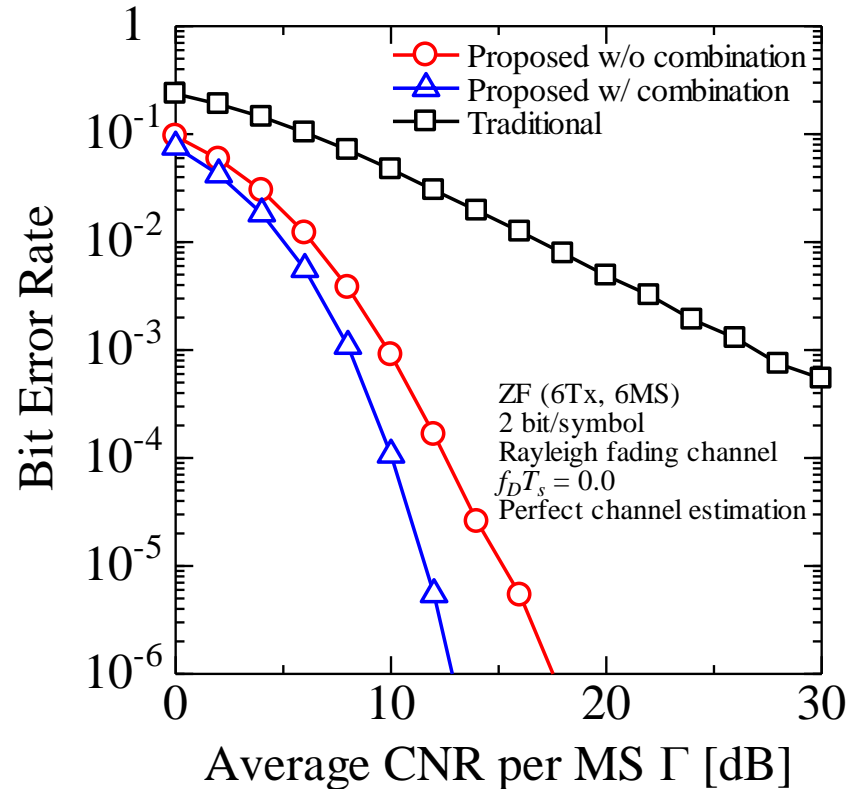
⇒ The proposed scheme can exploit the space diversity benefit by decreasing the effective MSs in each time slot, which fortunately exceeds the power efficiency loss due to the use of the higher level modulation.

Moreover, proposed scheme with the multi-user selection method provides better BER performance.

Numerical result ($T_x = 6$)



(a) Space and time allocation of the proposed scheme



(b) Performance comparison, in terms of average BER versus CNR between the proposed and traditional schemes

The proposed scheme using 6 transmit antennas also provides far better BER performance than the traditional scheme.

Conclusion

MU-MIMO transmission scheme aiming to exploit transmit diversity benefit

- This paper has proposed a new MU-MIMO transmission scheme to exploit the transmit diversity benefit. In the proposed scheme, the transmit diversity benefit is exploited by intentionally **decreasing the number of effective MSs in each time slot** while **the higher level modulation is adopted** for keeping the constant transmission rate.
- We further propose **the multi-user selection method using the theoretical BER prediction** to further improve the BER performance.

Conclusion

- By applying proposed method, **BER performance become better than traditional scheme** in the case of 2bit transmission with 4 and 6 transmit antennas.
- The proposed multi-user selection method **further improved the BER performance**.

