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## Information Communications Technology Pillar

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### Secure Communications Using Directional Modulation

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Limitations on the wireless communication resources (i.e., time and frequency) introduces the need for another domain that can help communication systems to match the increasing demand on high data transfer rates and quality of service (QoS). By using multiple antennas. Besides, the widespread use of wireless technology and its ease of access makes the privacy of the information, transferred over the wireless network, questionable. Along with the drawback of the traditional ciphering algorithms, physical layer security rises as a solution to over come such problem.

Multiple-antennas systems offer more resources (i.e. degrees of freedom) which can be used to achieve secure communication. One of the recently developed techniques, that make use of directive antenna-arrays to provide secrecy, is Directional Modulation (DM).

In DM, the antenna pattern is recognized as a spatial complex constellation, but it's not used as a source of information. The antenna pattern complex value, at a certain desired direction, is set to have the same complex value of the symbol to be transmitted. This scheme also randomizes the signal in the undesired directions, thus, providing a source of directional security. Contrary to the regular beam-forming, which provides directional power scaling, DM technique is applied in the transmitter by projecting digitally encoded information signals into a pre-specified spatial direction while simultaneously distorting the constellation formats of the same signals in all other directions.

In our previous work, we introduced the Multi-Directional DM transmission scheme (MDDM). By using MDDM, we were able to provide multiple secure communication links for different directions. We showed that the scheme increases the transmission capacity of the system up to the number of the antenna elements. Also, the secrecy capacity increases with the increase of the number of transmitted streams. Moreover, MDDM has a low complexity structure compared to other DM implementations and it does not necessitate the implementation of special receiver algorithms.

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Up till now, DM was only discussed from the algorithm construction perspective, and to the extent of the authors knowledge there has been no study of the employment of DM algorithms into the system level. Hereby, we introduce a multi-user access system level design that uses MDDM as a transmission technique. The new design utilizes the dispersive nature of the channel to provide a location-based secure communication link to each of the legitimate users. The scheme shows the ability to highly degrade the eavesdropper channel, even for the worst case scenarios. We also deduce the Achievable secrecy rate and secrecy outage probability for the scheme. The amount of degradation increases with the increase of the number of users in the system. Moreover, the secrecy analysis shows that the proposed system is always able to achieve a positive secrecy rate with a high probability. Besides, we compare the performance of this scheme to the performance of Artificial Noise (AN) precoding, as they share the same assumption about the channel knowledge. The results also shows that the DM scheme outperforms the ordinary AN scheme, while having a simpler hardware and processing structure.