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## Physical-Layer Wireless Security Technologies & Systems

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**Microwaves and Antenna Engineering Group**

<https://microwaves.site.hw.ac.uk>

## Motivation

Nowadays, hardly a week passes by without major incidents of cybercrime, which are constantly encroaching on the security and privacy confidence of each connected individual and the Nation as a whole. The increasingly prevalent wireless information exchanges face even greater challenges as the information is broadcast in open medium and the portable communication devices, e.g. mobile phones and laptops, are unlikely to be equipped with costly and power-hungry cryptographic solutions, especially in the coming quantum era. The physical-layer wireless security has long been regarded as a promising complementary or alternative as it requires little computation capability while endowing systems quantum-immune security.

## Research Fronts

The group researchers have established the theoretical and experimental frameworks for the Directional Modulation (DM) schemes, a keyless physical-layer wireless security technology. The latest developments demonstrate a synthesis-free architecture using retrodirective arrays and algorithms for more energy-efficient signal waveforms.

Funded by EPSRC, we are the first systematic study of the physical-layer wireless security under the energy awareness context. We propose to recover the energy penalty of the physical-layer security solutions without compromising security performance. This ambitious vision becomes achievable when a co-design approach, involving transmitter architecture, digital baseband, RF frontend and signal waveforms, is employed.

The group is also leading other physical-layer wireless security research including wireless key generation and Radio Frequency Fingerprinting (RFF).

## Achievements

1. The world's first synthesis-free dynamic DM demonstrator with real-time secure data transmission.
2. The first to explore nonlinear memory effect of power amplifiers for RFF.

## Relevant Demonstration Videos

<https://youtu.be/FsmCcxo-TPE>

## Funding Support

EPSRC (EP/V002635/1): 'Boosting Power Efficiency of Physical-layer Secured MIMO Communications'

## Selected Publications

Yuan Ding, et al., "PUF-assisted radio frequency fingerprinting exploiting power amplifier active load-pulling," IEEE Trans. Inf. Forensics Security, 2024. DOI: 10.1109/TIFS.2024.3389570

Yuan Ding, et al., "Orthogonal frequency division multiplexing directional modulation waveform design for integrated sensing and communication systems," IEEE J. IoT, 2024. DOI: 10.1109/JIOT.2024.3367490

Yuan Ding, et al., "Synthesis of energy efficiency enhanced directional modulation transmitters," IEEE Trans. Green Commun. Networking, 2023. DOI: 10.1109/TGCN.2022.3208023

Yuan Ding, et al., "Radio frequency fingerprinting exploiting non-linear memory effect," IEEE Trans. Cognitive Commun. Networking, 2022. DOI: 10.1109/TCCN.2022.3212414

Yuan Ding, et al., "Time-modulated OFDM directional modulation transmitters," IEEE Trans. Veh. Technol., Aug. 2019. DOI: 10.1109/TVT.2019.2924543

Yuan Ding, et al., "A synthesis-free directional modulation transmitter using retrodirective array," IEEE J. Sel. Topics Signal Process., Mar. 2017. DOI: 1109/JSTSP.2016.2605066

Yuan Ding, et al., "Retrodirective assisted secure wireless key establishment," IEEE Trans. Commun., Jan. 2017. DOI: 10.1109/TCOMM.2016.2616406

## Researchers

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