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# Wireless Communication Signal Processing Laboratory

Advisor: Dr. Wei-Ho Chung

## Topic — MIMO Transceiver Systems Design

In our laboratory, we focus **on radar and communication transceiver systems design**. Specifically, our topic compose to three topics: radar signal processing, communication system designs, integrated sensing and communications, semantic communication, and digital twins.

### Radar Signal Processing

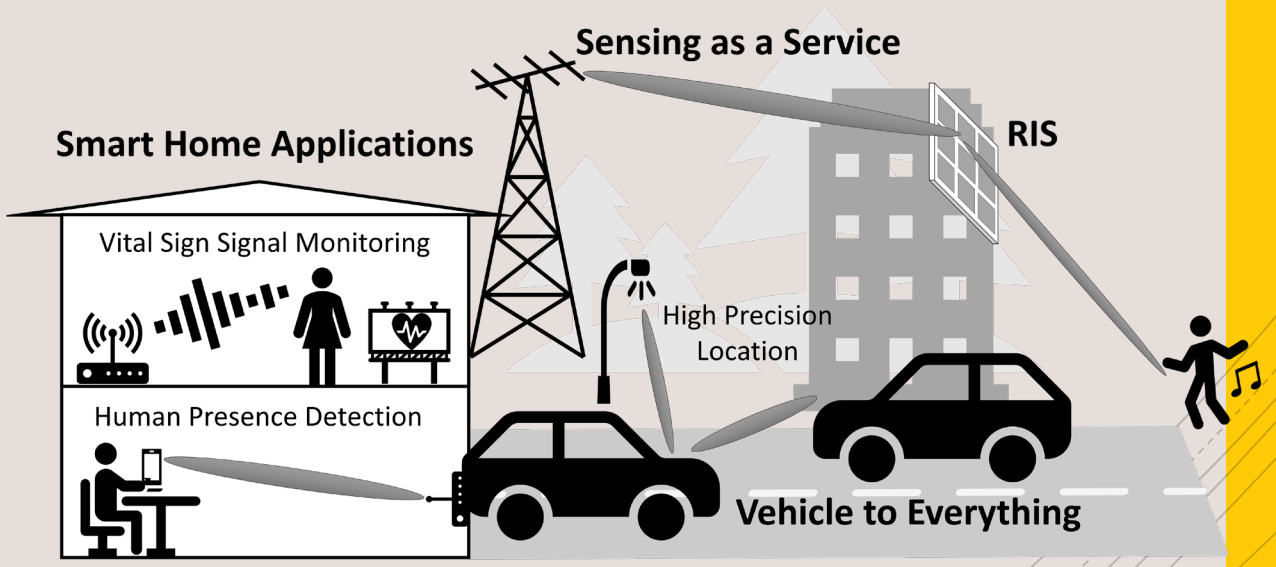
We mainly concentrate on **vital sign monitoring** and high-precision location.

### Communication Systems

We focus on MIMO **hybrid beamforming** design, which can be applied to many applications, e.g., RISs.

### Integrated Sensing and Communications

We are also **commit to integrate the sensing and communication systems** into a single system, e.g., Dual-functional RadCom and V2X.



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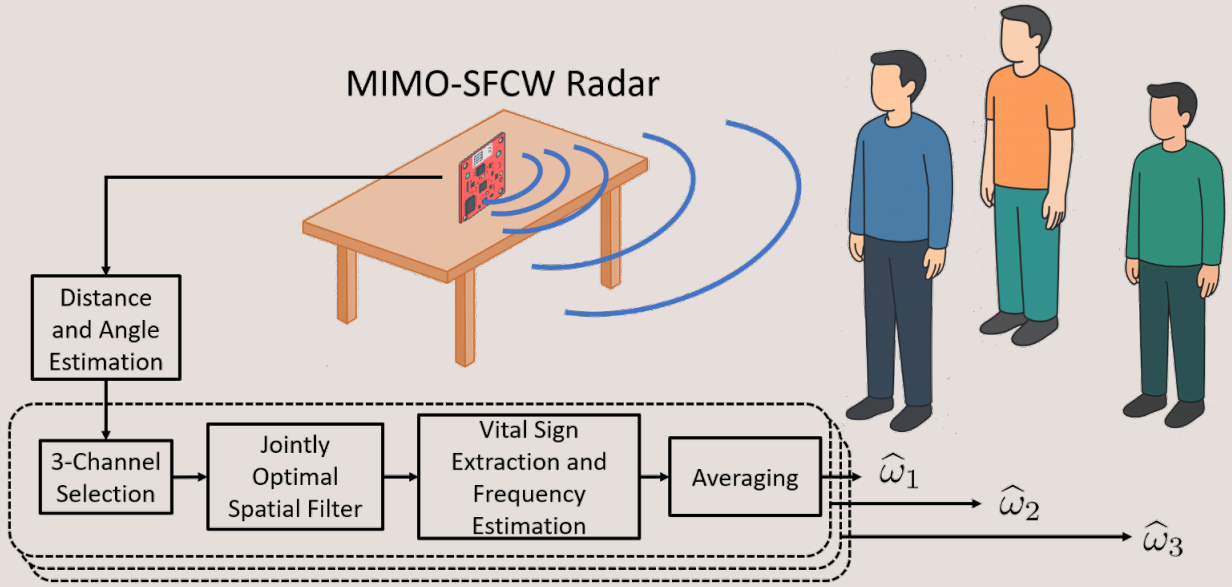
## Radar Signal Processing with Vital Signs Monitoring and System design

Our research explores radar signal processing for non-contact sensing, **emphasizing vital signs monitoring such as respiration and heartbeat**. Current efforts focus on developing advanced signal processing techniques and system architectures to enhance detection accuracy, robustness, and real-time performance in practical healthcare and monitoring scenarios.





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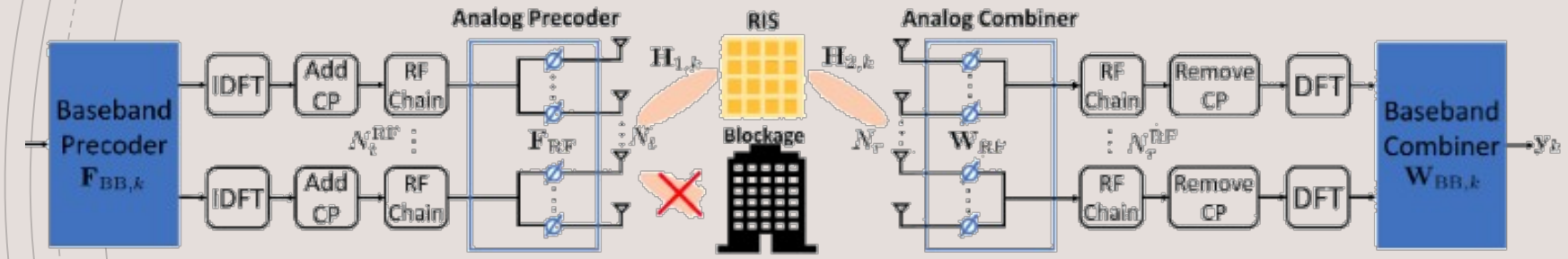
# MIMO Communication Systems Transceiver Design

Considering **different communication system architectures**, our research focuses on **resource optimization design to enhance communication performance**, while incorporating learning-based approaches to further improve algorithm efficiency.





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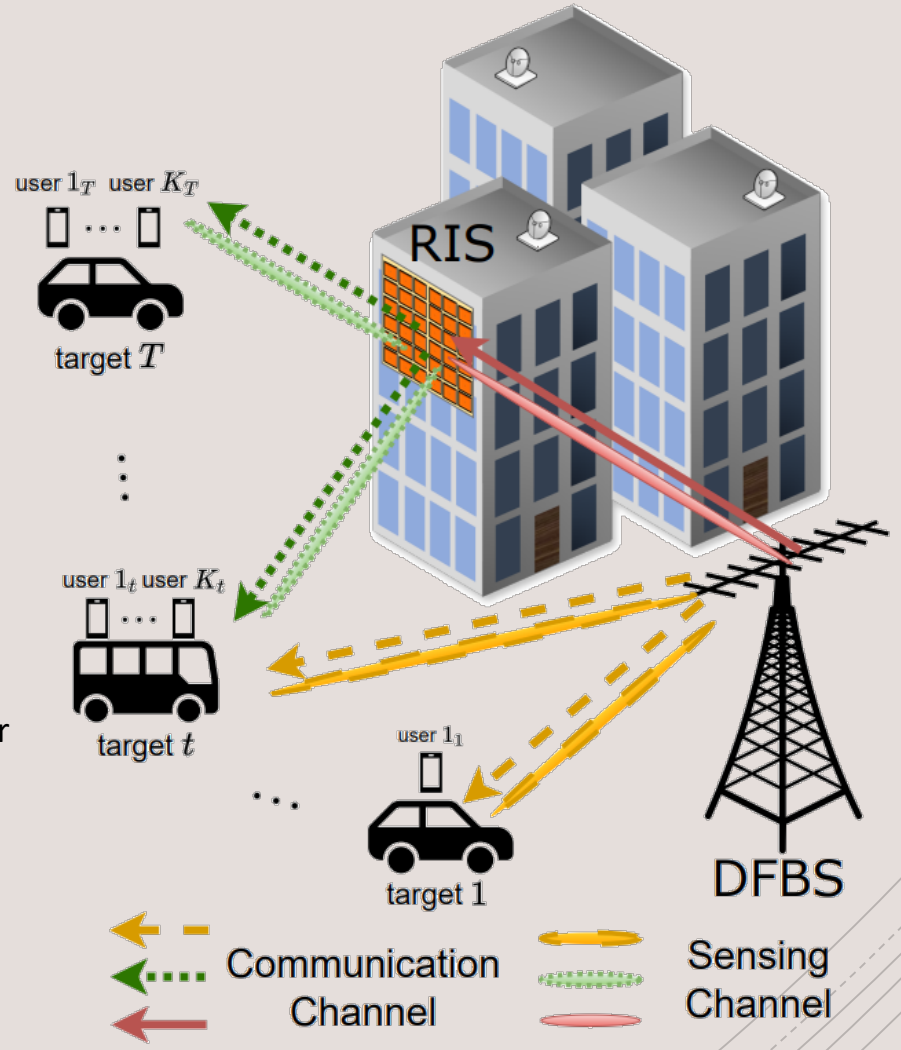
## Integrated Sensing and Communications

Our research explores ISAC systems that unify wireless communication and radar sensing. We focus on **joint resource allocation, waveform design, and signal processing techniques** to enable efficient spectrum usage and seamless integration of sensing with next-generation communication networks.





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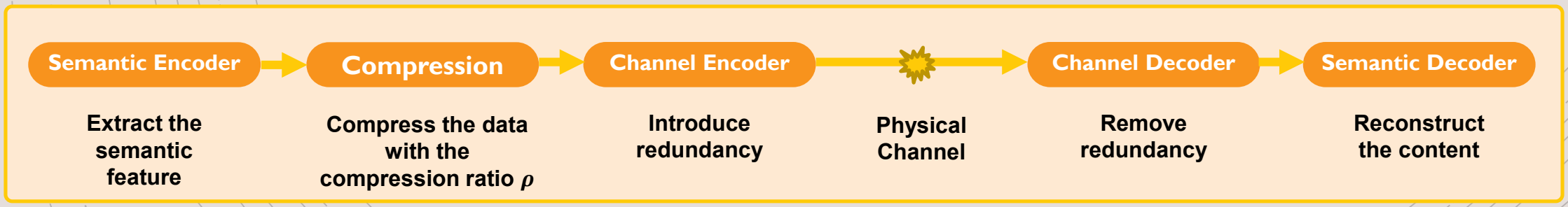
# The Optimal Trade-off in Semantic Communication

- Semantic communication:
  - Extracting semantic features from source data
  - Compressing them by adjusting the compression ratio to conserve resources
- Critical trade-off between transmission and decoding result
  - **Low compression ratio**: Leads to efficient transmission but causes a significant loss in semantic similarity
  - **High compression ratio**: Ensures high semantic similarity but results in inefficient transmission
- In our work, we aim to incorporate this trade-off into our analysis under practical system constraints



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## Digital Twins-aided MIMO Communication System Design

Our laboratory leverages digital twin technology to modern communication systems. **By creating a real-time, virtual replica of the physical communication environments**, we are able to model wireless channels, user mobility, and network dynamics with high fidelity. This enables us to test, optimize, and predict system performance in the digital world before deployment in the real world. Through this integration, we **improve channel estimation, resource allocation, and overall communication reliability,** paving the way for more intelligent and adaptive next-generation networks.