MONASH University

MONASH ENGINEERING

Faculty of Engineering

ASPIRE Summer Research Program 2026-2027

Project Title: **Machine-Learning-Assisted Selection of OTFS and AFDM for High-Mobility Wireless Channels**

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Objective

This project aims to provide a fair and systematic comparison of OTFS and AFDM over doubly selective channels using a common simulation framework with identical modulation, power, channel, noise, and receiver assumptions. Their performance will be evaluated across varying SNR, delay spread, Doppler spread, and fractional-Doppler conditions in terms of bit-error rate, channel-estimation accuracy, computational complexity, and processing time. The resulting data will then be used to train a machine-learning model that predicts which waveform offers the better reliability–complexity trade-off from observable channel characteristics such as SNR, delay spread, Doppler spread, and sparsity. The project will deliver validated OTFS and AFDM implementations, a performance map identifying the conditions under which each waveform is preferable, and an adaptive waveform-selection framework benchmarked against fixed-waveform baselines and an oracle selector.

Project Details

Research Question: Under which combinations of SNR, delay spread, Doppler spread and fractional Doppler does OTFS or AFDM provide better performance, and can a machine-learning model learn to select the more suitable waveform?

OTFS and AFDM are being investigated as alternatives to conventional OFDM for the **high-mobility, high-frequency, and doubly selective channels** expected in **future vehicular, satellite, and 6G systems,** where large Doppler shifts can destroy subcarrier orthogonality and cause severe inter-carrier interference. OTFS represents signals in the delay–Doppler domain, providing a structured channel representation that can support robust channel estimation, equalisation, and sensing, but often requires two-dimensional processing and careful treatment of fractional delay and Doppler. AFDM instead uses a flexible chirp-domain representation that can separate delay–Doppler paths, achieve multipath diversity,

and retain a compact one-dimensional block structure, although its performance depends strongly on chirp-parameter design and its receiver methods are less mature.
The two waveforms may therefore be complementary rather than universally competing. OTFS may be preferable when delay–Doppler structure and sensing are important, whereas AFDM may offer advantages in diversity, flexibility, or implementation efficiency. **A machine-learning model** can exploit observable channel features, including SNR, delay spread, Doppler spread, and sparsity, to predict which waveform is expected to provide either the lower bit-error rate or the best trade-off among reliability, receiver complexity, and signalling overhead.
As a **potential extension,** waveform selection can be formulated as a **contextual-bandit problem.** The system observes the current channel conditions, selects OTFS or AFDM, and receives feedback only for the chosen waveform, such as packet-error rate, throughput, or decoding success. The selector then learns online by balancing exploration and exploitation, with the objective of minimising cumulative regret relative to an oracle that always selects the better waveform.

Project Timeline

TASK	1	2	3	4	5	6	7	8	9	10
Literature review										
Common simulation framework										
OTFS implementation & validation										
AFDM implementation & validation										
Performance sweeps										
Feature extraction + dataset										
ML waveform-selection model										
Extension: contextual-bandit										
Analysis & comparison										
Report writing & final presentation										

Prerequisites
ECE5884/4024 Wireless Communications or ECE5883 Advanced Signal Processing

Student Placement Agreement
A student placement agreement must be signed by the project supervisor and the student prior to commencement of the ASPIRE program.

LV0554-72741 ASPIRE Program Co-Curricular-Student-Placement-Agreement-Short-term.docx

Additional Information
Applicants will be required to attend a short interview.