

PhD studentship available on Optical Switching in AI Data Centres.

The exponential growth of AI and high-performance computing workloads is placing unprecedented demands on data centre interconnect (DCI) infrastructure, with interconnect power consumption now exceeding that of compute in many deployments. Optical switching has emerged as a transformative approach to address this scaling challenge, but realising its potential requires moving beyond fixed network configurations toward architectures that can dynamically adapt to the traffic patterns of the applications they serve.

AI and HPC workloads exhibit strong structural regularity in their communication patterns: collective operations, parameter synchronisation, and pipeline stages produce traffic flows that are far from random. This predictability opens an opportunity: by characterising traffic patterns in real time and reconfiguring the optical topology to match them, the interconnect can be tuned to the workload rather than provisioned for the worst case. Realising this requires intelligent network control capable of building dynamic models from live traffic, predicting near-term demand, and translating predictions into wavelength tuning, optical path reconfiguration, and hybrid optical/electronic switching decisions on millisecond-to-microsecond timescales.

This research will develop machine learning models for traffic pattern recognition and prediction in AI/HPC data centres, and integrate them into a multi-layer control plane that drives optical topology reconfiguration. The work will use real workload traces from industry partners and target measurable improvements in GPU utilisation, end-to-end latency, and energy per bit, contributing to the broader goal of an order-of-magnitude reduction in DCI power consumption.

The aim of this PhD is to jointly optimise AI parallelism strategies with optical network configuration algorithms, and to quantify its improvements in terms of performance and energy consumption for distributed training and inference. The key research questions are:

1. How can LLM training and inference workflows be adapted to suit flow based optical switching?
2. What are the optical switching architectures and algorithms that can best be matched to ML workflows considering trade-off between cost/scalability vs switching speed?
3. How do architectures and trade-offs change between intra-DC and cloud to edge interconnect scenarios?

The work will start by comparing existing topology aware placement algorithms (e.g., Slurm, Volcano (Kubernetes), Megatron-LM, DeepSpeed). The analysis will be carried out through experiment: training and inference jobs of representative LLMs will be run on the IBM Dublin Research 100-node GPU cluster, to which Prof. Ruffini has research access under an existing agreement.

The PhD position is in a multi-institutional, interdisciplinary national centre for data science and AI funded by Research Ireland.

The PhD studentships are part of a multi-institutional interdisciplinary national centre for data science and AI funded by Research Ireland. These studentships are available through a cohort-based PhD training programme across a suite of research themes: foundational methods, translational methods, data & processing, people-centred AI, democratic governance, society & culture and health. Applications are sought from a broad range of graduates in arts & humanities, business and education, computer science, engineering, health sciences, life science & environment, mathematics & statistics and social science & law.

Alongside their individual PhD research, students will benefit from a structured, cohort-based PhD training programme. This programme will include transferable skills training (e.g., communication skills, ethics, and entrepreneurship), group activities (e.g., hackathons and spin-out sprints), training on domain-specific topics (e.g., machine learning, statistics, data management, programming, qualitative and digital policy methods), and peer-led learning opportunities (e.g., research seminars, peer-designed workshops, and reading groups). Dedicated career and skills development activities will also be offered.

Students will benefit from extensive engagement with industry and public service partners and from an enrichment experience e.g., industry training placements, an academic research visit to an internationally renowned collaborating institution, or other similar activities. This experience will equip graduates with the knowledge and skills necessary to thrive in academia, industry, and public service.

Funding:

Studentships provide a stipend of €25,000 per year for four years (tax free) with additional funds available to support e.g., conference attendance and training activities.

Application process:

We are committed to equality, diversity, and inclusion (EDI) and particularly encourage applications from under-represented groups.

We are currently recruiting for the September 2026 intake. Initial applications should be submitted to marco.ruffini@tcd.ie by the 15th June 2026.

Due to the large number of applications received, only applicants invited to interview will receive an email response.

Please note that applicants who are invited to interview and are successful, will have to subsequently apply to their host institution in line with their requirements.