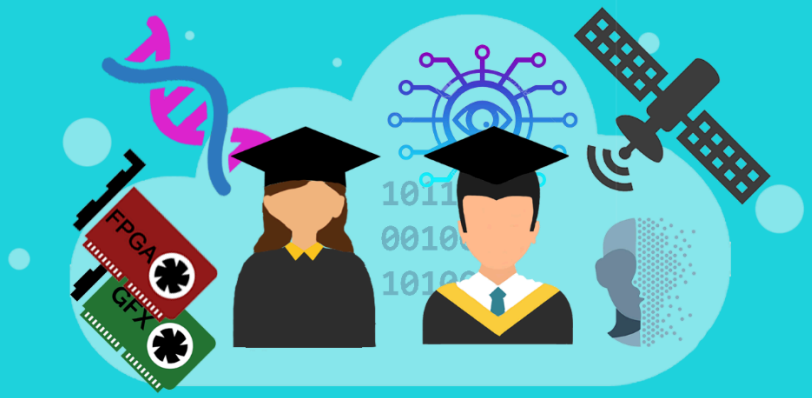


Diploma Thesis

Microprocessors and
Digital Systems
Laboratory



Multi-Agent AI Systems for Accelerating and Optimizing Integrated Circuit Design

Motivation

Modern physical-design flows require designers to navigate a large and highly coupled design space. Decisions made during **floorplanning and placement** strongly influence timing, congestion, power, wirelength, and ultimately the quality of the final implementation. Exploring this space typically requires repeated EDA runs, analysis of intermediate results, and expert-guided modifications. Recent advances in **Large Language Models (LLMs)** and **agentic AI** provide an opportunity to automate parts of this reasoning process [1]. Rather than simply predicting design metrics, AI agents can potentially interact directly with EDA tools, analyze implementation results, propose design modifications, and iteratively improve the physical design [2].

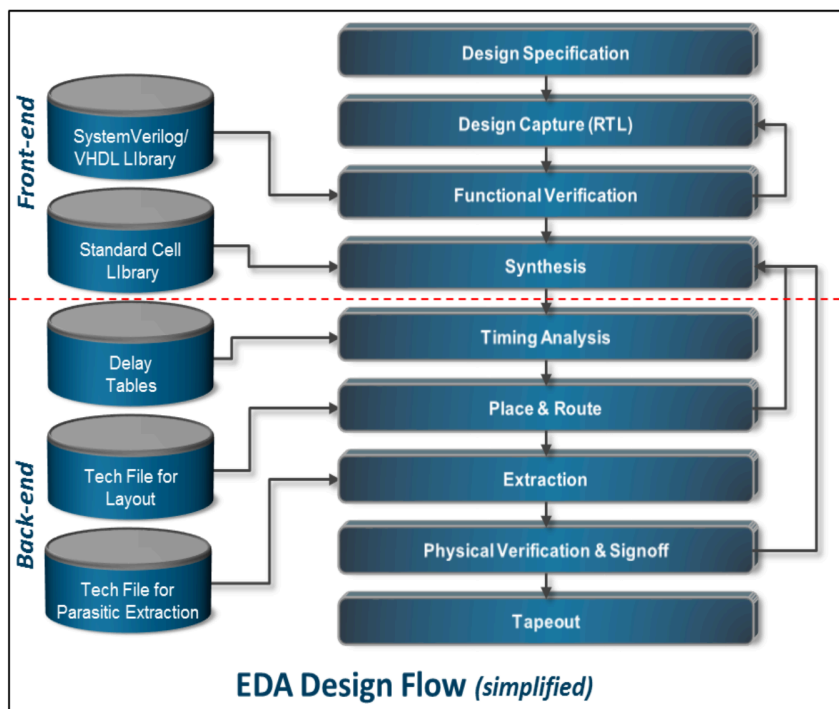


Figure 1: Standard workflow for EDA tools[1]

Scope

The objective of this diploma thesis is to develop an **agentic AI framework for automated physical-design exploration**, initially focusing on floorplanning and placement. The proposed framework will establish a closed interaction loop between AI agents and an EDA environment (Figure 1). The agents will observe relevant physical-design information, including **timing, congestion, utilization, wirelength, power, macro locations, and critical paths**, and use this information to propose modifications to the floorplan and placement constraints.

An important research direction will be the use of **multiple specialized agents**. Different agents may focus on timing, congestion, power, area, or floorplanning, while a coordinating agent combines their recommendations and resolves competing objectives. The thesis will investigate whether such specialization provides advantages over a single general-purpose AI agent and over conventional automated optimization techniques. The explored decisions may include **die dimensions and aspect ratio, macro placement, placement density, blockages, component grouping, pin placement, and other physical-design constraints**. Open-source EDA environments such as **OpenROAD** [3] can provide the primary experimentation platform, with commercial tools potentially used for higher-fidelity validation.

Possible Extensions

The thesis may additionally be extended toward **3D-integrated designs**, where the agents must decide not only where components should be placed within a chip, but also **how architectural blocks should be partitioned and placed across multiple silicon tiers**. In this case, agents could jointly reason about communication locality, vertical-interconnect requirements, power density, thermal constraints, and conventional placement objectives when selecting a 3D partitioning and floorplan.

On the higher level, we can extend this thesis by leveraging **High-Level Synthesis (HLS)** to expose dataflow optimizations (loop transformations, memory partitioning, etc.) on the agentic flow, before lowering the given workload to synthesis-ready descriptions, continuing the already described process (Figure 1). For this track, we will utilize the state-of-the-art framework of CIRCT [4] to support efficient lowering of workloads with the incorporation of the requested dataflow optimizations.

RELATED MATERIAL:

- [1] AiEDA: Agentic AI Design Framework for Digital ASIC System Design,
<https://arxiv.org/pdf/2412.09745>
- [2] [Amur Ghose, “Invited: Agentic AI for Physical Design R&D: Status and Prospects”. 2026 International Symposium on Physical Design \(ISPD\).](#)
- [3] <https://github.com/The-OpenROAD-Project/OpenROAD>
- [4] <https://circt.llvm.org/>

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