A Survey of AI-Aided FPGA Development Tools and Considerations for COTS Software Dedication

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Introduction

- FPGAs are alternative implementation platforms for nuclear safety I&C systems
- EDA tools used for FPGA development are classified as indirect COTS (commercial-off-the-shelf) software
- AI-aided EDA tools were not explicitly considered in existing COTS software dedication approaches

Objective: Survey AI-aided EDA tools and identify additional considerations for COTS software dedication

Background

FPGA EDA Flow

RTL Design

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Logic Synthesis

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Place & Route

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Bitstream Generation

COTS Software Dedication Process

Identification

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Categorization

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Acceptance Criteria & Methods

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Application

Survey of AI-Assisted EDA

Commercial AI-Assisted EDA Tools

FPGA	Mainly ASIC	Semiconductor
Vivado ML Edition	Synopsys.ai Copilot	Aprisa AI
Xilinx / AMD	Synopsys	Siemens
Machine Learning	LLM / Generative AI	Generative AI
Congestion & Delay Estimation	RTL Generation & Verification Support	RTL-to-GDS Transformation

Research Trends in AI-Assisted EDA

Task-specific ML	→	LLM / Generative AI	→	Agentic AI
Prediction & Optimization		Generation & Assistance		Workflow Orchestration
Parameter Tuning Placement Congestion Prediction		RTL Generation HLS Optimization Verification		Planning Tool Interaction Iterative Refinement

Expanding Role and Influence of AI

Considerations for COTS Software Dedication

01 AI behavior and performance
Output variability and performance uncertainty

02 Data and model assurance
Data quality, provenance, and model versioning

03 AI-specific V&V
Robustness and unseen-condition testing

04 Configuration and change management
Tracking changes to models, prompts, and data

05 Operating experience
Limited evidence across evolving model versions

06 Problem reporting and traceability
Tracing outputs to models and configurations

Conclusion

- AI in EDA is evolving from task-specific optimization to design generation and workflow orchestration
- Existing COTS categorization remains applicable, but current acceptance criteria do not explicitly address six identified AI-related assurance concerns

Future Work: Develop a graded dedication approach considering the role and influence of AI in FPGA development