OPENROAD: FOUNDATIONS AND REALIZATION OF OPEN, ACCESSIBLE DESIGN
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THE DESIGN CHALLENGE

• Enormous barriers to hardware design in advanced technologies: Cost, Expertise, Unpredictability
HOW IS IT DONE TODAY?

• Hardware design tools have evolved into complex “Swiss army knives”
• Chaos when tools are forced to “try hard”
Today: in a “local minimum” of design technology, methodology, and quality
NEW IN OUR APPROACH

Design Complexity

24 hours, no humans – no PPA loss

Extreme partitioning
Parallel optimization
Machine Learning of tools, flows
Restricted layout
FOUNDATIONS OF OUR APPROACH

• No Humans: tools must adapt and self-tune, must never get stuck unexpectedly
• 24 hours: extreme partitioning of problems
  + parallel search on cloud
  + machine learning for predictability
• Mantra: Correctness and safety by construction
• Mantra: Embrace freedom from choice
A NEW DESIGN PARADIGM

# Partitions
Design
Flexibility
↓↓
Predictability
↑
# Iterations
↓↓
Turnaround
Time
↓↓
Margins

NEW IN OUR APPROACH
24 hours, no humans – no PPA loss

Achieved
Design Quality
↑
TECHNICAL CHALLENGES

• Data: small and expensive!
• Humans: are in the loop for good reasons!
• Fundamental tradeoffs: analysis cost vs. accuracy, optimization effort vs. quality
• Activation energies: new sharing mindsets, open-source ecosystem
OUR GOAL

• 24-hour, No-Human-In-Loop layout design for SOC, Package and PCB with no Power-Performance-Area (PPA) loss
• Tapeout-capable tools in source code form, with permissive licensing → seed future “Linux of EDA”
IMPACT IF SUCCESSFUL

• Create new “Base Technologies” that enable 24-hour, **autonomous** design
  • Extreme partitioning (bite-sized problems)
  • Parallel search and optimization
  • Machine learning: models of tools, designs
• New paradigm for design tools and methods: autonomy first
• Bring down barriers → democratize HW design
IMPACT ON DESIGN COST

- Embedded vision chips (28nm/16nm) from Michigan Internal Design Advisors team
- Layout @Michigan: 10+ weeks, significant resource
- OpenROAD and IDEA goal: 1 day, no humans (!)
SWINGING FOR THE FENCES

- Must achieve critical mass and critical quality

11 of 13 IDEA TA-1 subtasks + Base Technologies, Design

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SWINGING FOR THE FENCES

• **Internal Design** team (Michigan)
  ~70 Ph.D., 50 M.S. graduates
  + 15 new SOC designs each year

• **Tools** team (UCSD, Illinois, UMinn, UT-Dallas, Brown):
  ~150 Ph.D., 80 M.S. graduates
  + many tools, engines “on the shelf”

• **Qualcomm**: HW design, SOC-Pkg-PCB

• **Arm**: IP, system design + ML guidance
AND MORE …

- Open-sourcing of commercial timing engine
- Donated commercial tool source code base
- Industry advisors and technical contributors
  - Dr. Chi-Ping Hsu, Avatar
  - Dr. Noel Menezes, Intel
  - Dr. Richard Ho, Google
  - ...
- Worldwide outreach, engagement, support …