

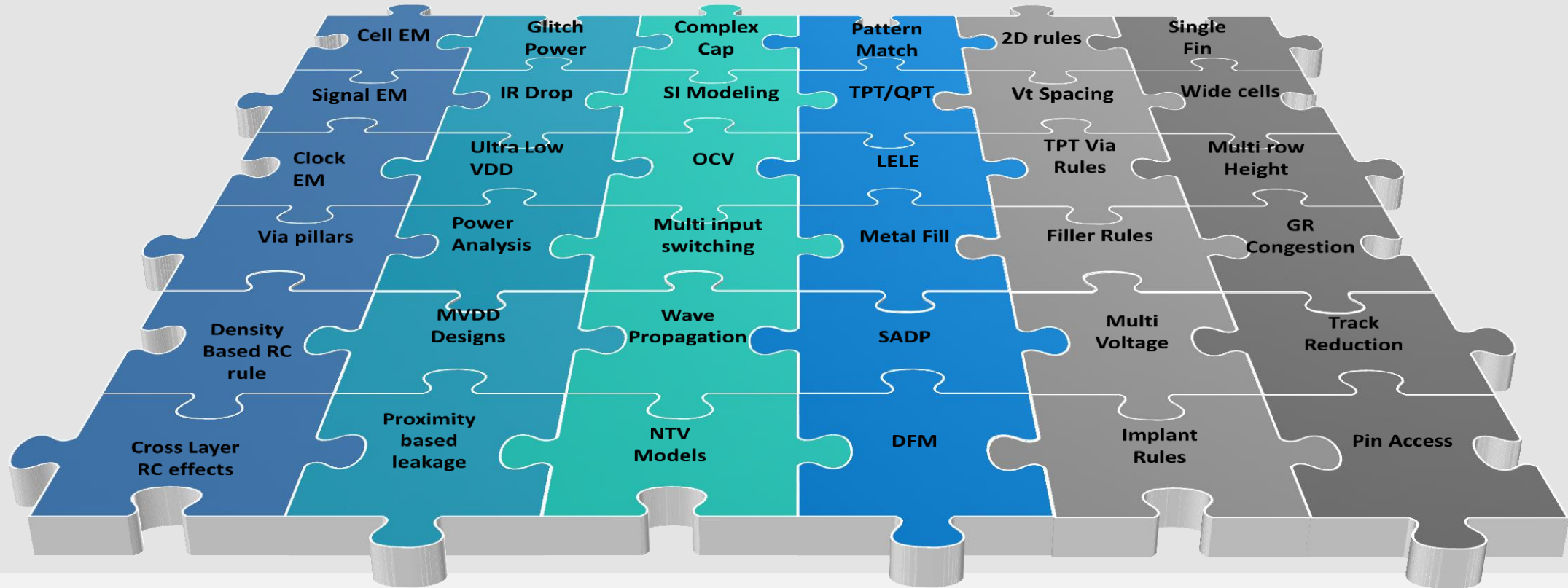
# Reinforcement Learning-Driven Optimization for Superior Performance, Power and Productivity in Chip Design

Thomas Andersen, PhD, Vice President, AI & ML

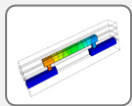
19 January 2022



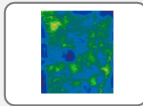
# Today's Design - A Deluge of New Design Challenges



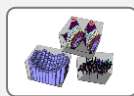
**ELECTROMIGRATION & EXTRACTION**



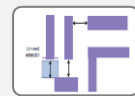
**POWER & IR DROP**



**STA COMPLEXITY**



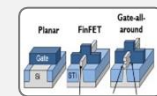
**ROUTING RULES**



**PLACEMENT RULES**

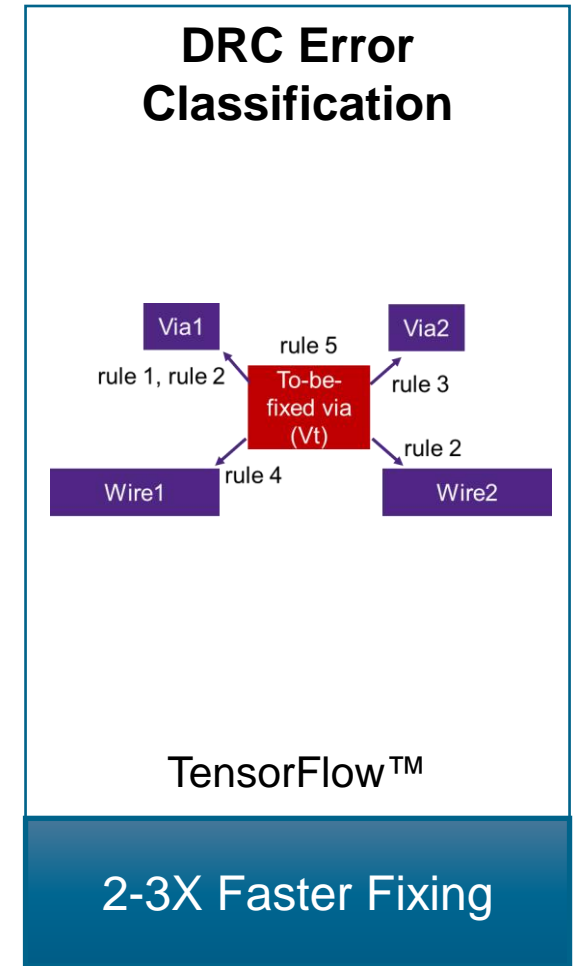
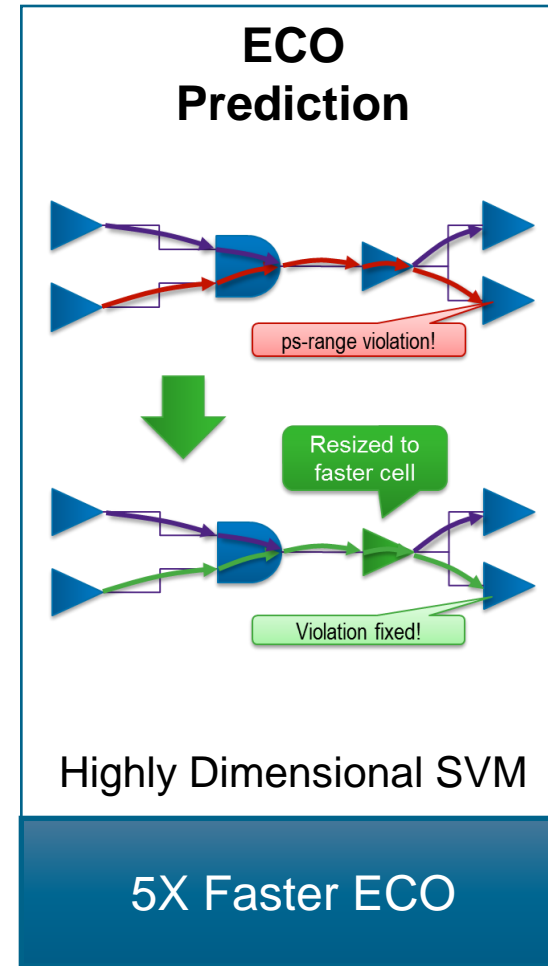
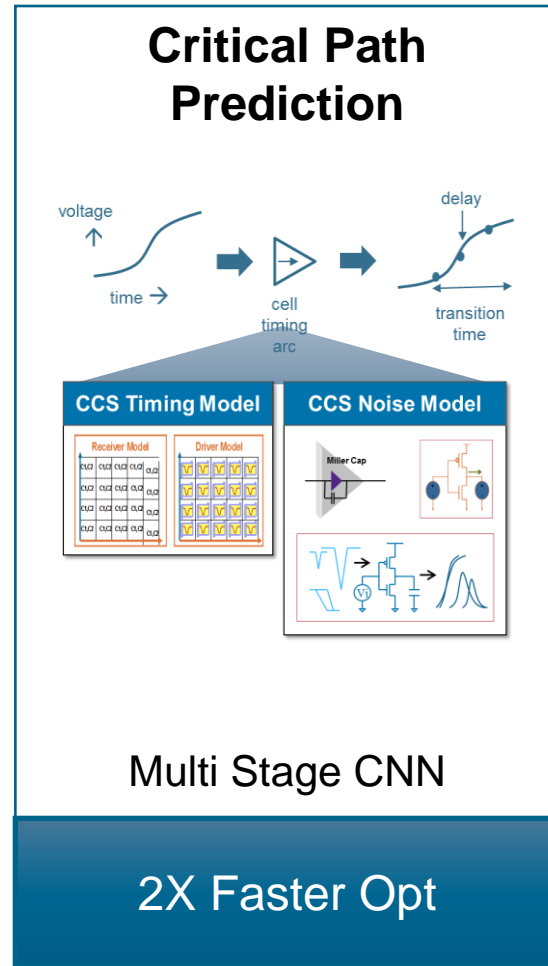
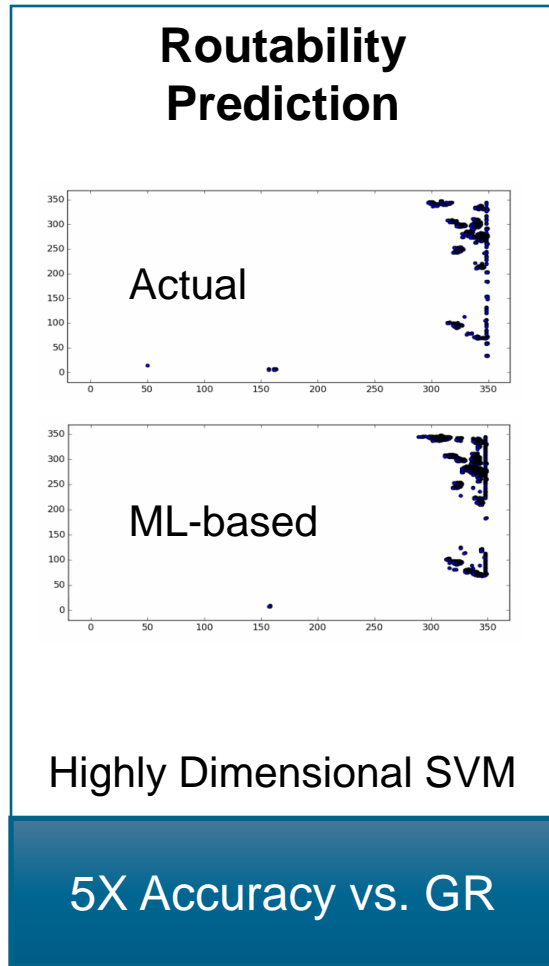


**TRANSISTOR ARCHITECTURE**



# Using Data-Driven Techniques to Improve Visibility

Predictive models accelerate outcomes, already deployed and proven in production

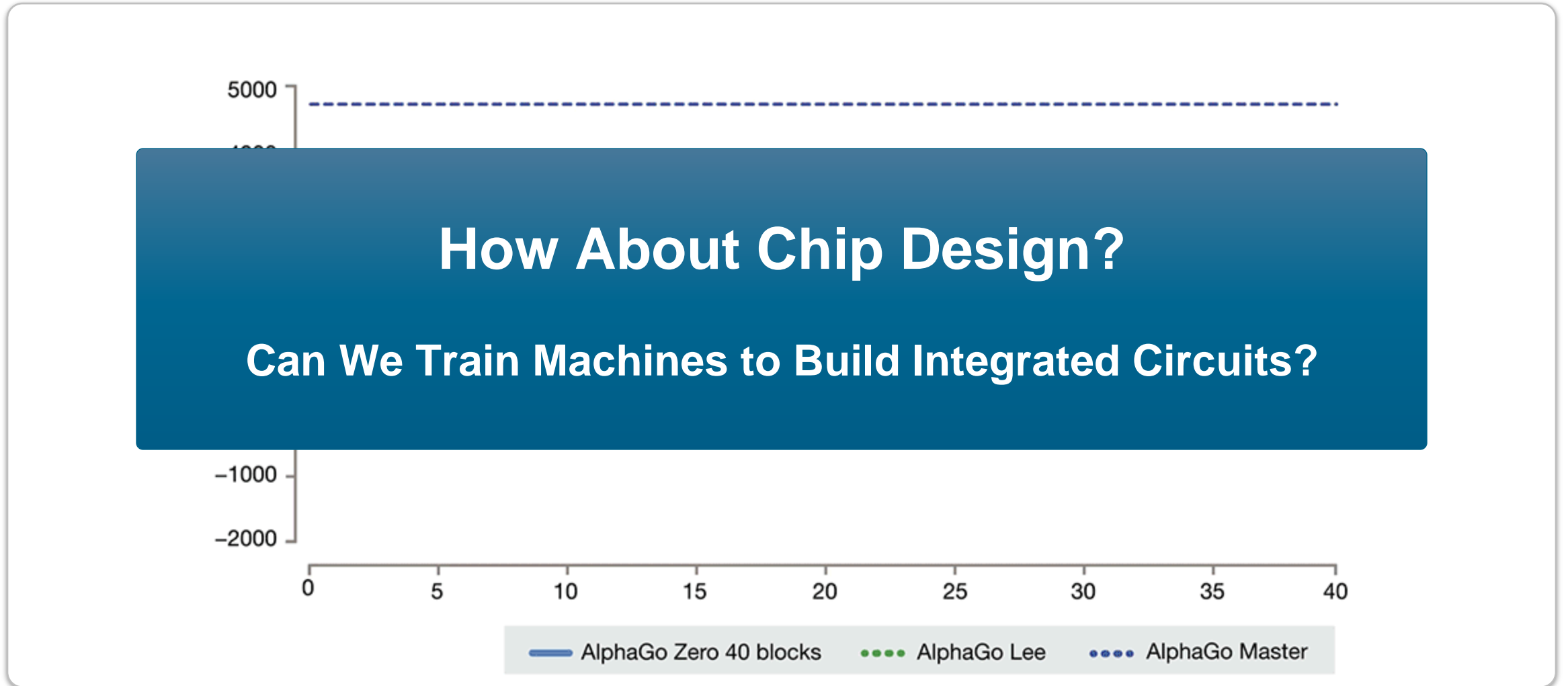


and many more...

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# Learning to play GO

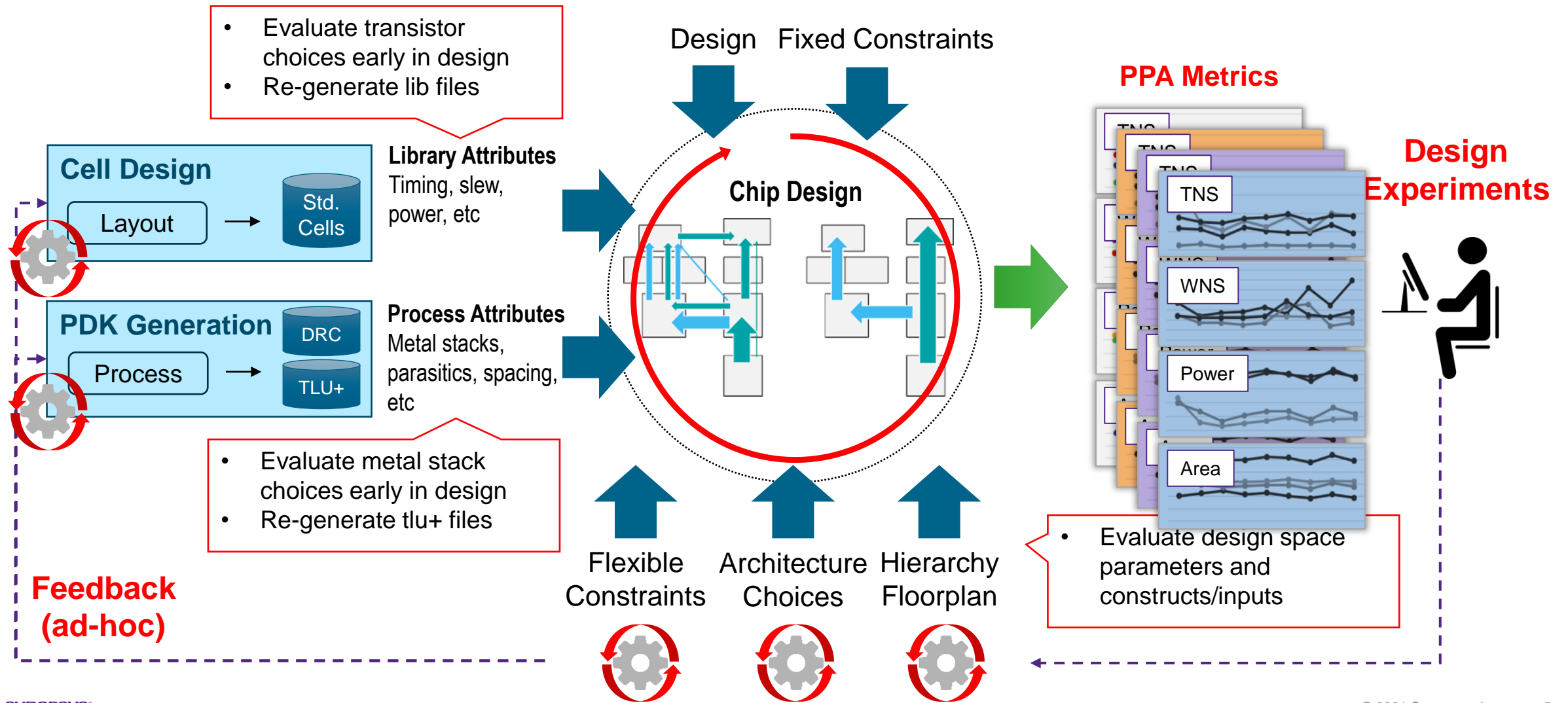
DeepMind AlphaGo goes from zero to world champion in 40 days

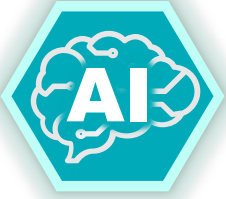


Example: <https://deepmind.com/blog/alphago-zero-learning-scratch/>

# A Closer Look at the Chip Design Process Today

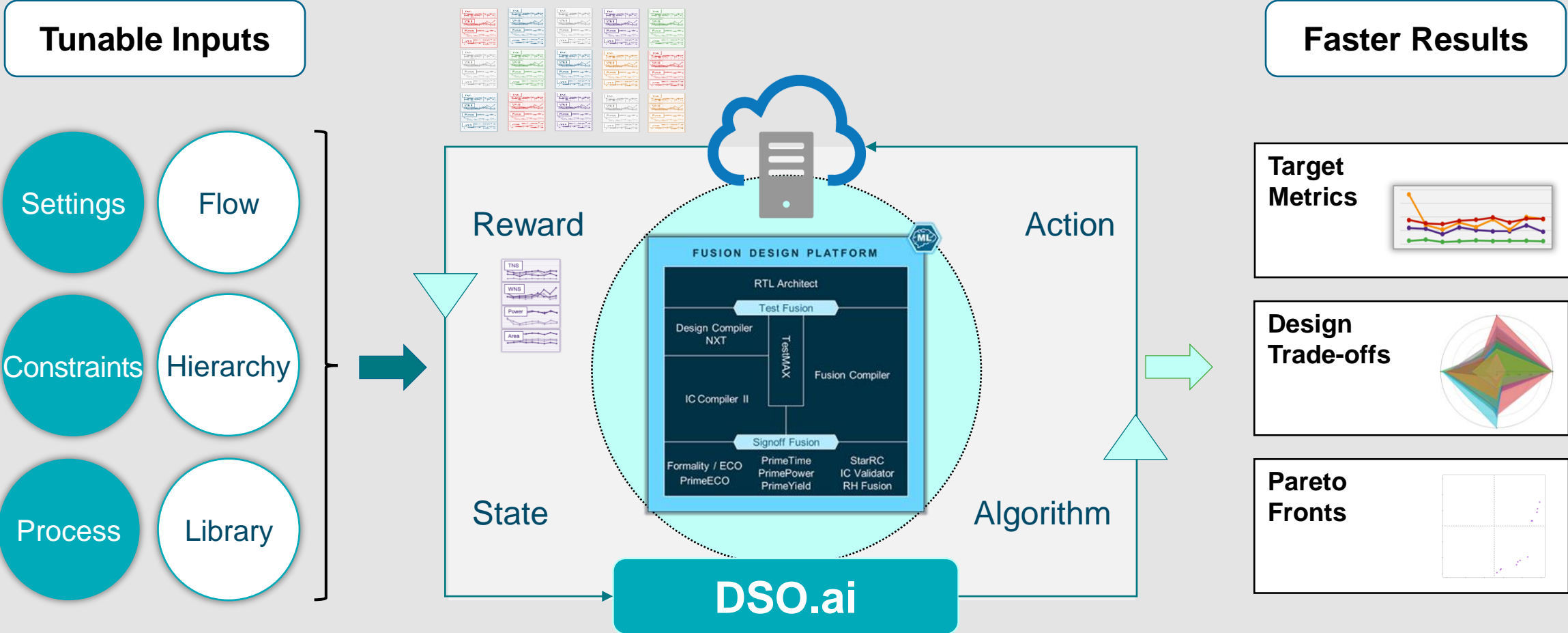
## Intelligent design processes





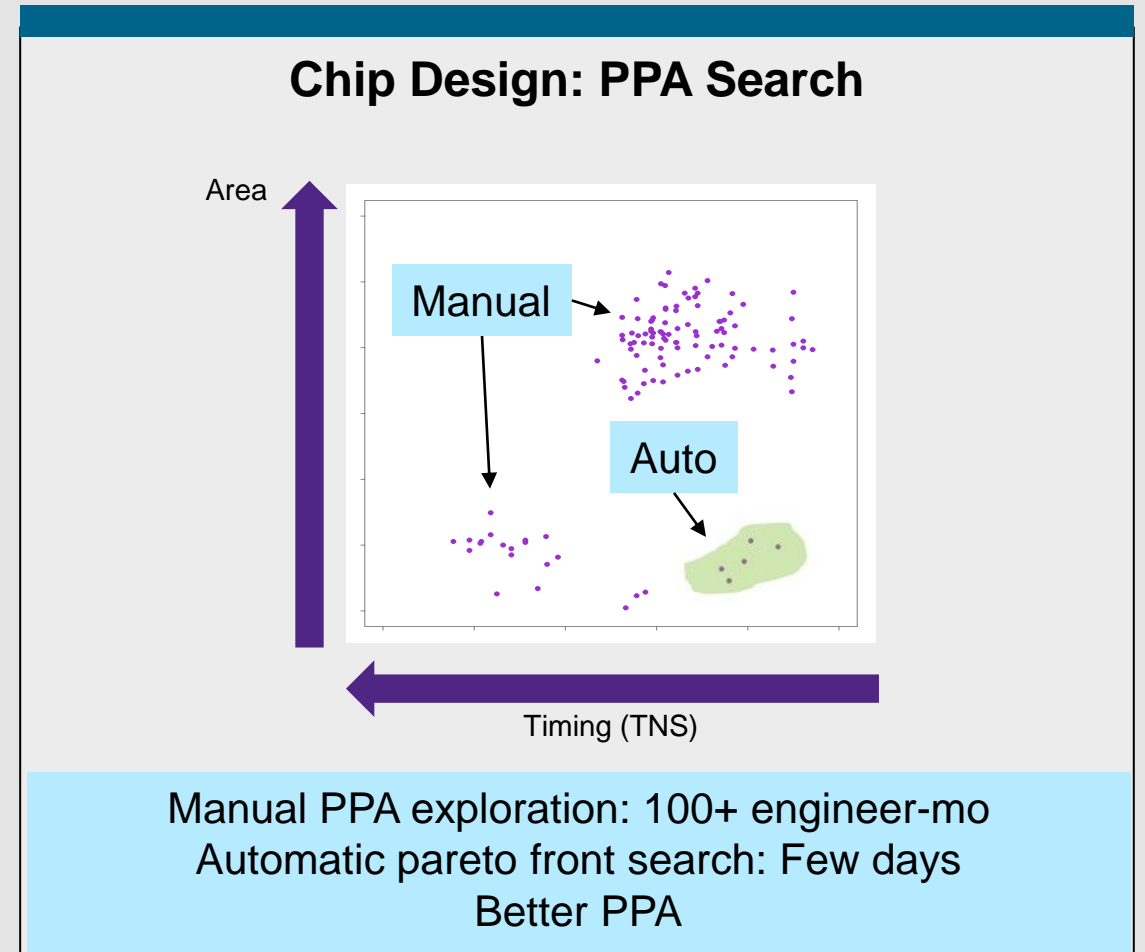
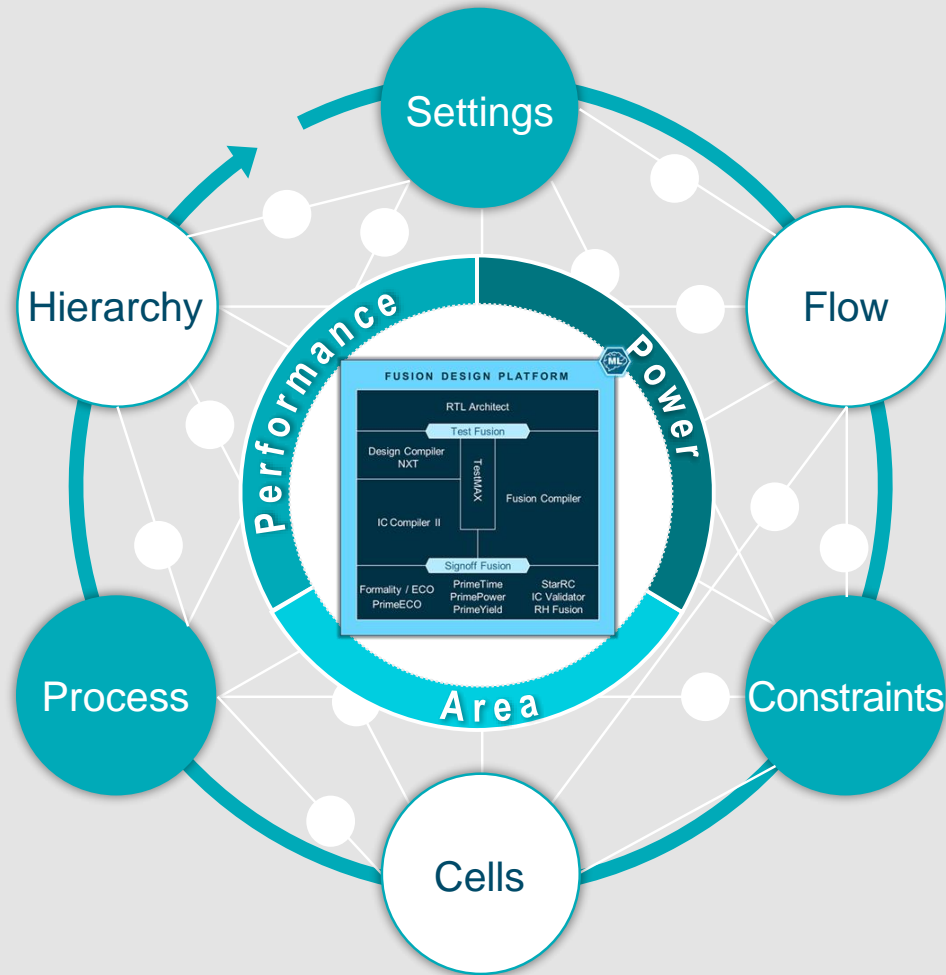
# AI Driven Design Space Optimization Loop

Uses reinforcement-learning to navigate the design-technology solution space



# DSO.ai – AI-driven Design Space Optimization

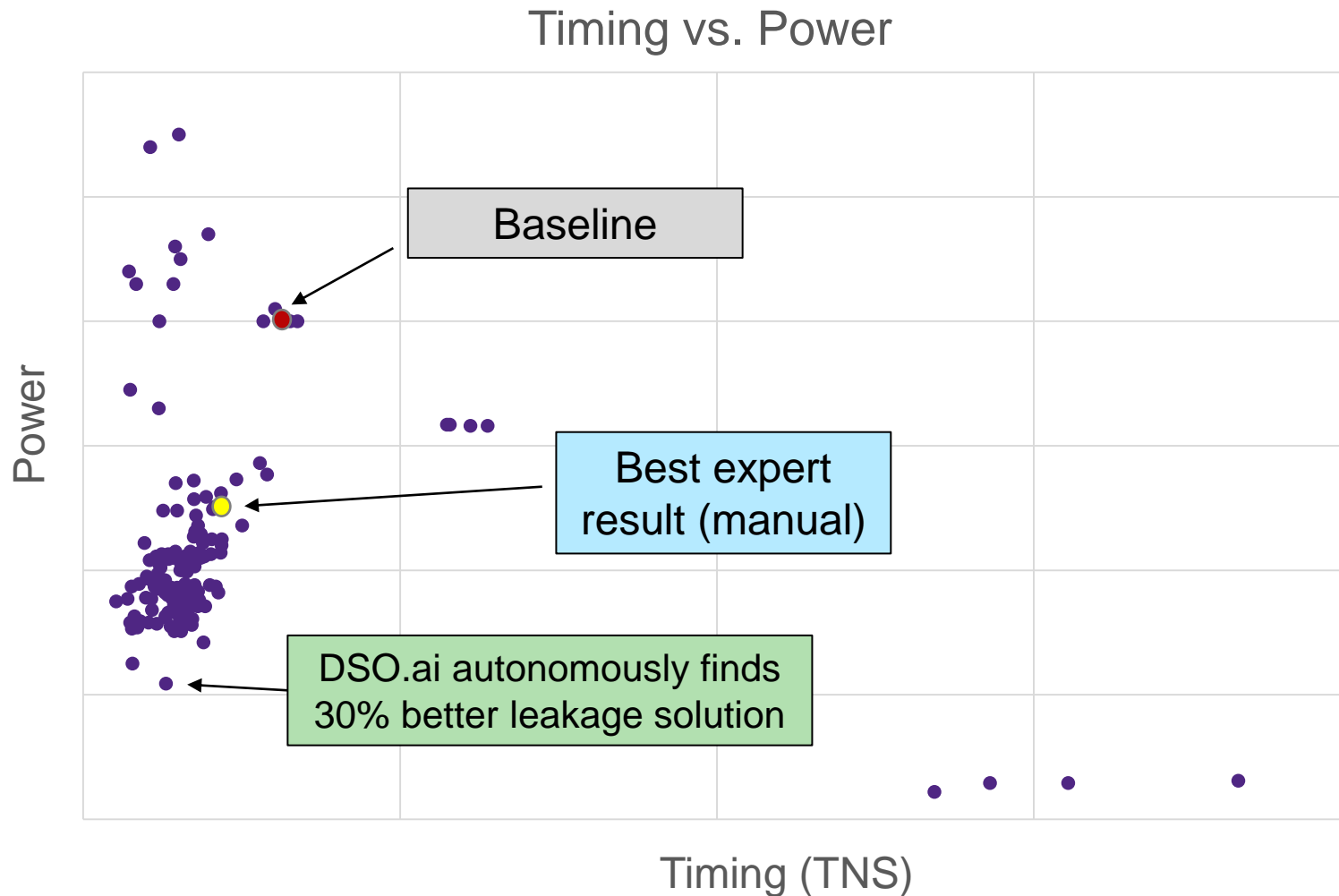
Uses machine-learning to navigate the combined design-technology solution space





# DSO.ai Case Study – No Prior Learning

Successful search for better power



## Problem Statement:

Achieve lowest power while keeping TNS

## Design Parameter Space

- Design, tool, flow parameters
- Library cell parameters

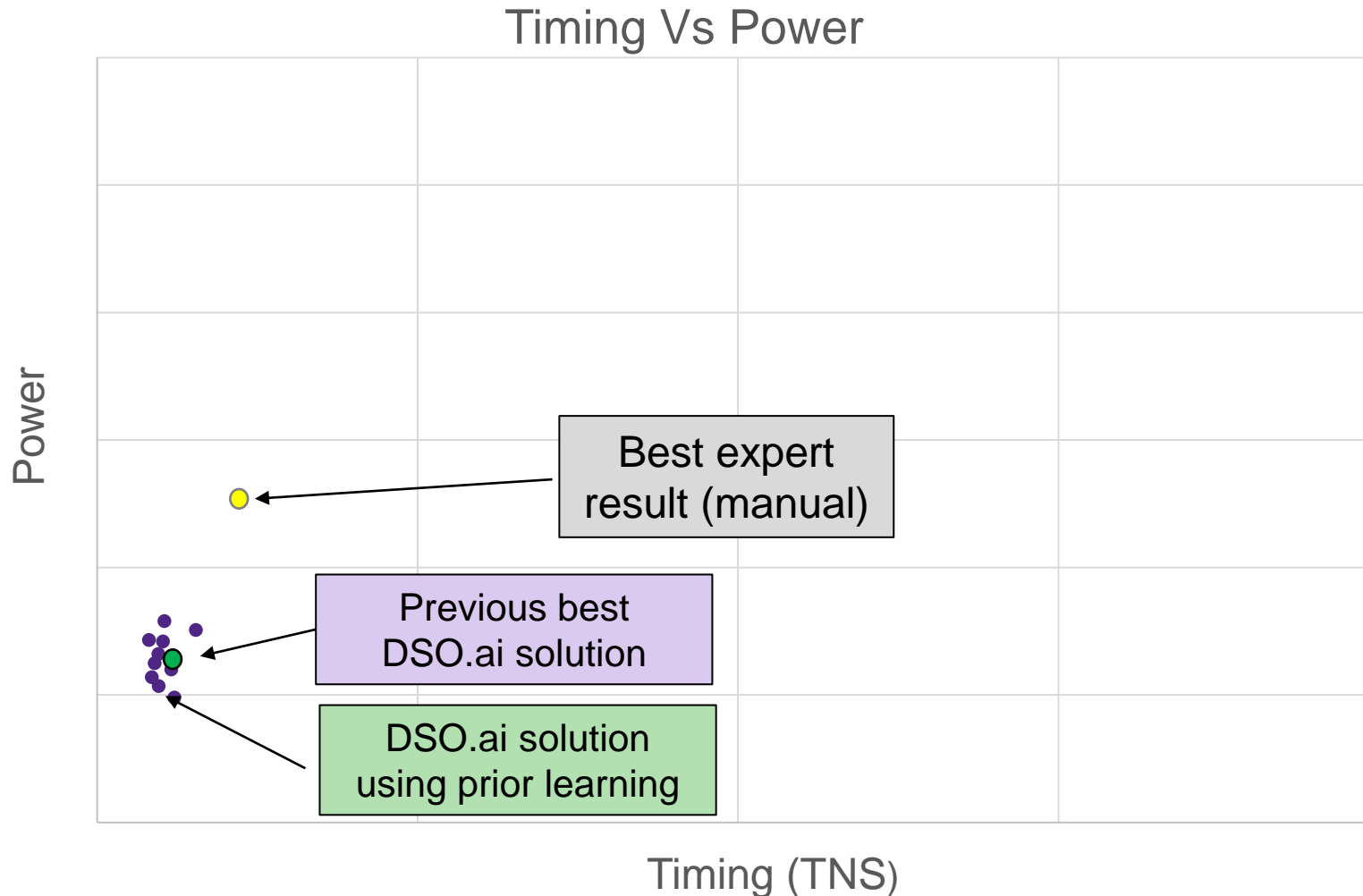
## Metrics (prioritized)

- Leakage
- TNS
- Plus secondary (DRC etc)



# DSO.ai Case Study – With Prior Learning

Finding a result using prior learning



## Problem Statement:

Achieve lowest power while keeping TNS

## Design Parameter Space

- Design, tool, flow parameters
- Library cell parameters

## Metrics (prioritized)

- Leakage
- TNS
- Plus secondary (DRC etc)

# Design Space Optimization 'Apps'

Plug-n-play exploration environments to further accelerate time to results with DSO.ai

## SpaceWare Apps

Powered by DSO.ai



Customized  
Design Spaces



Optimized  
Target Metrics

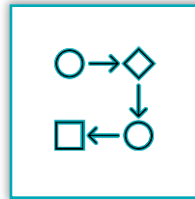


Plug-n-play  
Flow Scripts

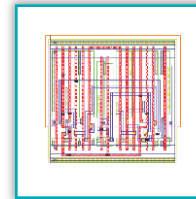


Pre-configured  
User Interface

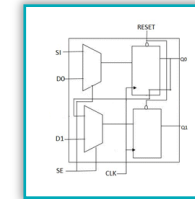
## Library Showcase



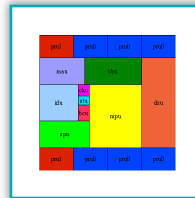
**Flow Opt.**  
Tool settings, flow  
steps



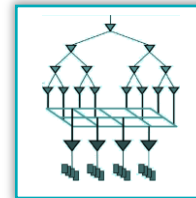
**Library Opt.**  
Cell selection



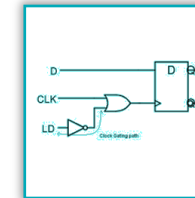
**Dynamic Power**  
Multi-bit strategies,  
ICG point, activity  
profiles, and more



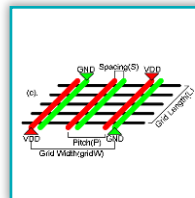
**Floorplanning**  
Macro placement,  
floorplan options



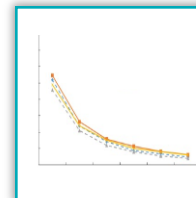
**Clock Space**  
Tree architecture,  
cell selection, tap  
points, and more



**Path Grouping**  
Explore path clustering  
for better Fmax



**Power Net**  
PDN architecture,  
IR-drop

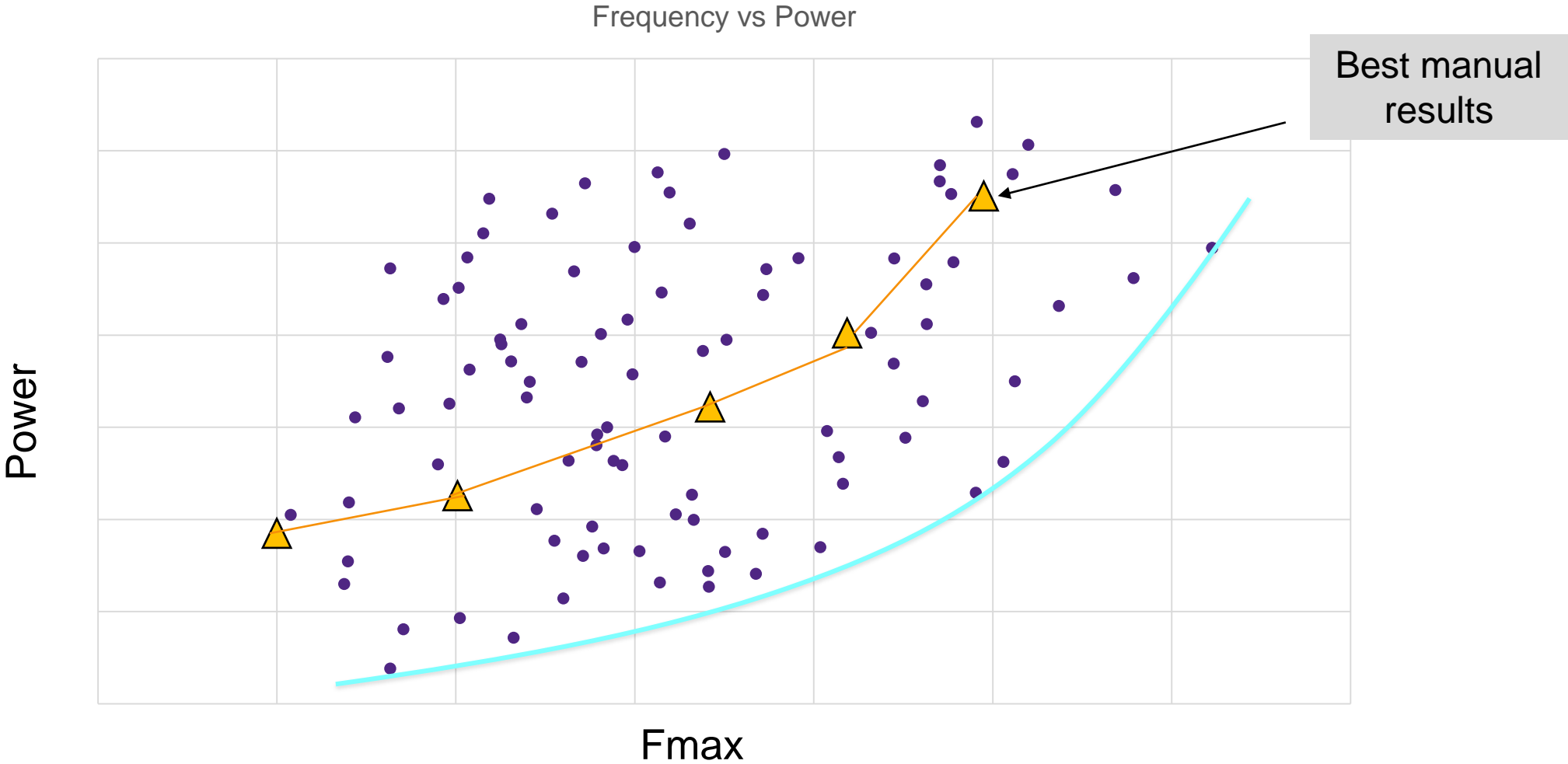


**V-Scaling**  
Vmin-Vmax voltage  
exploration

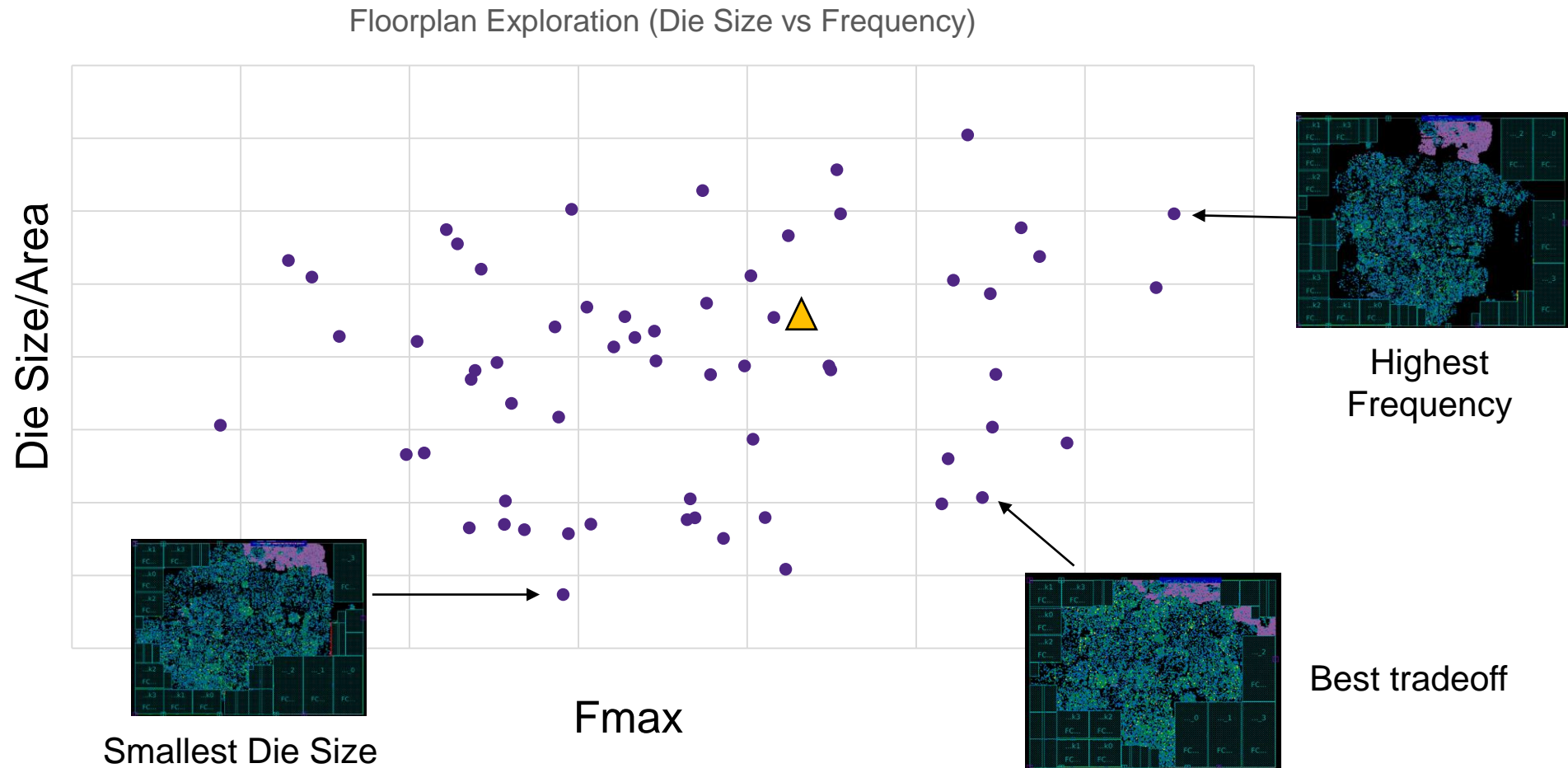


**DTCO**  
Metal stacks, cell  
architecture, VT  
classes

# Operating Condition Optimization with DSO.ai (PVT, Library + Flow)



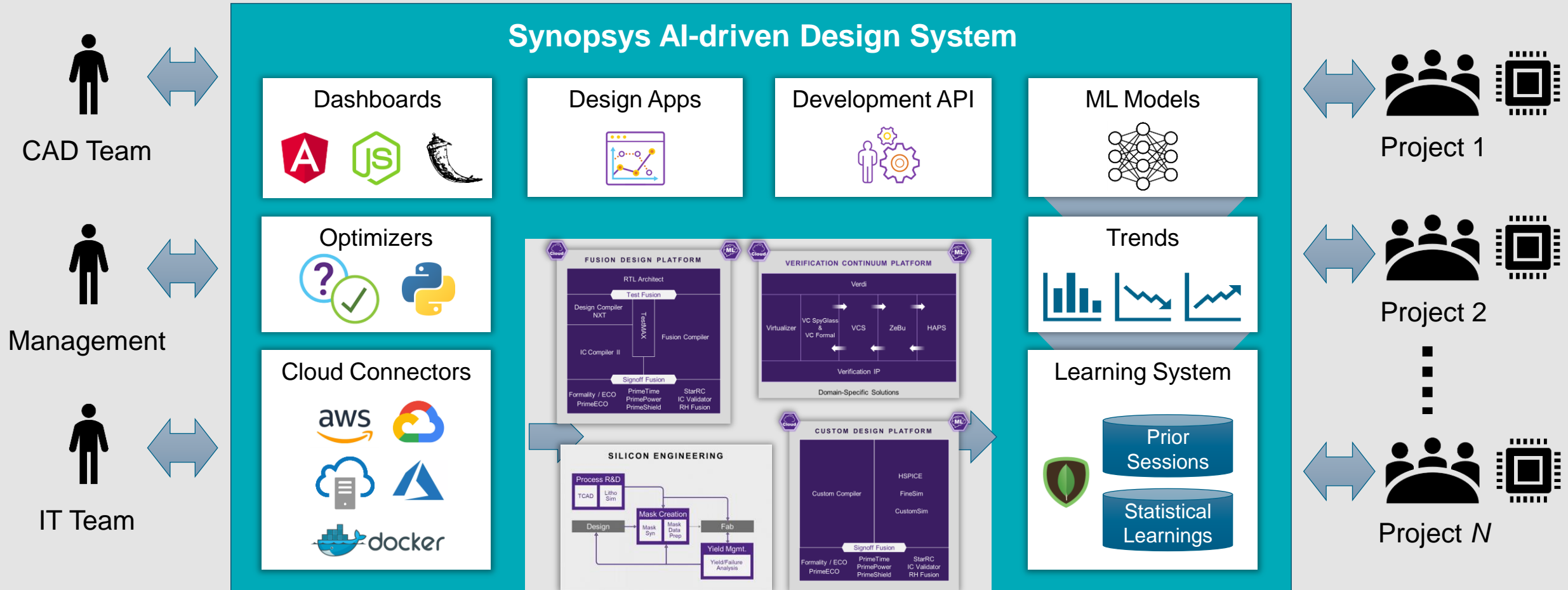
# Floorplan Optimization with DSO.ai for Area & Fmax



Synopsys Confidential Information

# Our Vision: A Complete AI-driven Design System

An autonomous design system that optimizes workflows across Synopsys platforms



# Thank You

