# Machine Learning in EDA

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# Machine Learning Is Not New…

Machine Learning is the field of study that gives computers the ability to learn without being explicitly programmed."

Arthur Samuel, 1959

60 Years of Research

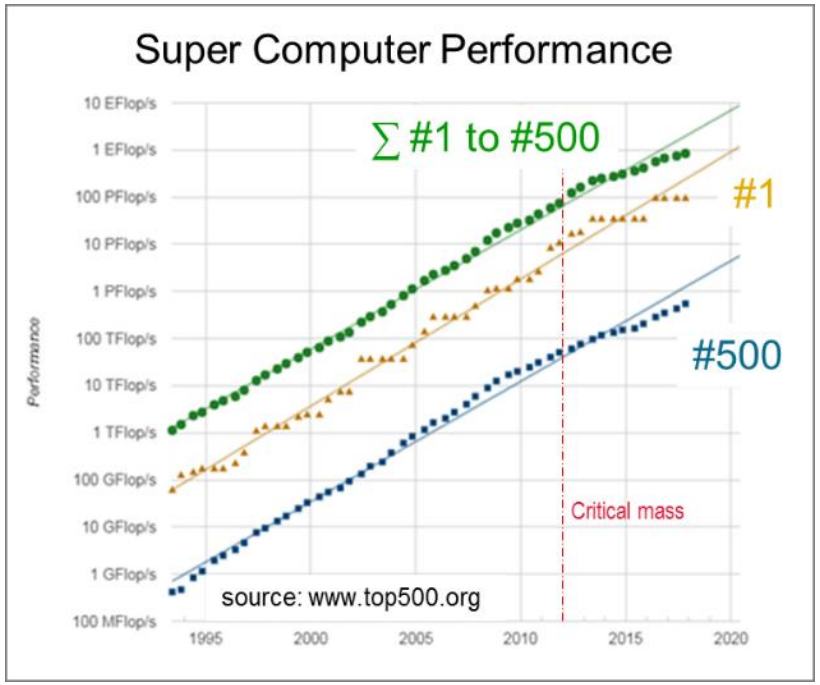
***Artificial Intelligence***

***Neural Networks***

***Big Data***

***CNN***

***Deep Learning***




High-Performance Cloud

Massive Storage  Massively Parallel





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# Drivers of Machine Learning and AI

**Cloud Datacenter**

**Automotive**

**Medical**

**Industrial IoT**


**Applies to All Verticals**

**Machine Learning**





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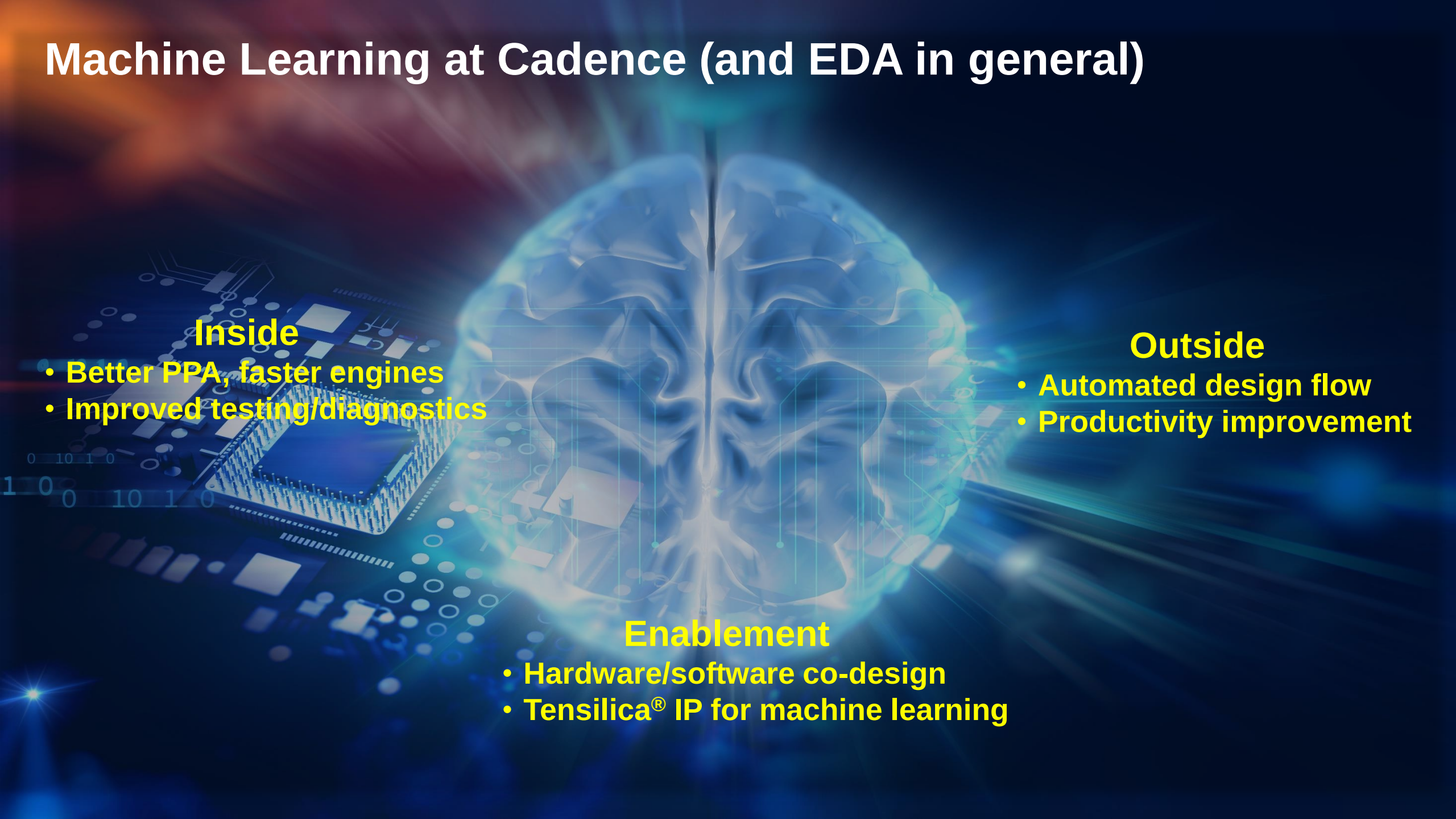
# Machine Learning at Cadence (and EDA in general)

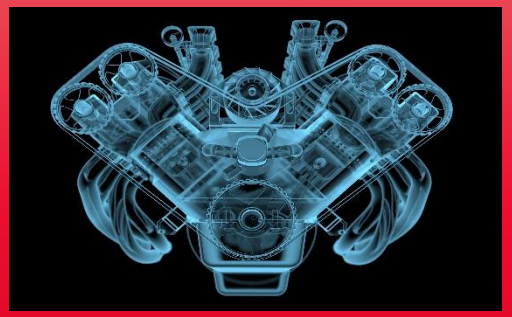


## Inside
- Better PPA, faster engines
- Improved testing/diagnostics

## Outside
- Automated design flow
- Productivity improvement

## Enablement
- Hardware/software co-design
- Tensilica® IP for machine learning

# What is needed to Do Well in ML / AI (Fast and Smart)

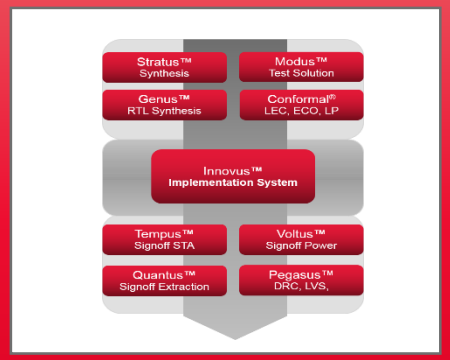


Core Engine Performance

Signoff Accuracy
Single-CPU Performance
Efficient Memory Mgmt
Cloud Ready

Compute Capacity

Massively Parallel
Multi-Thread
Fully Distributed
Cloud Ready




Smart Flows/Solutions

Natively Shared Engines
Smart Physically ECO
Common UI
PPA Closure

The Right Technology for Machine Learning

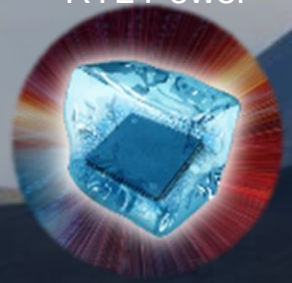
# FAST Engines

**Tempus™**
Signoff STA

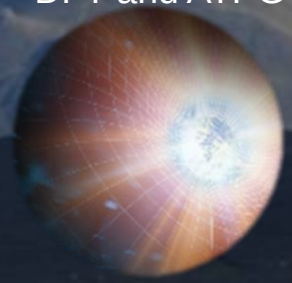
**Quantus™**
Signoff Extraction


**Innovus™**
Implementation

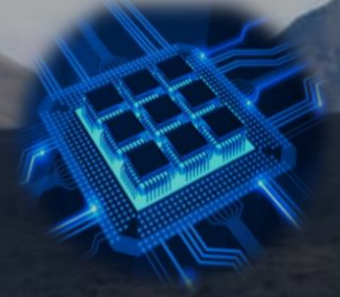
**Joules™**
RTL Power



**Modus DFT**
DFT and ATPG

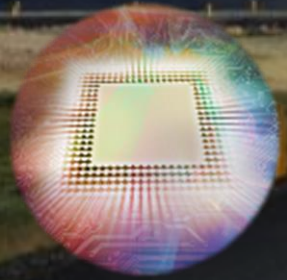


**Xcelium™**
Logic Simulation



**Voltus™**
Signoff Power

**Stratus™**
HLS



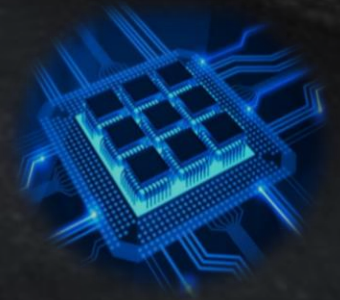
**Palladium®**
Hardware Emulation

**Protium™ S1**
FPGA Prototyping

**Genus™**
RTL Synthesis

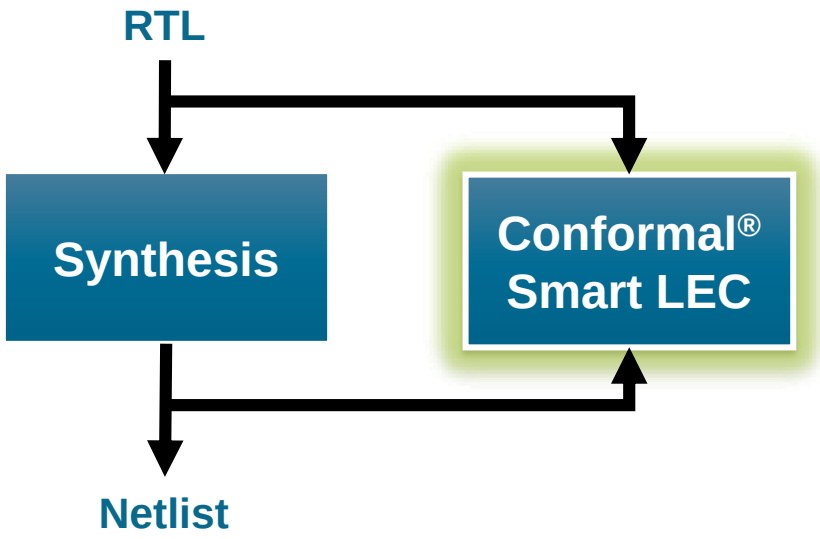
**Pegasus™**
DRC, LVS, DFM

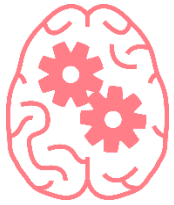
**JasperGold™**
Formal Verification



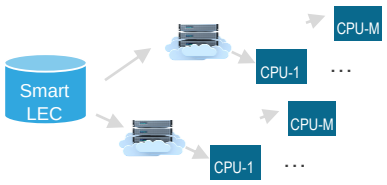
# Conformal Smart LEC

## Next-generation fast and smart logic equivalency checking

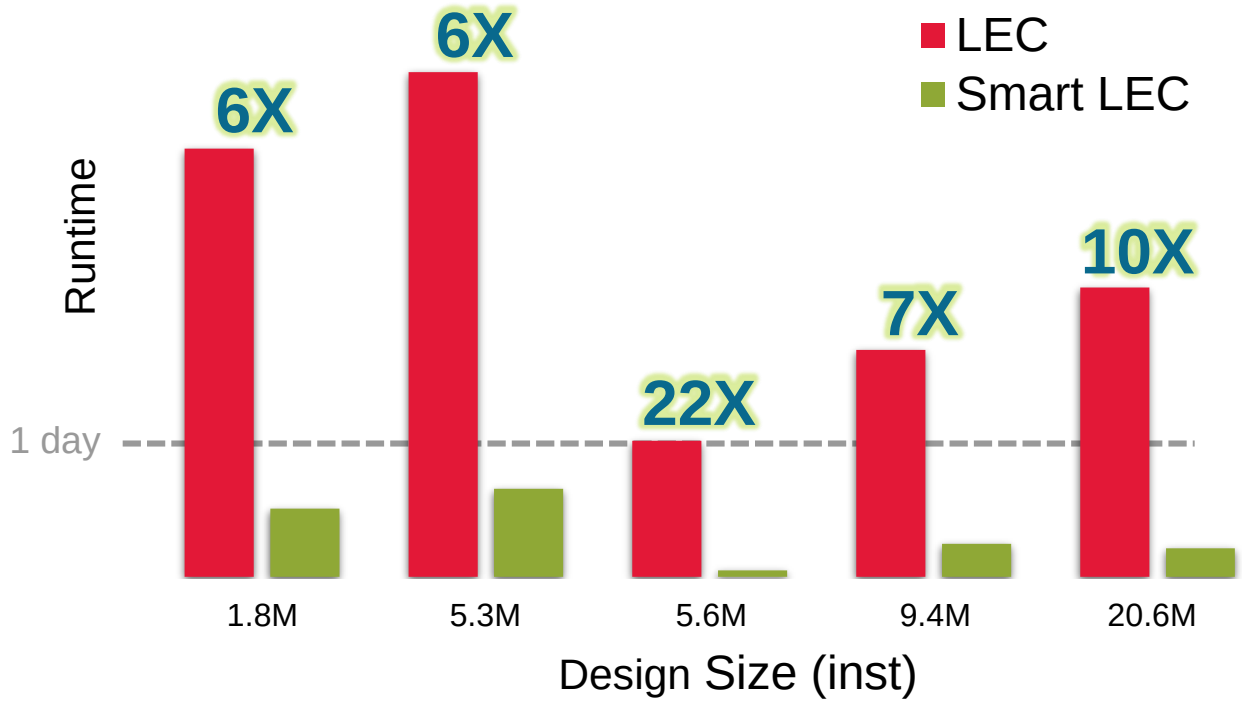


**Adaptive Proof**




**Massively Parallel**





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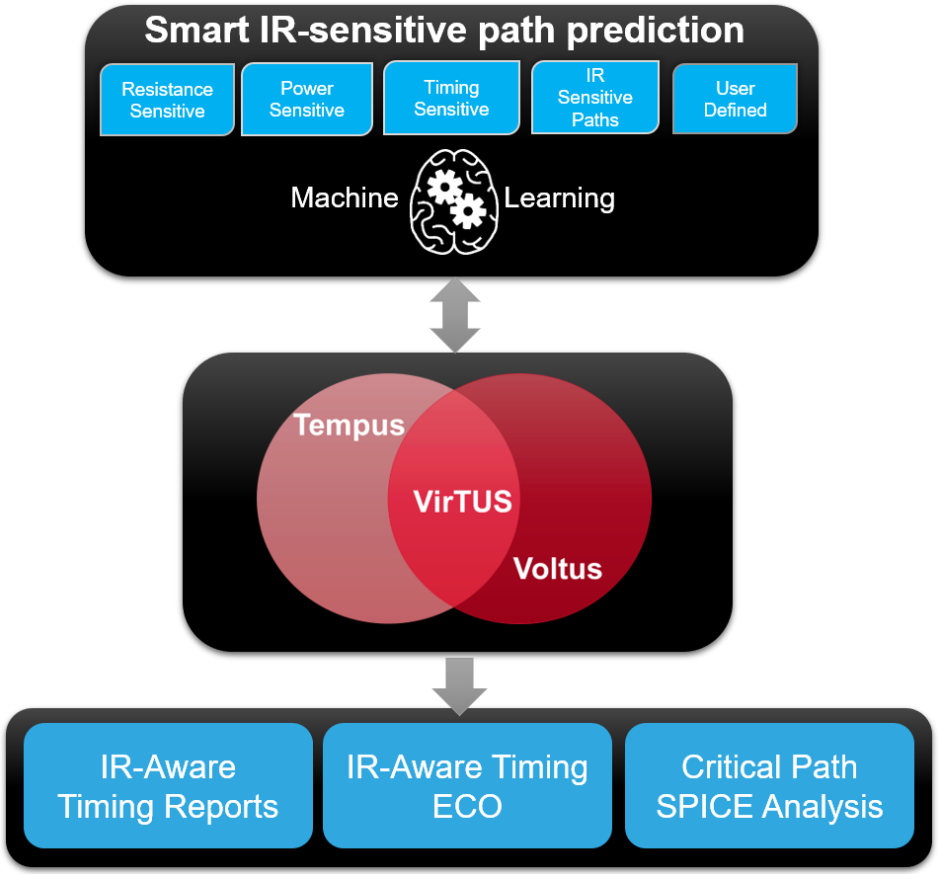
# Project VirTUS: A Technology for True Signoff

- Fully integrated, production-proven signoff
  - Tempus™ static timing
  - Voltus™ IR drop
  - Common database and runtime model
- Smart IR-sensitive path prediction
  - Machine learning for complete coverage
  - Factory trained for signoff
- Timing/sensitivity-driven IR analysis
  - Multi-cycle, functional, vector-less
  - IR drop and timing event natively aligned

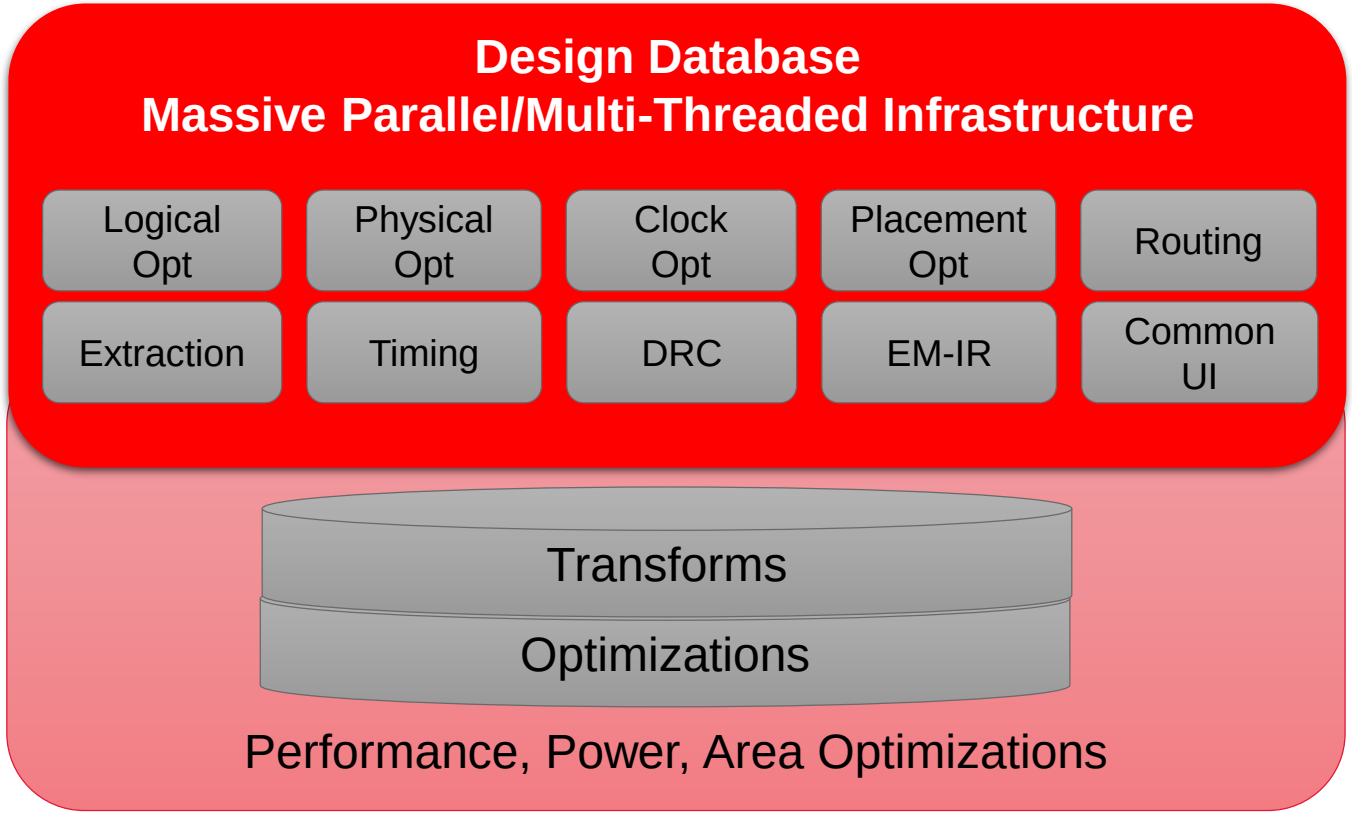


# Digital Full-Flow Technology: Database and Common Engines

Core Engines

Core Infrastructure Database

Full-Flow PPA Optimization




**Advanced-Node Features**

Via Pillar Optimization

IR-Aware Placement

IR-Aware Timing

Power Grid Trimming

DRC-Aware Routing

Metal Fill

Genus™ Innovus™ Quantus™ Tempus™ Voltus™ Pegasus™





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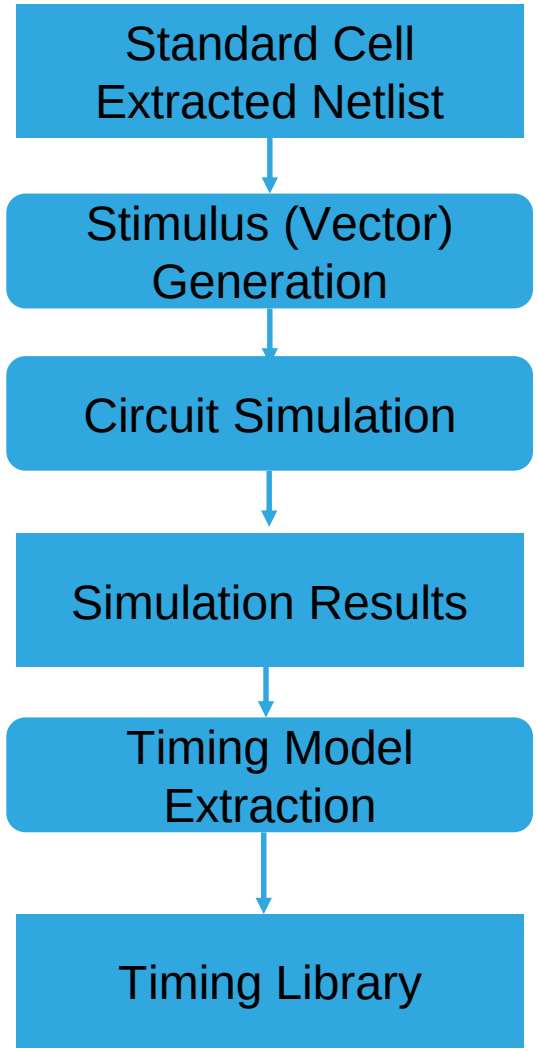
# Machine Learning for Library Characterization



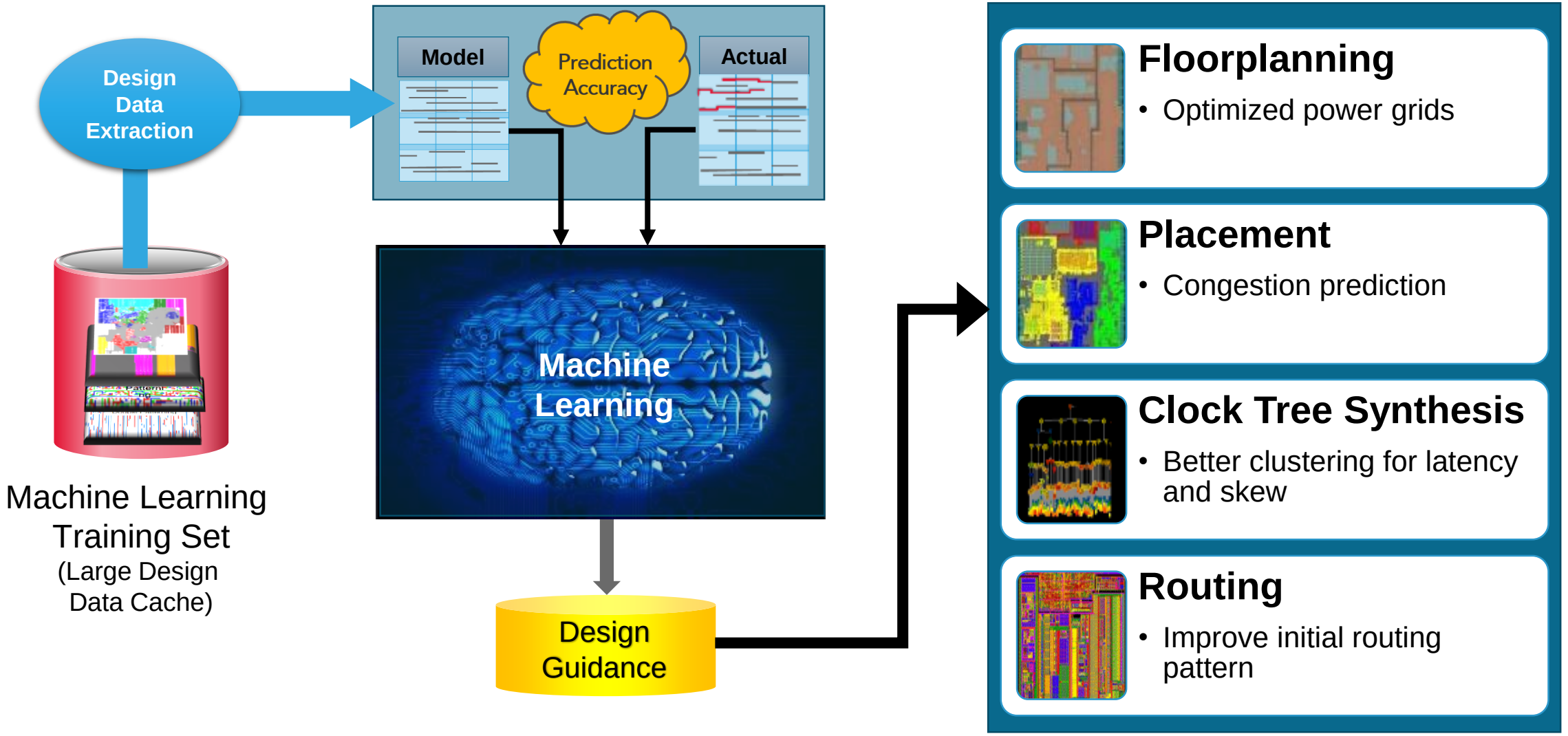

Challenges

- Many cells, many process corners
- Many new effects
- Millions of simulations for each new standard cell library

Machine learning improves throughput:

- Learn from previous process corners
- Smart interpolation by extracting critical measurements
- Critical corner identification

# Machine Learning: Digital Implementation



# Machine Learning Is Everywhere

- Cadence invested in developing fast and accurate leading-edge engines
- Cadence technology is designed to utilize the immense compute power available today via large networks or the cloud
- Cadence full flow, based on common engines and machine learning algorithms, delivers the best PPA with the best TAT

# Cadence in Brazil

- R&D office, working on different products and careers: software development, product experts, application engineers, dev ops

- Local group with focus on machine learning for verification

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