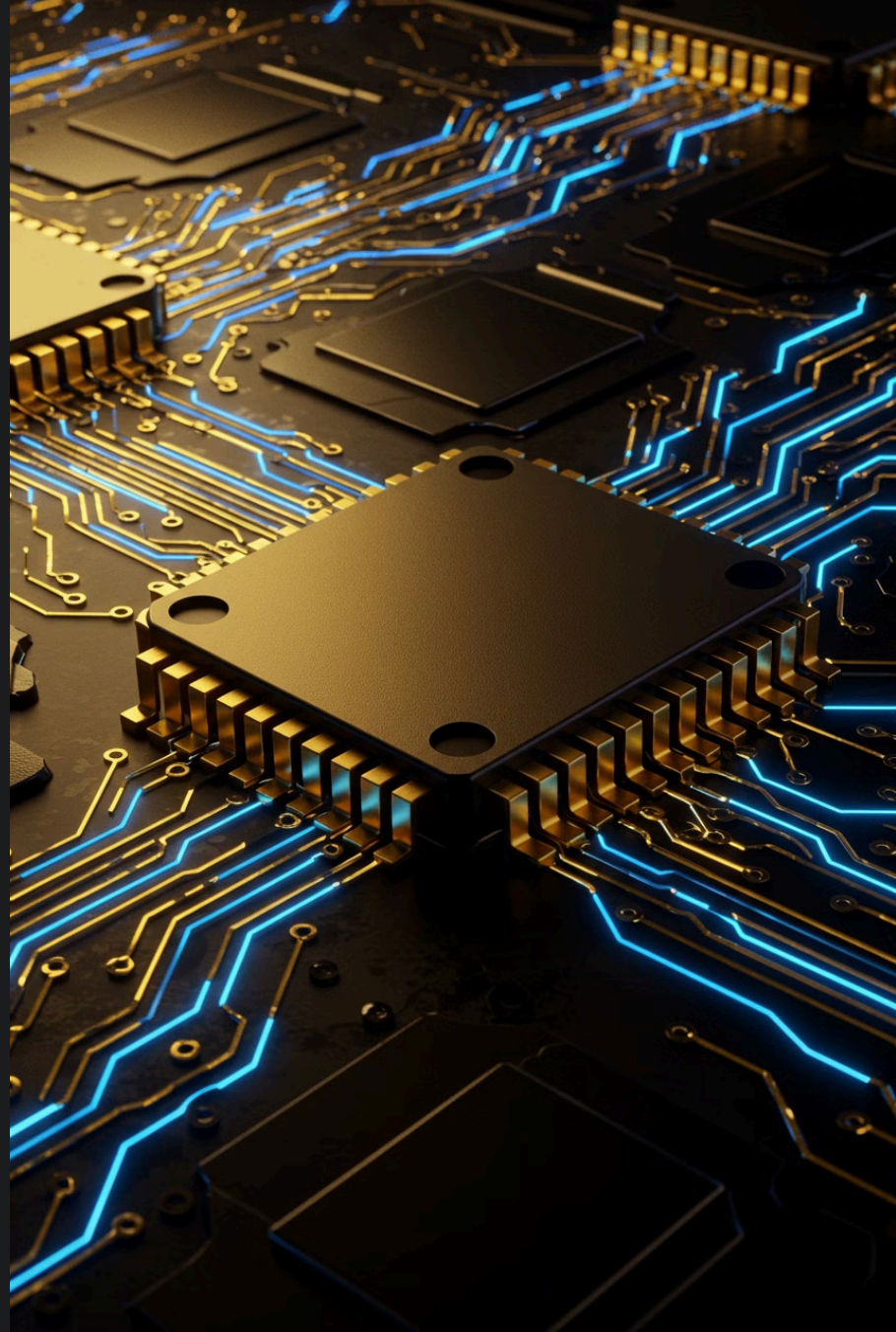
Adaptive Power Calculation for Battery-Operated Chip Design

Battery-powered devices demand meticulous power optimization throughout the design lifecycle. Our innovative adaptive methodology dynamically recalibrates power calculations in real-time, dramatically enhancing efficiency across both active operation and idle states. This breakthrough approach leads to extended battery life without compromising performance.

By: **Puneet Gupta**



The Power Calculation Challenge

Dynamic Parameters

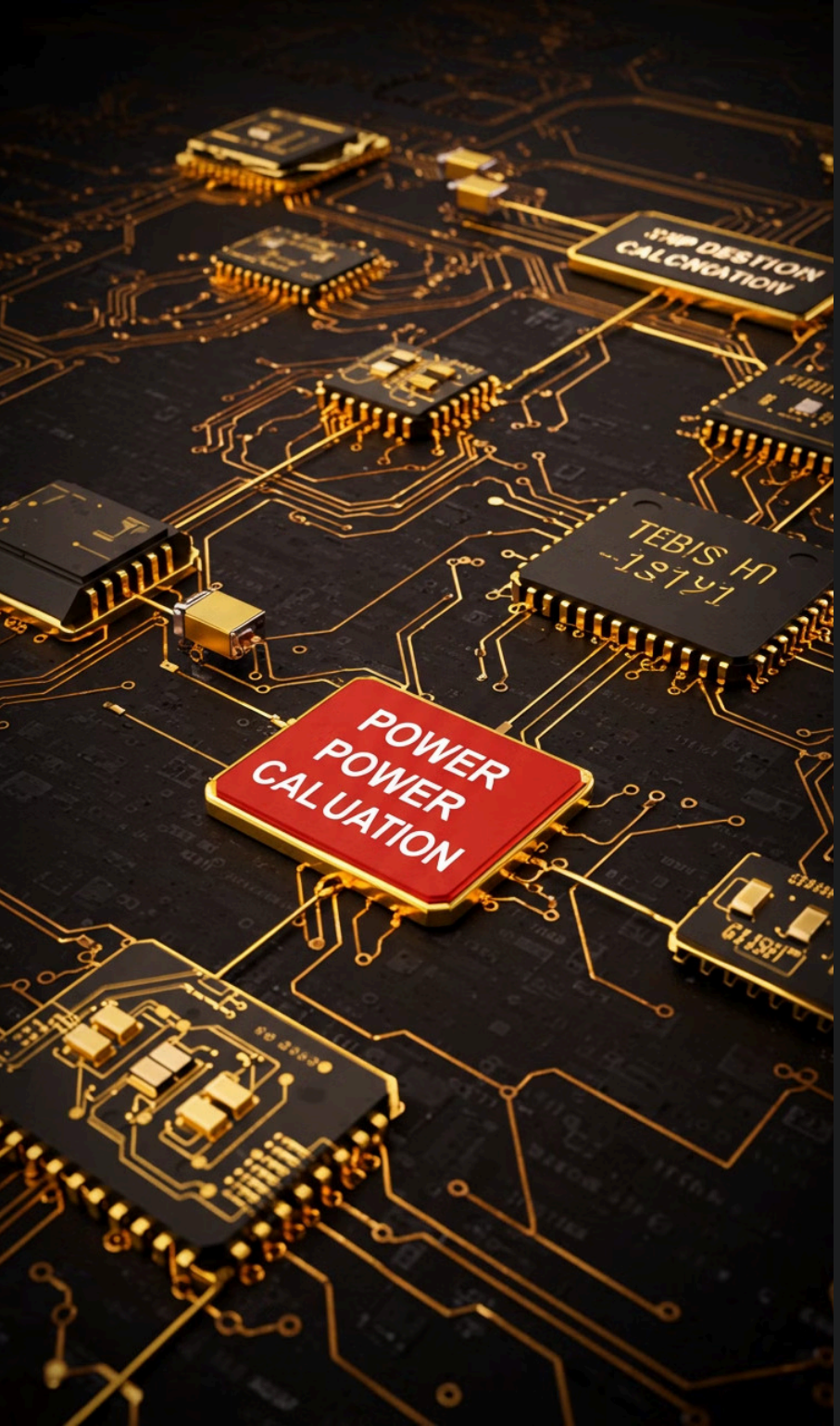
Activity factors, parasitic capacitances, and resistance values constantly shift throughout the design process, creating a perpetually moving target for accurate power estimation.

Early Inaccuracies

Initial power estimations frequently neglect critical variables, triggering cascading design errors that compound over time and become increasingly costly to rectify.

Distribution Network Issues

Power delivery networks based on flawed baseline calculations introduce significant reliability vulnerabilities, potentially leading to catastrophic device failures under real-world operating conditions.



Current State: Fixed Calculations

1

Initial Estimations

Power budgets established on preliminary specifications with significant margin for error

2

Static Design Parameters

Minimal recalibration despite continuous influx of critical design data

3

Late-Stage Detection

Power inefficiencies identified during validation necessitate expensive and time-consuming redesigns

4

Suboptimal Results

Finished devices operate with compromised battery longevity or reduced feature capabilities

Introducing Adaptive Methodology

Calculate

Generate comprehensive power estimates using preliminary specifications and statistical models

Integrate

Dynamically incorporate real-time measurement data and refined parameters throughout development

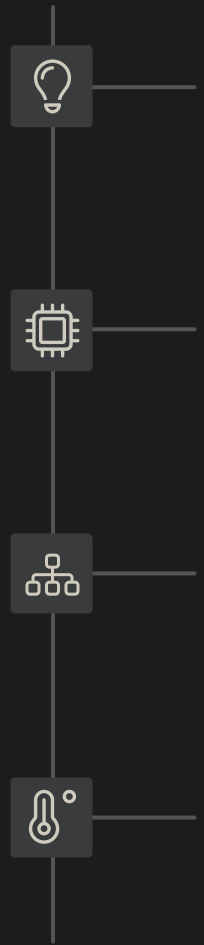
Validate

Benchmark against previous iterations to quantify efficiency improvements and confirm design targets

Adjust

Recalibrate power specifications with enhanced precision to optimize battery performance

Key Milestones for Adaptive Recalculation



Architecture Definition

Comprehensive baseline power budgets established with preliminary specifications and statistical modeling

RTL Development

Dynamic activity factors calibrated through extensive functional simulations and workload analysis

Physical Design

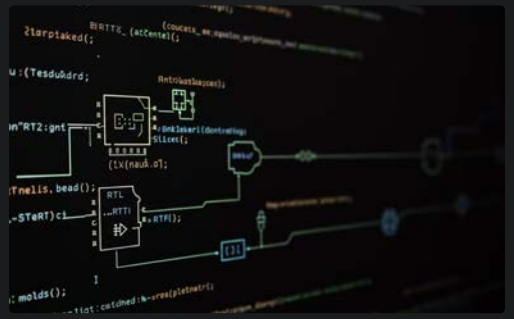
Precise parasitic extraction delivers critical capacitance and resistance values for accurate power profiling

Pre-Silicon Validation

Robust power distribution network rigorously validated against diverse real-world usage scenarios

Tracking Input Quality

Quality metrics improve significantly across the design process, enabling more accurate power calculations at each stage.



Early RTL Phase

Activity Factor Certainty: 45%

Parasitic Data Completeness: 20%

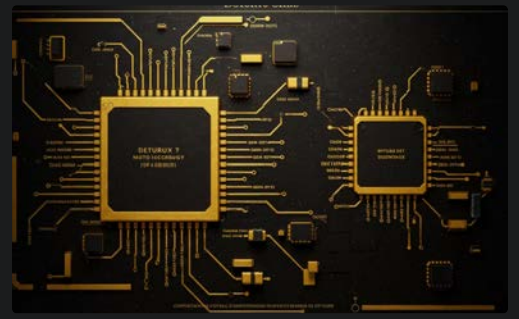
Capacitance Measurement Accuracy: 30%

Synthesis Phase

Activity Factor Certainty: 65%

Parasitic Data Completeness: 55%

Capacitance Measurement Accuracy: 60%

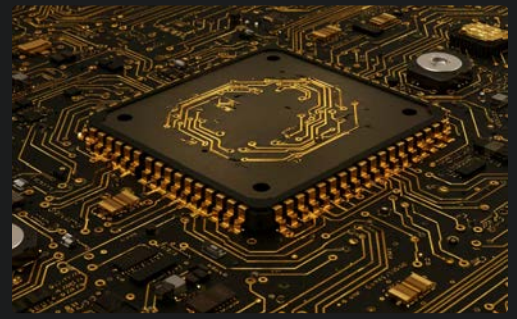


Place & Route Phase

Activity Factor Certainty: 80%

Parasitic Data Completeness: 85%

Capacitance Measurement Accuracy: 90%



Final Design Phase

Activity Factor Certainty: 95%

Parasitic Data Completeness: 98%

Capacitance Measurement Accuracy: 97%

Automation Strategy

Dynamic Scripts

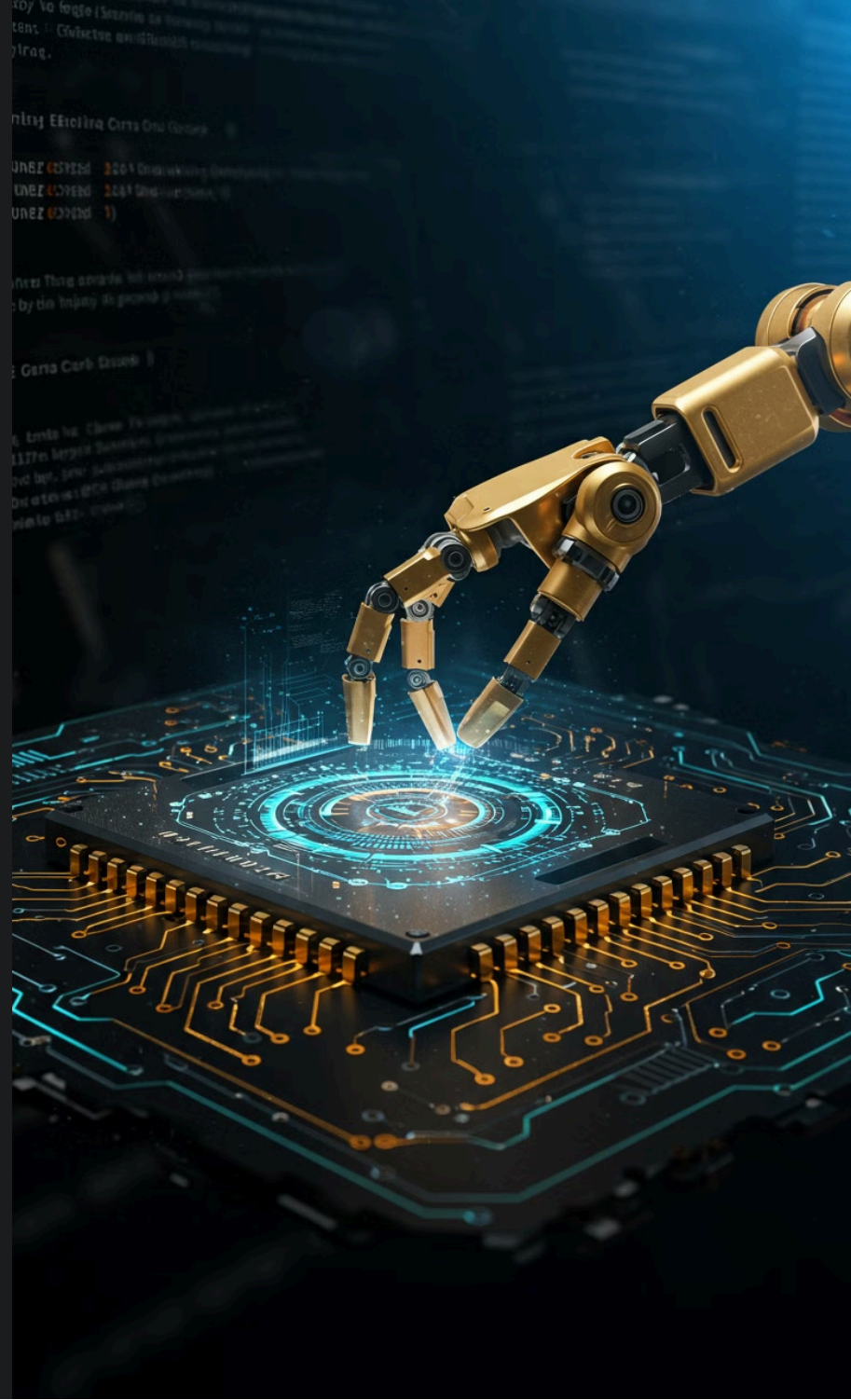
- Intelligently identify available input parameters at each design stage
- Implement optimal calculation models based on data maturity
- Proactively flag missing critical data with severity classifications

Predictive Models

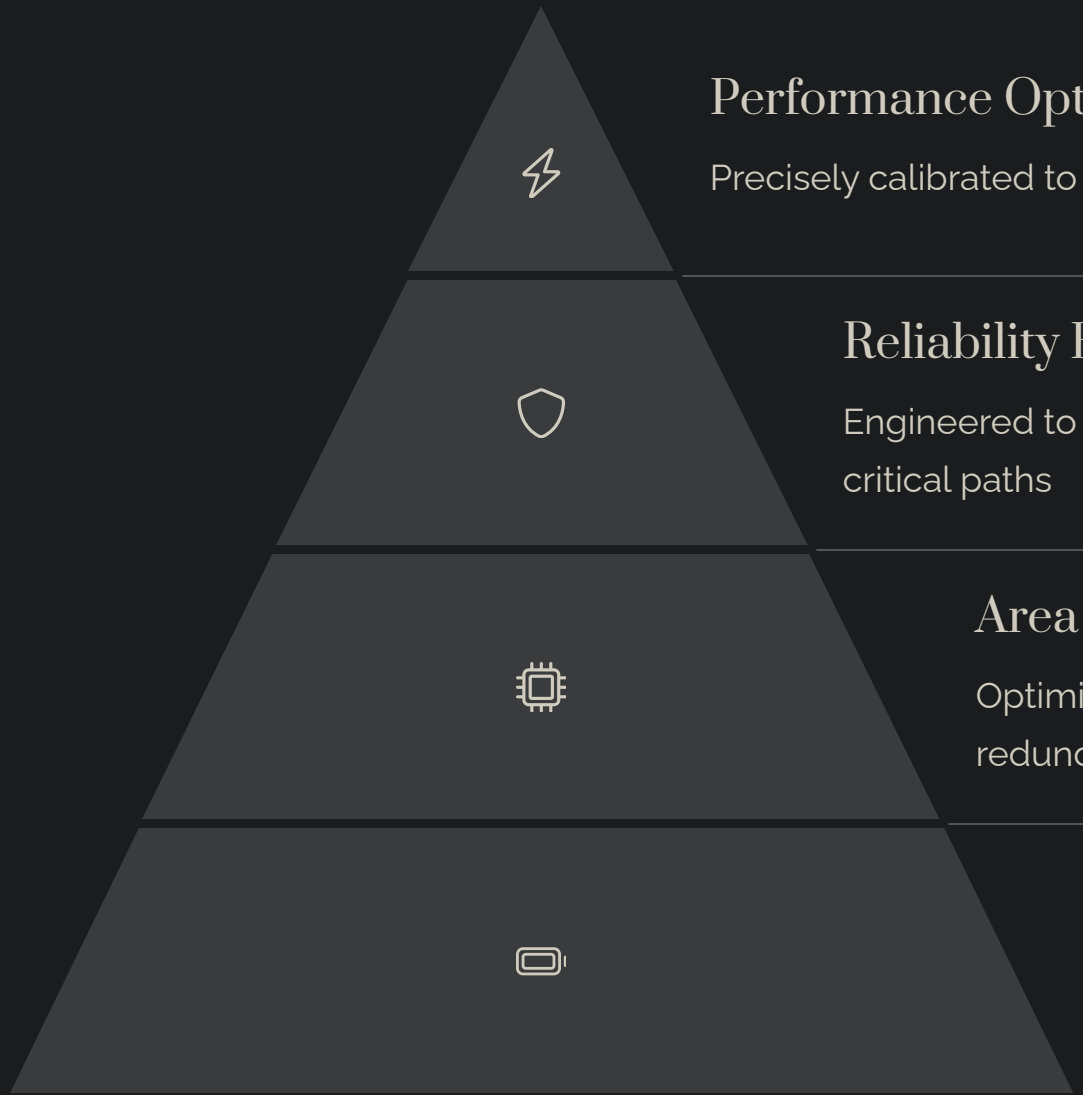
- Bridge information gaps using machine learning estimations
- Leverage historical patterns from previous chip designs
- Self-optimize prediction accuracy with each design iteration

Cross-Team Integration

- Real-time notification system for power specification changes
- Seamless API connections to industry-standard design tools
- Comprehensive power analytics dashboards with trend visualization



Power Distribution Network Optimization



Performance Optimization

Precisely calibrated to match dynamic power requirements with minimal overhead

Reliability Enhancements

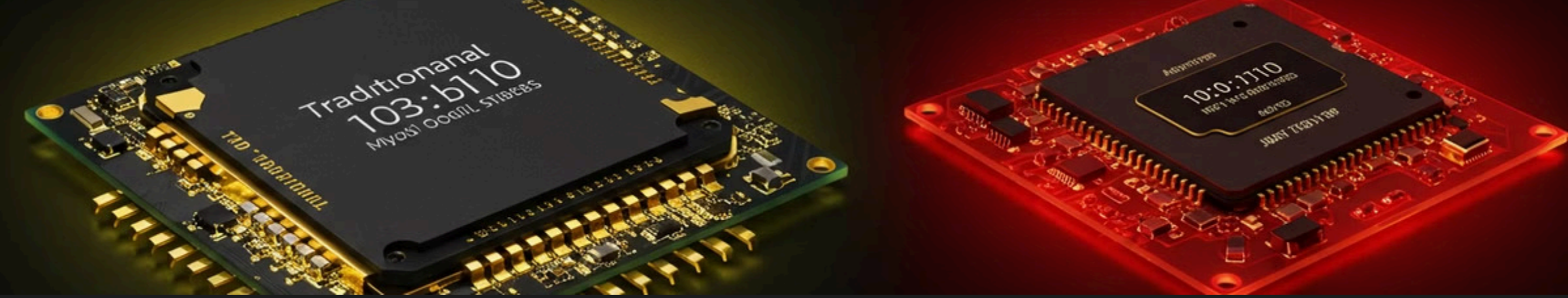
Engineered to eliminate IR drops and mitigate electromigration effects in critical paths

Area Efficiency

Optimized metal utilization through adaptive width/spacing without redundant routing

Battery Life Extension

Strategic power gating and voltage scaling to maximize energy efficiency during operation



Real-World Results

37%

Power Savings

Significant reduction in active mode power consumption, enabling more efficient chip operation

42%

Design Efficiency

Dramatic decrease in redesign cycles, accelerating time-to-market while reducing development costs

2.8x

Battery Longevity

Substantial extension in operational runtime compared to previous generation designs

Implementation Roadmap

Tool Integration

Seamlessly integrate adaptive power calculation with existing EDA infrastructure for frictionless adoption

Team Training

Equip engineering teams with comprehensive understanding of adaptive methodologies and practical implementation techniques

Process Updates

Implement strategic design checkpoints to trigger automated power recalculation based on data quality thresholds

Continuous Improvement

Systematically refine prediction models using real-world power measurements to enhance accuracy with each design iteration

Key Takeaways

Adaptive > Static

Dynamic power calculation methodologies significantly outperform fixed approaches throughout the design lifecycle. Static methods inevitably lead to performance compromises and potential thermal failures.

Data-Driven Design

Comprehensive input quality tracking enables transparent, confidence-based decision-making. Engineers can precisely evaluate reliability levels for each calculation, ensuring informed design choices.

Automation Imperative

Intelligent algorithms and ML-based predictive models eliminate human error in repetitive recalculations. Seamless integration with established EDA workflows dramatically accelerates team adoption and implementation.

Thankyou