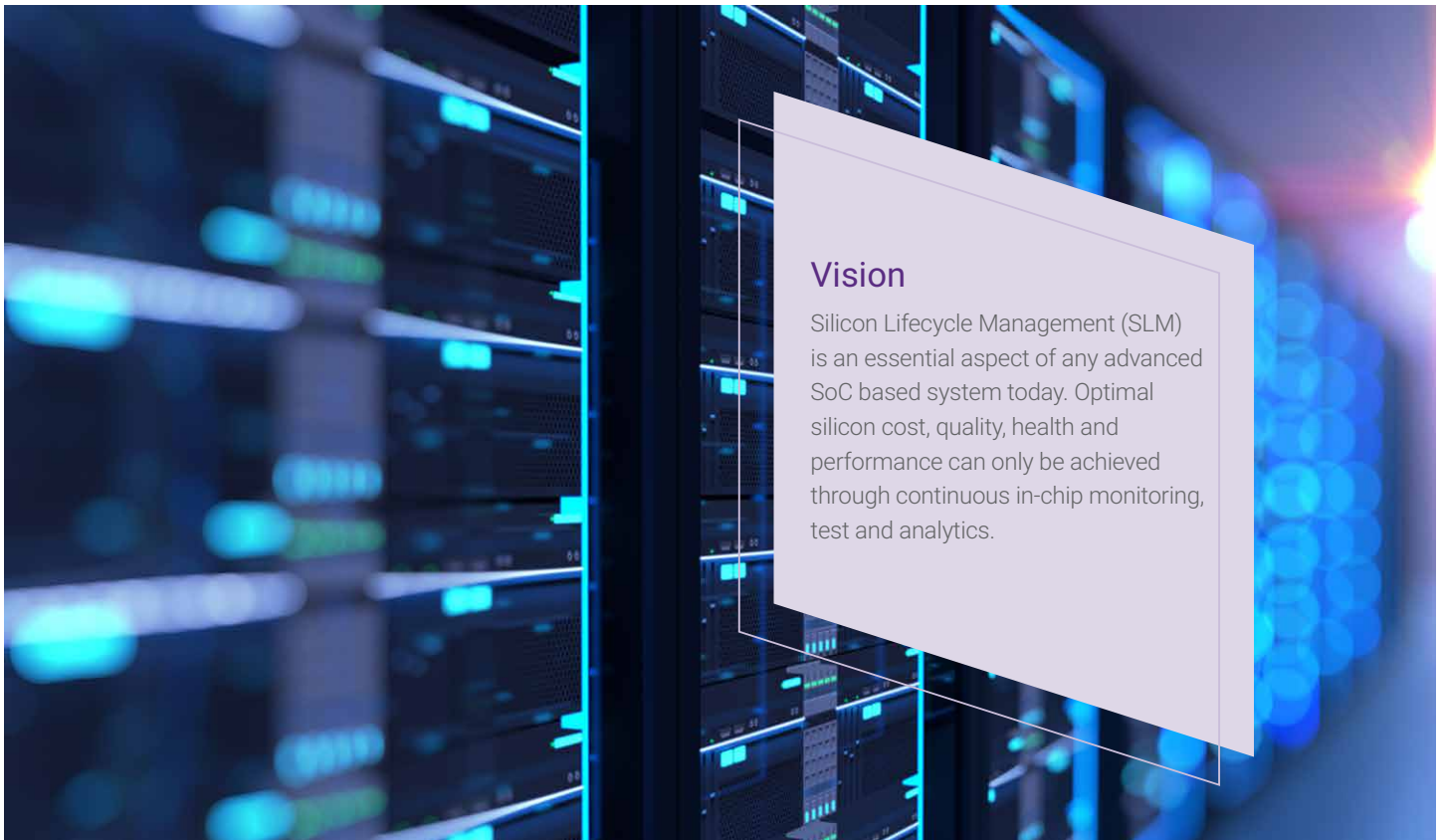# Silicon Lifecycle Management Family

Improving silicon health and operational metrics
at each phase of the system lifecycle

www.synopsys.com/slm

Vision

Silicon Lifecycle Management (SLM) is an essential aspect of any advanced SoC based system today. Optimal silicon cost, quality, health and performance can only be achieved through continuous in-chip monitoring, test and analytics.
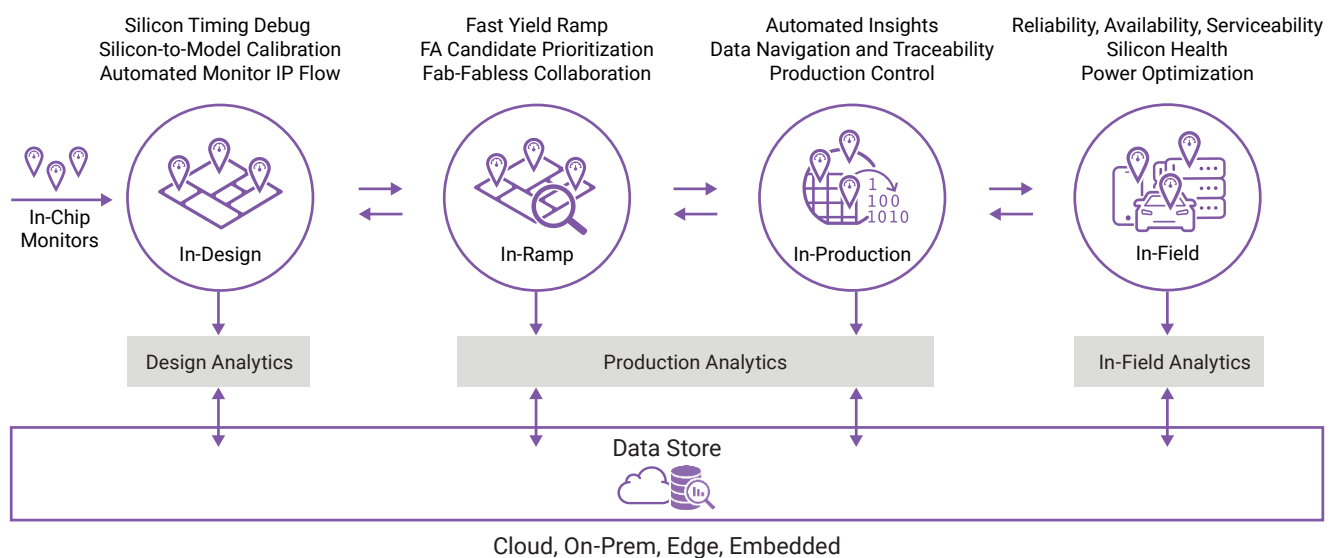
Synopsys SLM Family

The Synopsys SLM family is designed to improve silicon health and operational metrics at every phase of the system lifecycle. SLM is built on a foundation of in-chip IP, data analytics and design automation. Environmental, structural and functional monitors enable deep insights from SoC manufacturing to In-Field systems. Meaningful data is gathered at every opportunity for continuous analysis and actionable feedback. SLM fully leverages Synopsys' solutions for design automation.

## Actionable Insights Through Silicon Lifecycle Monitoring and Analytics

Silicon Timing Debug
Silicon-to-Model Calibration
Automated Monitor IP Flow

Fast Yield Ramp
FA Candidate Prioritization
Fab-Fabless Collaboration

Automated Insights
Data Navigation and Traceability
Production Control

Reliability, Availability, Serviceability
Silicon Health
Power Optimization

In-Chip Monitors

In-Design

In-Ramp

In-Production

In-Field

Design Analytics

Production Analytics

In-Field Analytics

Data Store

Cloud, On-Prem, Edge, Embedded

SLM IP

The Synopsys SLM family is built on the objective of monitoring silicon health and reliability. They are classified as: environmental, structural and functional monitors. They gather relevant data throughout the silicon lifecycle.

PVT Monitors

Process, Voltage and Temperature (PVT) monitoring is critical for optimal operation and performance in today's SoCs

- Maximizes performance, power, reliability
- Highly accurate, distributed monitoring throughout the die
- Available on process nodes from 28nm to 2nm
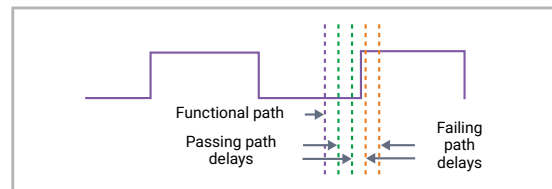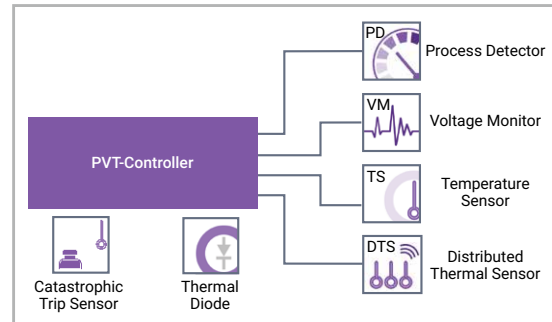
Path Margin Monitors (PMM)

Measure timing margin of actual functional paths In-Test and In-Field

- Monitor 1000s of synthetic and functional paths
- Optimize silicon performance based on actual margins available
- Automated path selection, IP insertion, and scan generation
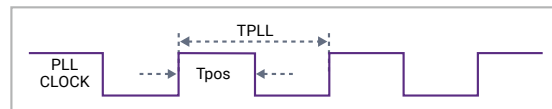
Clock and Delay Monitors (CDM)

Measure delay between edges of a signal(s)

- Clock duty cycle quality check
- Clock frequency measurement
- Memory access time tracking with and without BIST

High Speed Access and Test (HSAT)

Enable testing over functional interface (PCIe, USB, SPI, ...)

- Used during In-Field operation as well as WS, FT, SLT
- Supported by instruments from leading ATE providers
- Reduced pin count and test hardware saves cost
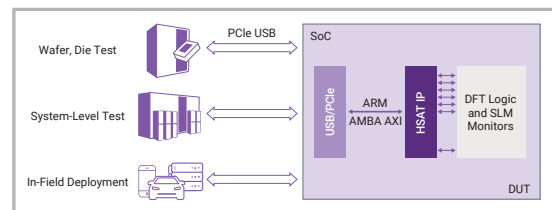
STAR Hierarchical System (SHS)

Automated DFx NoC (network on chip) solution for SoC's

- Hierarchical observability and control for all SLM IP
- Automated test integration of all IP/cores with in-system scheduling via APB
- Pre-validated ready ATE patterns with pattern porting
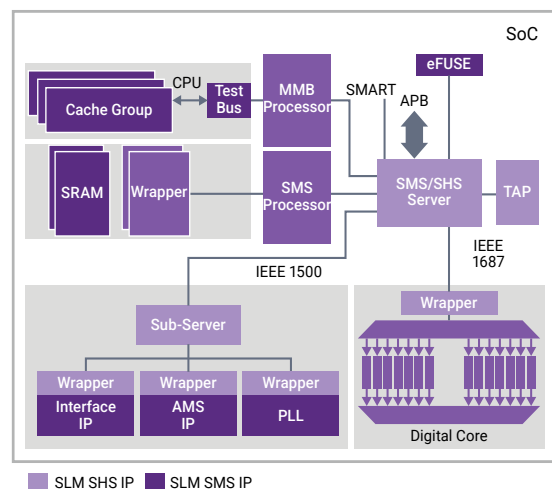
STAR Memory System (SMS)

Comprehensive silicon proven test, repair and diagnostics solution

- Supports Synopsys and 3rd party SRAM/RF/ROM, CAM, eMRAM and eFlash
- High Performance core support
- FinFET specific memory test algorithm programmability

External RAM Test and Repair (Ext-RAM)

Test and Repair for Multi-Die systems with External RAM

- Supports external DRAM (DDR/LPDDR/HBM/cHBM)
- Eliminates need for CPU to perform PHY initialization by enabling access via JTAG during production test
- Accelerates bring up for MCM/system by performing diagnostics on external memory and interconnect
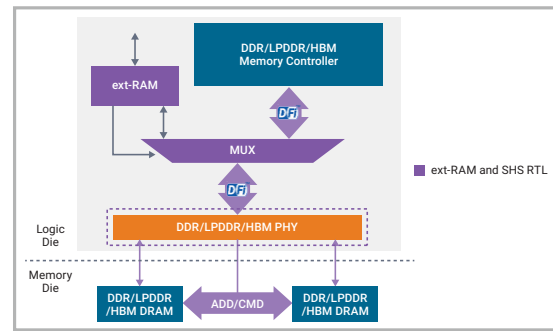
UCIe Monitor, Test and Repair (MTR)

Comprehensive SLM solution for UCIe PHY

- Monitor signal quality on D2D UCIe lane(s)
- Algorithmic test to mitigate cross-talk
- Aggregate repair across cumulative corners
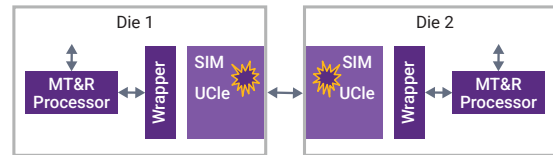
Lane, Test and Repair (LTR)

Test, Repair and Diagnostics of High-Volume Interconnect Lanes

- Intended for high data rate interconnects typically having redundancy
- Efficient broadcast support for multiple wrappers/groups
- Improves product test coverage and quality with at-speed D2D BIST with pre-defined and programmable test patterns
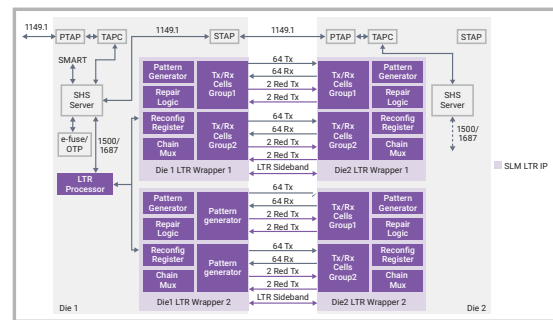
Advanced Clock Generator (ACG)

Configurable clock generator with clock response modes and clock metrics

- Utilizes only core voltage supply
- Provides fine-grained frequencies and programmable smooth ramp between frequencies
- Dynamic Frequency Manager for DVFS transitions and droop mitigation
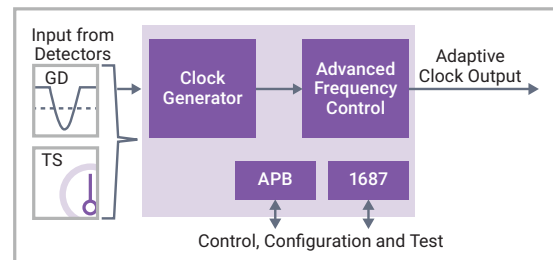
SLM Production Analytics

Silicon.da is a unified analytics solution that covers all product manufacturing phases, and provides the ability to analyze petabytes of silicon and system data. It automatically highlights silicon data outliers, enabling engineering teams to quickly identify and correct underlying issues in the semiconductor supply chain.

With Silicon.da, engineering teams can leverage silicon design, monitor, diagnostic, fab and production test data to improve key chip production metrics such as quality, yield and throughput, as well as key silicon operational metrics such as chip power and performance.

Silicon.da provides key benefits in the area of Engineering Productivity, Silicon Efficiency, and Tool Scalability.
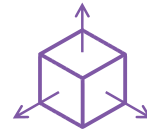
Productivity

- Actionable insights out-of-the-box
- Automated root cause analysis
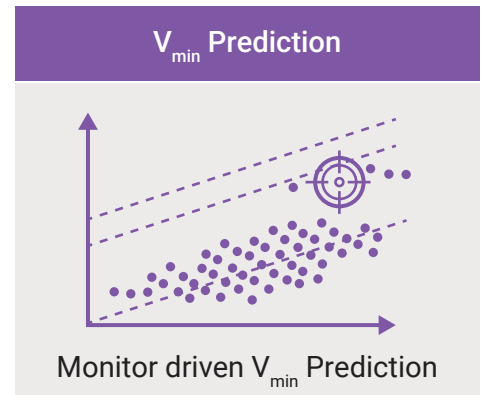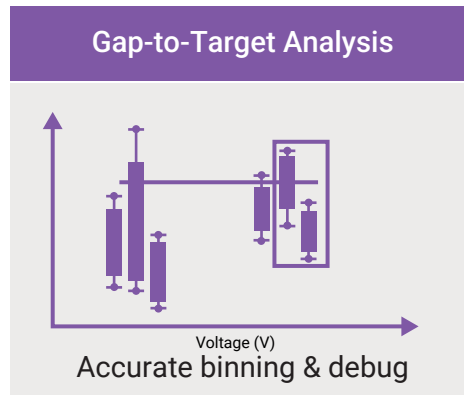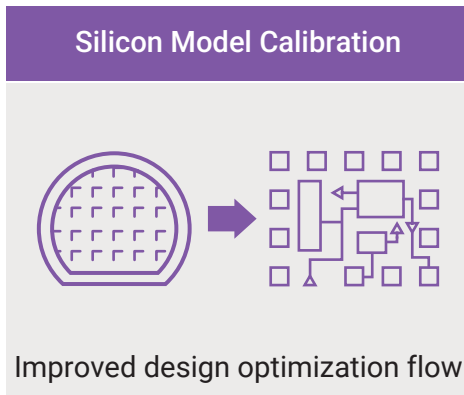- Accurate FA candidate selection

Efficiency

- Power and performance optimization
- Quality, yield, throughput optimization
- Machine Learning/AI Applications

Scalability

- Petabytes of data
- Multi domain support
- Cloud enabled

Below are several popular SLM monitor-aware analytics use cases:

Silicon Model Calibration

Improved design optimization flow

Gap-to-Target Analysis

Voltage (V)

Accurate binning & debug

V_{min} Prediction

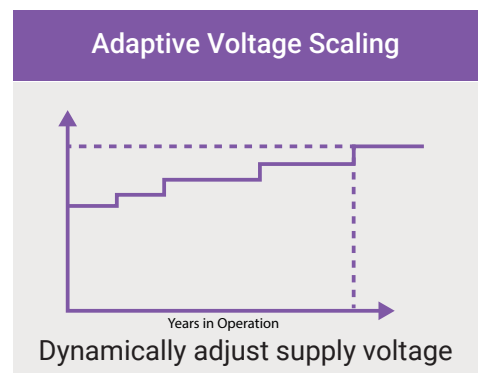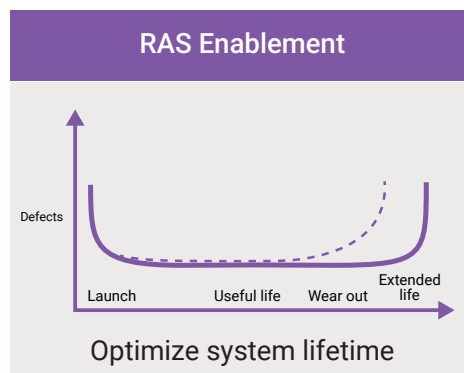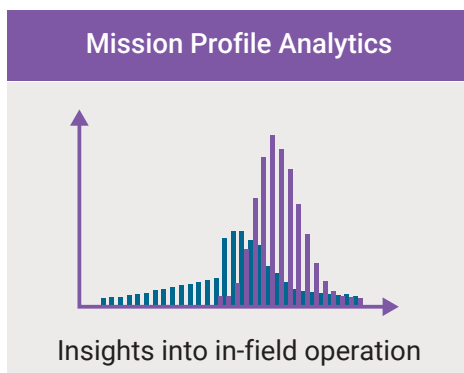Monitor driven V_{min} Prediction

SLM In-Field Analytics

Once a device is deployed into the field it is essential that it is continually monitored, tested, analyzed and potentially adapted.
On-chip or cloud-based analytics can be used for predictive maintenance, aging identification, and fault detection in order to mitigate the risk of catastrophic system failures.

Monitor data can also enable real-time analytics and optimization schemes, such as Adaptive Voltage Scaling (AVS) resulting in lower power and extend device lifetime.

Finally, cloud-based analysis of data from design, manufacturing and in-field provides powerful insights into the health of a fleet of devices, enabling better informed decisions to address root cause analysis for traceability and RMAs.

Below are some of the most popular SLM In-Field Analytics Use Cases:

Mission Profile Analytics

Insights into in-field operation

RAS Enablement

Defects

Launch Useful life Wear out Extended life

Optimize system lifetime

Adaptive Voltage Scaling

Years in Operation

Dynamically adjust supply voltage

SLM Established Tool Solutions

The Synopsys Silicon Lifecycle Management Family includes multiple integrated products and capabilities. The key components of SLM are highlighted below:

SYNOPSYS SILICON LIFECYCLE MANAGEMENT FAMILY

Cloud, On-Prem, and Edge Analytics

Design Calibration Analytics Digital Design Family	Design, Ramp, Production Analytics Silicon.da	Die Level and Package/PCB Failure Analysis Avalon	In-Field Management Optimizer

Data Store

Embedded Analytics and Communication

ATE High-Speed Access and Test, SHS	Chip IP Device Drivers	System Embedded Analytics

Silicon Monitors

Environmental PVT Monitor	Structural Path Margin Monitor, SMS, LBIST, XLBIST, MTR	Functional Clock & Delay Monitor

ML / LOCK / CLOUD

SLM and Test Synergy

Synopsys SLM and Synopsys TestMAX™ solutions encompass integrated tools, IP and methodologies to test, monitor and analyze SoCs, providing actionable insights at every phase of the device lifecycle.

These innovative test and analytics tools enable a unified flow that is securely connected to Synopsys' Fusion Design Platform for deep insights, from in-design to in-field, meeting design, test, and operational goals concurrently for the entire lifespan of a silicon device.

Synopsys SLM

In-Ramp Optimization · In-Production Optimization · Optimized Implementation · Test Generation · In-Design Optimization · DET Architecture Optimization · Silicon Diagnosis · In-Field Optimization

Synopsys TestMAX

For additional information on Synopsys Silicon Lifecycle Management and Synopsys TestMAX solutions, please visit our website or contact us.