



“Photons & Qubits” Design Solutions for Photonic ICs and Quantum Computers

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Change Occurring in Many Markets



Demand for
Smart Everything
seems limitless

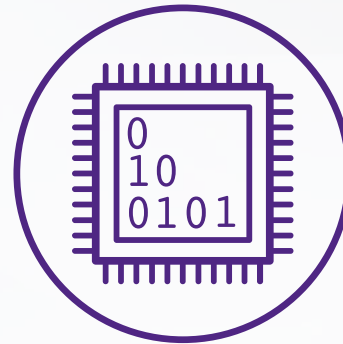
Innovation is fueled by
semiconductor and software
advances

Driven by fusion of big data,
massive compute,
and machine learning

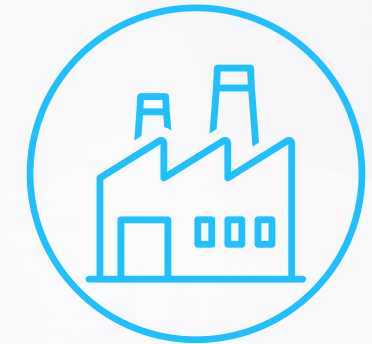
Macrotrends



Software Drives
Differentiation

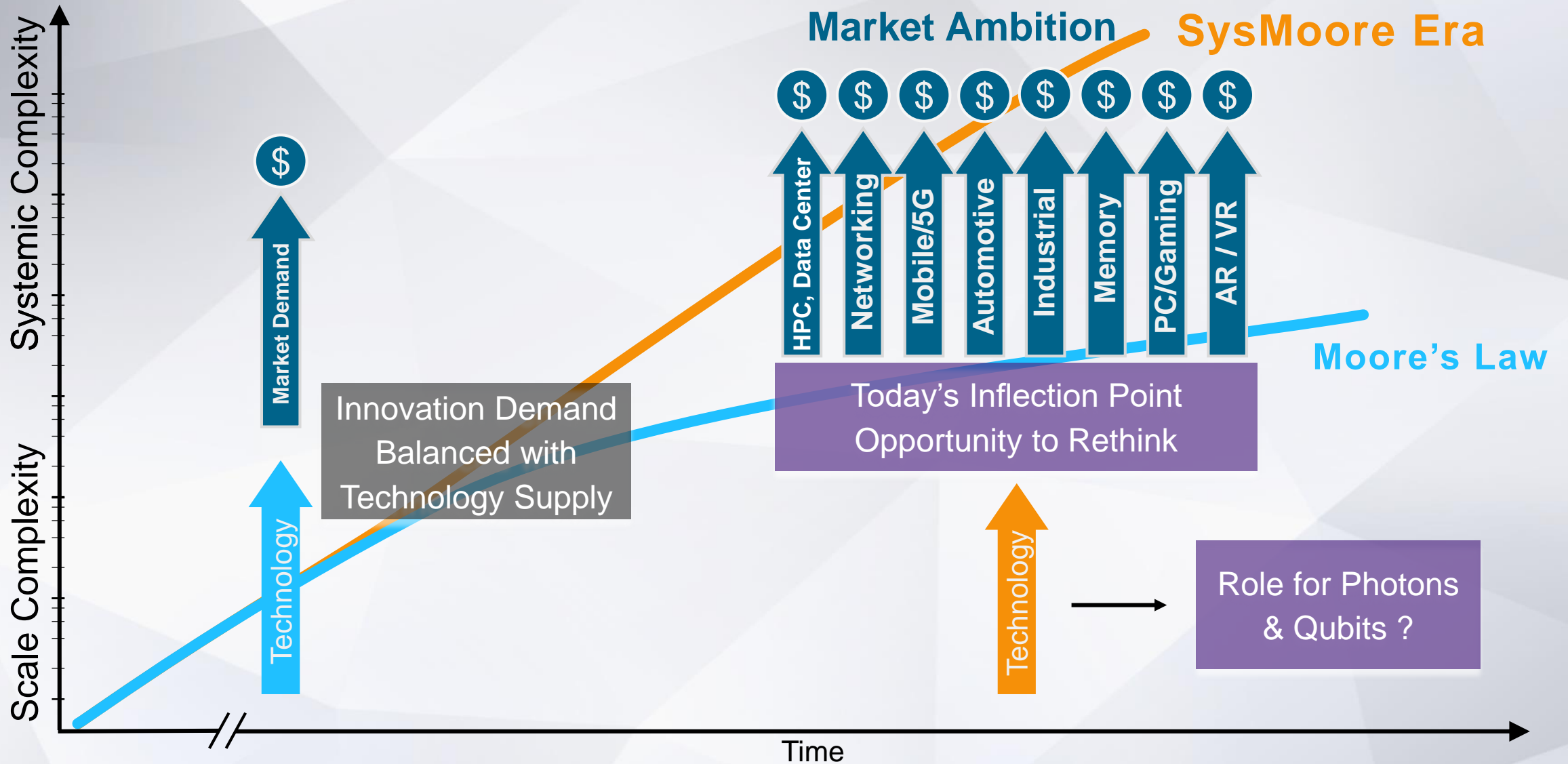


Chips Make This
Possible

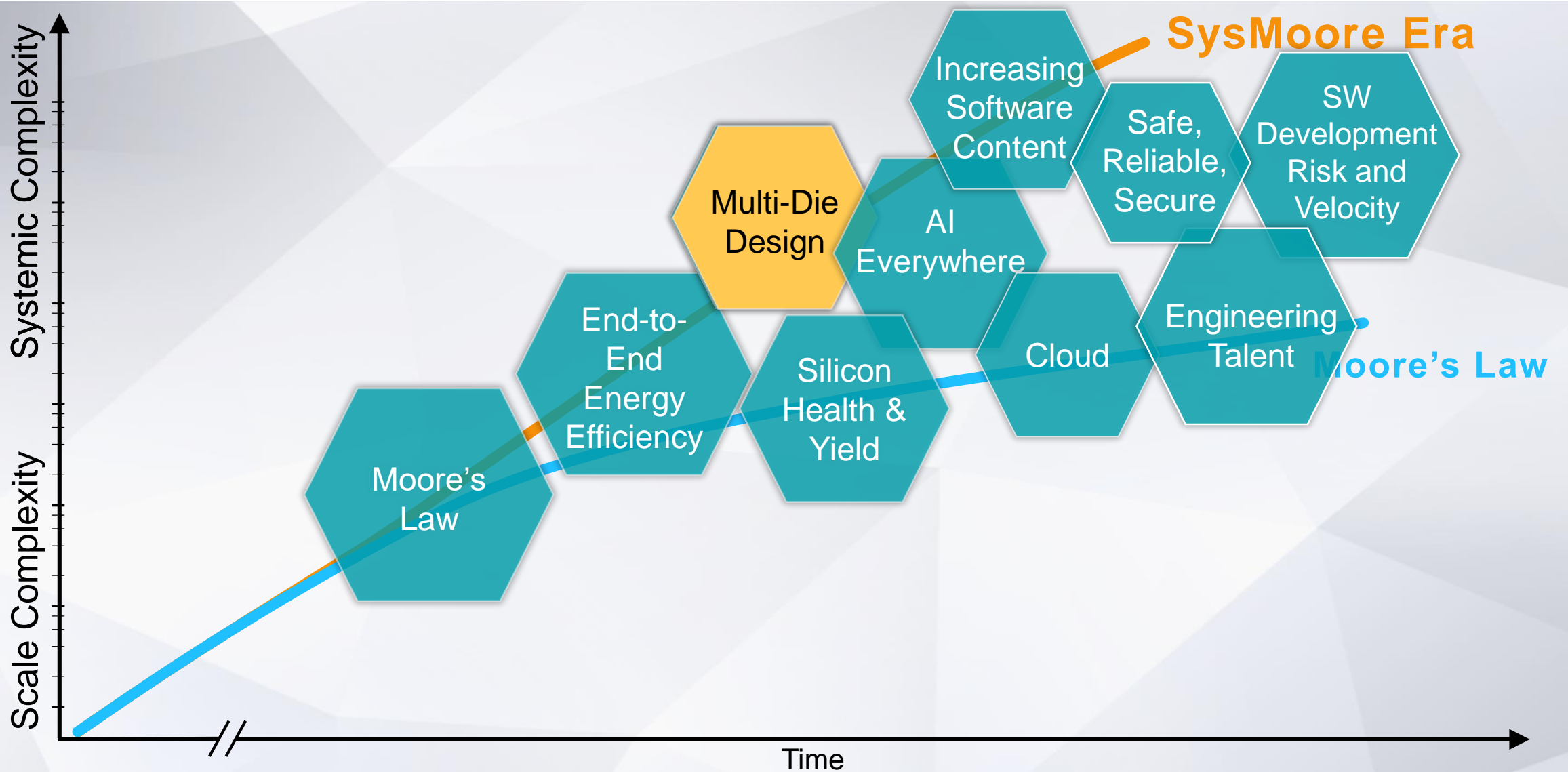


Optimized Software
& Chip Development
Key to Success

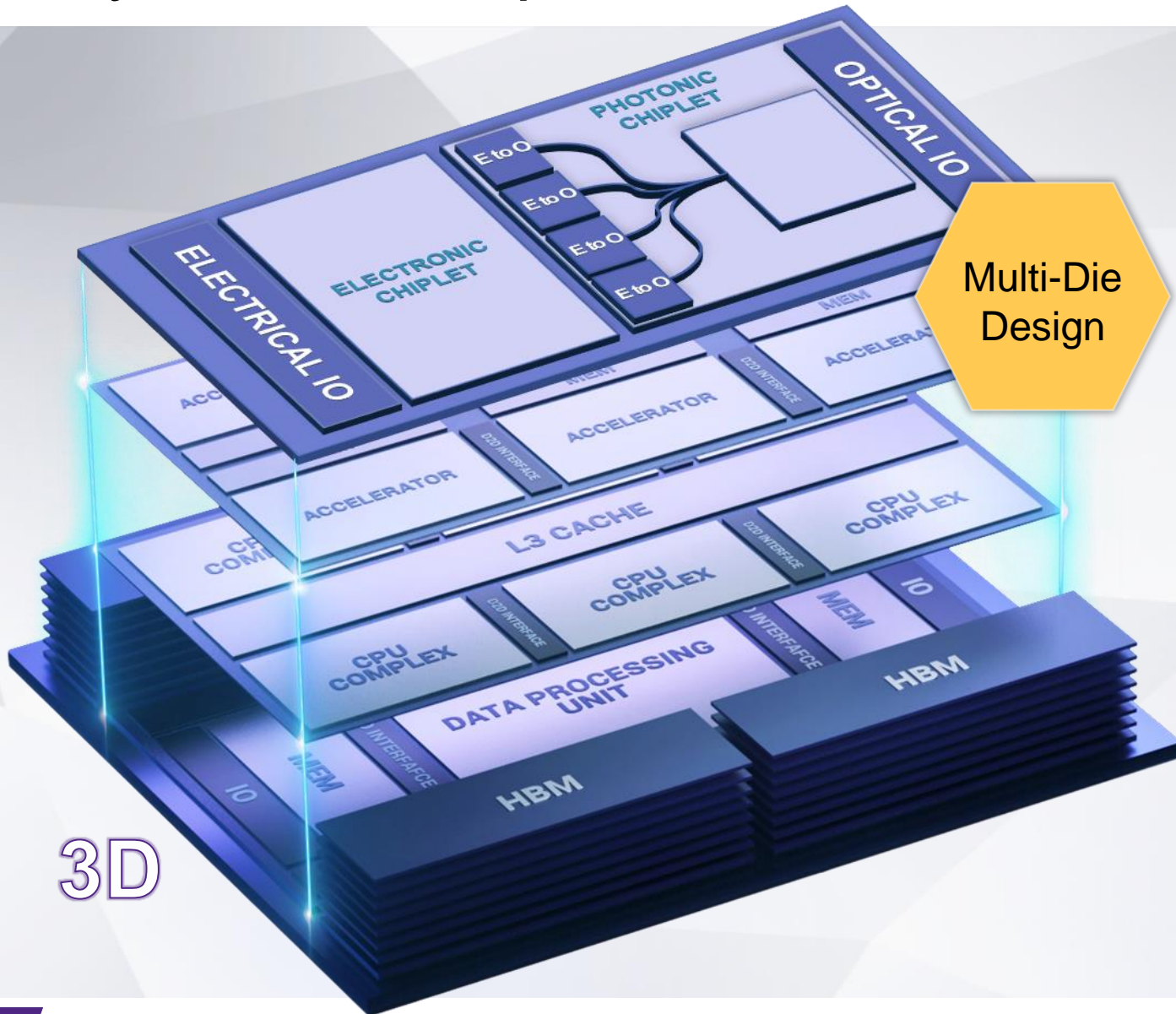
Changing Market Dynamics



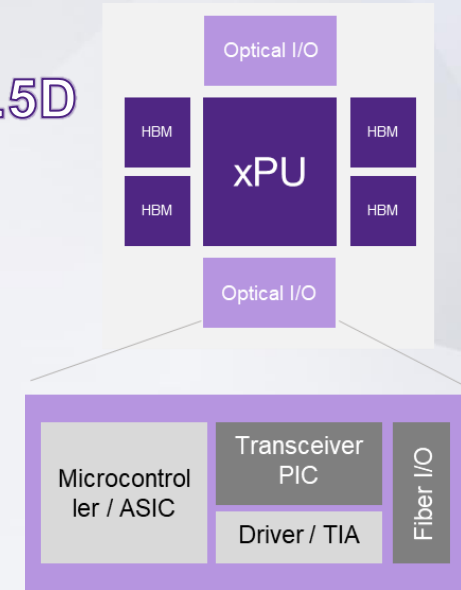
Techonomic Disruptors in SysMoore Era



System-of-Chips



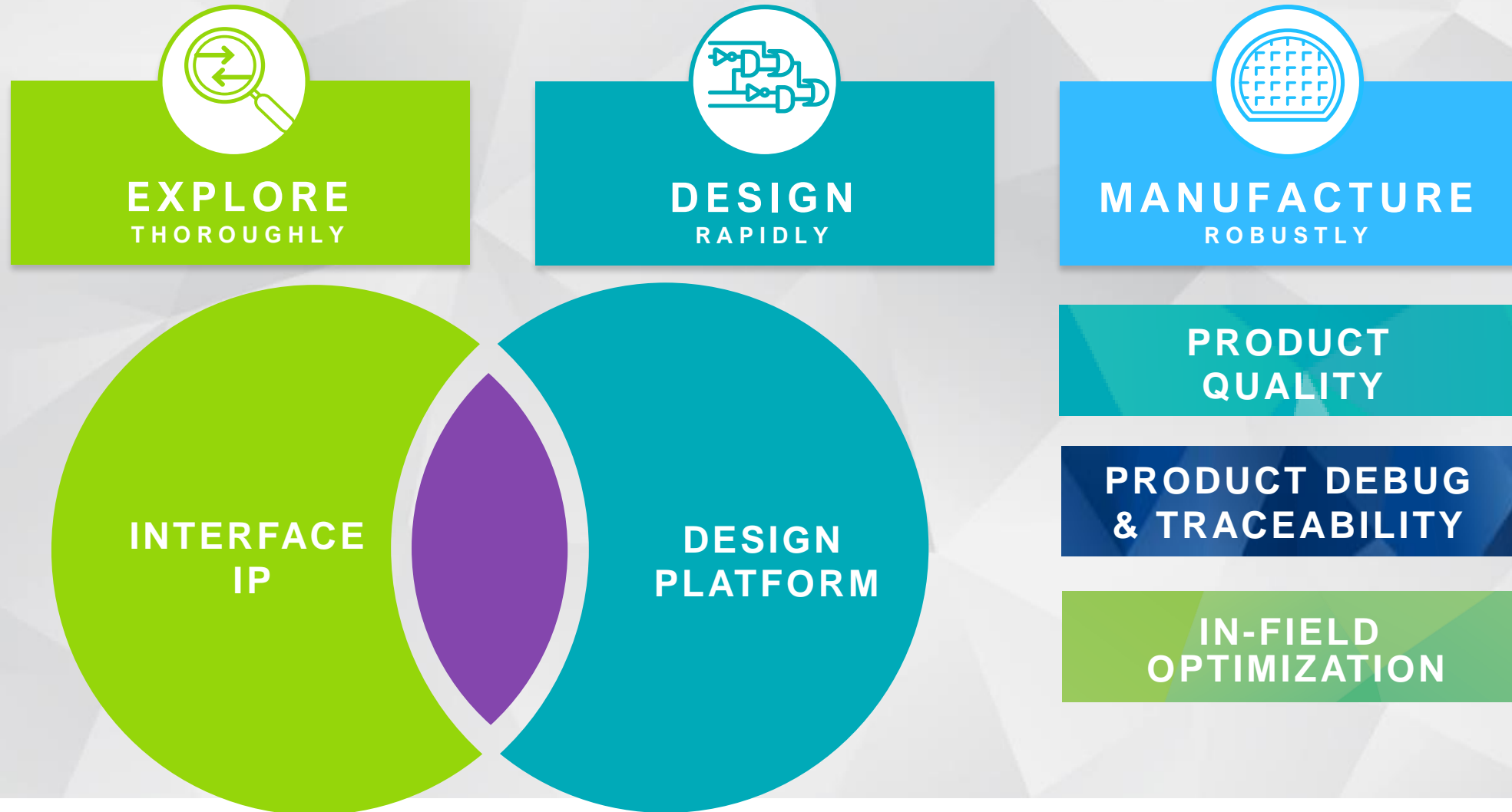
2D/2.5D



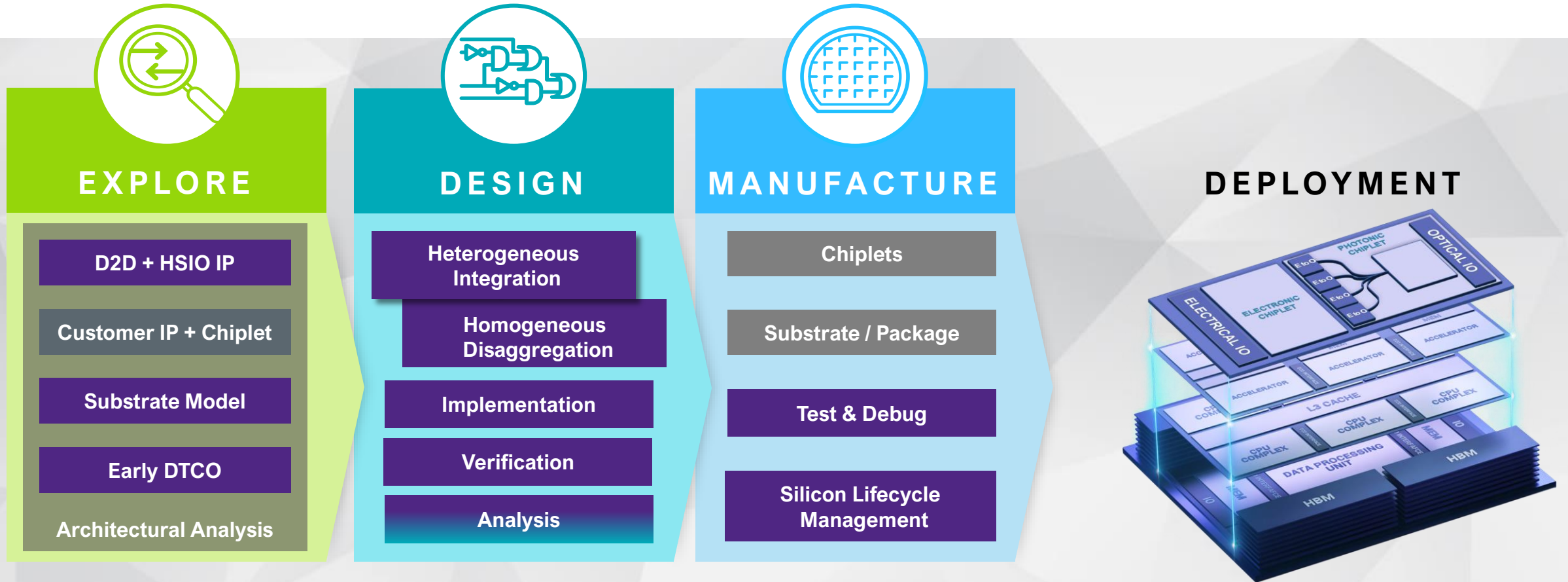
Electronics & Photonics
Two sides of the same coin

Digital + Analog + Photonic

System-of-Chips Innovators' Journey

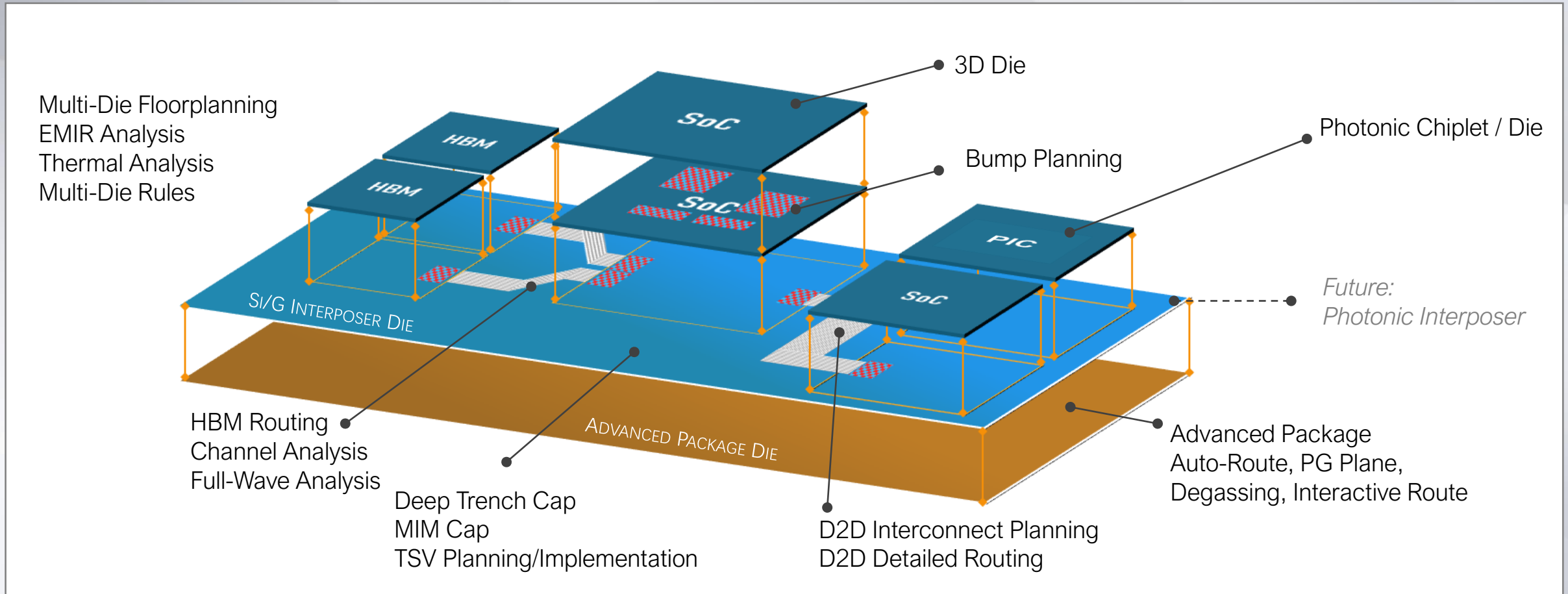


System-of-Chips EDA Methodology

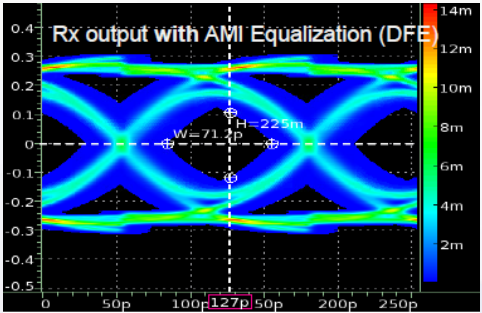
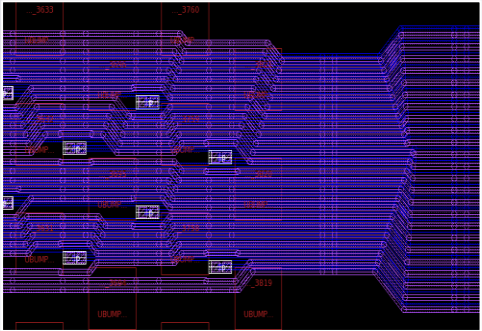
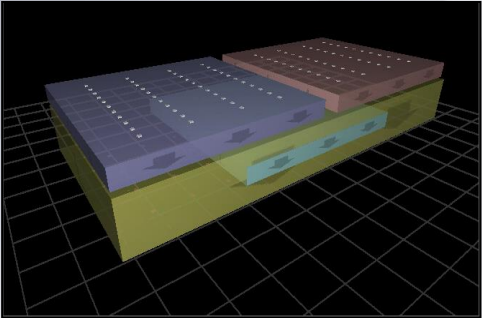


KEY: Synopsys Technology

Multi-die / Multi-domain System Implementation



3D Design Platform



3D Pathfinding

3D Design Architecture

Place & Route

Test

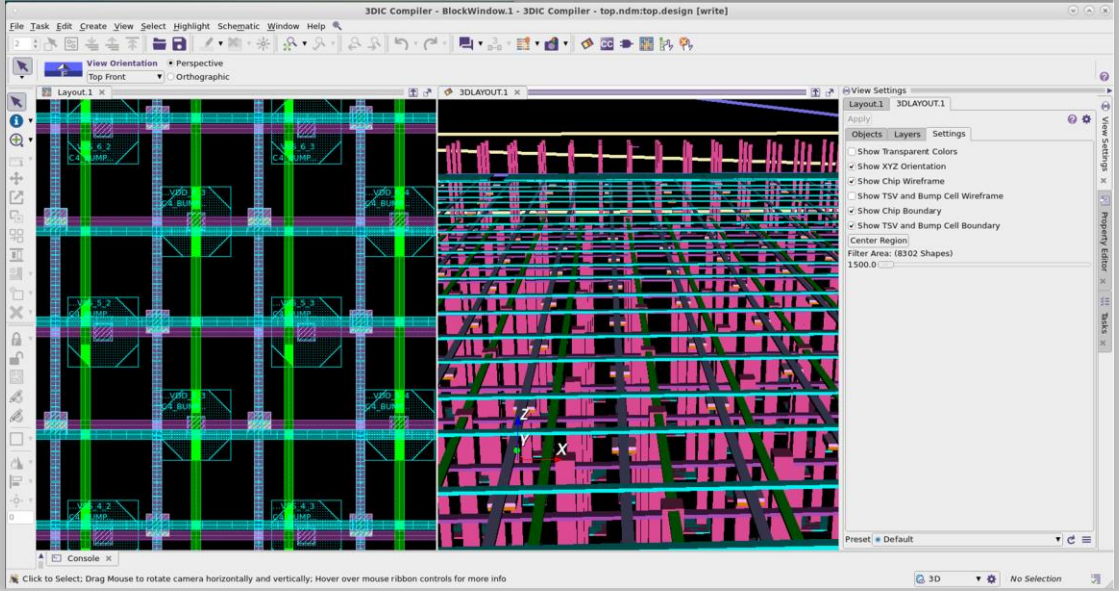
Extraction

Signal & Power Integrity

Thermal Integrity

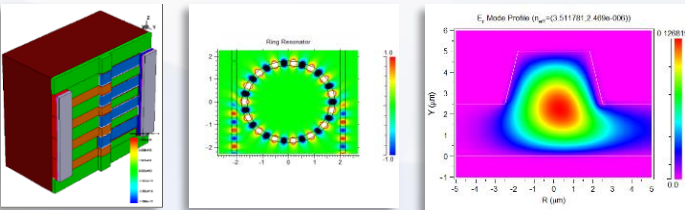
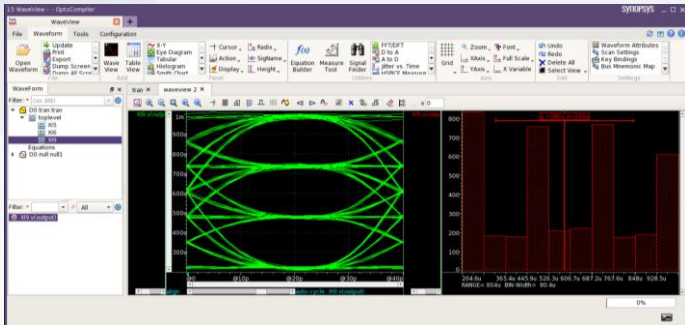
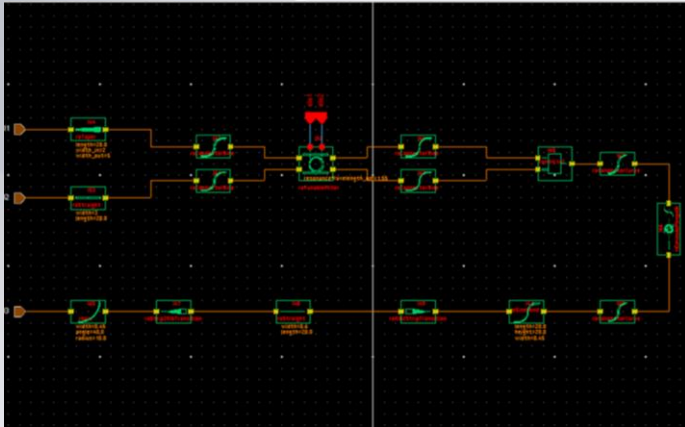
Timing Analysis

Physical Verification



Synopsys 3DIC Compiler

Electronic & Photonic IC Co-Design Platform



Schematic

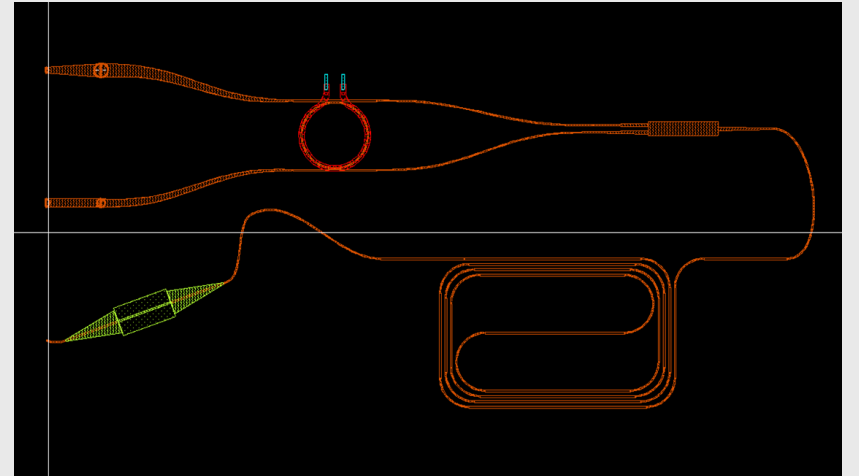
Layout

Simulation

Physical Verification

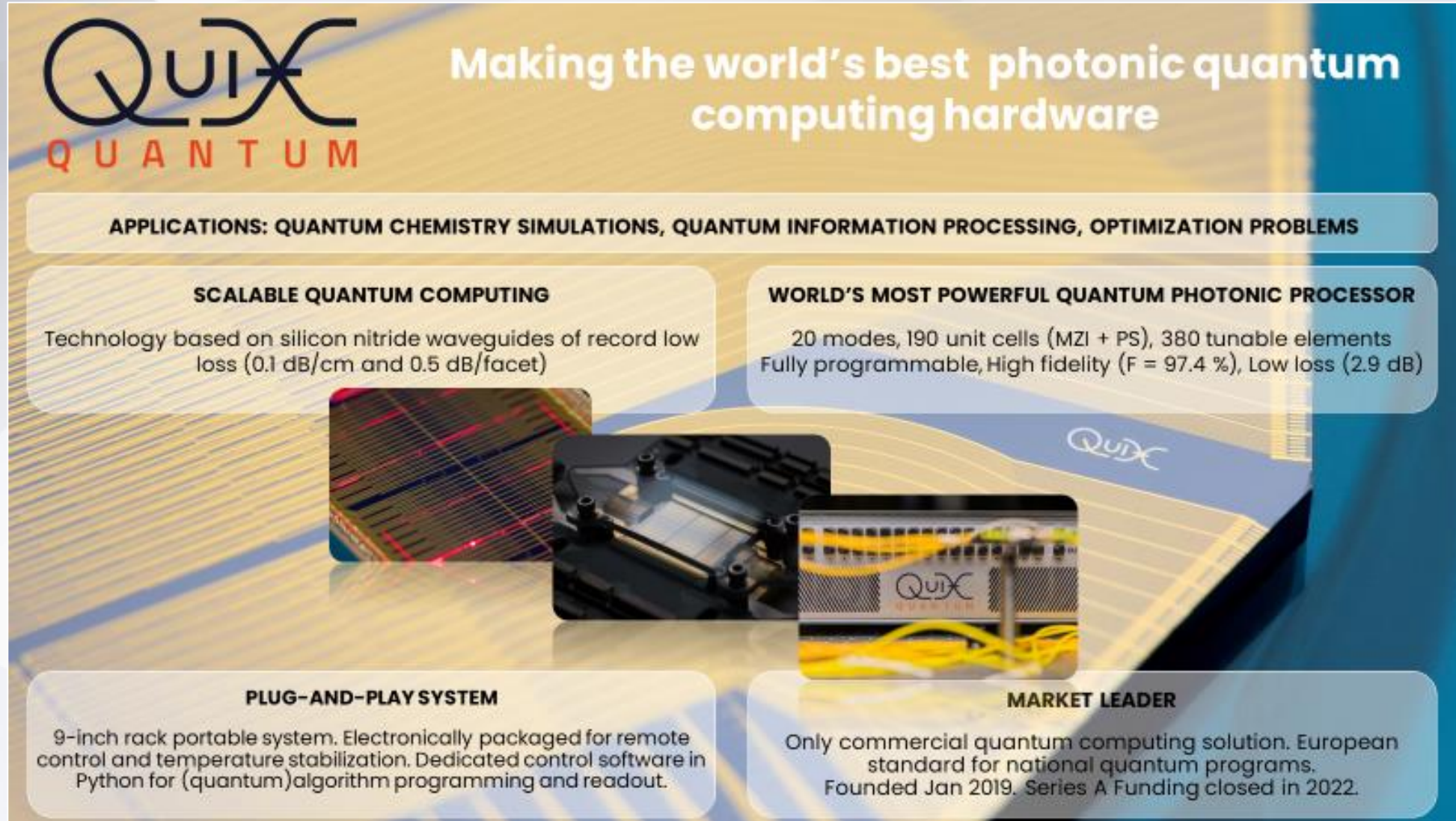
Extraction

Device design



Synopsys OptoCompiler, OptSim, PrimeSim, Photonic Device Compiler, IC Validator, StarRC

Quantum Computing based on Photonic ICs



QUIX QUANTUM

Making the world's best photonic quantum computing hardware

APPLICATIONS: QUANTUM CHEMISTRY SIMULATIONS, QUANTUM INFORMATION PROCESSING, OPTIMIZATION PROBLEMS

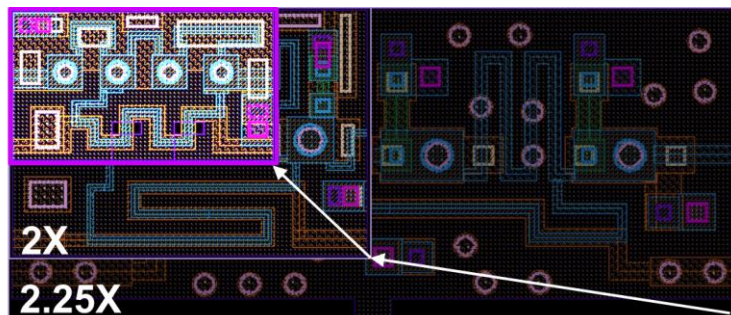
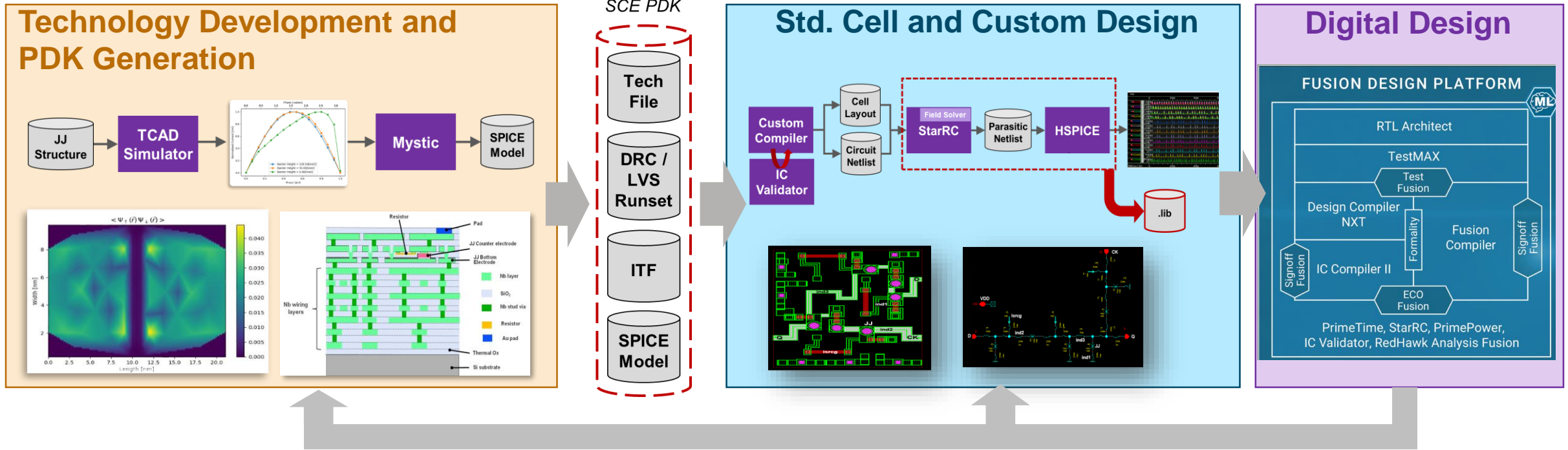
SCALABLE QUANTUM COMPUTING
Technology based on silicon nitride waveguides of record low loss (0.1 dB/cm and 0.5 dB/facet)

WORLD'S MOST POWERFUL QUANTUM PHOTONIC PROCESSOR
20 modes, 190 unit cells (MZI + PS), 380 tunable elements
Fully programmable, High fidelity (F = 97.4 %), Low loss (2.9 dB)

PLUG-AND-PLAY SYSTEM
9-inch rack portable system. Electronically packaged for remote control and temperature stabilization. Dedicated control software in Python for (quantum)algorithm programming and readout.

MARKET LEADER
Only commercial quantum computing solution. European standard for national quantum programs.
Founded Jan 2019. Series A Funding closed in 2022.

Superconducting Electronics (SCE) TCAD & EDA Flow Developed Under The IARPA sponsored SuperTools Program: A Comprehensive Flow for DTCO of Superconducting Technologies and Circuits



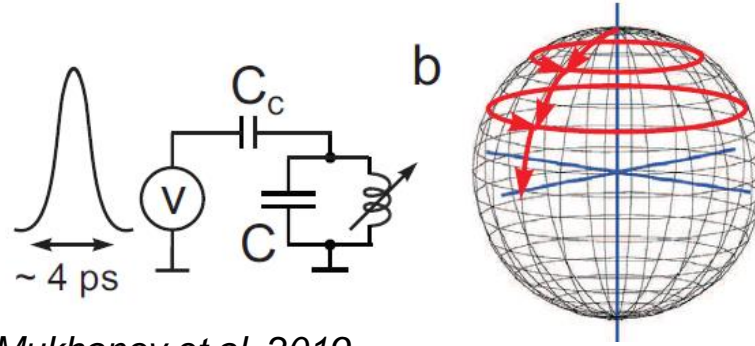
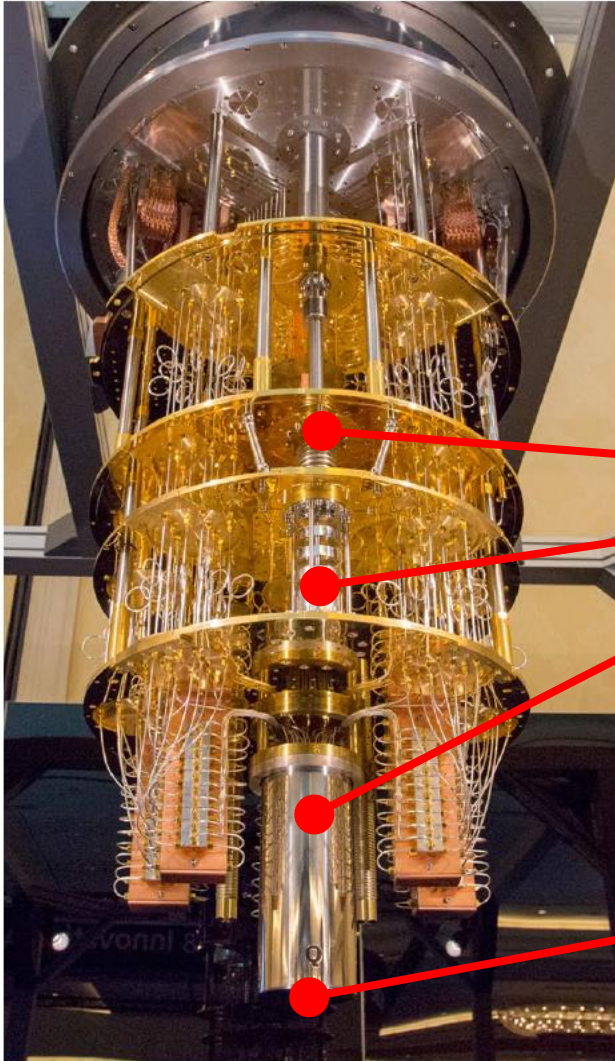
Source: S. Tolpygo, et al., MIT LL, EUCAS 2017

DTCO flow supports scaling of SCE technologies to achieve higher functionality

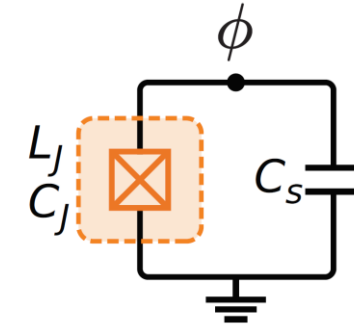
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Provides foundation for new solutions to address Quantum Computing superconducting designs

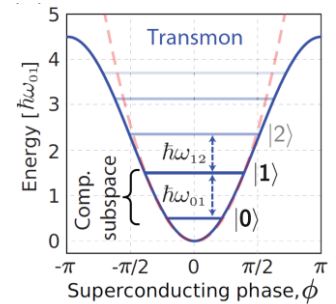
Synopsys Activity: Extend SuperTools Flow to Support Optimization of Superconducting-Based Quantum Hardware



Mukhanov et al, 2019

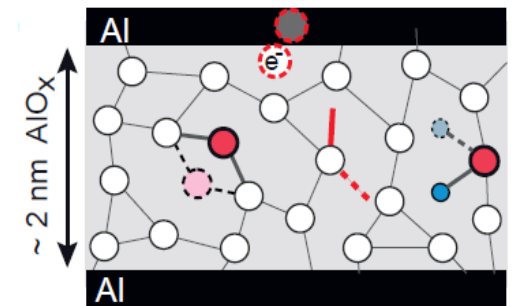
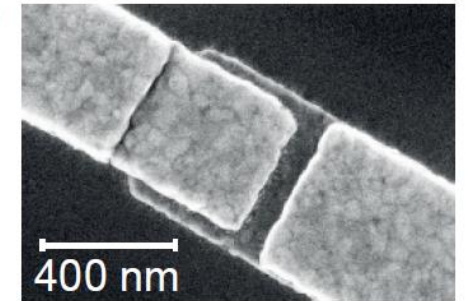


Krantz et al, 2019



Design of superconducting and cryo-CMOS qubit control and read out interface circuits

Design, noise modeling and manufacturing optimization of superconducting qubits



Müller et al, 2019

Thank You



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Silicon to Software[™]