Multi-programming

An overview on Parallel Processing with Silicon, Graphics and Quantum Chips

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March 2023

Outline of Talk

1 Introduction

2 Basics of Parallel Processing

3 Compute Architectures

4 Quantum Architecture

5 References

Overview of Coverage I

- Basics of Parallel Processing

  Multi-programming, Multi-core Programming
- Computing Core Types

  CPU - Central Processing Unit
  GPU - Graphics Processing Unit

  QPU - Quantum Processing Unit
- Complexity of Solution

  Complexity of implementation with CPU, GPU, QPU
- Scalability of Architecture

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Types of parallel processing

- Single Instruction, Single Data (SISD)
- Multiple Instruction, Single Data (MISD)
- Single Instruction, Multiple Data (SIMD)
- Multiple Instruction, Multiple Data (MIMD)
- Single Program, Multiple Data (SPMD)
- Massively Parallel Processing (MPP)

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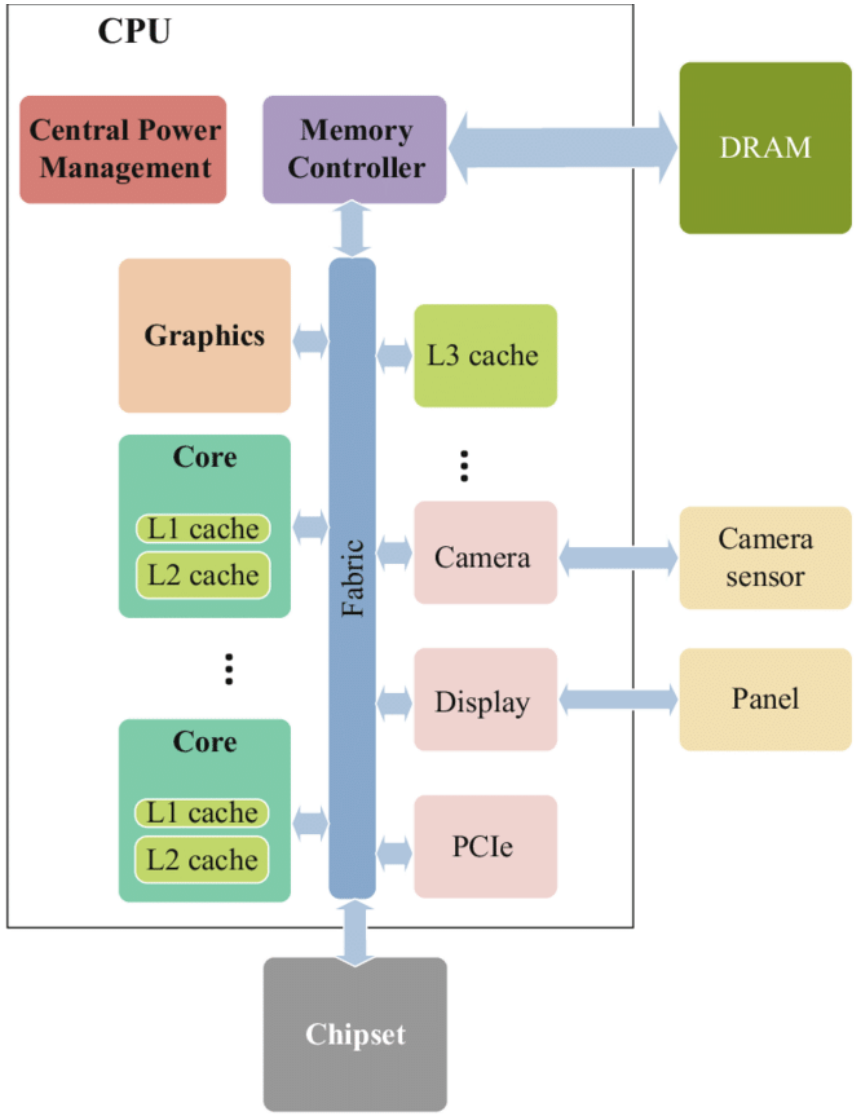
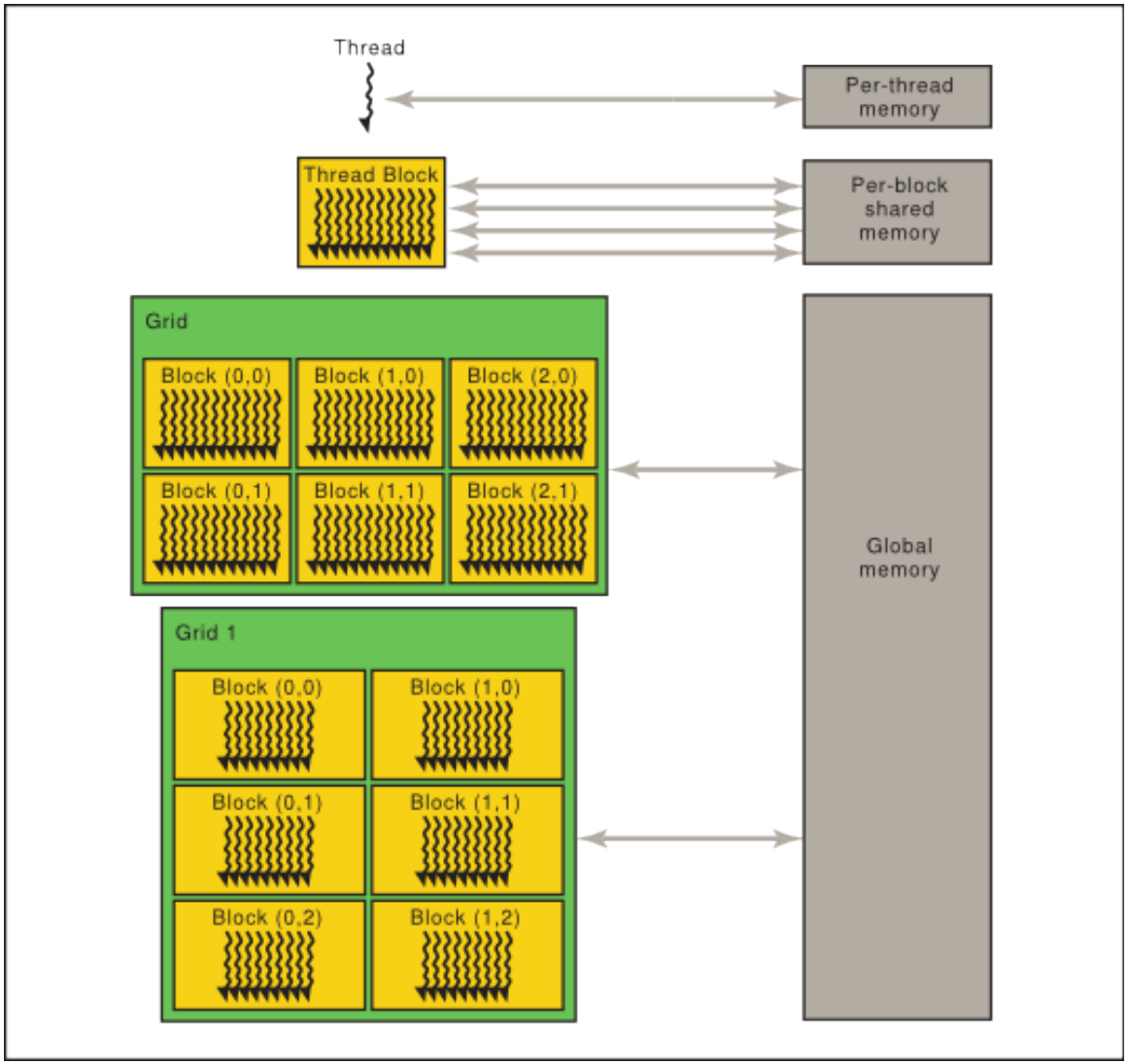
CPU - Central Processing Unit



GPU - Graphics Processing Unit I



GPU - Graphics Processing Unit II

CPU	GPU
<100 (typically 4 to 8) cores	100s or 1000s of cores
Low latency	High Throughput
Serial Processing	Parallel Processing
Quick for Interactive Tasks	Breaks jobs into separate tasks to process simultaneously
Traditional Program for sequential execution	Requires Additional software to convert CPU function to GPU functions

More details at - **link 1** , **link 2** , **Sample Code**

GPU - Graphics Processing Unit III

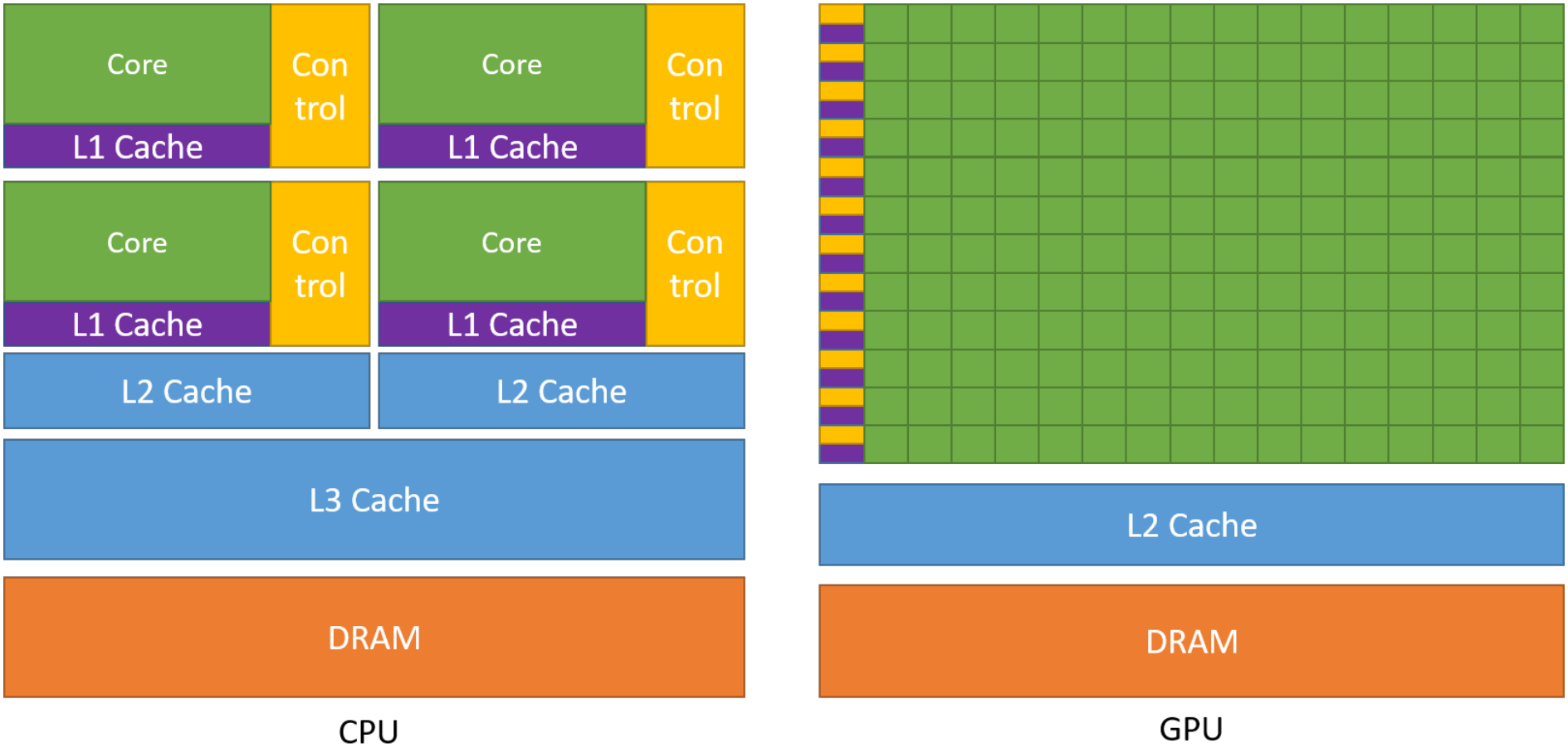


Figure: Block Diagram of Memory Architecture of CPU and GPU

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Quantum Mechanics at the core of what we use on everyday basis –

- **Qiskit - Quantum Isn't Spooky.**

QPU - Quantum Processing Unit

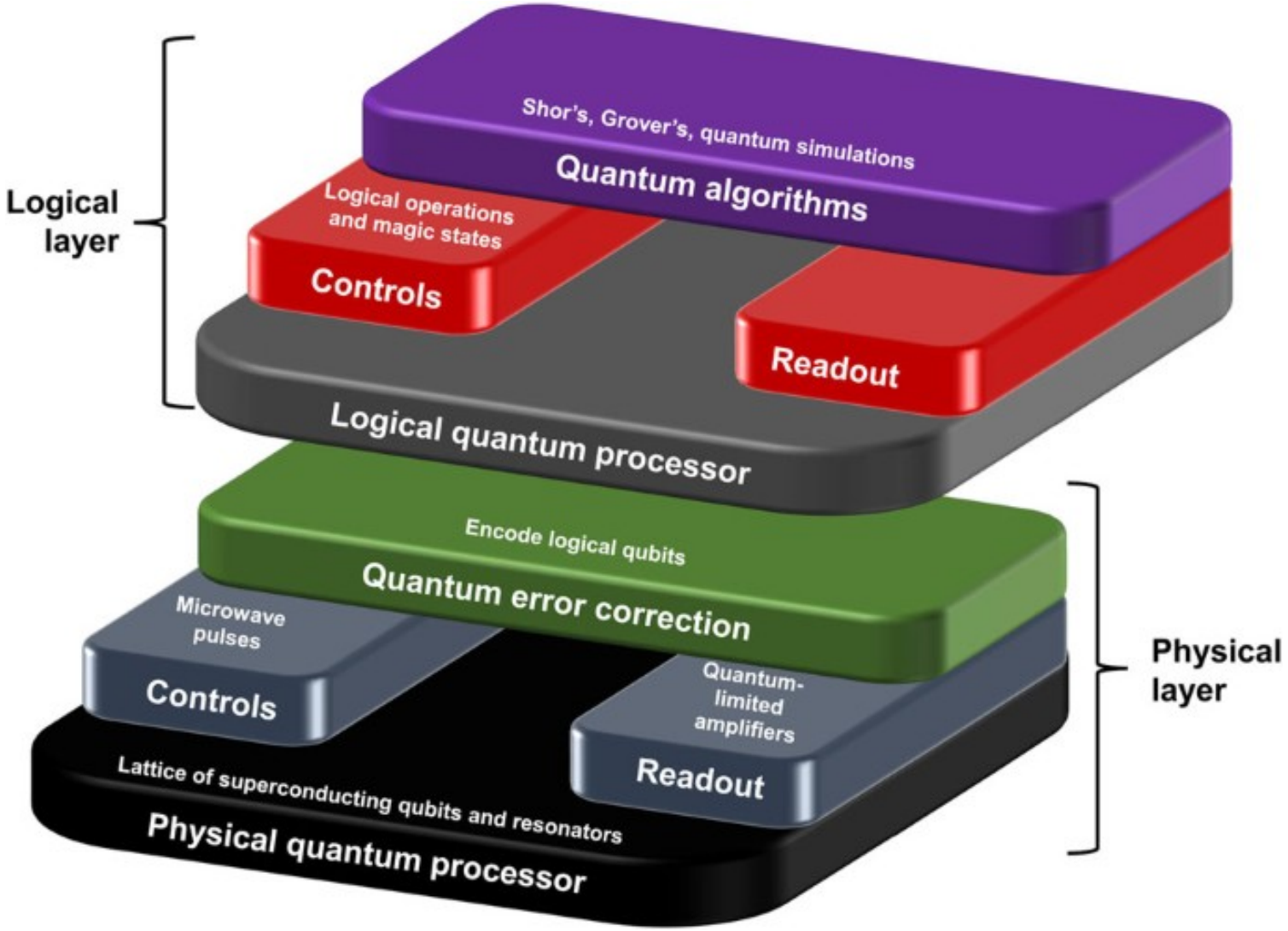

Figure: Layers of Quantum Computing

Quantum Roadmap I

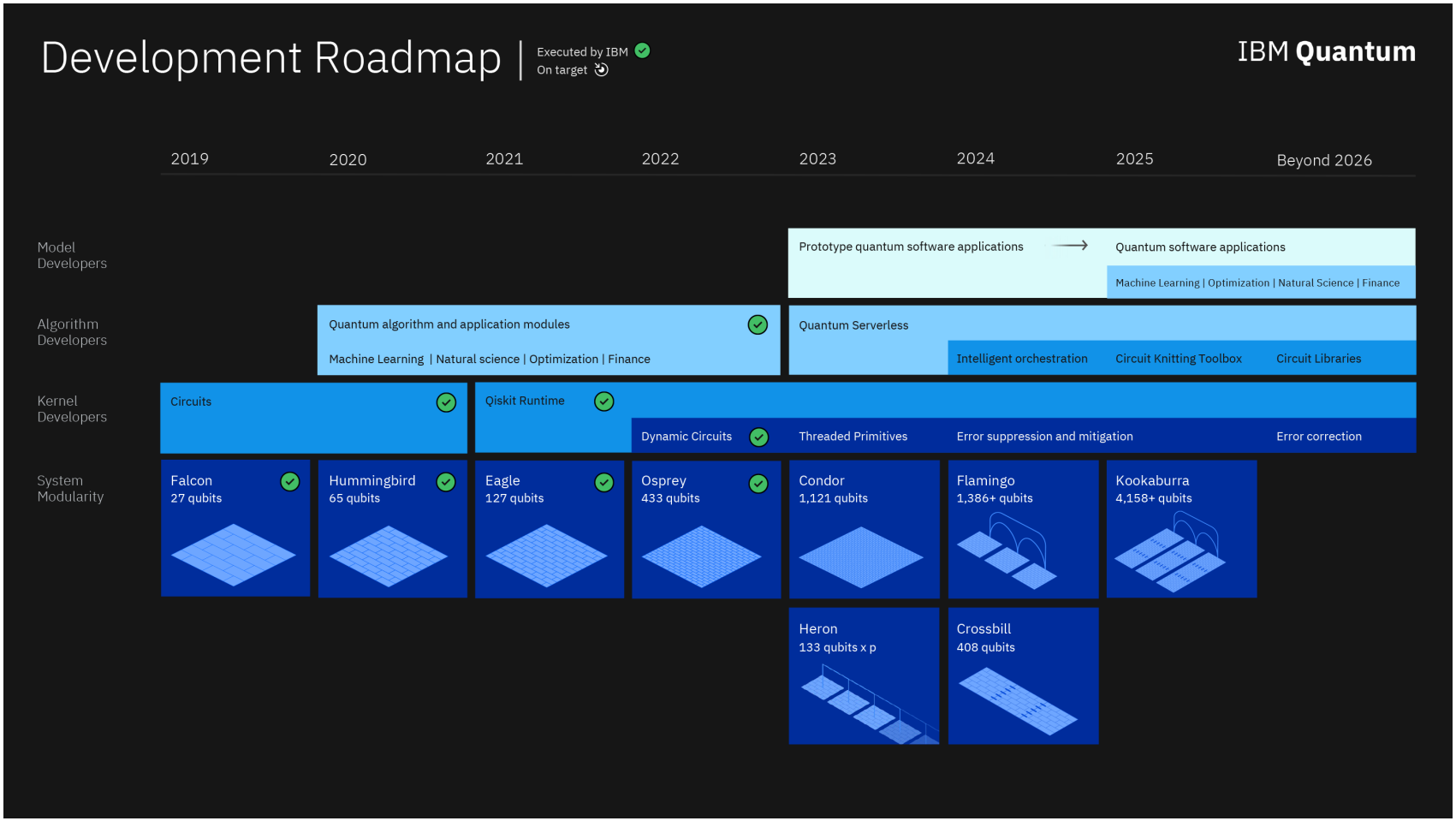

Figure: IBM Quantum Development Roadmap

Applications Require Massively Parallel Computation I

- **Optimization**
  - systems design
  - airline scheduling
- **Machine Learning**
  - Improving forecast capability with neural network
  - learn to recognize essences of objects by recognizing patterns in huge amount of data
- **Biomedical Simulations**
  - simulate molecular structures
- **Financial Services**
  - complex financial modeling and risk management within the financial industry

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References

- Multicore Programming
- Quantum Computing Expert Explains One Concept in 5 Levels of Difficulty | WIRED
- Quantum Computers Explained in a Way Anyone Can Understand
- Quantum Computing 2022 Update