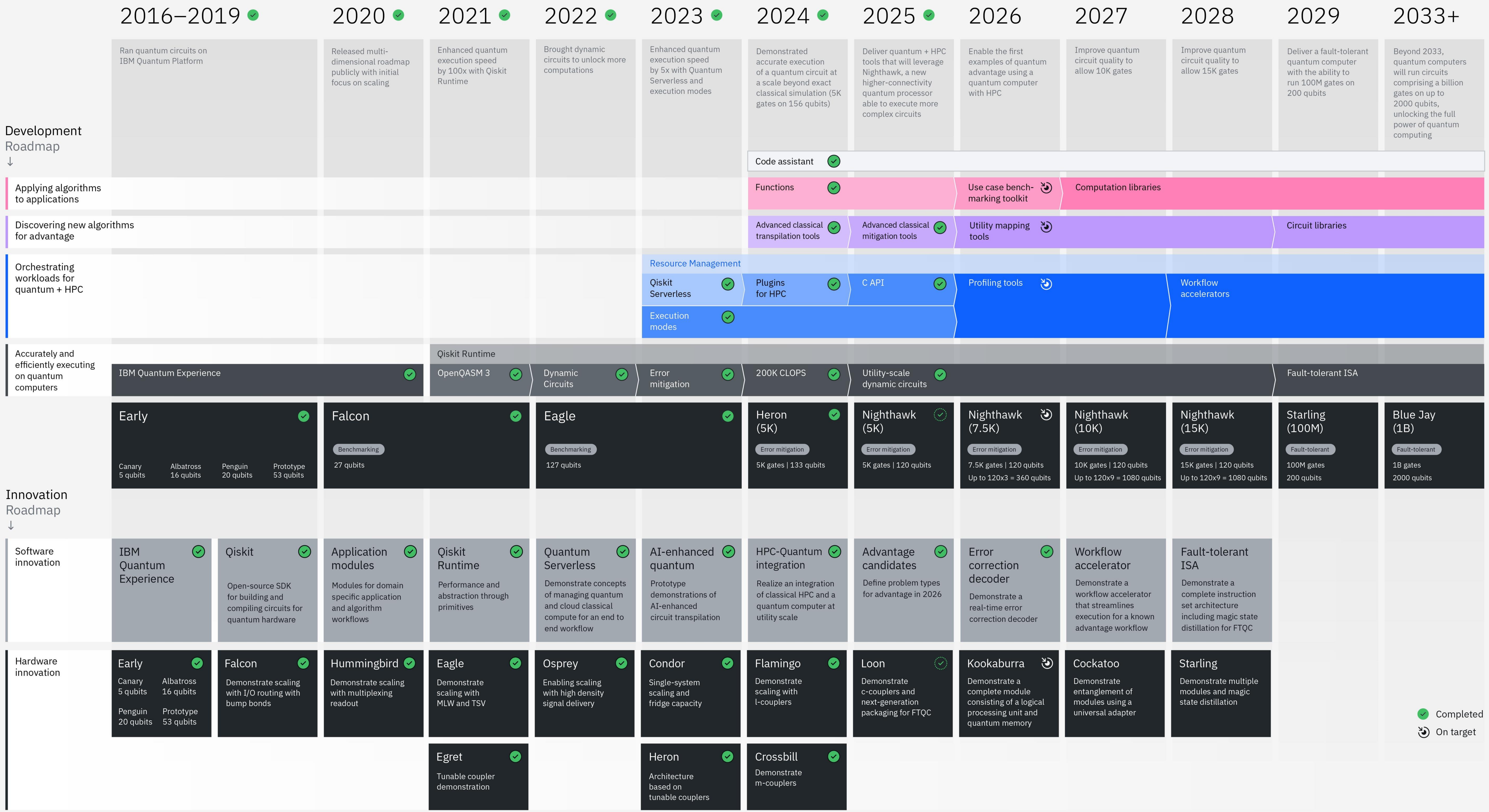
IBM Quantum Roadmap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Deliver quantum + HPC tools that will leverage Nighthawk, a new higher-connectivity quantum processor able to execute more complex circuits
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Qiskit Serverless
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C API
Profiling tools
Workflow accelerators
Execution modes
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Qiskit Runtime
IBM Quantum Experience
OpenQASM 3
Dynamic Circuits
Error mitigation
200K CLOPS
Utility-scale dynamic circuits
Fault-tolerant ISA
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Albatross 16 qubits
Penguin 20 qubits
Prototype 53 qubits
Falcon
Benchmarking
27 qubits
Eagle
Benchmarking
127 qubits
Heron (5K)
Error mitigation
5K gates | 133 qubits
Nighthawk (5K)
Error mitigation
5K gates | 120 qubits
Nighthawk (7.5K)
Error mitigation
7.5K gates | 120 qubits
Up to 120x3 = 360 qubits
Nighthawk (10K)
Error mitigation
10K gates | 120 qubits
Up to 120x9 = 1080 qubits
Nighthawk (15K)
Error mitigation
15K gates | 120 qubits
Up to 120x9 = 1080 qubits
Starling (100M)
Fault-tolerant
100M gates
200 qubits
Blue Jay (1B)
Fault-tolerant
1B gates
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Starling
Demonstrate multiple modules and magic state distillation
Egret
Tunable coupler demonstration
Heron
Architecture based on tunable couplers
Crossbill
Demonstrate m-couplers
Completed
On target

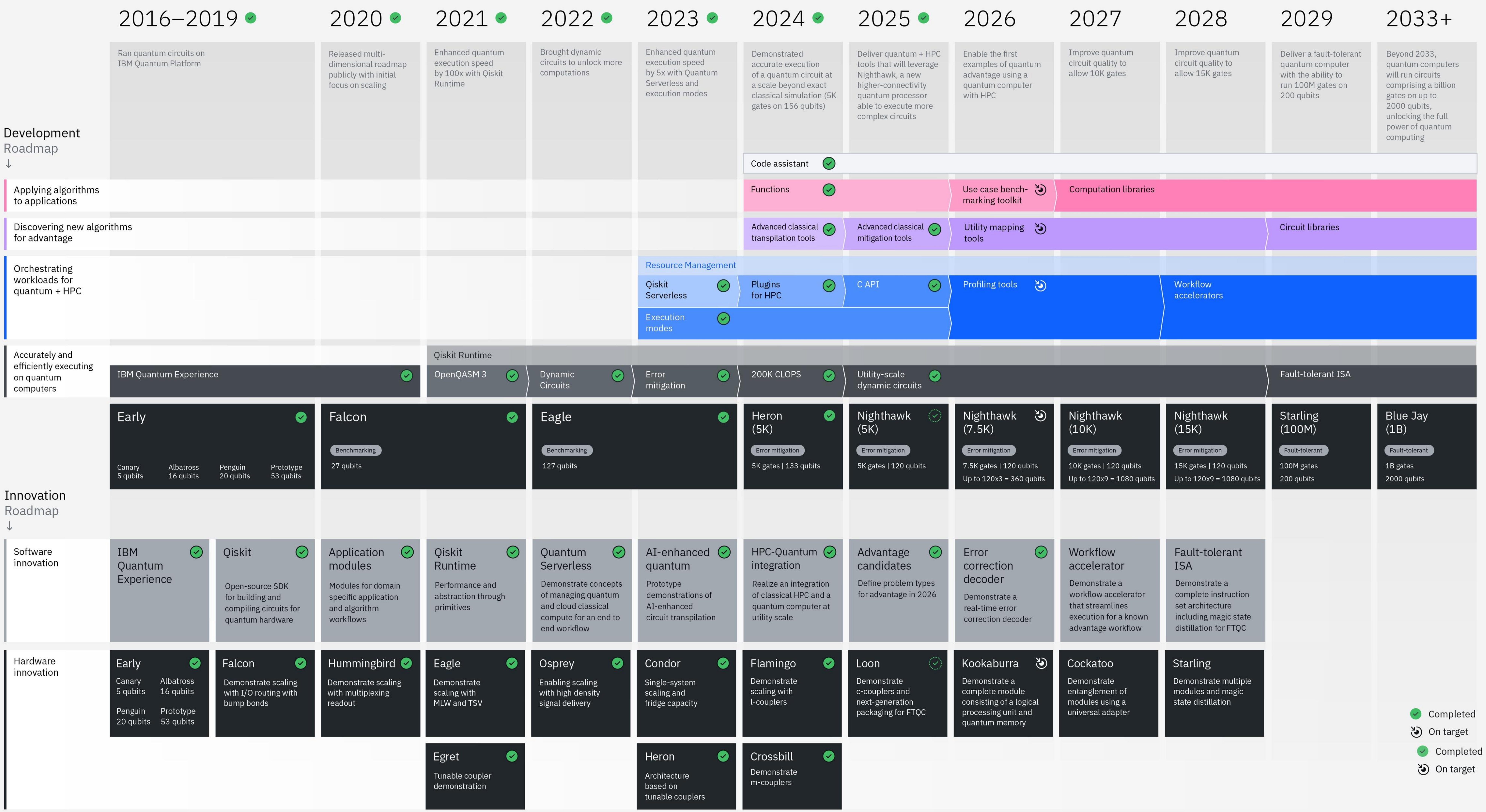
IBM Quantum Roadmap

IBM **Quantum**

Since 2020, we have tracked our plans to advance quantum computing with a public roadmap, checking off milestones as we achieved them.

In our 2023 roadmap, we committed to developing IBM Quantum Starling–the first large-scale, fault tolerant quantum computer–by 2029.

Our roadmap reflects two more years of progress toward that milestone, with the most recent updates made in October 2025.



Our roadmap is split into two parts:

Development Roadmap

Tracks the release of production hardware, software, and services delivered to users.

Innovation Roadmap

Charts the scientific breakthroughs and internal releases that underpin development milestones. Some items will remain internal proofs-of-concept, while others may evolve into future external releases.

Development Roadmap→

Development Roadmap: Hardware

IBM Quantum

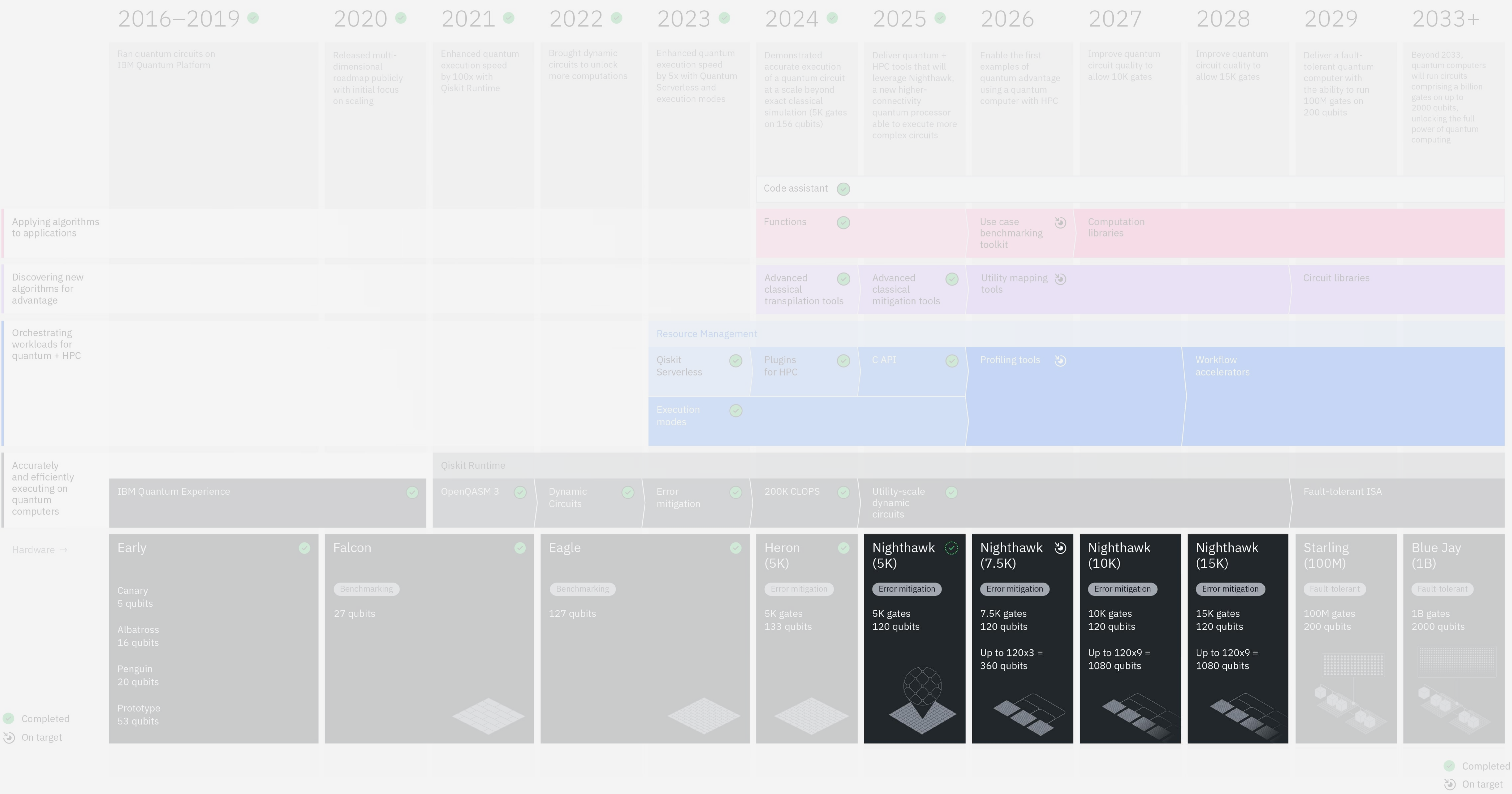
IBM Quantum Nighthawk is our platform for exploring and scaling quantum advantage ahead of large-scale fault-tolerant quantum computing.

Earlier quantum processors use a “heavy-hex” lattice, with each qubit connected to up to three neighbors. Nighthawk moves us to a square lattice, connecting each qubit to up to four neighbors.

This square lattice supports more efficient circuits, with fewer gates required for information routing. As a result, users can run more complex algorithms at the same gate scale.

Paired with techniques that reduce errors, Nighthawk is expected to run circuits with 5,000 gates by the end of 2025, 7,500 gates in 2026, 10,000 gates in 2027, and 15,000 gates in 2028.

As we improve and scale Nighthawk, we expect our team and partners to make major progress toward quantum advantages.



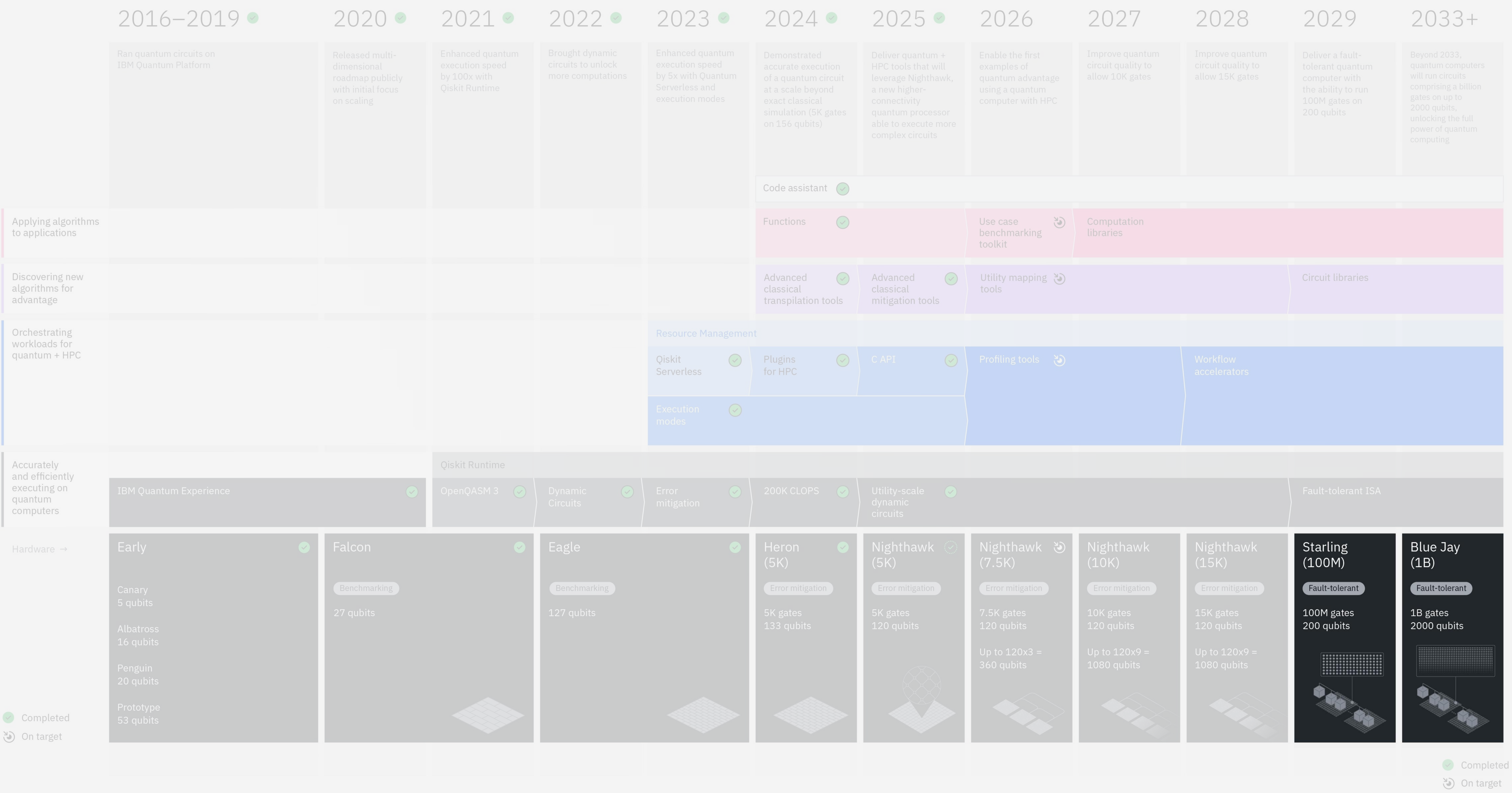
Development Roadmap: Hardware

IBM **Quantum**

At the same time, we are driving toward **IBM Quantum Starling**—a system capable of running circuits with 100 million gates on 200 qubits—and aim to debut it by 2029.

In 2033, we will debut **IBM Quantum Blue Jay**, a system capable of running circuits with a billion gates on 2,000 qubits. These large-scale fault-tolerant quantum computers will unlock a new era of algorithmic complexity and application discovery.

Developers will not need to change how they write quantum programs in this era. They will simply notice that they can run longer workloads.



Development Roadmap: Software, orchestration, and execution

IBM **Quantum**

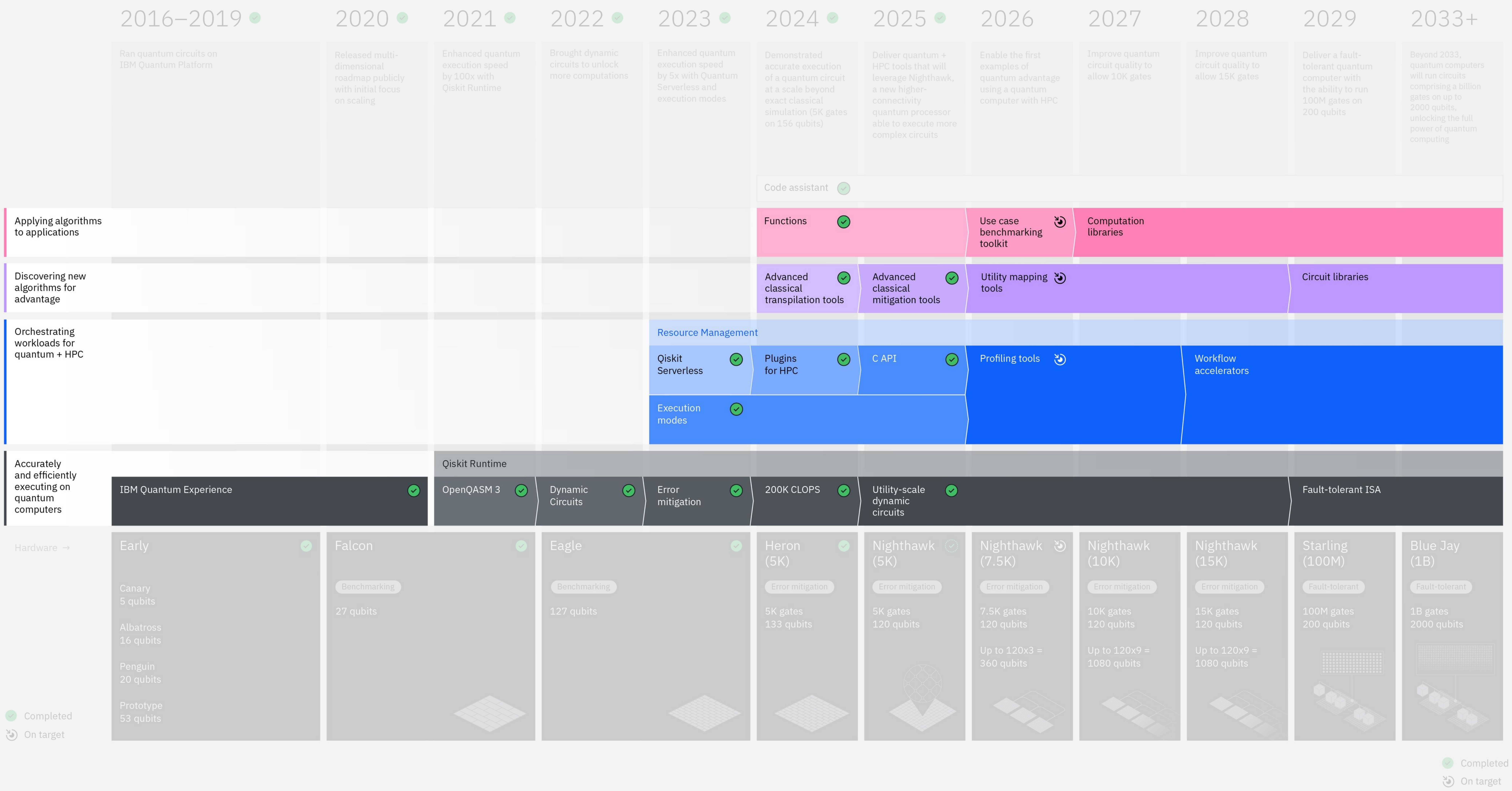
Useful quantum computing requires high-performance software. Our roadmap outlines four broad software objectives:

Apply algorithms to applications. These advances will let users adapt existing algorithms to domain-specific use cases.

Discover new algorithms for advantage. To move quickly to advantage, we must continue to improve and discover new algorithms. These advances provide a roadmap
for tools that will enable new algorithm discovery.

Orchestrate workloads for quantum & high-performance computing (HPC). No algorithms are purely quantum, and we can more efficiently scale algorithms when we leverage quantum and classical resources together. So we are developing tools to better integrate and use quantum and classical resources.

Execute accurately and efficiently. We will continue to deliver high-performance software that runs circuits accurately on our evolving quantum hardware.

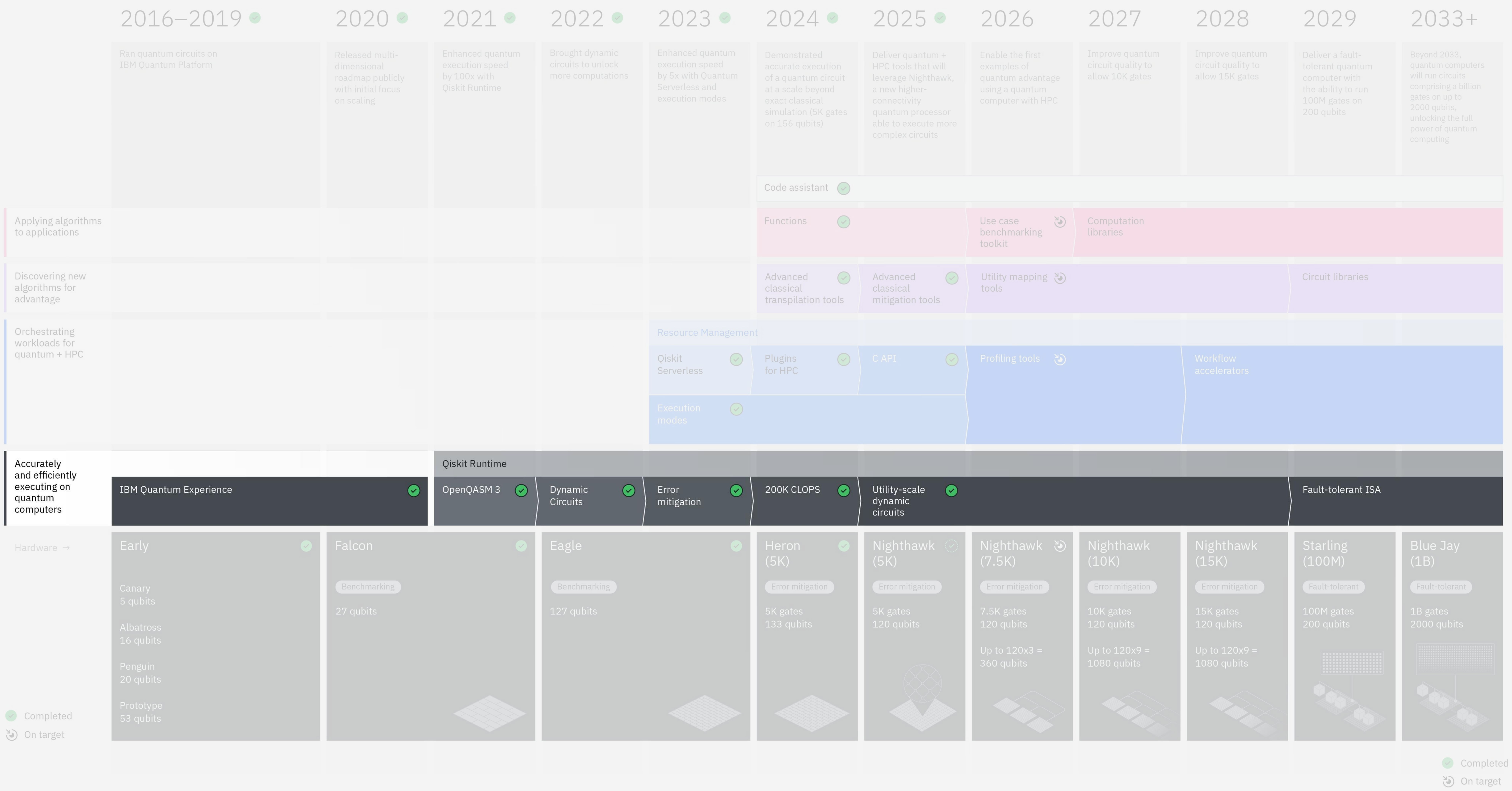


Development Roadmap: Execute accurately and efficiently

In 2025, we introduced utility-scale dynamic circuits, extending the horizon of what can be accomplished on our existing quantum computers. This will allow us to run even larger and more complex circuits, which are required to realize useful quantum computing.

The work continues, even after a box is checked off on our roadmap. We will continue to deliver improvements to dynamic circuits, error mitigation, and speed in the coming years, further extending the capabilities available to our users.

IBM **Quantum**



IBM **Quantum**

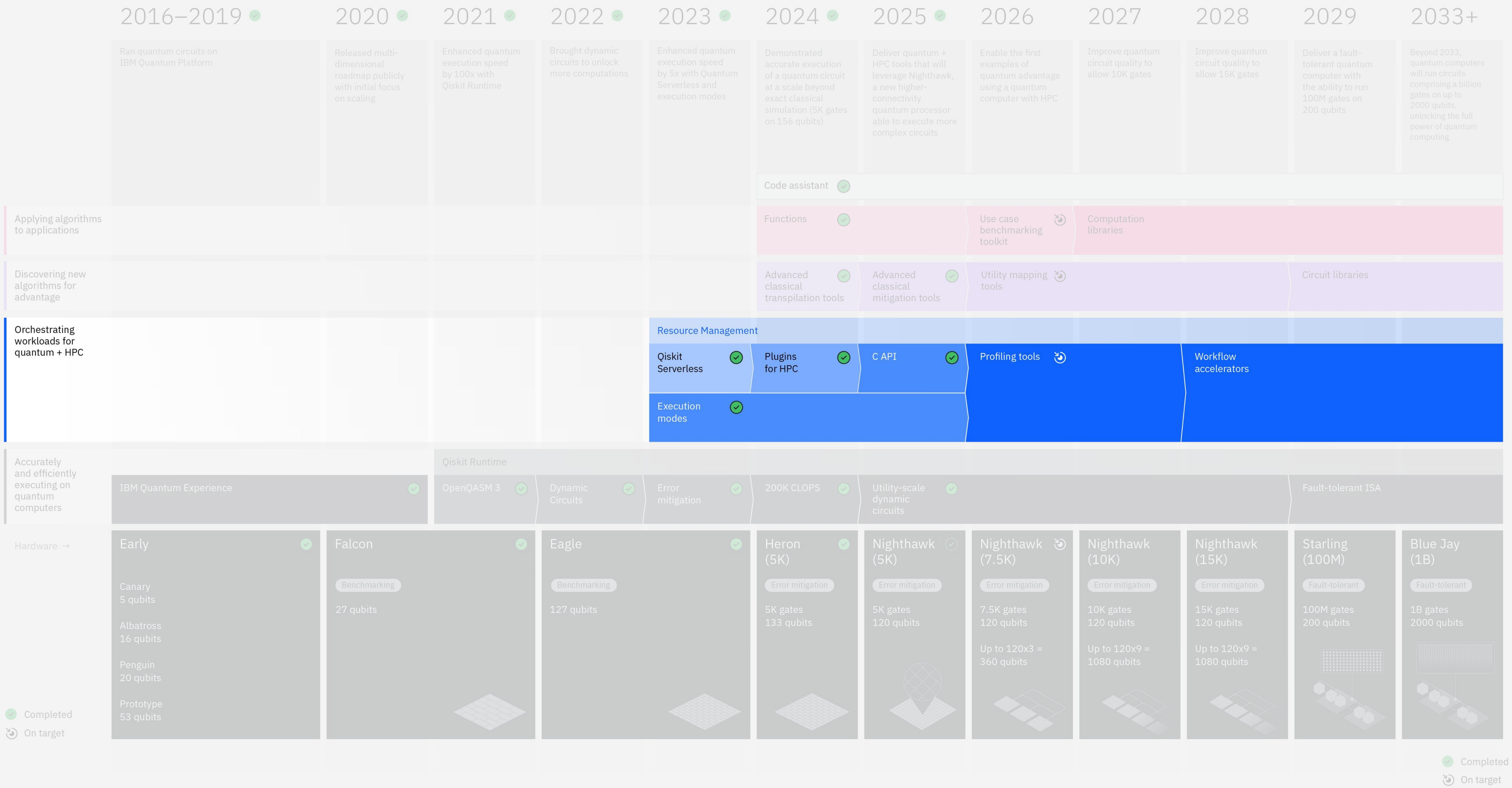
Development Roadmap: Orchestrating workloads for quantum & HPC

Running quantum workloads requires infrastructure that coordinates quantum resources with scalable classical resources.

In 2025, we released the C-API, enabling users to write Qiskit code in C, which is widely used for HPC. Soon, users will be able to write quantum and classical code in the same language and deploy it in an integrated system.

Moving into 2026 and beyond, we will introduce new profiling tools to help users monitor, verify, and debug workloads across quantum and classical resources.

In 2027 we will introduce workflow accelerators that deliver optimized quantum-classical execution pipelines for efficiently running similar tasks.



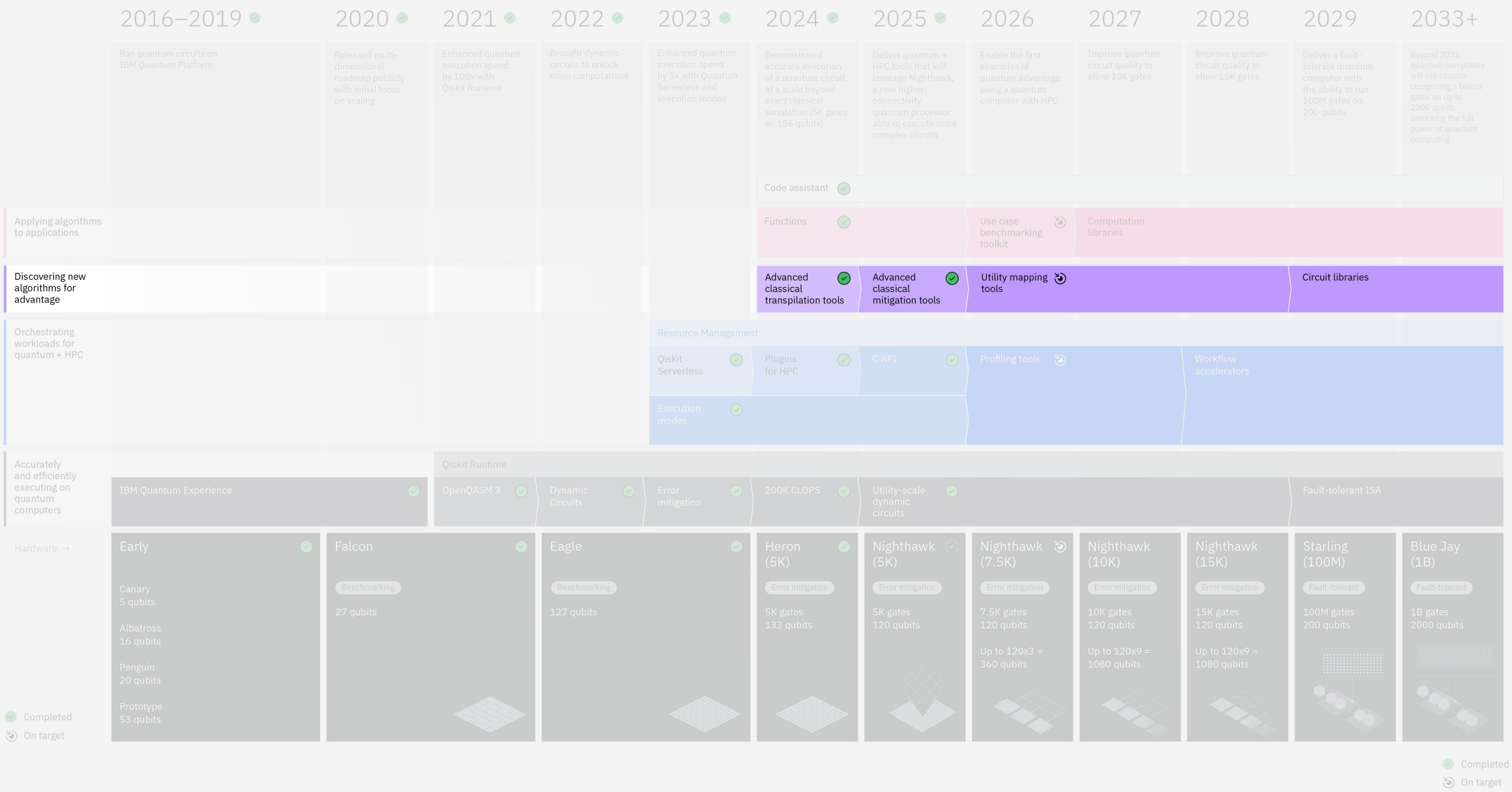
Development Roadmap: Discovering new algorithms for advantage

In 2024, we saw the emergence of powerful tools like AI transpilation passes and sample-based quantum diagonalization (SQD), which operate outside the runtime and use classical resources to suppress and mitigate errors.

In 2025, these tools matured further. We introduced error mitigation capabilities that leverage advanced classical subroutines to mitigate errors outside the runtime. These will help users identify circuit types and characteristics that scale prior to fault tolerance.

In 2026, we will introduce utility mapping tools. These support the exploration and design of new algorithms by mapping problems to circuits that also scale prior to fault tolerance.

By 2029, we expect to provide libraries that offer an expanded, generalized set of circuits ideal for execution on fault-tolerant processors.



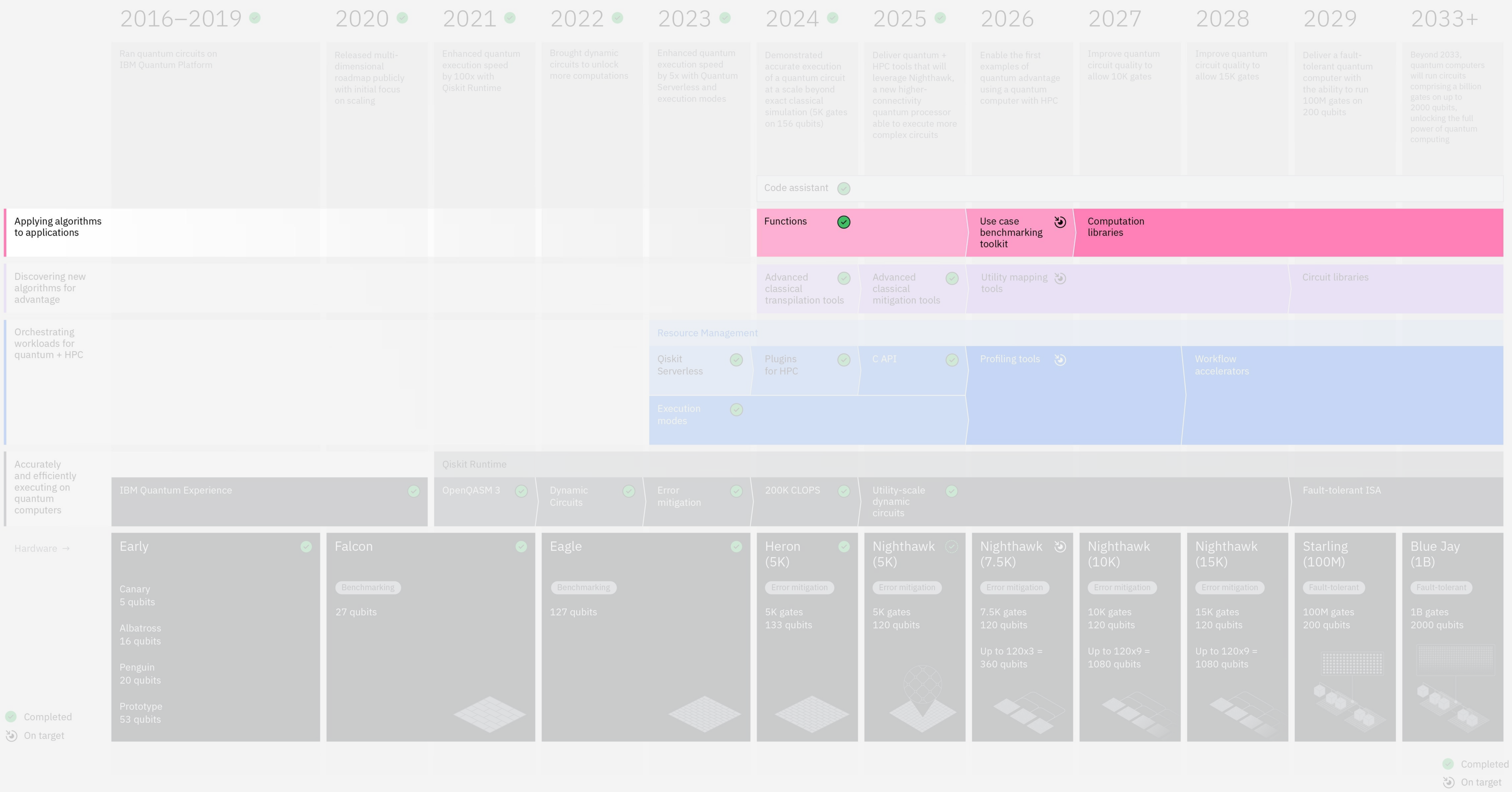
IBM **Quantum**

Development Roadmap: Applying algorithms to applications

In 2024, we successfully delivered the Qiskit Functions Service to our Premium Plan users. In 2025, we enhanced it with new functions.

Additionally in 2025, we established candidates for quantum advantage, as planned on our innovation roadmap. In 2026, we will work with partners to create a use case benchmarking tool, enabling others to explore which of their applications are ripe for near-term quantum value.

In 2027, we will introduce computation libraries. These provide abstractions—mathematical subroutines for applications—that integrate with popular existing computational libraries. This will support collaboration, integration, and help users more efficiently build and orchestrate workflows across classical and quantum compute resources.



Innovation Roadmap→

IBM **Quantum**

Innovation Roadmap: Hardware

IBM Quantum Loon features a new chip architecture that leverages c- couplers to link qubits across the chip, beyond nearest neighbors. It enables up to six degrees of connectivity between qubits.

Capitalizing on this improved connectivity, IBM has developed a scalable error-correcting code that outperforms earlier methods. This advancement strengthens our confidence in achieving large-scale, fault-tolerant quantum computing by 2029.

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Software innovation	IBM Quantum Experience	Qiskit Open-source SDK for building and compiling circuits for quantum hardware	Application modules Modules for domain specific application and algorithm workflows	Qiskit Runtime Performance and abstraction through primitives	Quantum Serverless Demonstrate concepts of managing quantum and cloud classical compute for an end to end workflow	AI-enhanced quantum Prototype demonstrations of AI-enhanced circuit transpilation	HPC-Quantum integration Realize an integration of classical HPC and a quantum computer at utility scale	Advantage candidates Define problem types for advantage in 2026	Error correction decoder Demonstrate a real-time error correction decoder	Workflow accelerator Demonstrate a workflow accelerator that streamlines execution for a known advantage workflow	Fault-tolerant ISA Demonstrate a complete instruction set architecture including magic state distillation for FTQC		
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Completed
On target

Completed
On target

Innovation Roadmap: Software, algorithms, and workflows

IBM **Quantum**

In 2025, we shortlisted candidate algorithms to demonstrate quantum advantage in 2026 and prototyped our error correction decoder ahead of schedule. This decoder will enable real-time error correction—a key capability for scalable, fault- tolerant quantum computing.

In 2026, we aim to demonstrate the first examples of quantum advantage using a quantum computer with HPC.

In 2027, we will prototype workflow acceleration strategies to streamline executions for known advantage workflows. This will help optimize execution across quantum and classical resources, saving developers valuable compute time.

In 2028, we will prototype a fault-tolerant instruction set architecture on our Starling proof-of concept, to be released the following year.

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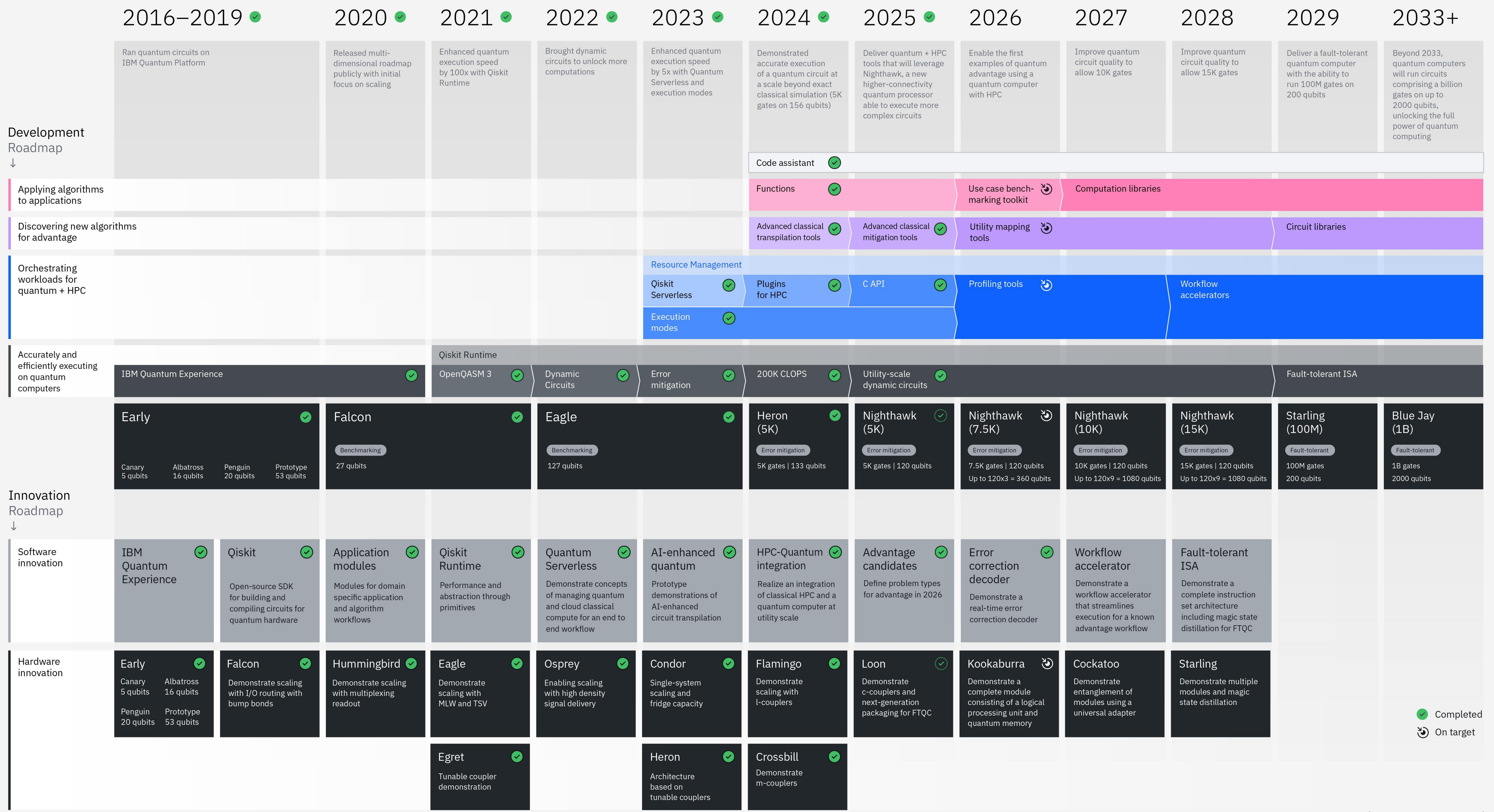
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