



## Quantum Computing Consulting, Software, and Services

# Response to Request for Information on Quantum Information Science and the Needs of U.S. Industry

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**Submitted To:**

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## ***Background***

QxBranch is a software and services firm at the forefront of deploying applications enabled by the advantages of quantum computing. The leading independent company in the sector, QxBranch takes an objective approach to the technology, assessing capabilities with rigor, delivering tailored development, and providing transparent technical benchmarking and analysis to its clients and partners.

QxBranch is active internationally in finance, aerospace, and insurance verticals. Over the past two years, we have conducted hundreds of meetings and workshops with leading executives in our target industries about the near and medium term prospects for quantum computing.

While currently available systems have limitations constraining their scalability and operation, they are valuable for helping commercial entities understand and assess the applicability of quantum systems. This will assist in the proliferation of future devices and will accelerate the industry as a whole.

Early commercial engagement is critical to the successful adoption of quantum systems. Working with industry to better understand use cases will increase the likelihood of funding for quantum systems research and development. It will increase by compelling commercial R&D investments, increasing the profile of quantum computing in general public, and creating nearer term opportunities for public / private partnerships that can grow overall government funding.

We believe resources dedicated toward near-term, minimal viable products targeted at commercial use will generate a virtuous loop that that will accelerate both near- and far-term goals of the research community.

## ***Opportunities for Research and Development***

QxBranch is particularly interested in applied applications that transition hardware capabilities into products, or map the pathway towards commercialization. Our R&D interests are:

- Error correction and characterization on quantum annealing systems
- Applications of current systems to real world problems
- The use of quantum annealing systems in monte carlo analysis
- Benchmarking
- Technology forecasting, roadmaps and timeline development

We believe international collaboration is essential to accelerate technology development as effectively as possible, and we advocate for international engagement whenever practical. QxBranch has active R&D relationships with quantum computing efforts with teams at Oxford University, University of New South Wales, National University of Singapore, and Government offices in the UK and Australia.

The efforts at these institutions are complementary to those in the US and in some cases even partly funded through government or commercial research grants from US-based institutions.

Commercial firms interested in the early adoption of quantum computing technology are similarly internationally oriented.

## ***Emerging Market Needs***

Quantum computing offers a diverse set of opportunities that will revolutionize analysis in all areas of economic activity. Quantum annealing systems currently available and in development provide only a subset of these solutions, but there are likely to be transformative applications that generate billions of dollars in economic activity over the next 10 years. Specific applications of interest to the commercial sector are in machine learning, optimization, and probabilistic analysis.

The near term market needs (12-24 months) QxBranch has seen are:

- 1) Complex optimization, aligned with the capabilities of quantum annealing systems. In particular, we perceive the near-term value of current systems (compared to existing classical solutions) in their ability to identify “black swans” in complex optimization problems, where close-to-optimal solutions exist near the corner cases of a given function. For data of certain variance, current quantum annealers can identify these close-to-optimal solutions more readily than classical solutions, due to the limitations of existing systems with given levels of complexity, or the simplifying assumptions required of classical heuristics. These black swans can be instances of low probability, high consequence scenarios that are the subject of many forms of risk analysis and regulations.
- 2) Technology road-mapping to help commercial entities understand their role in the industry. The technology maturity of quantum computing will soon reach a stage where the application space will exert strong influence on R&D and product decisions, and vice versa. Currently, commercial firms are eager to be prepared for that point to ensure they can capture the benefits of the technology as soon as possible. Part of this is making investments directly in R&D, and their own internal investments in supporting infrastructure, including human resources.

## ***Barriers to Near-Term and Future Applications***

Near-term applications are constrained by hardware performance and the economically-viable alternatives in classical computers. Niche commercial applications exist, and many companies are investing in the development of hybrid classical / quantum algorithms, that are hybrid both in the sense that they can run on either machine, and that they employ both quantum and classical approaches in a given function. However the barrier is making the economic argument for investment in quantum over other high performance computing technologies.

The other near term barrier is appropriate problem identification. High-end analytic problems typically require many steps and iterations, and even in instances where current quantum systems are useful, the quantum-ready piece of the operation is contained within a much larger function. Identifying these use cases has required in-depth cooperation from willing partners.

## ***Workforce Needs***

The skills that QxBranch is and will be seeking to hire are in systems engineering, simulation (including of quantum systems), data analytics, computer science, mathematics, and software engineering.

QxBranch has been able to identify and attract highly capable technical talent, and given the needs of our clients we can only hire the best of the best. The market for this talent is highly competitive, and international.

We've found considerable interest in quantum computing, and among those with the qualifications to make meaningful contributions to the field, the competitive nature of the market is a cost function.