

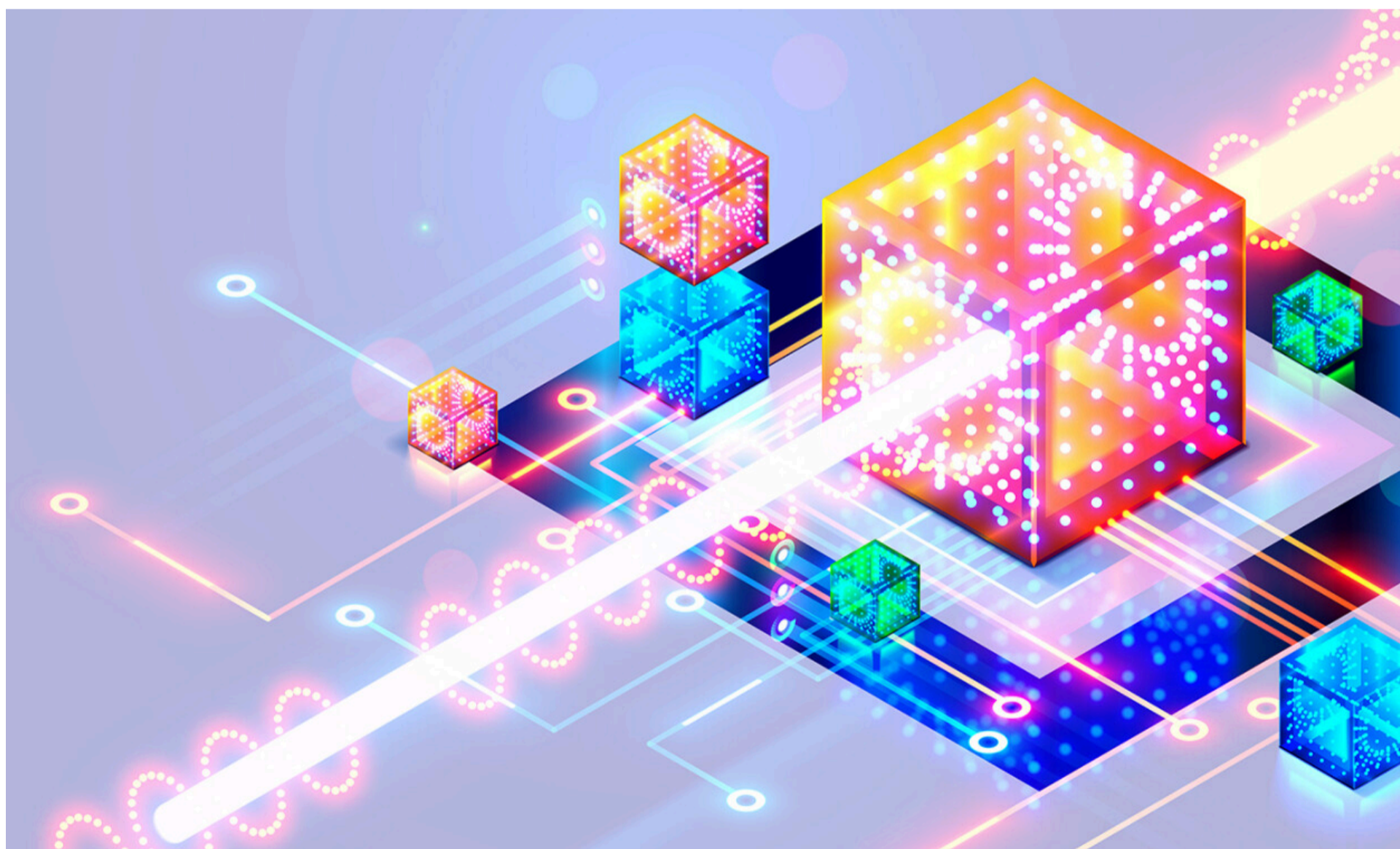
# The steps to laying out an embedded system quantum roadmap

Story

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There is a tendency to think of quantum technology as being “far in the future” or something that’s “too big” to matter for systems at the military edge or other embedded systems. You might think, “My company isn’t really in a business impacted by this.” You aren’t alone, but you would still be mistaken. So, is it time to panic? No, but it is time to lay out a quantum roadmap for your organization.

Organizations can take a number of steps to work toward quantum readiness.

**Step zero:** Understand what every intelligence agency knows – your encryption is a ticking time bomb

One of the first applications of quantum computers will be the destruction of the two most pervasive forms of encrypting information. Opponents who “harvest now, decrypt later” are collecting your encrypted files. These will be stored until mature quantum computers are available. Your files are a future liability, particularly when they are in motion.

You might think “I’m fully compliant, and we comply with FIPS 140-2 (or some other standard).” That’s good and necessary, but probably insufficient. Planning for a move to quantum-resistant encryption is essential. In fact, the National Institute of Standards and Technology (NIST) has been [benchmarking and promoting it](#). (Figure 1.)



**[Figure 1 | The first four algorithms NIST announced for post-quantum cryptography are based on structured lattices and hash functions, two families of math problems that could resist a quantum computer’s assault. Diagram: N. Hanacek/NIST.]**

Before the new standards come out, you need to protect today’s data. If you have older systems using outdated encryption, like DES [data encryption standard] or short key lengths, your teams should be moving away from those standards NOW. This might mean some SCADA controllers collecting HVAC data, or any other old legacy systems which are not being updated. Consider what information is worth protecting two to five years from now and prioritize what is moved to the new schemes.

You may have a fiduciary responsibility to do this to protect your company. You likely have a duty of care for your stakeholders whose data you house, whether those are customers, employees, vendors, or stockholders. Consider this before you move to the four steps in building your roadmap.

**Step one:** Begin to understand the ways in which quantum technology will change our organizations and how we perform our missions

Don’t think of quantum technology as just “computing.” Quantum entanglement as a form of communication is already providing tantalizing results. For embedded systems, you might consider that currently installed fiber-optic networks will probably allow us to share both conventional and quantum data.



Quantum technology will change more than computing and networking. It will change sensors, precision timing, and other components of modern systems. Since embedded systems depend on things like precision timing and support the processing appetite of data-rich sensors, it's worth the effort to imagine how quantum computing would change product offerings, system configurations, and future mission capabilities.

Only your team can determine what this means for your organization. Before you spend a great deal of time and money, strive to gain some understanding about what can change, and how it might shift your competitiveness. You may later need to spend a great deal, but throwing money at quantum now is a bad bet for most organizations.

Don't fool yourself into thinking expensive activity is valuable progress. That mistake is just as bad as doing nothing.

**Step two:** Look deeply into what quantum can't change

Google, IBM, Amazon, and others are putting great effort into the development of quantum neural networks. This is due in part to the hope that quantum artificial intelligence (AI) is likely to be less of a data hog than the current mainstream systems.

But understand that this kind of AI still depends on enormous amounts of labeled data, and that much of the quantum AI work is focused on just making AI possible on a quantum machine which does not yet exist.

Some competitive advantages won't be impacted by quantum technology, and this will be true for your organization as well. Be careful, though: This is an area where disciplined thinking is hard. It is also where hubris and denial are amazingly easy.

Only your team can determine how this question applies to your products and systems.

**Step three:** Think about where quantum allows you to exploit your core competencies to create future competitive advantage

Your competencies are your own. But if you complete steps zero through two, you will find some opportunities to consider. A few of those opportunities will be worth the allocation of some investment. For example, expertise in sophisticated use of uncertainty, which is at the core of many of quantum's most promising attributes, creates a natural area to focus R&D efforts.

For example, some defense companies' core competencies include sophisticated use of uncertainty, which is at the core of many of quantum's most promising attributes. In turn, that creates a natural way to think about where an organization's R&D team should focus.

**Step four:** Build a quantum roadmap for your organization

It won't be perfect. Developments in coming months and years will require revisions.

Competitors will create some surprises. You'll have to adjust your course. Revisions and adjustments are only possible if you have a course previously charted.

Sharing roadmap capabilities with key customers is essential: They'll want and need to know your plans to extend leadership in prescriptive and predictive analytics.

What roadmap will you share with your stakeholders?

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