# Editorial: PRX's Scope and Standards: A Case in Point

In selecting the papers that it publishes, PRX intends to be both broad in scope and highly selective in standard. The paper by Jones *et al.* [Phys. Rev. X 2, 031007 (2012)] entitled ''Layered Architecture for Quantum Computing'' that we are publishing today shows the broad scope that we wish to achieve. The paper comes from the highly interdisciplinary field of quantum information and quantum communication, where experimental and theoretical physicists have a strong presence together with mathematicians, information theorists, and computer scientists. It reflects the interest of those physicists, and their activities and contributions in collaboration with players from the other disciplines. It is original and substantive; it looks boldly ahead and beyond short-term development. One of PRX's roles is to promote outstanding interdisciplinary research, and we believe that this paper is an excellent example of that.

We have invited a brief Commentary by David DiVincenzo on the paper. We hope that his insightful and forthright appraisal will help you not only better appreciate the paper, both its strength and its limitations, but also better understand some of the basic principles that guide our editorial decision making.

The Editors
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## Roadmap for the Large-Scale Quantum Computer

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A Commentary on:
Layered Architecture for Quantum Computing
N. Cody Jones, Rodney Van Meter, Austin G. Fowler, Peter L. McMahon, Jungsang Kim, Thaddeus D. Ladd, Yoshihisa Yamamoto
Phys. Rev. X 2, 031007 (2012)

Fundamental advances in physics will be the key enablers for the construction of a functioning, reliable, large-scale quantum computer. But physicists alone will not do the construction job—It will be a complex task, technologically and organizationally demanding. In this audacious paper, Jones *et al.* take the bold step of attempting to foresee this enterprise in its totality. It introduces a layered paradigm—five layers, with physics only in the first. This is the layer of physical qubits, controlled quantum gates, and measurements: the principal concerns of almost all of the current physics literature in quantum computing. But these are only the enablers for all the action in the four layers above, in which quantum control gets the most out of each physical qubit (Layer 2), parity checking fixes higher-level errors (Layer 3), logical modules are reliably executed (Layer 4), and the users get their answers (Layer 5). Looking up from the physics layer, this may seem like overkill, but in fact a lot is learned from this full parsing of these architectural considerations, which have been coming together only piecemeal in the traditional literature in the last five years or so. With this full framework in place, the authors can give justified estimates for many practical quantities that many people have been wondering about: How many physical bits are needed to factor a 1024-bit number? (About a half-billion.) What fidelity is needed for 2-qubit gates? (About 99.9%.) How strong an error-correction code is needed? (Distance 31.) The paper has something of the flavor of science fiction, but it is really science fact, at least in that it is a serious, soberly considered projection of what lies in our future.

It is quite possible that every interested reader will quickly find some things with which he or she is strongly dissatisfied. For myself, I think that there are clearly several better candidates for the physical layer than the optically controlled quantum dots that are considered here. And, while I am also a fan of the surface code, I find it hard to believe that we will really live with the 90% inefficiency at the algorithmic level that the surface code implies. But, laying out this framework in such a clear way, the authors have made the process of further criticism and improvement much easier, and the community will benefit from it.

About the commentary author:

David DiVincenzo is the first JARA Professor (Juelich-Aachen Research Alliance), and heads the Institute for Quantum Information in Aachen. He has worked on many topics in theoretical condensed-matter physics, and has pursued many interests in quantum computing and quantum information theory, including studies of quantum-dot spin qubits and superconducting qubits.

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