IEEE standards processes with emphasis on quantum resource estimation

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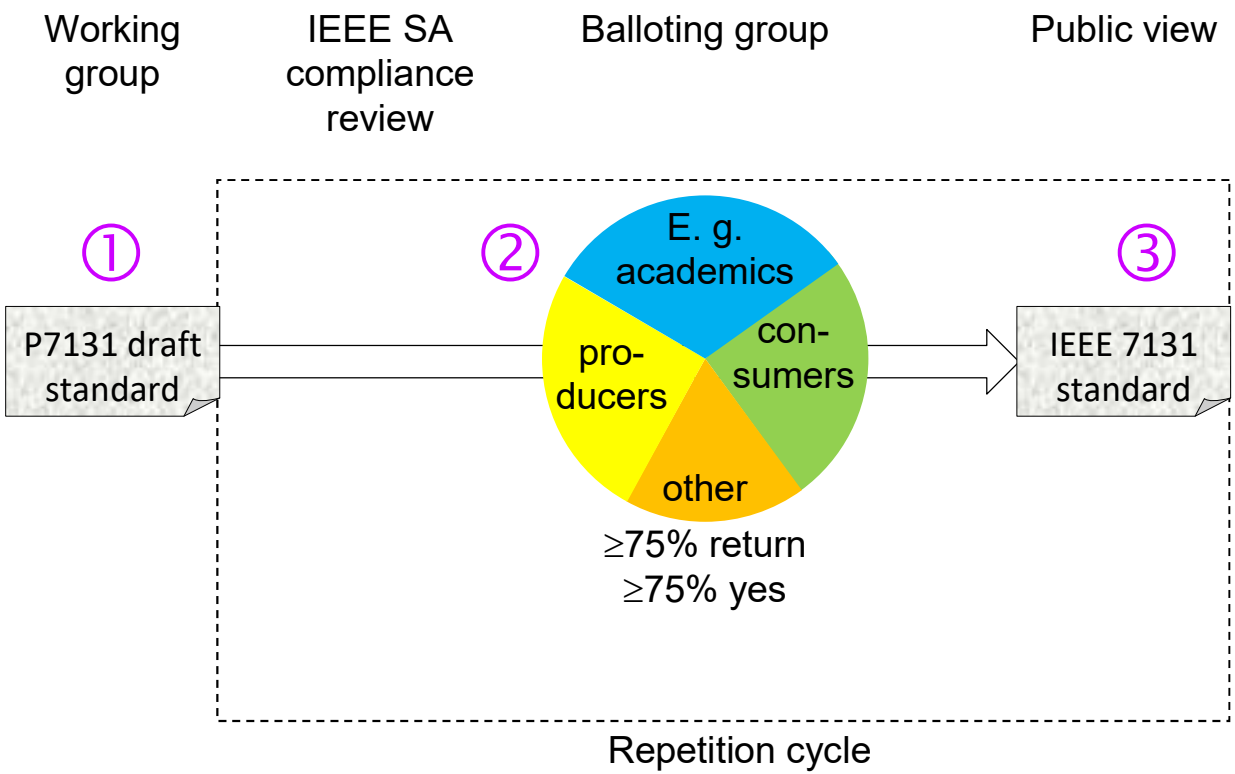
Status of speaker

- I am chair of the Quantum Computing Benchmarking Working group and standard P7131
- I am expressing my personal opinion
- I do not represent the formal positions of IEEE, the IEEE Standards Association, the Computer Society Standards Activity Board, or the working group

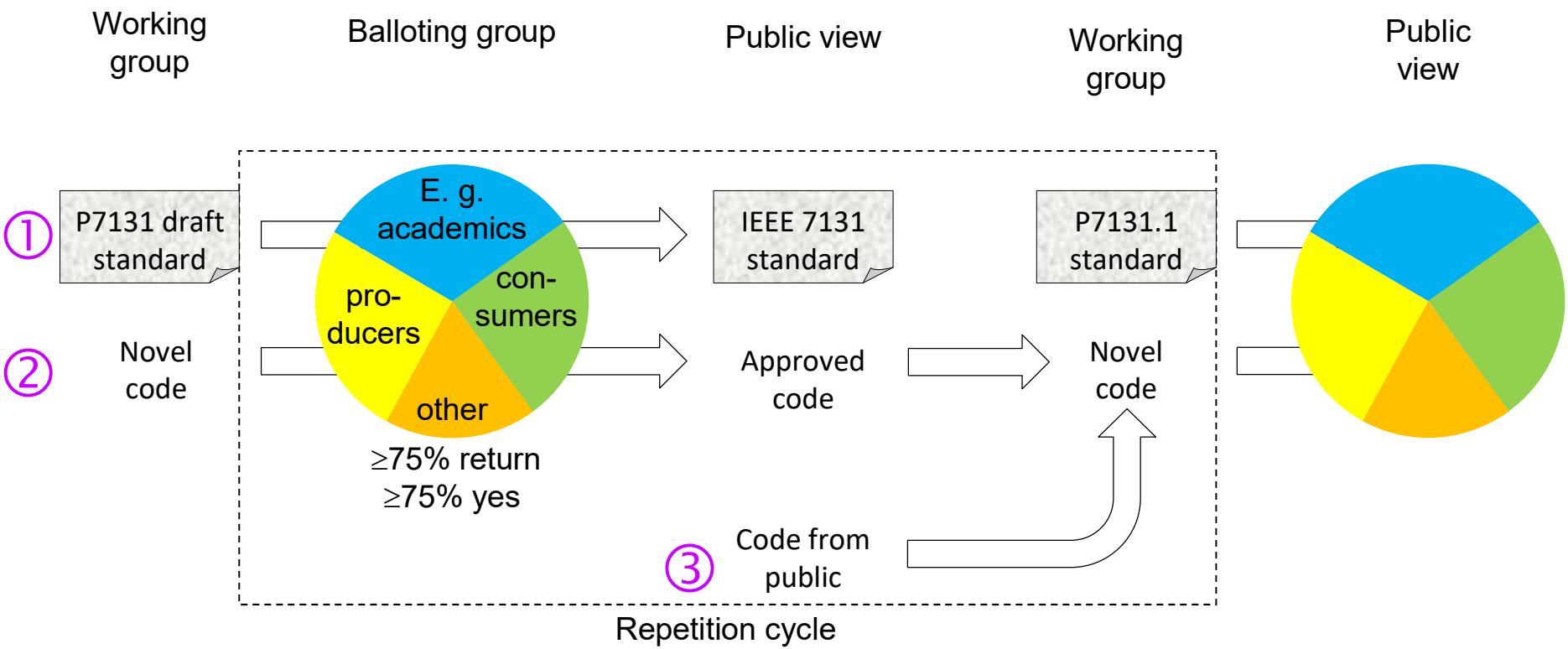
IEEE balloting process assures a broad consensus

- A working group prepares a draft standard
- To become a (non-draft) standard requires passing a ballot
  - "Balloters usually fall into one of several interest categories (e.g. producers, users). No interest category can comprise over one-third of the balloting group. The goal in balloting is to gain the greatest consensus. A standard will pass if at least 75 percent of all ballots from a balloting group are returned and if 75 percent of these bear a "yes" vote. If ballot returns of 30 percent are abstentions, the ballot fails."
- Ballots can be returned with comments, which must be addressed
- Consequences
  - Non-interesting standards will have too many abstentions to pass
  - One interest group cannot get enough yes votes by itself to pass
  - Hence, standards that do pass have broad consensus

Traditional standards, which are documents



New support for document + code standard



Could quantum resource estimation be standardized?

- Analogy 1: DARPA benchmarking project
- Analogy 2: “Quipper” in project below

Concrete resource analysis of the quantum linear system algorithm used to compute the electromagnetic scattering cross section of a 2D target

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We provide a detailed estimate for the logical resource requirements of the quantum linear system algorithm [Harrow et al., Phys. Rev. Lett. **103**, 150502 (2009)] including the recently described elaborations and application to computing the electromagnetic scattering cross section of a metallic target [Clader et al., Phys. Rev. Lett. **110**, 250504 (2013)]. Our resource estimates are based on the standard quantum-circuit model of quantum computation; they comprise circuit width (related to parallelism), circuit depth (total number of steps), the number of qubits and ancilla qubits employed, and the overall number of elementary quantum gate operations as well as more specific gate counts for each elementary fault-tolerant gate from the standard set $\{X, Y, Z, H, S, T, \mathrm{CNOT}\}$. In order to perform these estimates, we used an approach that combines manual analysis with automated

2016

Option 1: join an existing working group

- This topic is close enough to quantum computing benchmarking that initial discussions could be in QCB-WG working group meetings
- Alexandru will talk

- At some point, it might be necessary to create a dedicated project
  - For example, P7131.1 or P7131a
  - Historical example: WiFi IEEE 802.11 to IEEE 802.11be (20 versions)

Option 2: Create a project I

Is the topic in the ballpark of other IEEE quantum standards?

- P1913: "This standard defines the Software-Defined Quantum Communication…"
- P2995: "This trial-use standard defines a standardized method for the design of quantum algorithms…"
- P3120: This standard defines the technical architecture of a quantum computer according to the technological type…"
- P3172: "Recommended Practice for Post-Quantum Cryptography Migration"
- P3155: "Standard for Programmable Quantum Simulator"
- P3185: "Standard for Hybrid Quantum-Classical Computing"
- P7130: "This standard addresses quantum … terminology …"
- P7131: "The standard covers quantum computing performance metrics…"

Option 2: Create a project II

- An IEEE volunteer submits a project authorization request to myProject
- Needs
  - A standards committee in an organizational unit (one of dozens)
  - Name, title, description of project
  - Set a bunch of parameters via drop down menus
- After approval, working group meets for a few years w/staff support
  - IEEE can supply resources (open source tools; Zoom account)
  - Free if you like, but can have a budget (example, 802.11)

Conclusions

- IEEE is an standards development organization (SDO); consensus is the unique value-add of SDOs
- IEEE standards are bottom's up, i. e. proposed by IEEE members
  - There is no IEEE "boss of standards" that decides what to standardize
- IEEE has a new consensus-based open source capability
  - Open for reading, need to pass balloting to contribute
- Quantum resource estimation looks like the