Standards for quantum technologies

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Q&A Transcript

Q1 Are there any commercial consumer products that utilise quantum coherence and quantum properties (besides lasers and semiconductors) that operate at room temperature?

- *Quantum Key Distribution (QKD)*

Q2 How much improvement in performance to semiclassical systems is there when compared to quantum-based systems? Is it an order of magnitude?

- *Varies application by application. It is totally different for various systems.*

Q3 What about Post-Quantum Cryptography (PQC) in current classical architecture? Or a hybrid of QKD and PQC?

- *Post quantum is a good idea, but we do not know its long-term security. A hybrid of QKD and PQC might be a better solution.*
- *Post-Quantum Cryptography is an alternative to QKD in some cases. In many more cases hybrid utilisation might be preferable.*

Q4 Are there any other quantum localization applications beside the use of quantum atomic clock synchronization to enhance the accuracy of GPS localization?

- *I hope so. Perhaps in the RAN space when we need ultra MIMO, for example.*

Q5 Which encoding approach (polarization, phase, position) of photons is more common in industry?

- *In the case of Discrete Variable QKD or "single photon" QKD phase is the most common. But, certainly there are alternatives. And if we say "industry" with two or three commercial companies world-wide there are no real statistics.*
- *For free space communication, polarization is used in most cases, but phase qubit is also exploited in some experiments. For fibre QKD, phase is used most frequently, but polarization qubit is also exploited.*

Q6 And how about discrete and continuous variable use cases in industry?

- *Discrete variables are more distributed (better known) but continuous variables are catching up!*

Q7 What is the security threat that QKD protects against? Wiretapping nowadays rarely happens at the wire, but by bribing or hacking a BT exchange.

- *QKD can support symmetric key generation. Then it cannot be directly applied but can serve as an alternative to other key generation mechanisms in secure communication. It is particularly valuable in case other key generation mechanisms are threatened by other technologies (e.g., quantum computing).*

Q8 Standardization too early? - In Microelectronics, anticipative standardization for the transition to 300mm diameter Si wafers was a huge success, for the first time a transition to the next wafer diameter happened "without tears".

- *People always quote VHS vs BetaMax - the worse video tape technology won the battle - you could argue - because standardisation was too early. I also think standardisation is much more competitive these days and competition isn't always healthy in an area where we might want to take our time?*

Q9 Is it possible to propose standards for co-propagation of QKD and classical communication? Such as link distance, wavelength allocation, co-propagated number of classical channels (wavelength), total launch power of all classical communication channels

- *Maybe yes. If you think about the Ethernet standard - that is entirely about type of fibre, distance, loss etc. So, you might imagine a quantum encrypted ethernet standard for example. But each QKD technology gives different performance in the presence of DWDM and this might make it quite hard to standardise. I feel any standard would be a 'watered down' version of the others - a kind of lowest common denominator.*

Q10 Since quantum computing is a statistical-based computing solution, do you believe we are training engineers properly as most educational institutions do not require rigor on higher-order methods?

- *Well, many algorithms, are deterministic, although Gaussian Boson Sampling (GBS) - current demonstrator for supremacy - are sampling algorithms so necessarily require statistical approaches. It will require some new skills for engineers, though I expect the high-level software users will not need to know much of the physics or statistics.*

Q11 Which resources are there that are freely accessible for more on the theory and the engineering, a real deep dive?

- *You can find general material on the NQIT website, www.nqit.org. More pedagogical introduction to the theory and concepts can be found (open access) at Michael Nielsen's web: https://quantum.country/search.*
- *There are a number of good texts if you want more technical and deeper material - but not free.*

Q12 I do not understand *what* can be standardised when it comes to fibre. The lower the loss, the better it is, for classical or quantum, and it is not like the classical world has somehow limited fibre loss to today's record of ~0.16 dB/km. It is simply as low as materials technology can take us, and I do not see what a quantum "standard" can say that will help the loss go lower.

- *Of course, lower attenuation is better. But, regarding standards you need to think of it another way - what is the maximum attenuation you can tolerate for your communications architecture.*

Q13 How can I engage with ITU-T as an individual?

- *The ITU-T Focus Group on Quantum Information Technology for Networks (FG-QIT4N) is open to any individual. Full details are available on the FG-QIT4N webpage: https://www.itu.int/go/fgqit4n.*
- *You may also contact the Secretariat directly at tsbfgqit4n@itu.int and they will offer some assistance and responses to any questions you may have.*

Q14 Some solutions use free space optical communication. Is this kind of communication studied somewhere in IEC or ITU-T? Or the scope of existing standardization groups should suitably be enlarged?

- *ITU-T has not traditionally written standards regarding free-space optical communications. Free-space optical communications is a bit less mature than fibre and there has been less work regarding standardization in this area. Most standardization in this area has been done by government groups, however, given the importance of space-based distribution for quantum communications it may need to be addressed by ITU-T at some point in the near future, especially as free-space and fibre optical communications merge.*