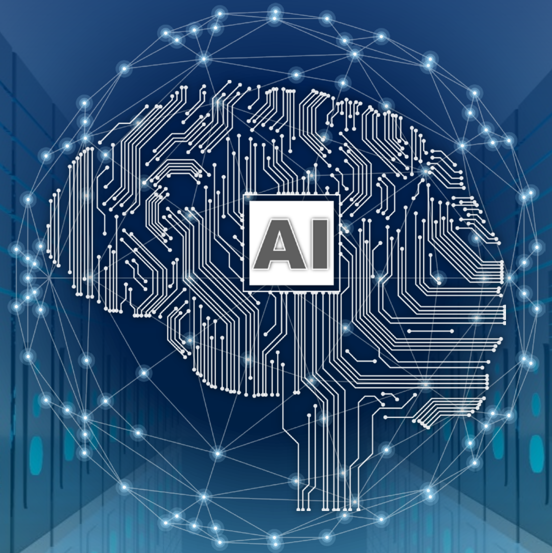
Quantum Korea 2024

Quantum talents needed in quantum engineering

-Quantum Workforce-



Jungjin Ju

ETRI
한국전자통신연구원

CONTENTS

목 차

There are multiple drivers for growth in the quantum engineering workforce

1. Market Drivers of growth in the quantum engineering workforce

Important sources of investment enabling research to transition into a commercialization phase

Government funding: Multiple governments are funding the development of quantum technology, with the aim of boosting economic growth and enhancing national security.
Many actors, including China, the US, Europe and the UK, are dedicating billions of dollars towards their quantum strategy.

Security Risks: In the case of quantum communications, the risk of mass encryption redundancy and compromised data security is a major driver for the growth of the industry.

Commercial partnerships: Hardware, software and platform providers are partnering to demonstrate compelling use-cases to end users. Many end-users are now investing in developing quantum applications and in educating their in-house teams.

Venture capitalists: The number of start-ups and established companies pursuing a commercial quantum technology is growing. This has been enabled in part by private investment from venture capitalists looking to for long-term ROI on an this early-stage technology.

1. Market Drivers of growth in the quantum engineering workforce

Shortage of quantum talent is a challenge for the industry

As the sector is increasingly shifting out of the lab and into the market,

there aren't enough graduate students with relevant experience ready to be recruited.

Companies who would benefit from the range of quantum technology available today, in the next few years, and beyond are facing the challenge of reskilling and expanding their existing workforces quickly.

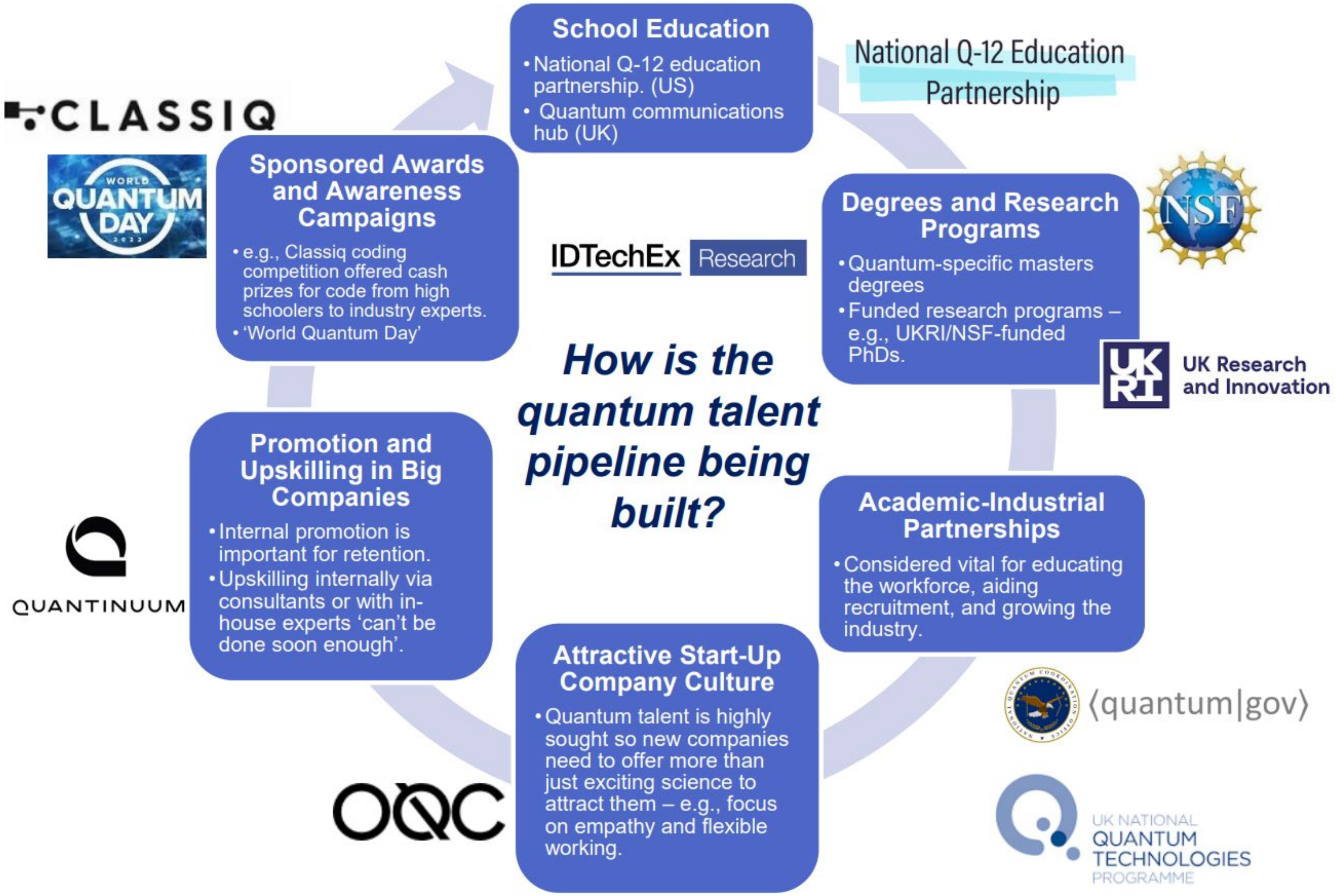


Image Source: IDTechEx

1. Market Drivers of growth in the quantum engineering workforce

Quantum in Korea : It would commit more than 2 billion by 2035 in efforts to become a global leader in the 2030s

- Build a general-purpose superconducting quantum computer by 2031.
- GPS free quantum sensors and quantum radar
- 100km intercity quantum communications network/link
- Grow the number of professional quantum researchers from 384 to 2500, dispatching 500 oversees into the US and EU.
- Build quantum fabs by 2027 for research and a public-sector foundry by 2031 followed by a private sector foundry in 2035.
- Increase the number of start-ups to 100 and create a special distract eligible for support.
- Strengthen industry ties with IBM and IonQ

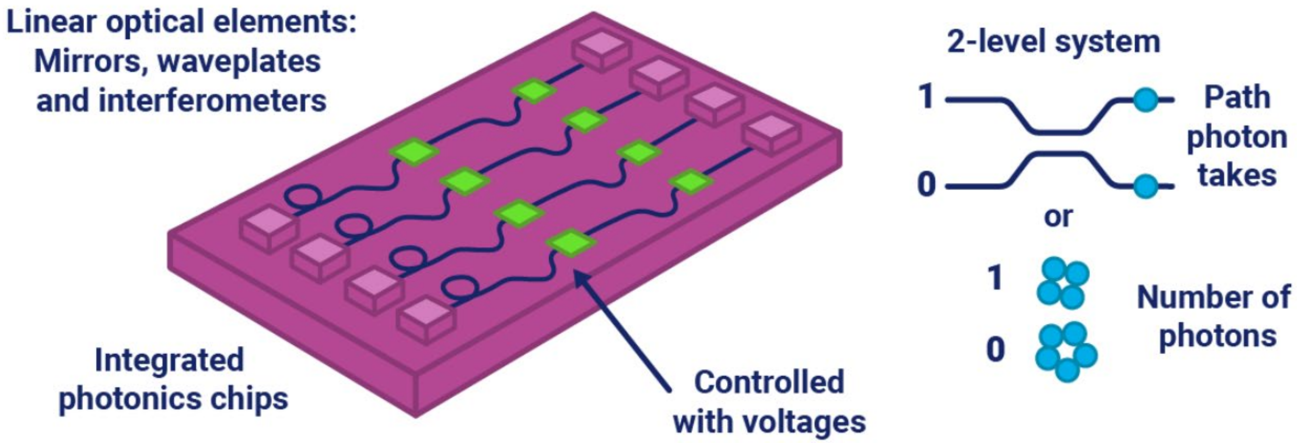
2. Technology Challenges

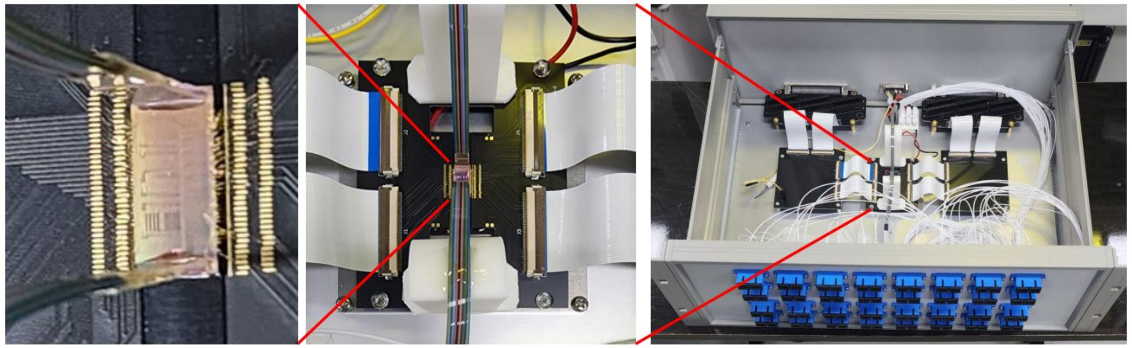
Complex ecosystem: Quantum computing technology : The lack of standards in the industry is a challenge.
Technology approaches to quantum computing have commonality,
but also vary significantly in terms of computational power and infrastructure requirement.
This makes transitioning out of research and scaling up challenging – with investors and potential users struggling to understand industry potential.

Unclear scale-up timelines: Quantum computers today are still very early stage, and there are still many technological challenges to overcome before it scales up in capability.
There are specific technological challenges for each hardware type – but all are trying to overcome noise which is creating errors. These errors add to the burden of increasing qubit number (analogous to computing power).
Overall, this means so far, the industry has been scaling up very slowly, and the timeline to progress from a few to millions of qubits remains unclear.

Lack of quantum talent: The number of quantum physicists/quantum engineers needed to be recruited into hardware companies and by end-users to build use cases is very low.
There is a significant lack of quantum talent available to help the industry scale.
Whilst there are national initiatives to improve this,
it will take time to translate this into the recruitment pool required globally.

2. Technology Challenges : Photonic Qubits





8 qubits photonic chip
/module/system
developed by ETRI

Still needs cryogenically cooled photo-detectors which can limit scalability
Need more scalable electronics for readout and control
Limited number of good single photon sources
Optical losses due to chip material/architecture

2. Technology Challenges : Divincenzo Criteria

The 'DiVencenzo criteria' proposed in 2000 as a set of requirements for a quantum computer.
None of these are distinct from any of the needs,
but is a useful summary and often referred to within the industry.

DIVINCENZO CRITERIA

REQUIREMENTS FOR THE PHYSICAL IMPLEMENTATION OF QUANTUM COMPUTATION	
D1: Scalable qubits	Scalable physical system of well-defined, characterized qubits
D2: Initialization	Prepare a simple, fiducial input state
D3: Measurement	Measure the qubit state
D4: Universal gate set	Perform a universal set of gate operations with high fidelity
D5: Coherence	Robustly represent quantum information (long coherence times)
REQUIREMENTS FOR ROUTING QUANTUM INFORMATION	
D6: Interconversion	Ability to interconvert stationary and flying qubits
D7: Communication	Ability to transmit flying qubits faithfully between two locations

2. Technology Challenges : Quantum Network

Using **quantum communications** to secure communications for high user numbers requires more than a point-to-point solution, **it needs a network**

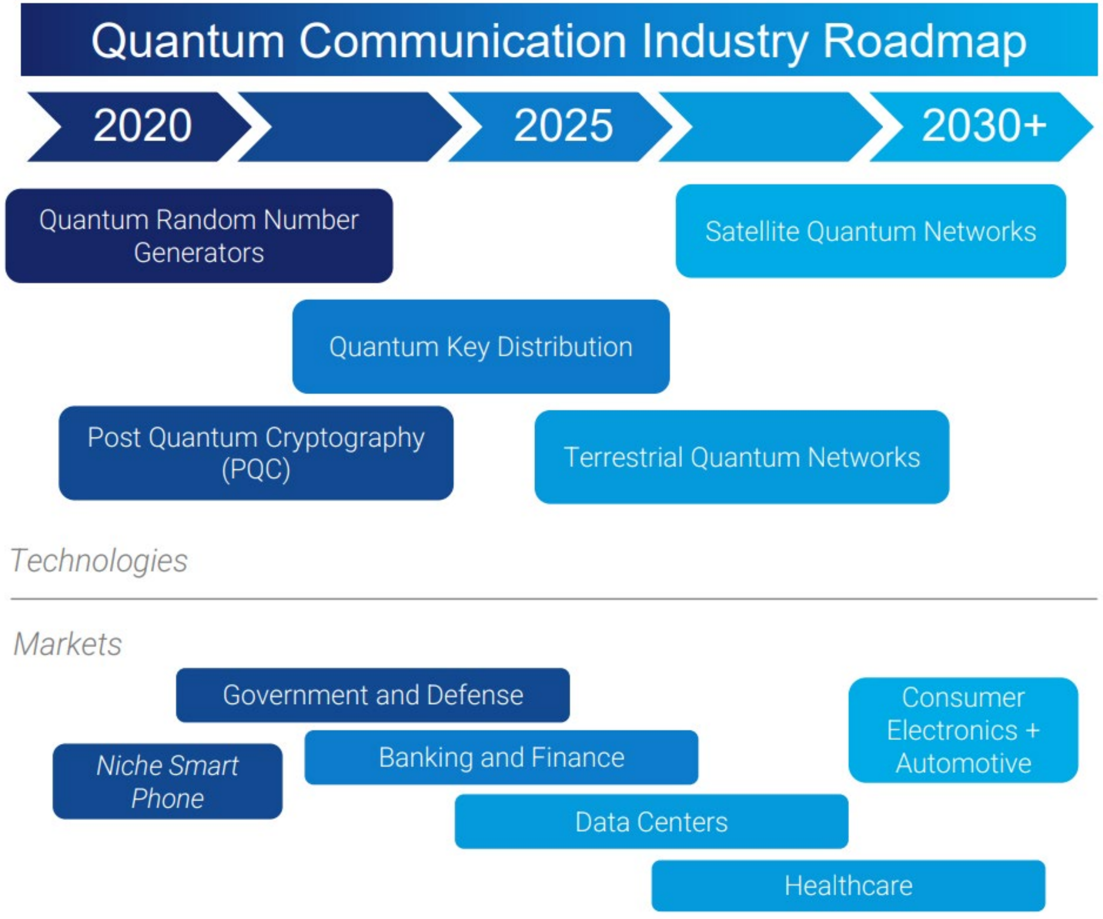


Image Source: IDTechEx

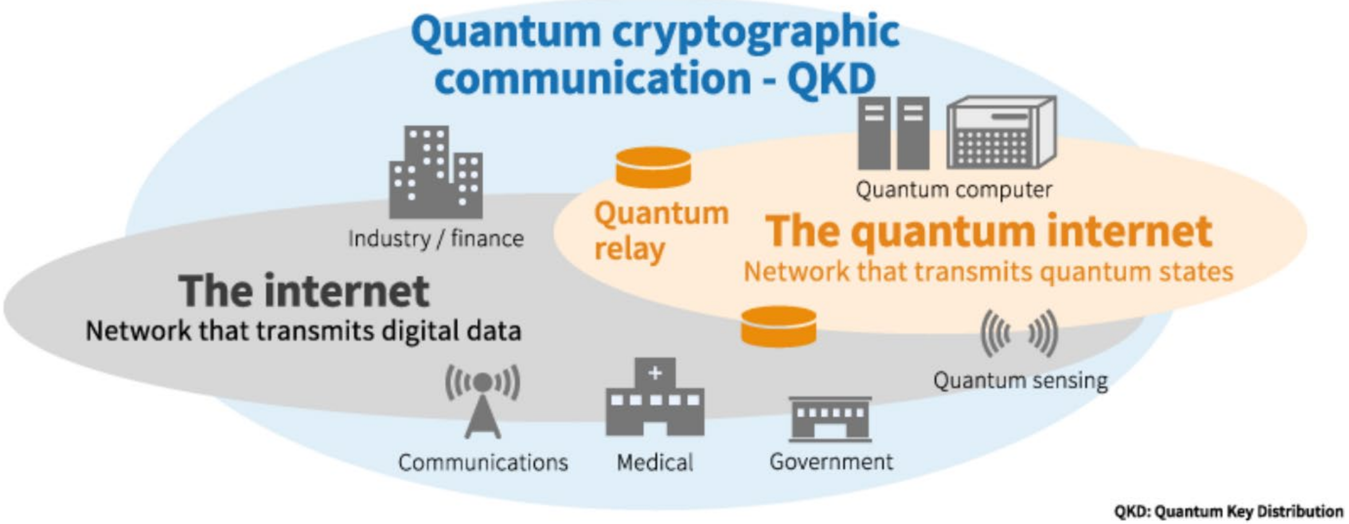


Image Source: Toshiba

The cost of QKD systems remains very high(>US$100,000) for a pair of receivers and transmitters.
The size of currently commercialized systems is limited to a rack mountable form-factor
The security of key-exchange does not necessarily guarantee security of an entire tele-communications eco-system

3. Recommendations

Monitoring the workforce needs of industry

- Continuous tracking of the emergent workforce needs
- Analyze and continuously develop a wide range of skill profiles and clarify the match to targeted education and training programs

Foster upskilling and workforce training efforts

- Foster the emergence of a comprehensive platform of high-quality, open-source training modules which can be recombined by commercial actors to suit specialized needs
- Foster the commercialization of QT training by supporting programms for QT training directed to different stakeholders from industry
- Matching companies wishing to reskill their staff with companies and training institutions that have the expertise

Foster academic QT programs beyond the traditional boundaries of QT

- Foster the development of an ecosystem of academic institutions with QT master programs to exchange best practices, build networks and develop common learning opportunities
- Development of an open source ecosystem of learning and assessment modules enabling recombination to suit diverse stakeholder training needs
- Expansion of quantum technology education to business schools

감사합니다

ETRI
한국전자통신연구원