



# ***PNT Trends: Managing the Dichotomy: Better GNSS and less Dependence on GNSS.***

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# What's it About?

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- Technology Trends
- Investment Trends
- Applications
- GNSS and Alternatives to GNSS
- Standards, regulations and export controls
- Close cousins – AI and MEMS
- Using the Quantum lens!

# The Trends

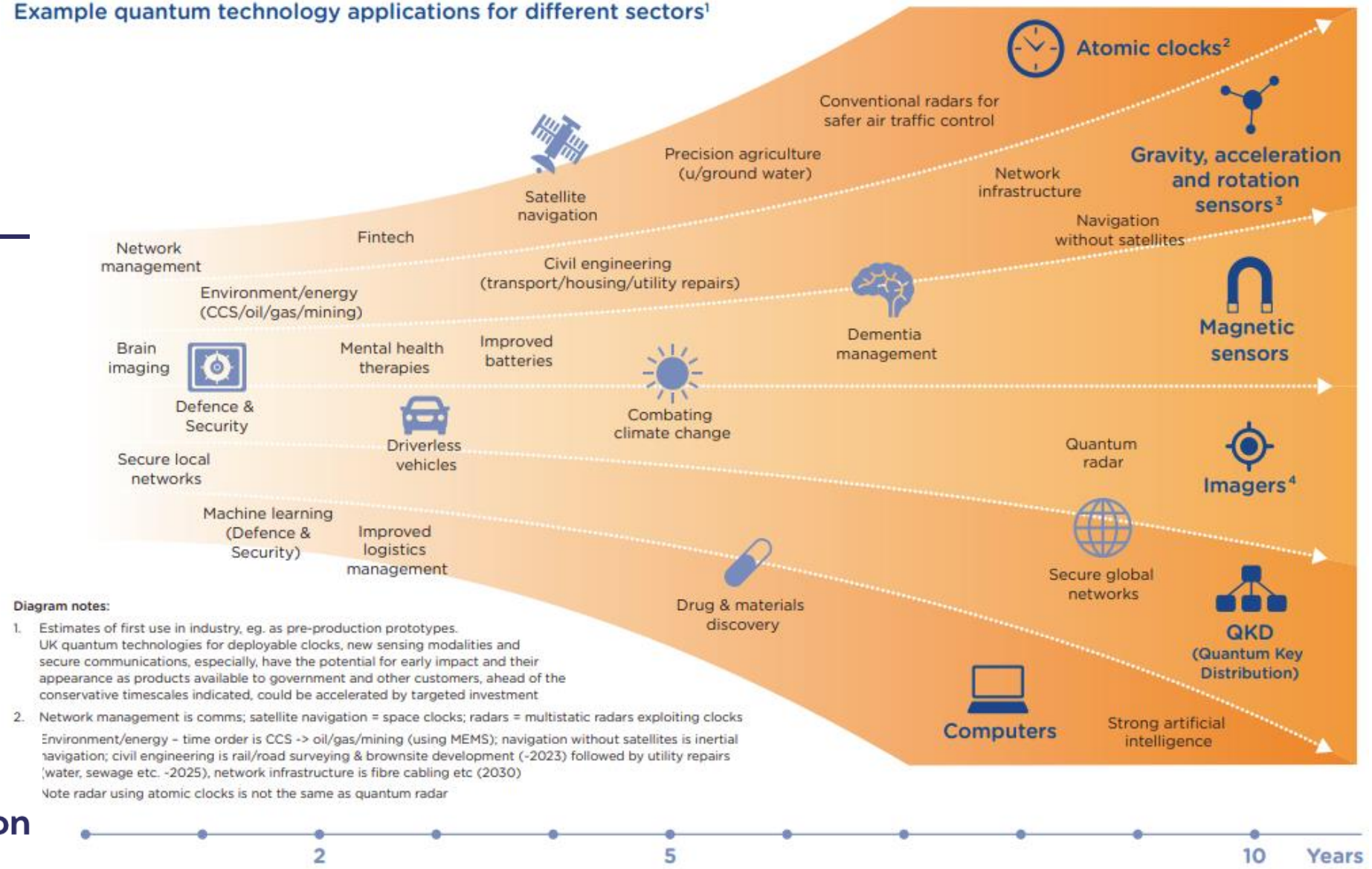
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- Small Satellites.
- Large constellations – LEOs.
- Advanced communications including security.
- Sensing (Ongoing)
- Managing complexity and Optimisation (Spectrum & orbit).
- (More) resilient navigation.
- Quantum. Photonics. Physics. Engineering. Hardware. New stuff.

# Looking through the quantum lens.

Quantum 2.0 – exploiting entanglement and superposition

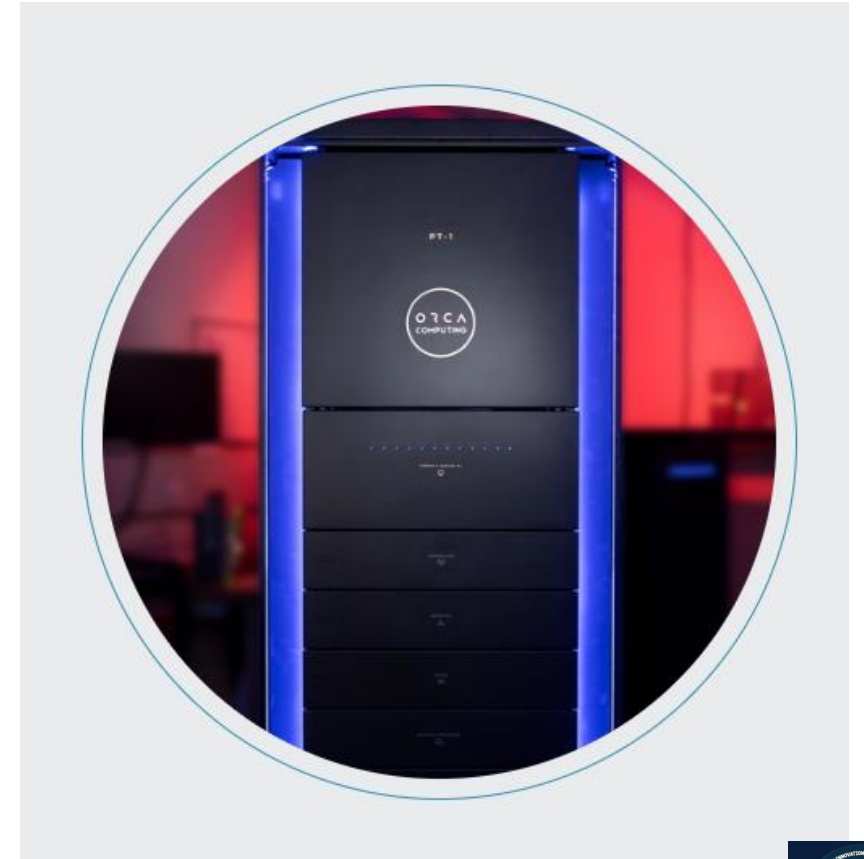
Example quantum technology applications for different sectors<sup>1</sup>





# Quantum Computing In Space?

- Not all quantum computers require a fridge  
ORCA use photonic qubits.
- ORCA has sold a photonic computer to the UK MOD.
- Think: Intel; COMINT; SIGINT;  
Data/Sensor fusion on-platform.
- Procurement – the ultimate form of support.



# Sensing. Troublesome...



Magneto  
sensors.



Gravitational  
Sensors.



Acceleration/  
Rotation  
Sensors.  
(Inertial  
platforms /  
Quantum  
Navigator).



Imaging (in  
all forms)



Clocks.

## Sensing/Imaging Examples

- Cerca Brain Imaging – optically pumped MEG.
- QLM – LIDAR imaging.



THE SOLUTION  
A Security Camera for  
Greenhouse Gas  
Emissions



# Clocks.

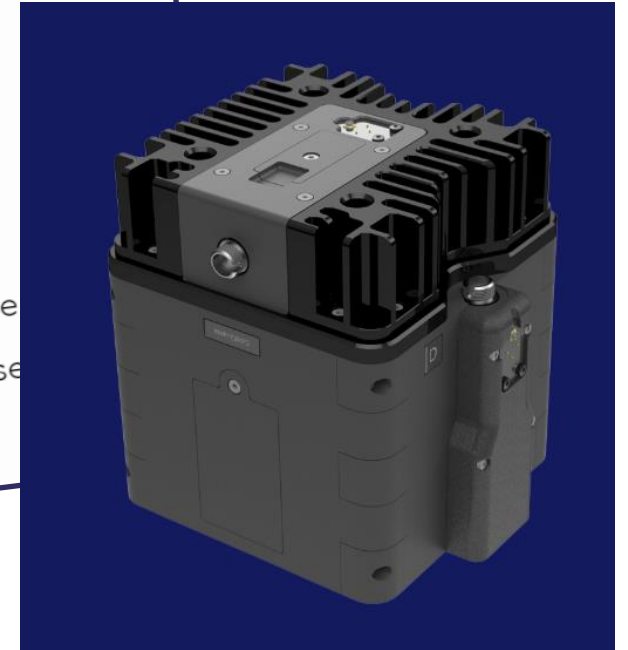


## Press Release

25 October 2023

Aquark Technologies Demonstrates Airborne Cold Atom System on a Small Drone

Aquark Technologies has successfully demonstrated continuous trapping of cold atoms suitable for sensing while a drone. The world first achievement will support an array of applications, including enhanced navigation, precise measurements, and situational awareness, all with the potential to revolutionize multiple industries.



Infleqtion: Magneto Optical Traps.

# Communications: Toshiba - QKD

- Close cousin of PNT
- QKD (Fibre and Free Space)
- Networks
- Communications.
- Security
- Key Management
- Others...



# 6 Industry Landscape

Companies are just as colourful as technologies!



# Example: We need impartial systems engineering.

- Quantum Safe
- Post Quantum Crypt
- Key management
- “Managing the sprawling network”
- Systems engineering; architectures; integration; assurance; cyber/security.



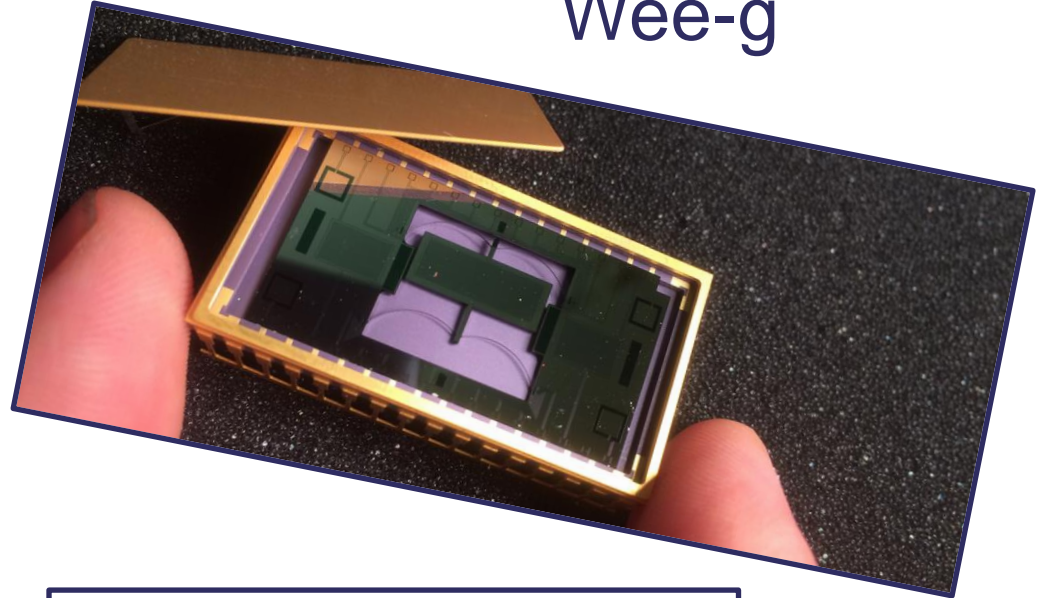
## The Future is Complex Systems

# Quantum or Not Quantum? Who Cares?

- MEMS

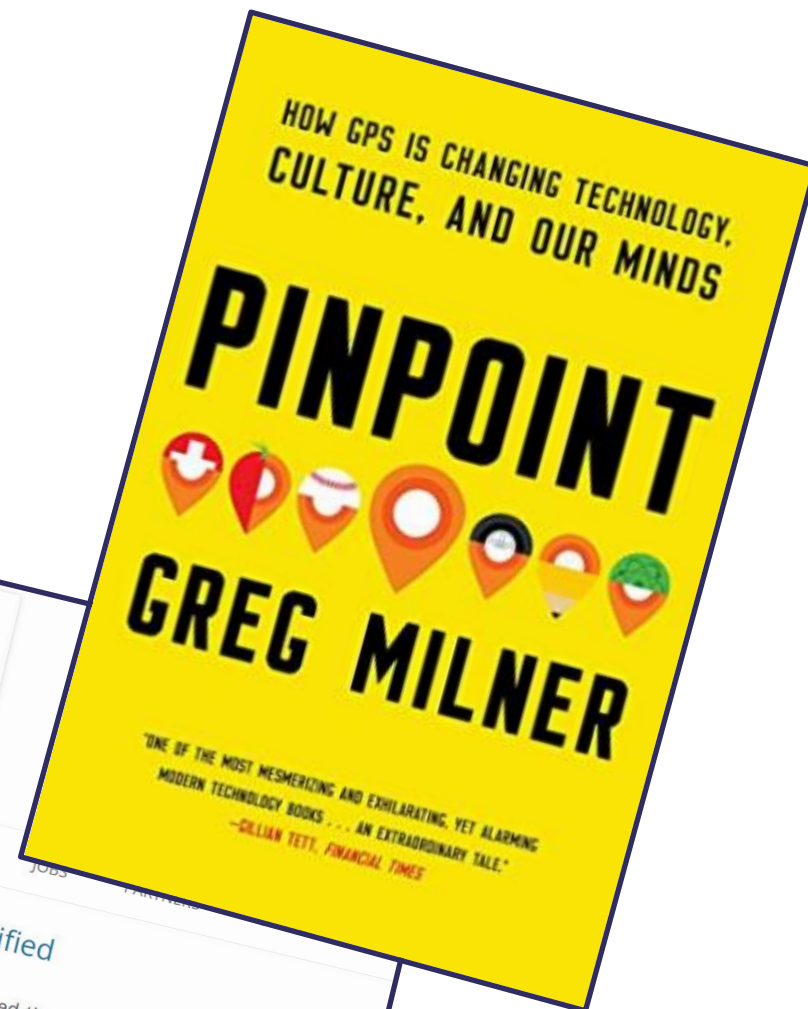


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# The Dichotomy Space or Not-Space?

- Has much changed since *Timation* – 1967?

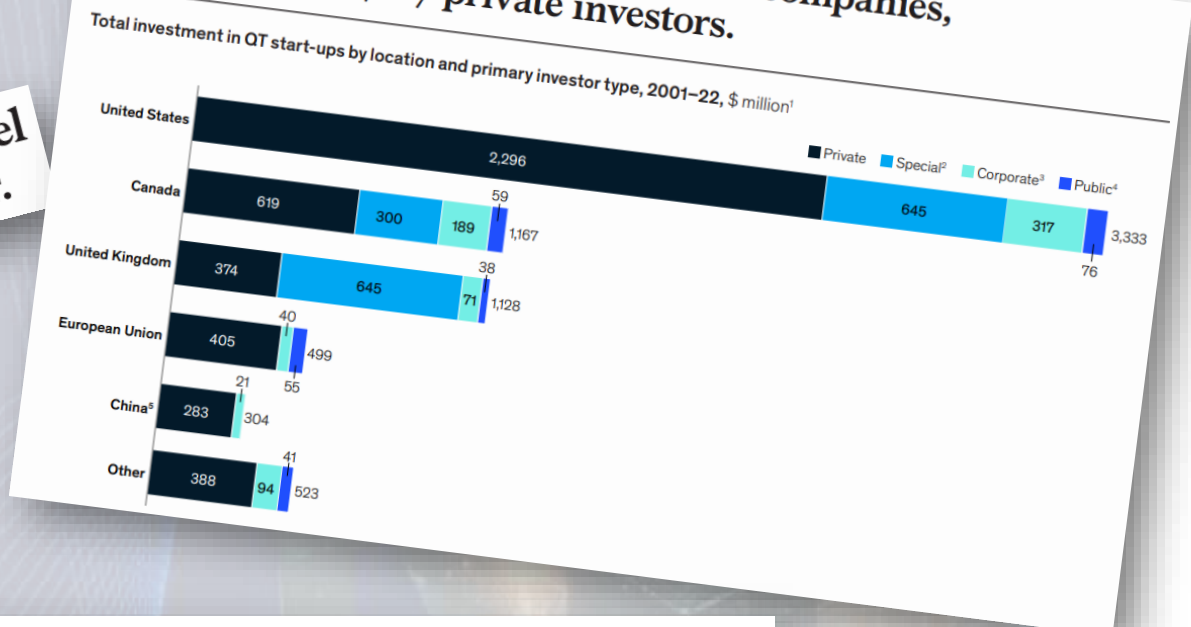


Venture capital and other private funding make up nearly 80 percent of QT inflows; venture capital, private, and angel investments grew in 2022.

## Quantum Technology Monitor

Total annual QT start-up investment hit the highest level of all-time, though it grew only 1 percent year over year.

The majority of investments are in US companies, driven primarily by private investors.



Seven out of ten deals in 2022 were valued at more than \$100 million.

Don't become obsessed with roadmaps. The future is not fixed. It can be influenced. Be on your own roadmap!

Purchasing power. It's never too early to make a sale.

The QLM story. Don't focus on the end user – focus on the dominant industrial entity. (Prime or Integrator.) Don't strive to replace – aim to augment.

There is something special about clocks and time.

The QKD story. Photonics.



UK Research  
and Innovation

# Conclusions i

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1. Don't become obsessed with roadmaps. The future is not fixed. It can be influenced. Be on your own roadmap!
2. Purchasing power. It's never too early to make a sale.
3. The QLM story. Don't focus on the end user – focus on the dominant industrial entity. (Prime or Integrator.) Don't strive to replace – aim to augment.
4. There is something special about clocks and time.
5. The QKD story. Photonics.

# Conclusions ii

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6. Ecosystem Readiness Levels – mature the industrial capability as well as the technology.
7. Remain technology agnostic. Strive for solutions or applications but not for both the same time.
8. Clocks for satellites or clocks instead of satellites? There is always more than one answer to the resilience question.
9. It is impossible to develop a significant new technology with public money alone. All public funding must be catalytic. Investors need global markets.

Companies are just as colourful as technologies!

