QuantCom: On Quantum-Communications Futures...

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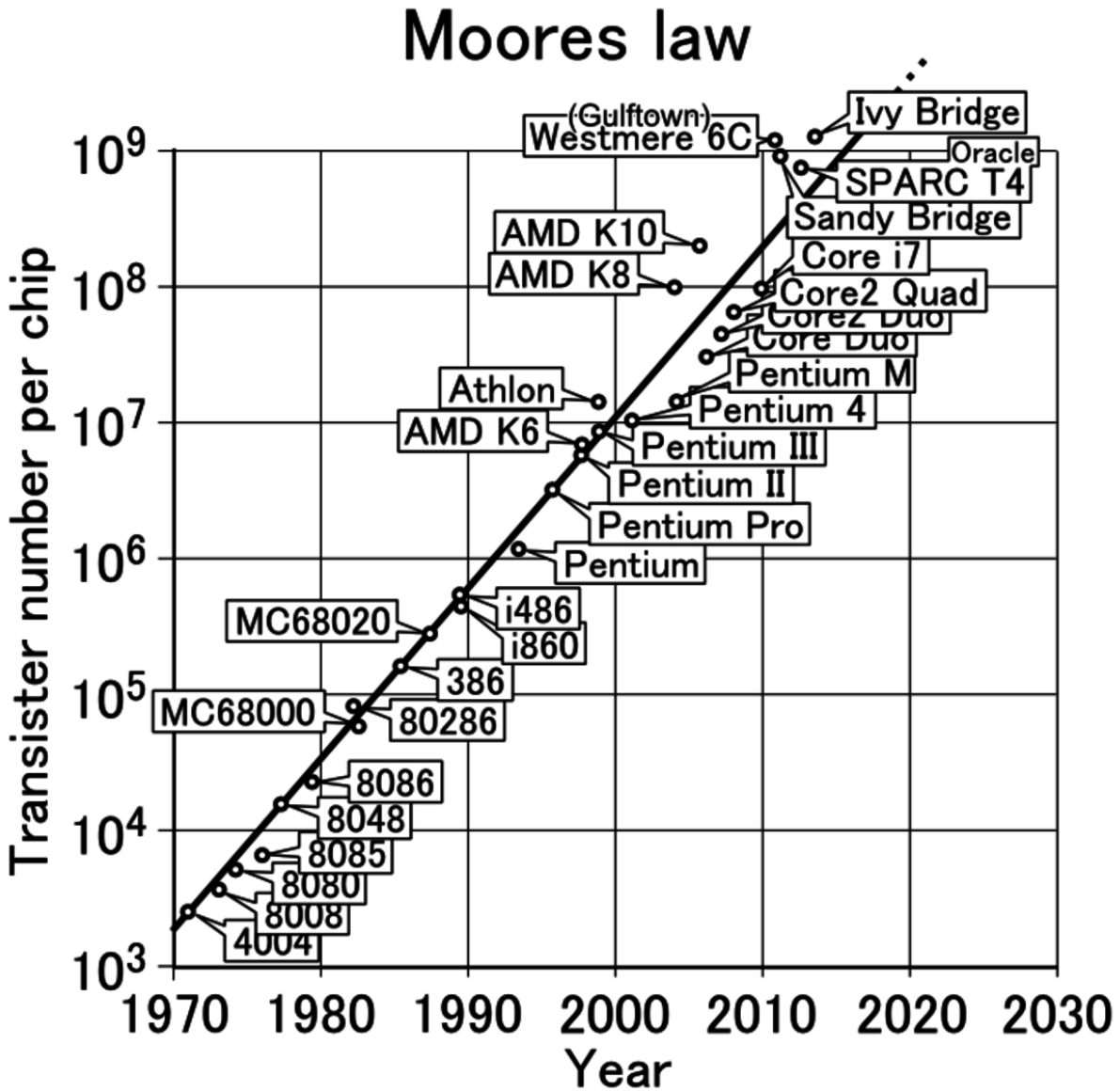
Overview

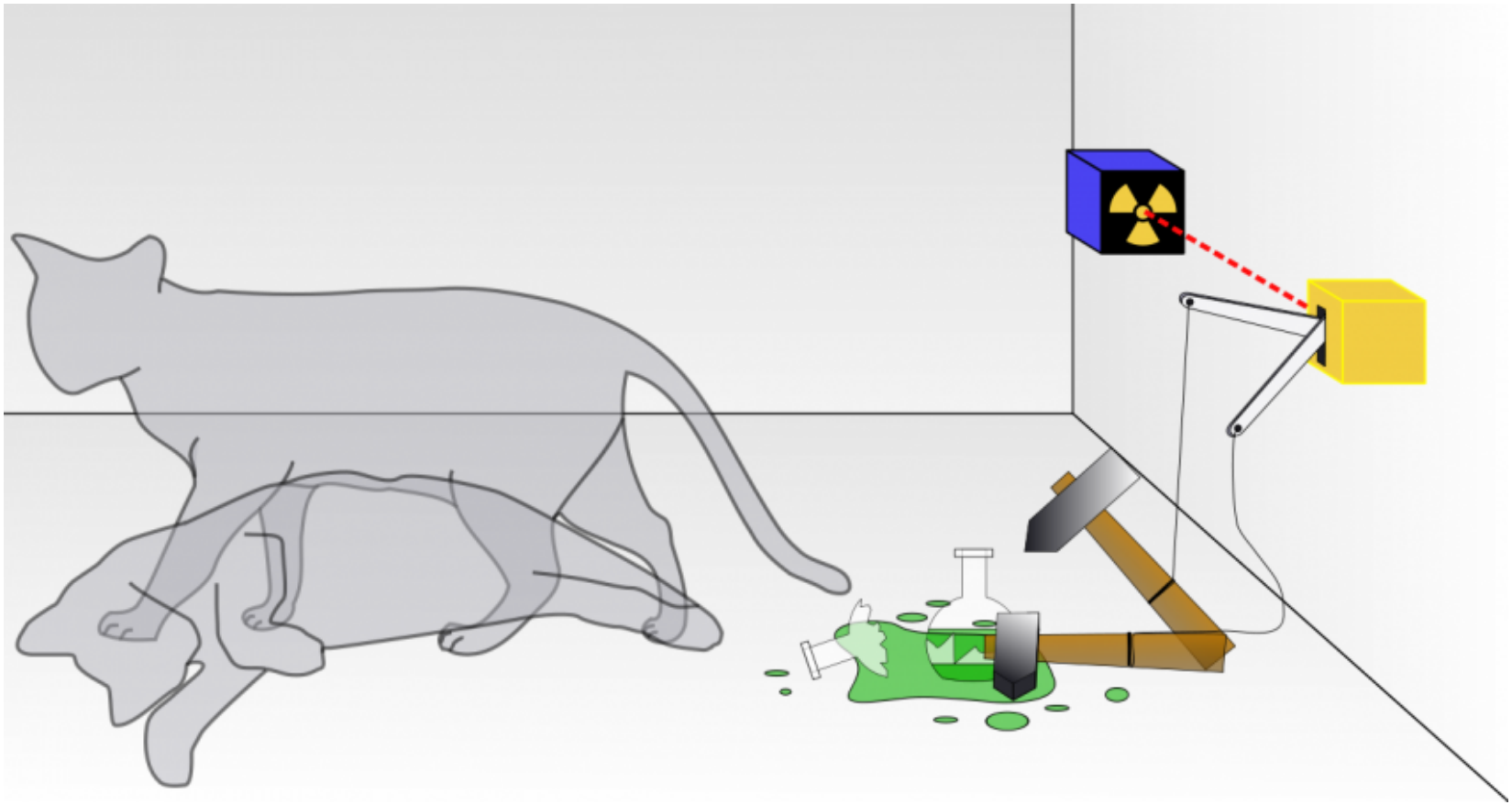
- **Moore's Law leads to nano-scale integration**
- **Superposition, Entanglement and all that...**
- **EXAMPLE - Quantum-Internet Above the Clouds**
- **The Future?**

Moore's Law...

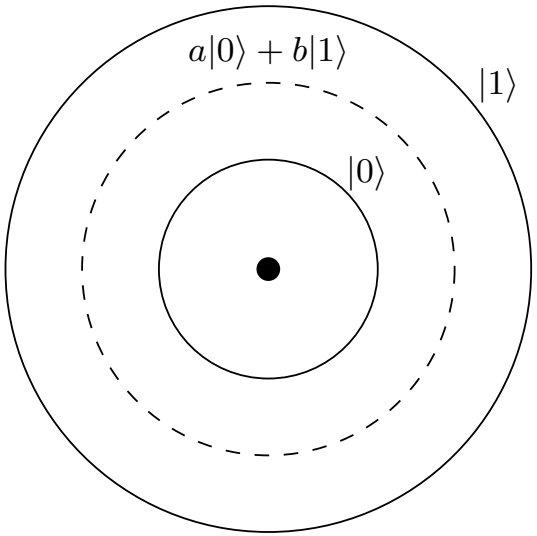


Source: http://theconversation.com/uk/technology

Superposition



Superposition

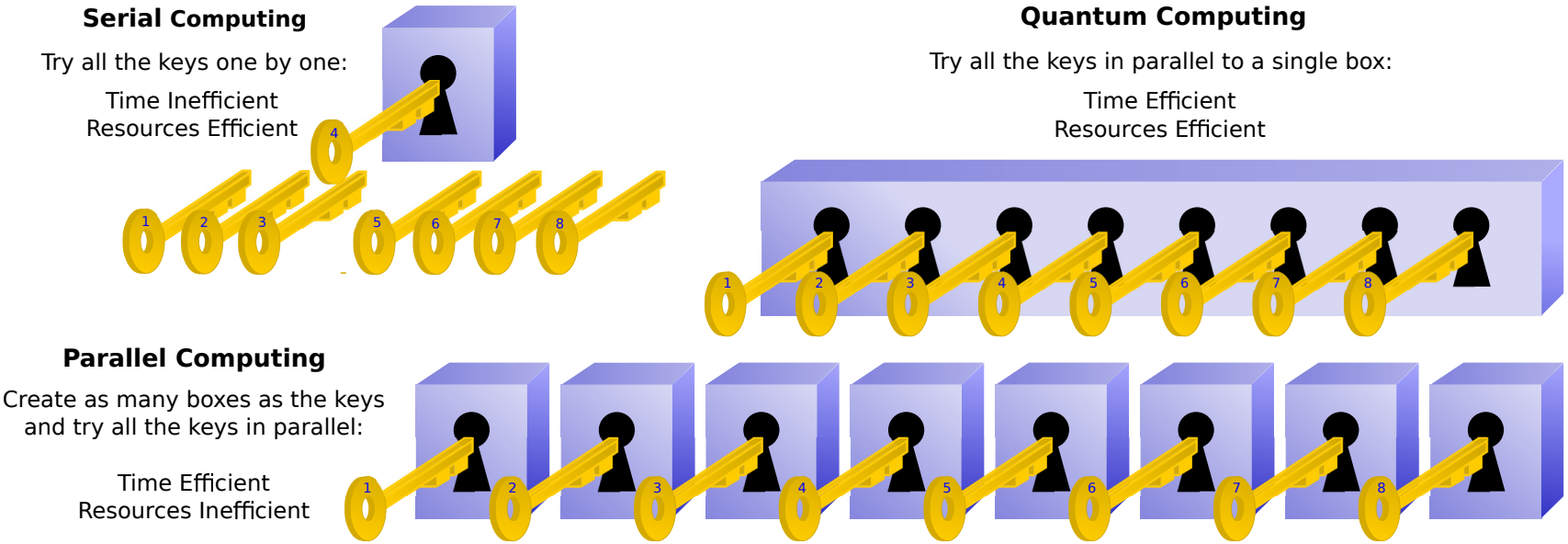


An atom with one electron orbiting around the nucleus having two legitimate energy levels (solid orbits). Quantum mechanics allow the electron to be in an arbitrary superposition of these two energy levels (dashed orbit), but when it is observed it may only be found in one of the two legitimate orbits.

Some Open Issues in Quantum Communicatiomns

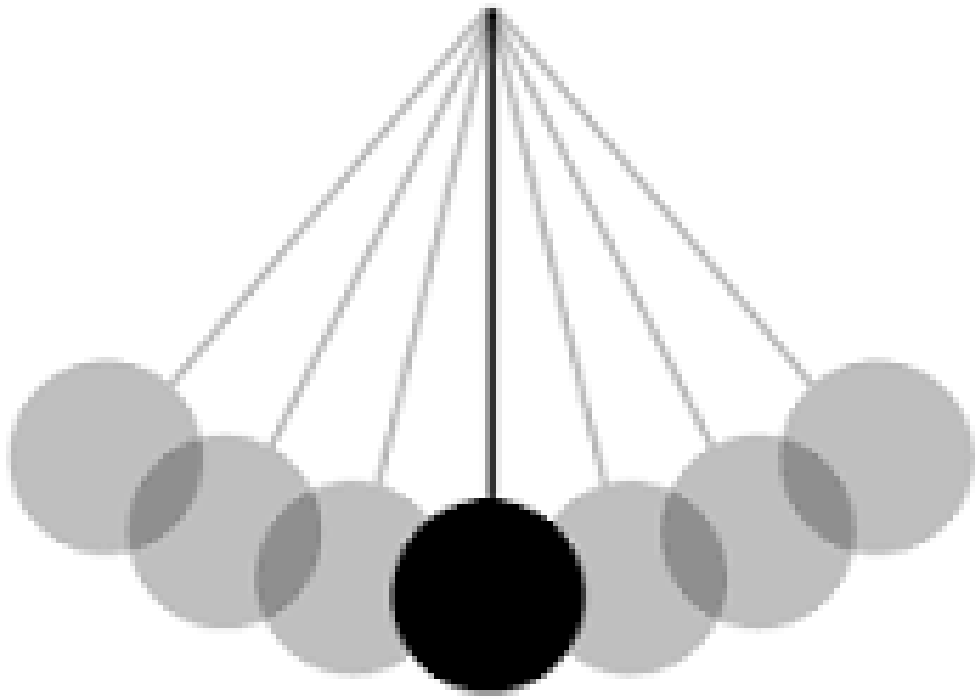
- The main challenge is to design perfectly secure communications systems, including the Quantum Internet, terrestrial as well as satellite systems. This requires the design of numerous new quantum componewnts, such as:
- Quantum-Key Distribution (QKD), quantum repeaters, quantum memory, quantum network coding, entanglement swapping, quantum codes etc;
- Since the fragile quantum states are prone to the deleterious effects of quantum flips, the design of powerful quantum codes is central to making this a reality;
- The most grave challenge is to conceive quantum communications systems for mobile objects, especially for high-velocity drones and airplanes.

The Quantum-Wireless Saga...



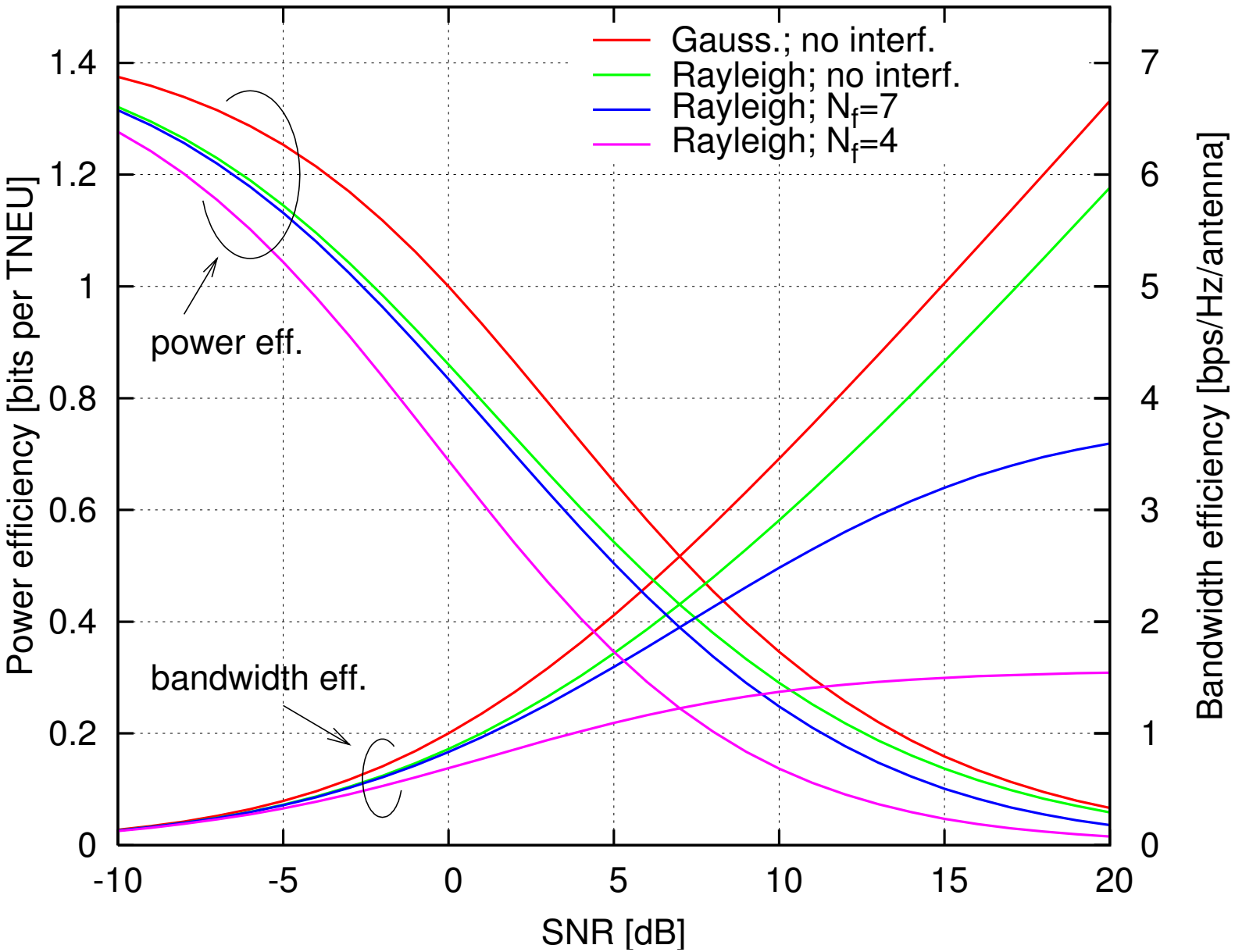
- **[Hanzo et al.]** Wireless Myths, Realities and Futures, Proc. of the IEEE, 13th of May 2012, Centennial Issue, Xplore Open Access
- **[Botsinis, Ng & Hanzo]**: Quantum Search Algorithms, Quantum Wireless and a Low-Complexity Maximum Likelihood Iterative Quantum Multi-User Detector Design, IEEE Access, May 2013, Xplore Open Access

Near-Capacity versus 'Green Radio Systems'... The Road from Single-Component to Multi-Component Optimization: Pareto-Optimal Systems



Pendulum Swing

Power vs Bandwidth-Efficiency - Single-Component OF

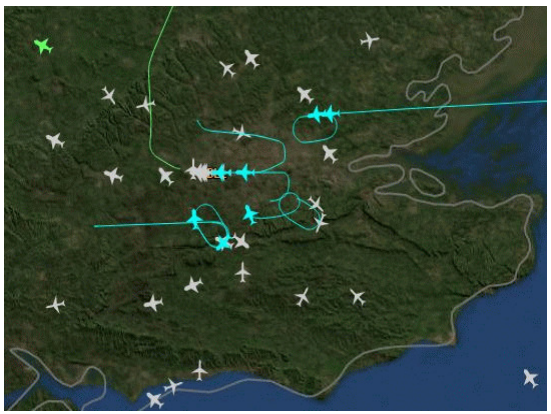


Quantum-Search Algorithm Aided Multi-Component Routing Optimization Examples

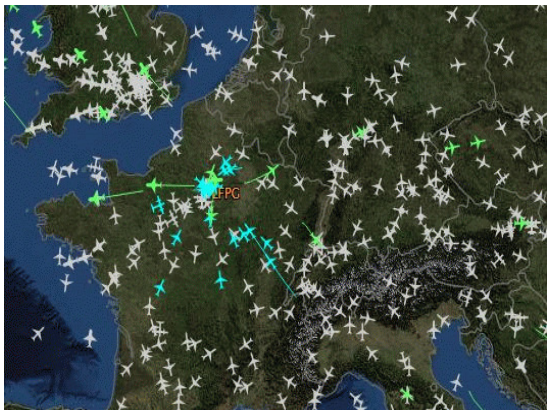
- Alanis, D.; Botsinis, P.; Babar, Z.; Ng, S.X.; Hanzo, L.: Non-Dominated Quantum Iterative Routing Optimization for Wireless Multihop Networks, IEEE Access
- Alanis, D. ; Botsinis, P. ; Soon Xin Ng ; Hanzo, L.: Quantum-Assisted Routing Optimization for Self-Organizing Networks: IEEE Access, Volume: 2, 2014, pp 614 - 632

Quantum-Assisted Routing Design Example: Multi-Component Pareto Optimization - BER, DELAY, POWER & COMPLEXITY

Aircraft mobility pattern for LHR, in the European airspace and over the North Atlantic, where quantum-search algorithms could be used for routing either classic or quantum-domain messages through the *ad hoc* network of planes



Heathrow Airport



European Airspace

North Atlantic

- https://uk.flightaware.com/live/airport/EGLL

An exciting era for quantum communications