

SUDDENLY SEVENTY - YET STILL FULL
STEAM AHEAD!
BUT WHERE ARE WE HEADING DR
EINSTEIN?...

Presented by
Lajos Hanzo

November 7, 2019

Historic Preamble...



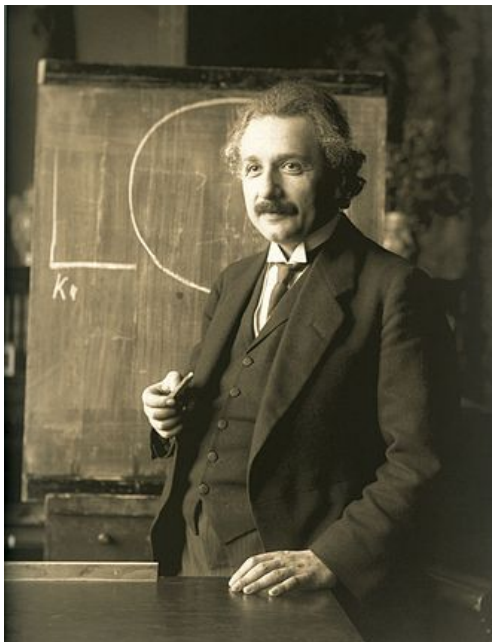
The Founders of Our Field



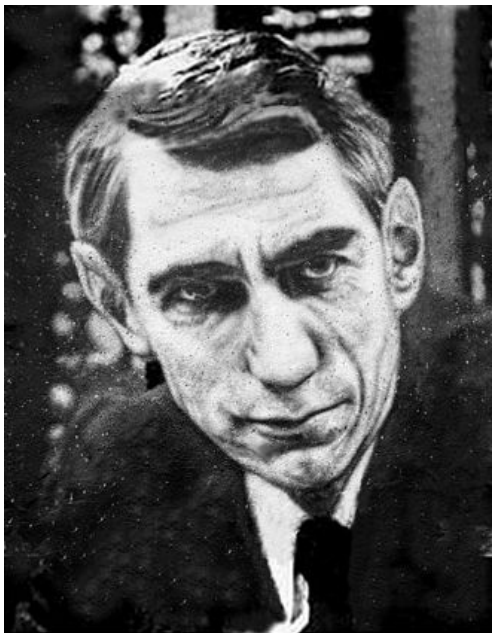
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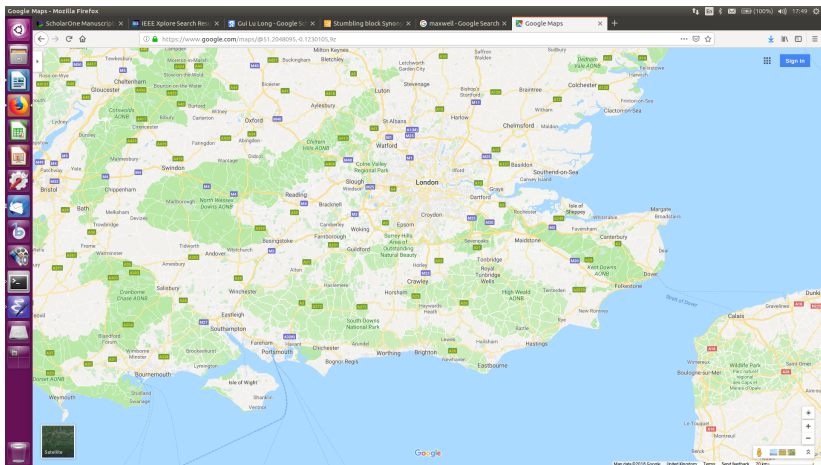
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Life Through the Communications Era V 1.0...



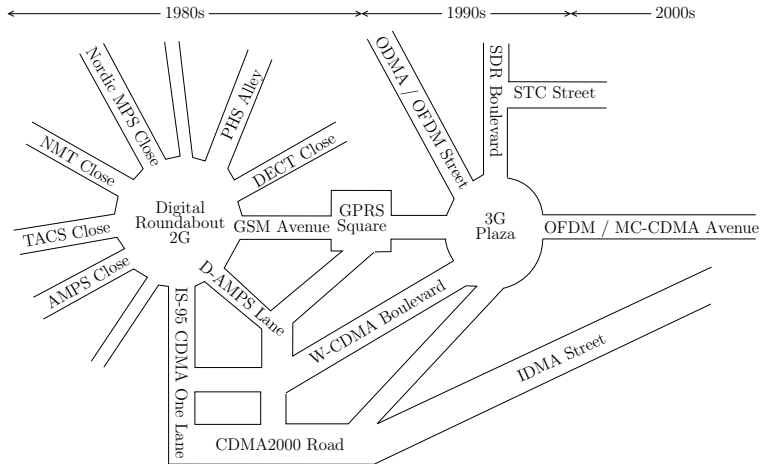
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UNIVERSITY OF
Southampton

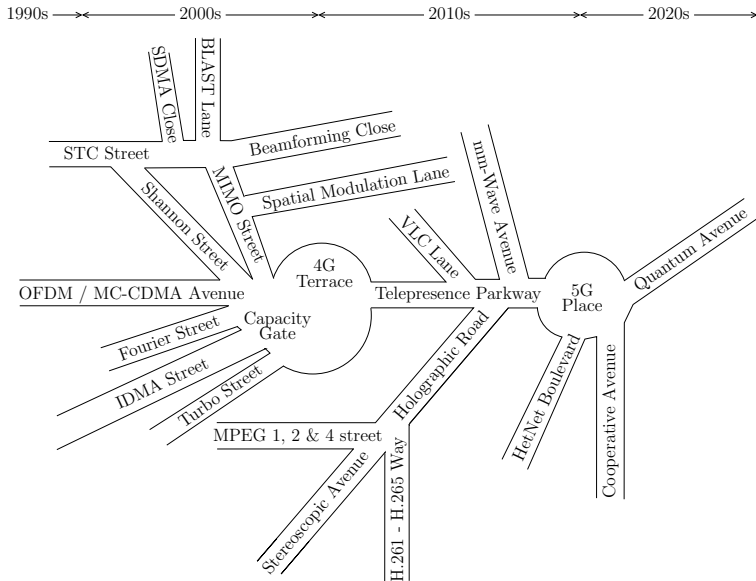
Southampton Wireless Research Group

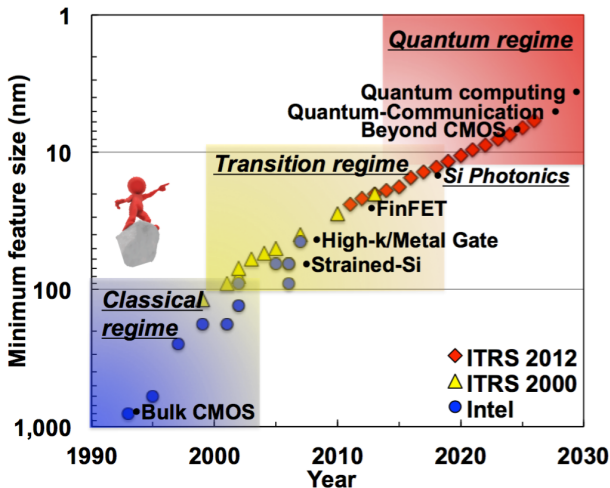


A Stroll with Shannon to Next-Generation Plaza...



A Stroll with Shannon to Next-Generation Plaza...



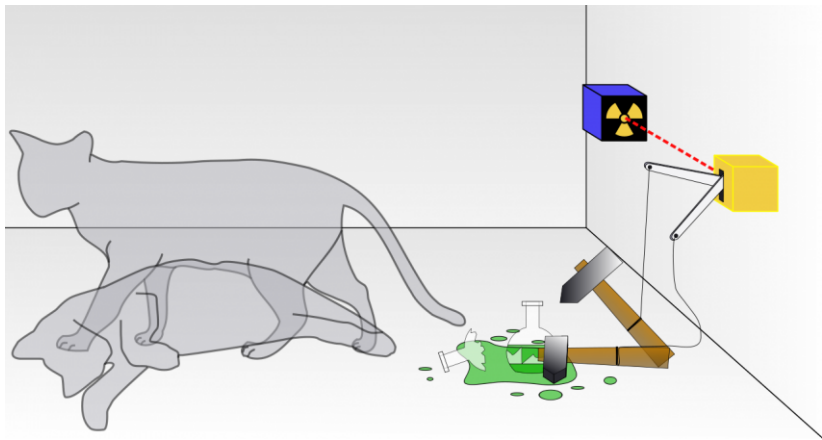


Source: The Conversation

<http://theconversation.com/uk/technology>



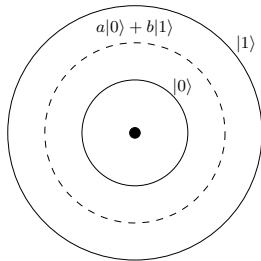
Hey Lajos, so what's so special about this quantum-buzz -
exclaims Barney...? ©CCBY



Introduction to Quantum Computing

Would it Ever Happen...?

Superposition - Schroedinger's Cat & Feynman Suggestion

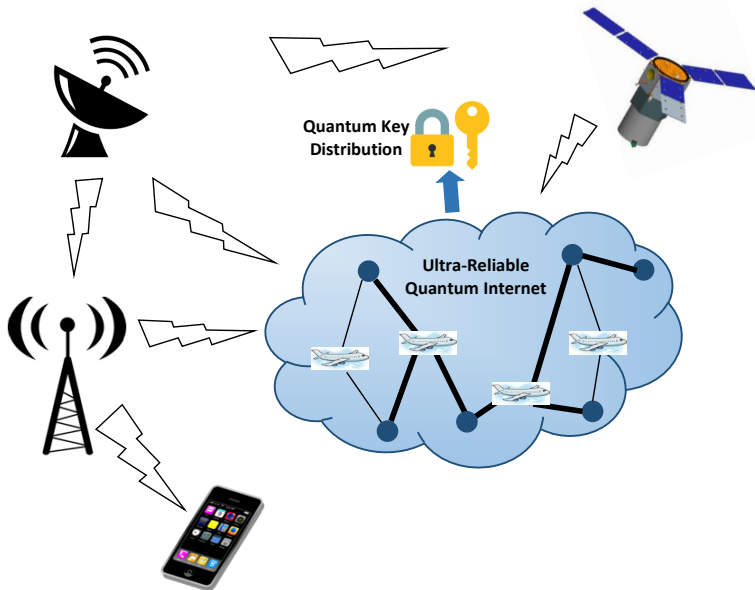


An atom with one electron orbiting around the nucleus having two legitimate energy levels (solid orbits). Quantum mechanics allow the electron to be in an arbitrary superposition of these two energy levels (dashed orbit), but when it is observed it may only be found in one of the two legitimate orbits.

So, now I understand superposition, volunteers Barney...
So... does this mean I could chase all these bunnies at the
same time...? ©CCBY

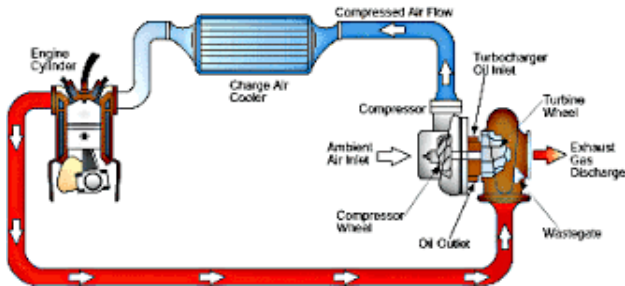


Quantum-Wireless Futures...





How Do We Turbo-Charge Quantum Research?

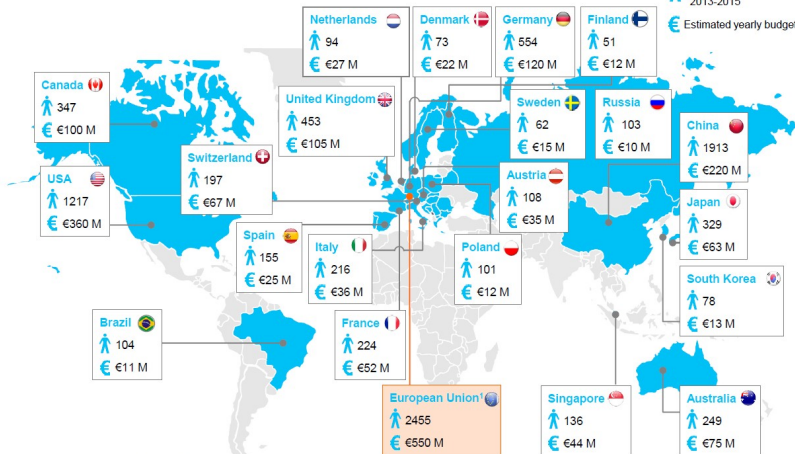
The closely-knit multi-disciplinary collaboration of physics, signal processing, communications, computer science, hardware design etc is required to answer many hitherto unanswered **frontier-research** questions.



Worldwide, ~7000 researchers work with budget of ~€1.5 B, expected to increase to ~€5 B

NON-CLASSIFIED

 Nr of unique authors 2013-2015
 Estimated yearly budget



¹ Combined estimated budget of EU countries

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NSF 2026 NSF INCLUDES Quantum Leap Understanding the Rules of Life Windows on the Universe

Quantum Leap

Enabling quantum mechanics to observe, manipulate, and control the behavior of particles and energy at atomic and subatomic scales, resulting in next-generation technologies for sensing, computing, modeling, and communicating.

Many of today's technologies -- lasers, computers, GPS and LEDs among them -- rely on the interaction of matter and energy at extremely small and discrete dimensions. By exploiting interactions of these quantum systems, next-generation technologies for sensing, computing, modeling and communicating will be more accurate and efficient. To reach these capabilities, researchers need understanding of quantum mechanics to observe, manipulate and control the behavior of particles and energy at dimensions at least a million times smaller than the width of a human hair.

Research into quantum materials is essential for preparing future scientists to implement the discoveries of the next quantum revolution into technologies that will benefit the average consumer. There will be strong connections to industry, federal agencies and international partners.

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[Quantum Leap Challenge Institutes \(QLCI\)](#)
(Program Announcement, Feb. 19, 2019)

[Enabling Quantum Leap: Quantum Idea Incubator for Transformational Advances in Quantum Systems \(QI - TAQS\)](#)

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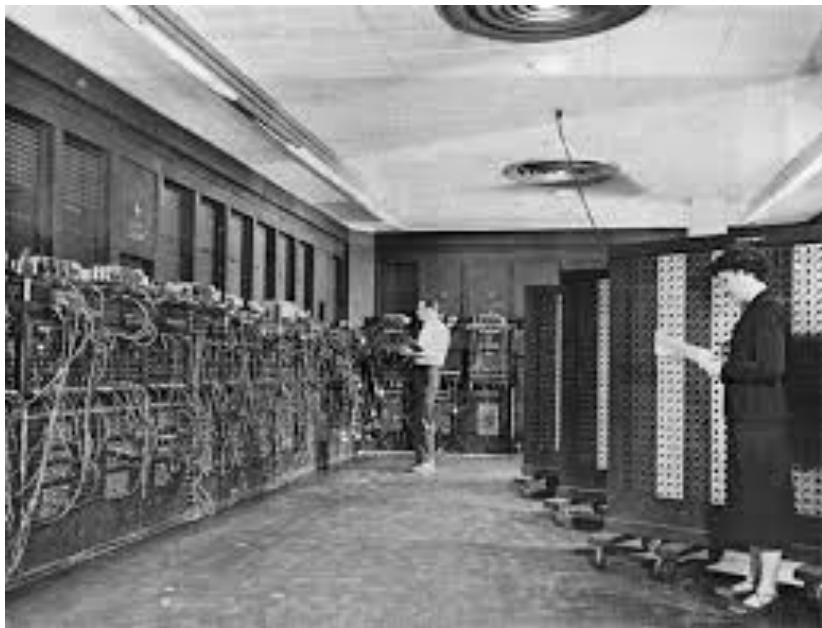
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The First Computers in the 1950s ©CCBY

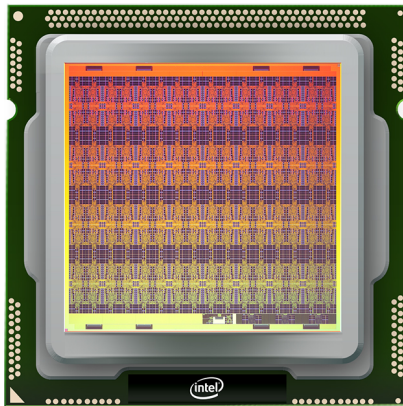
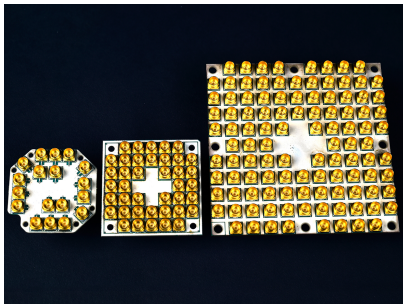


In 50 Years of Moore's Law - We've Arrived Here...

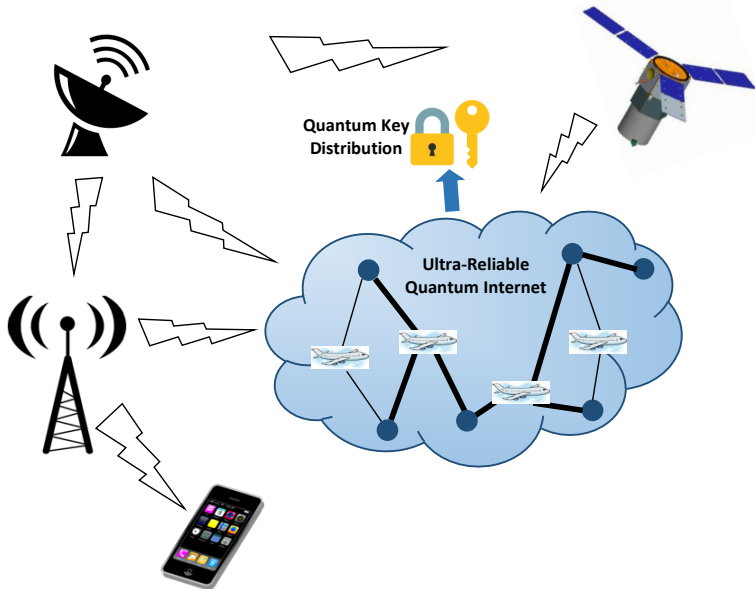


The 17-Qubit IBM Quantum Computer ©CCBY





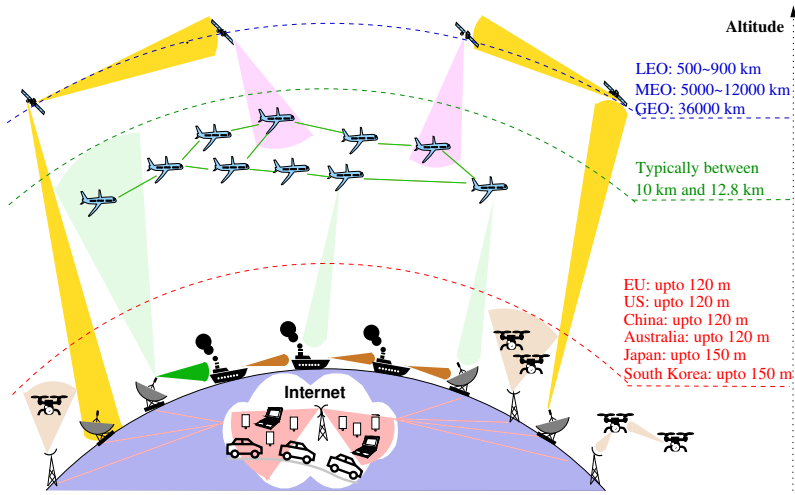
So, Would We Ever Get To This...?



Oh, I am so bored - may I finally chase some bunnies...?



What Will 6G Be?



So Full Steam Ahead Towards a Quantum Future... But Would It Work Dr Einstein? ©CCBY

