FACT SHEET

QUANTUM COMPUTING (QC)

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COMPUTERS BEYOND IMAGINATION

The Essence: Using the characteristics of quantum mechanics to create superior computing power.

Characteristics: *Ordinary computers* work with binary digits – or "*bits*" – which may resume *two values*: 0 or 1. These are represented by *electronic charges* in transistors and microchips, and are at the core of the functionality of the conventional computer. The more bits which can operate in parallel, and the faster these electronic charges can alternate and move, the more processing power does the computer have. However, it will always have the limitation of the two single values. *Quantum computers* work with *quantum bits* – or "*qbits*" – which may resume the same *two values*, but also *any other value in between*. They can even hold the two values at once. These features are explained by quantum mechanical phenomena like superposition and entanglement. Such qbits are constructed as *oscillating electronic charges* on tiny capacitors, distributed in a chessboard pattern on a microchip. There are couplers (resonators) between these capacitors which are controlled in an *electromagnetic field*, and the *near absolute zero temperature* (0.015 Kelvin) maintains stability. Due to this "multi-value" feature of qbits, quantum computers may theoretically perform an unimaginable *higher number of simultaneous computations* than the conventional computer. The main challenge is to develop a technology which is stable enough to keep error rates down - and to keep that stability over time.

Business value: Wherever complex and large computing tasks are required quantum computers have the potential to literally change the world. So far, there are prototype quantum computers which perform certain parts of what a full quantum computer may eventually do, but system stability remains a serious challenge. We are still several years – perhaps decades – away from a quantum computer with full functionality and capacity.

Concerns: As with so many other emerging and disruptive technologies, there are serious concerns about such a powerful technology falling into the hands of malicious actors, and/or being breached and used for purposes other than serving good.

Successful implementations: None yet. But there is a potential to radically alter resource-demanding computations of complex nature, e.g. chemistry modeling, material design, aerospace physics, climate forecasts, cryptography – and any type of big data analytics.

Hot tip: Let's wait and see. Meanwhile – we will follow the development with interest!

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