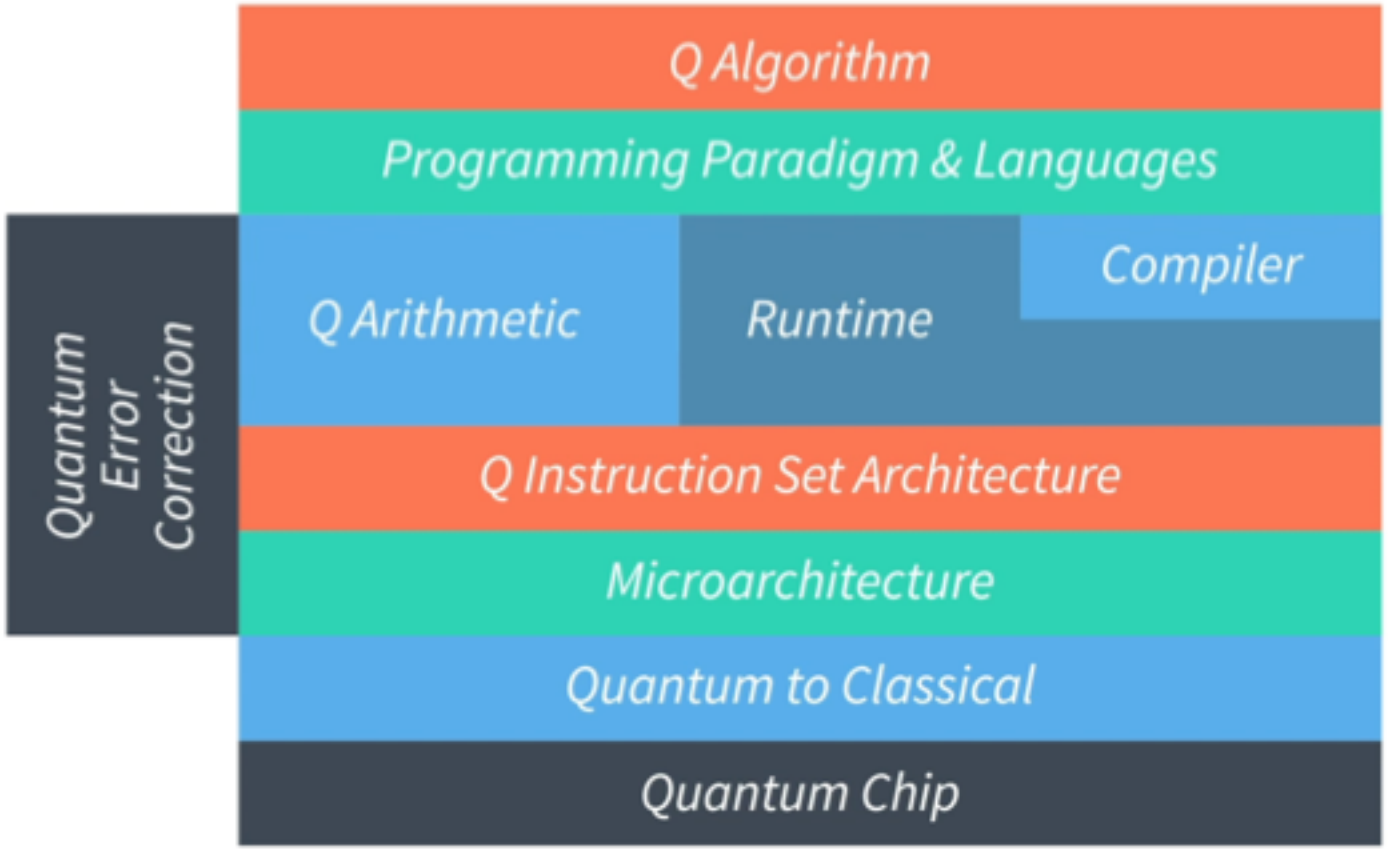
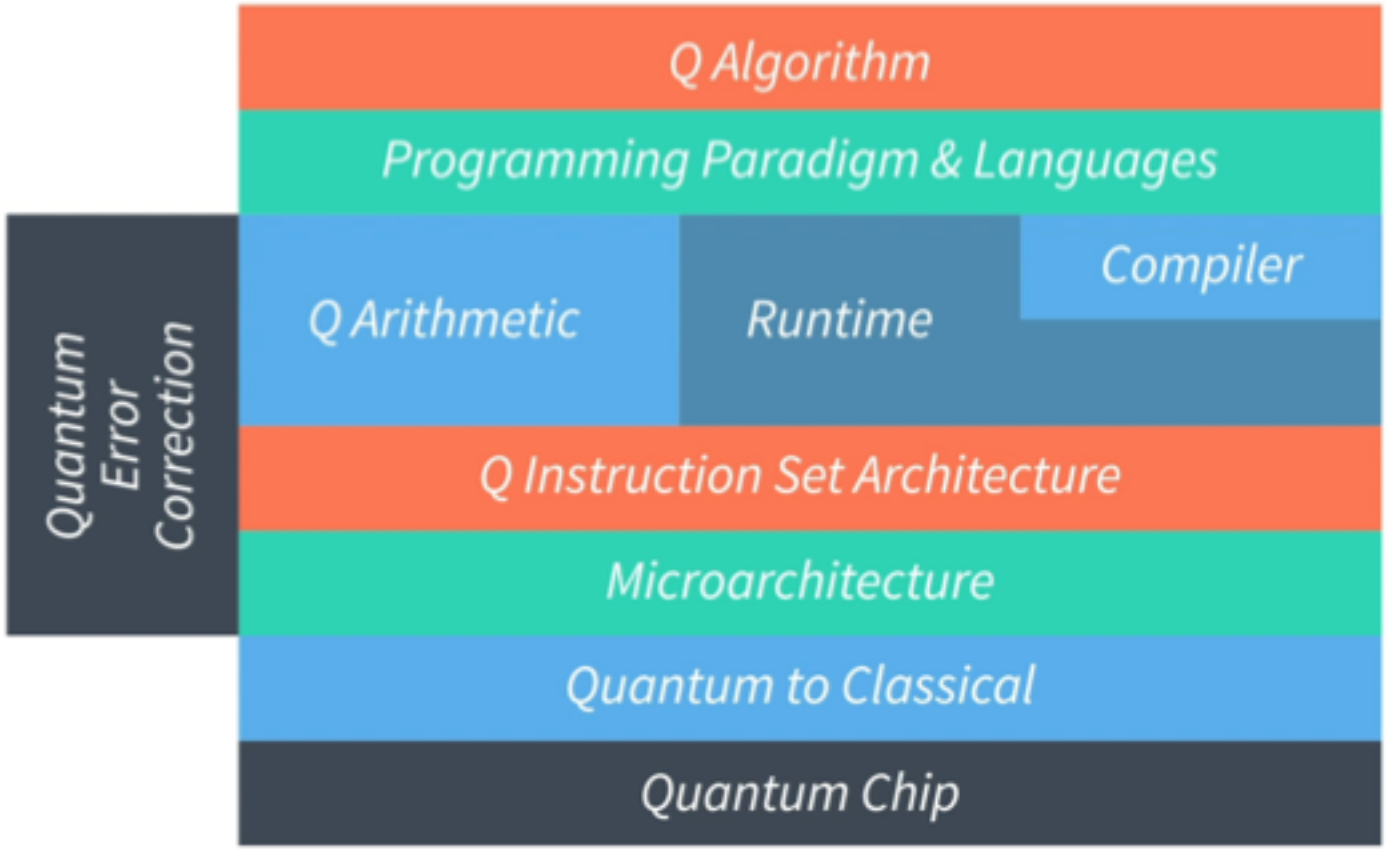
Menno Veldhorst

Closing lecture

The quantum computer stack vision

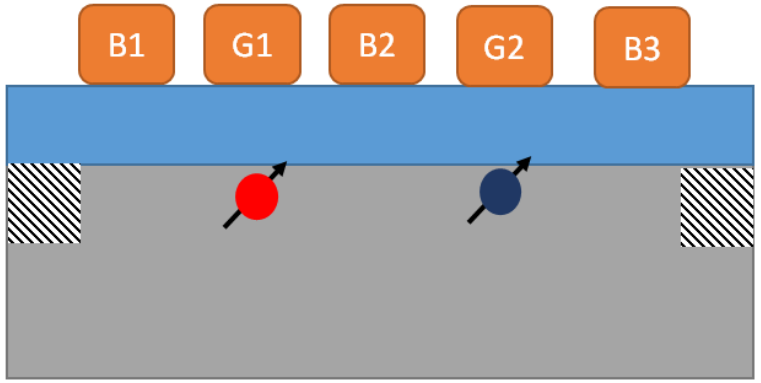


The quantum computer stack vision

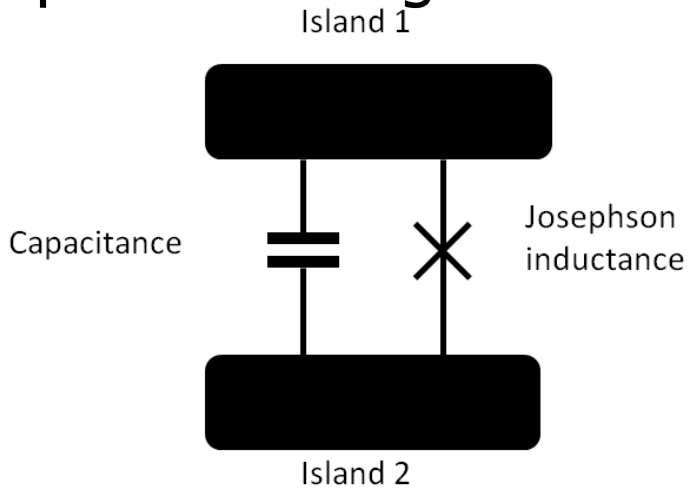


The qubits

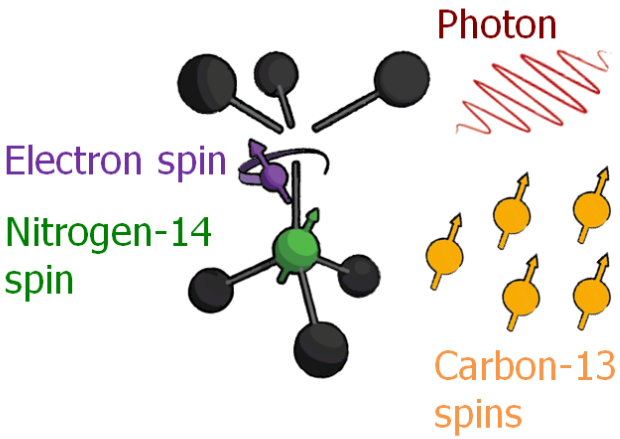
Ouantum dot



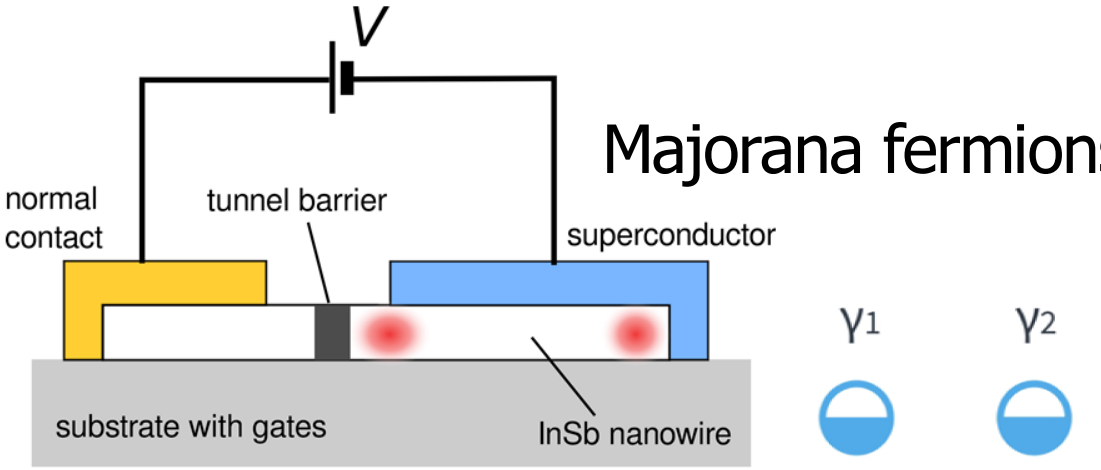
Superconducting transmon



The NV center in diamond



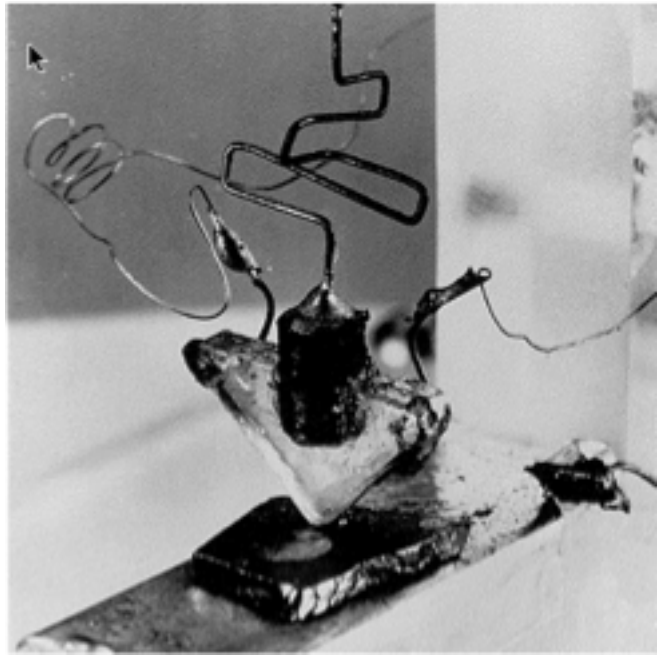
Majorana fermions



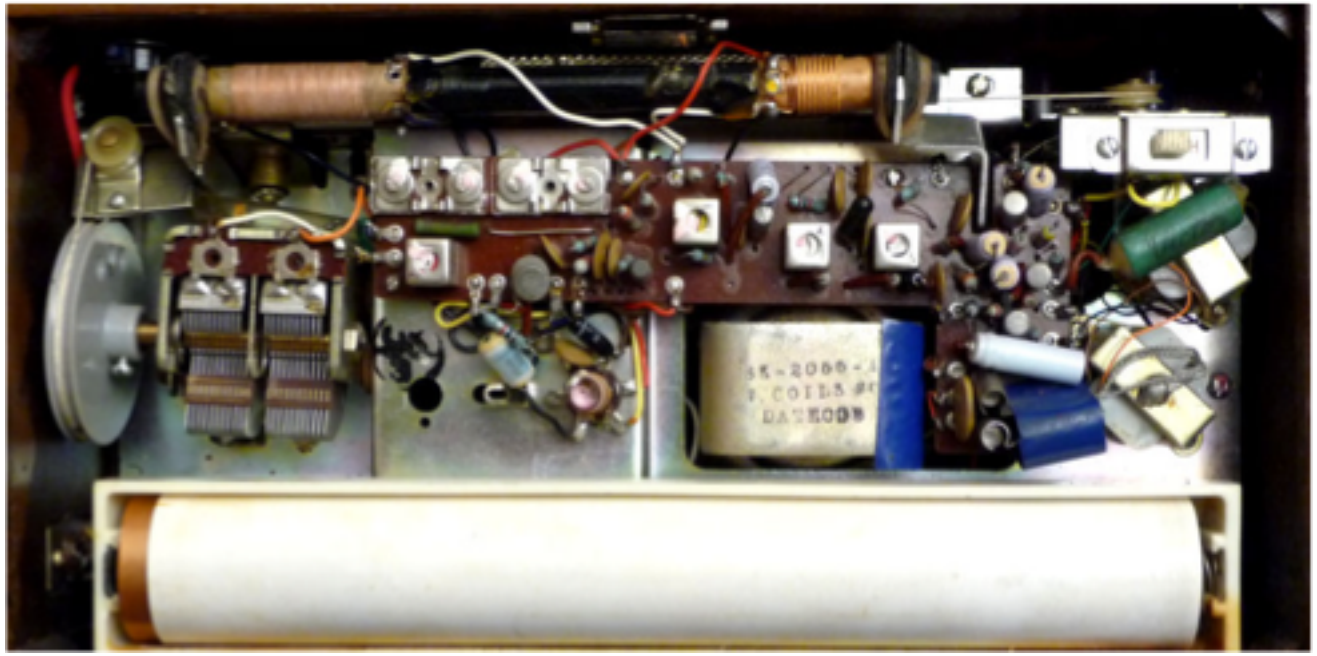
Quantum computing

Where are we now? A classical perspective

1947 First transistor



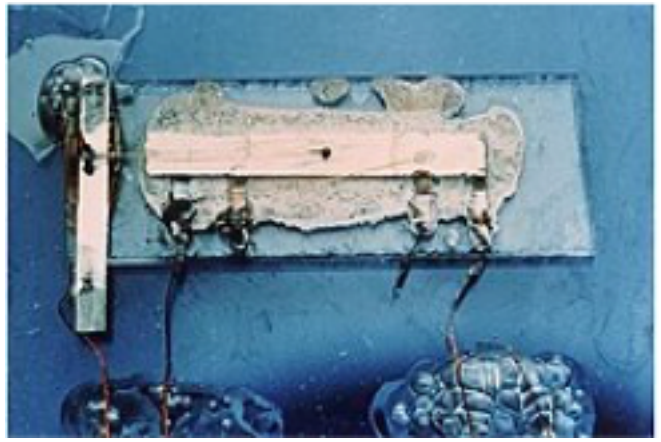
1954 First transistor radio's



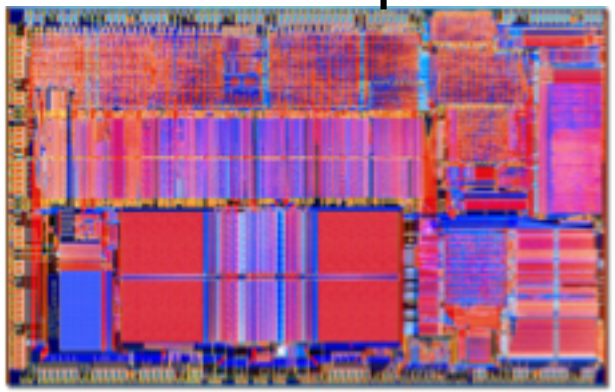
'*The tyranny of numbers'* Jack Morton vice president Bell labs 1958

Rent's rule

1958 First integrated circuit



1989 Intel 486 processor



$$T = tg^p$$

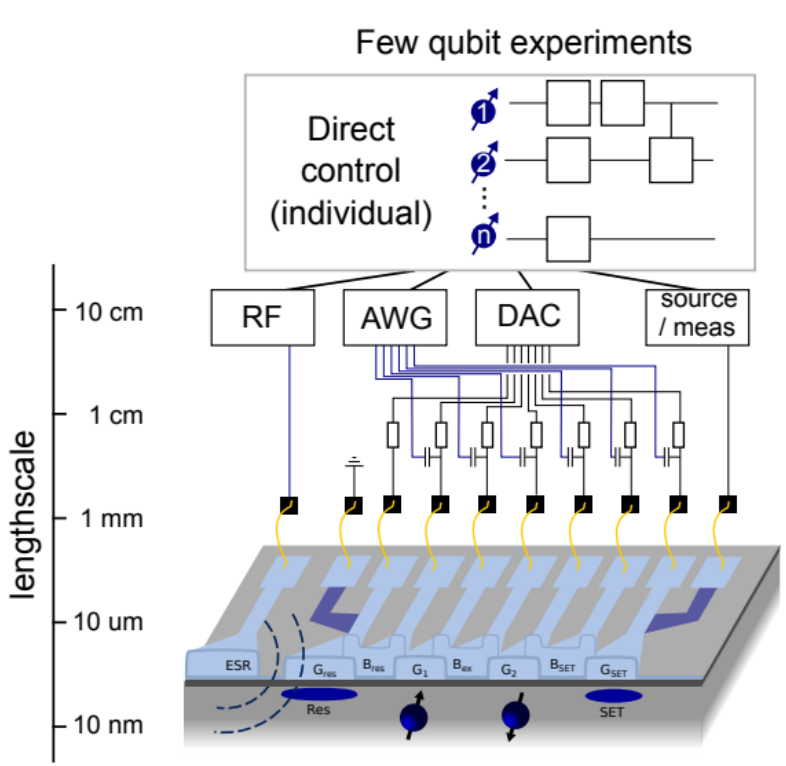
T control terminals
g internal components
p Rent exponent – level of optimization

p = 1 no optimization
p = 0.36 Intel X86 microprocessors

Rent's rule in quantum computing

Today: $p = 1$

Future: $p < 0.5$?



Quantum Rent's rule for *g* qubits

$T = t\, g^p$

RT wires

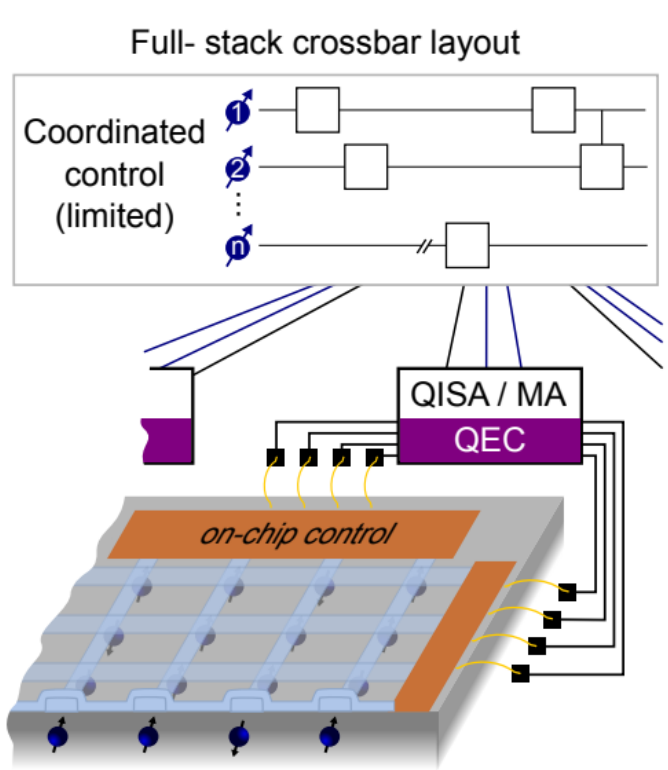
$p_{RT} = p_{IO}$ | $p_{RT} < p_{IO}$

chip IOs

$p_{IO} = p_g$ | $p_{IO} < p_g$

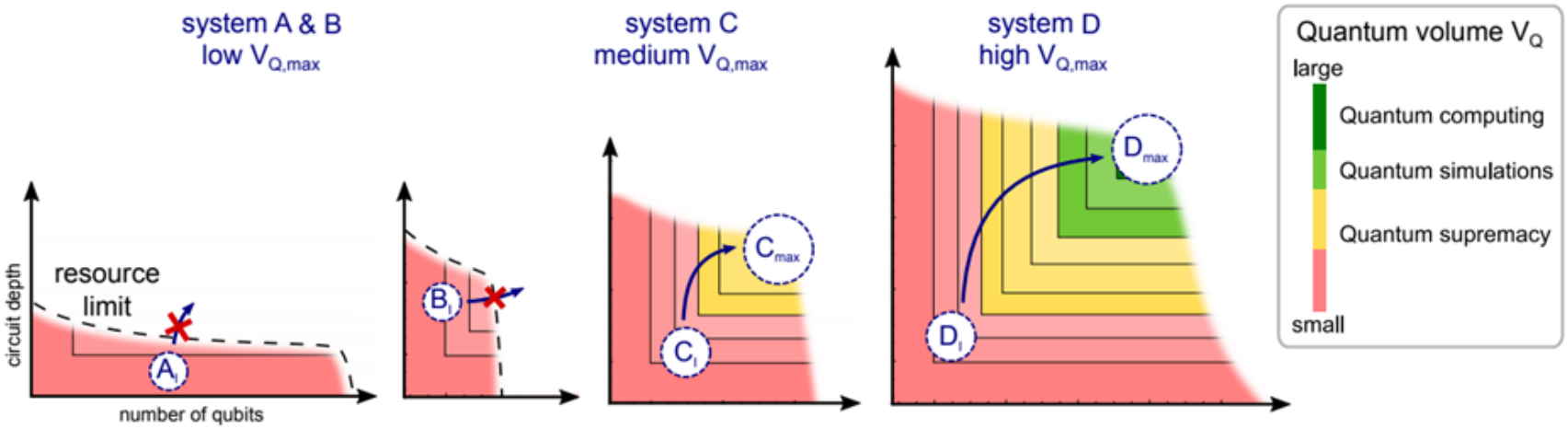
gates

$p_g \sim 1$ | $p_g \sim 0.5$



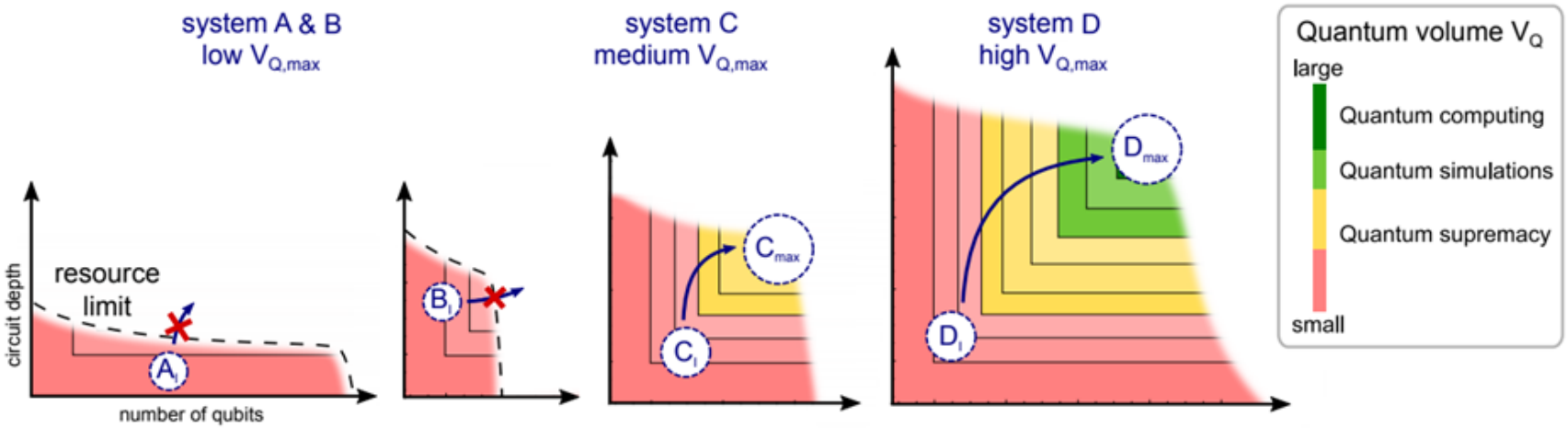
D.P. Franke, J.S. Clarke, L.M.K. Vandersypen, M. Veldhorst, arXiv:1806.02145

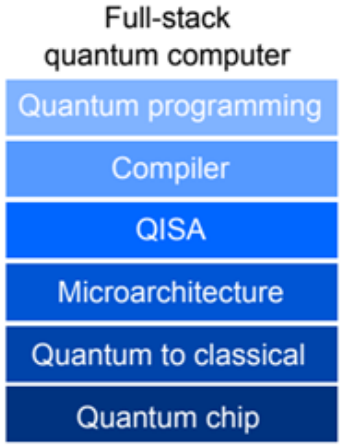
Functionality of a quantum system

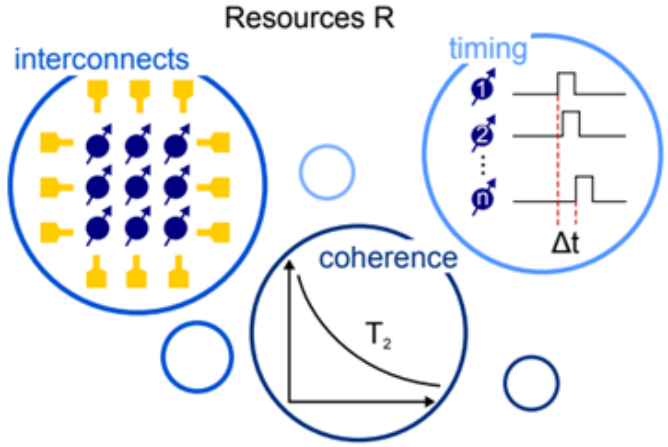


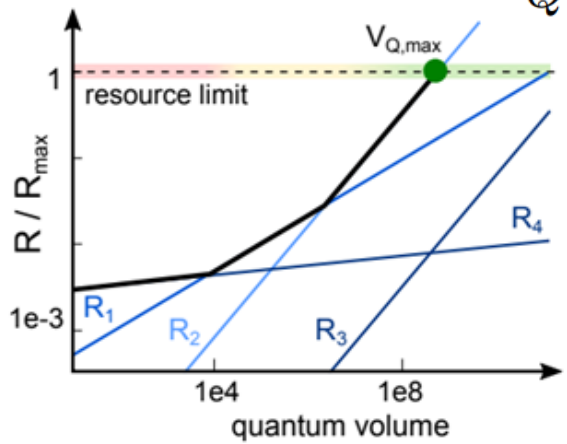
D.P. Franke, J.S. Clarke, L.M.K. Vandersypen, M. Veldhorst, arXiv:1806.02145

What is your quantum extensibility?









$$V_{Q,\max} = \left(\frac{R_{\max}}{R_I}\right)^{X_R} V_{Q,I}$$

Resource R
Quantum volume V
Quantum extensibility X

D.P. Franke, J.S. Clarke, L.M.K. Vandersypen, M. Veldhorst, arXiv:1806.02145

Quantum computer and quantum internet

Part 1: The quantum hardware

Part 2: The higher layers on the stack, including

- Quantum algorithms
- Quantum error correction
- Compiler and programming
- QISA
- Micro Architecture
- Classical control electronics

- Quantum internet
- Quantum network
- Quantum communication