

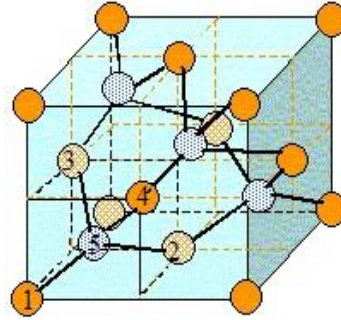
Atos Quantum : an application-oriented program for business

SCAsia2019 in Singapore

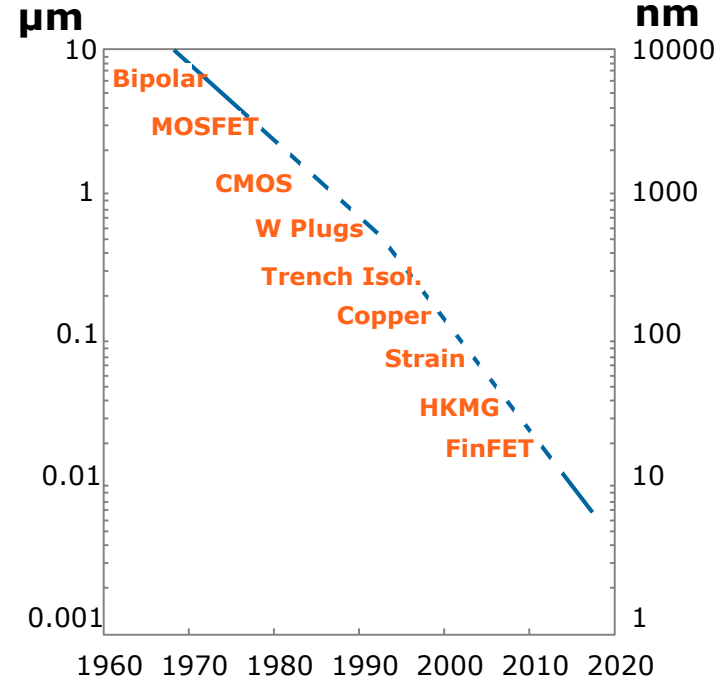
Philippe Duluc,
Atos CTO Big Data & Security

The Atos logo is displayed in a bold, white, sans-serif font. The letter 'o' is stylized with a circular cutout in the center. The background of the slide is a dark blue field filled with numerous small, bright white stars, creating a starry or quantum-like effect.

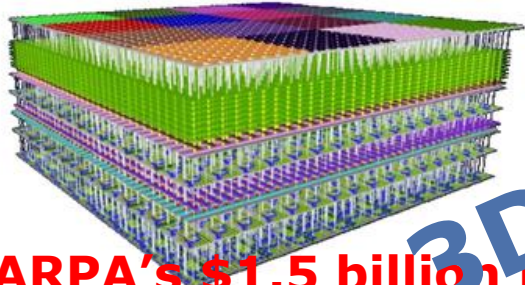
The computing disruption for Atos



- ▶ Moore's law declining: 0,3 nm between 2 atoms in Silicon crystal, chip fabrication process < 10 nm
- ▶ obligation for Atos to find new directions in order to provide accelerations required by customers



Alternatives?



3DCPU?

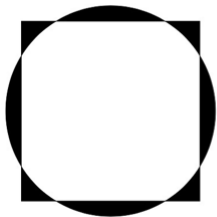
DARPA's \$1.5 billion Electronics Resurgence Initiative (ERI): the Three Dimensional Monolithic System-on-a-Chip (3DSoC) program

Why Bio Computing ??

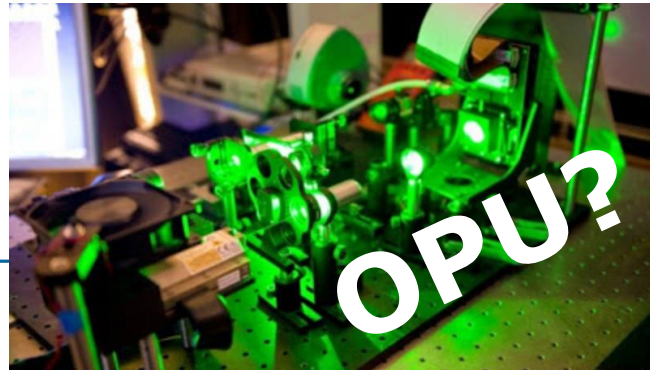
- Moore's Law states that silicon microprocessor complexity will double in every 18 months.
- One day this will no longer hold true when miniaturization limits are reached.
- Solving complex problems which today's supercomputers are unable to perform in stipulated period of time.
- Require a Successor to Silicon

BPU?

ABDULLAH FARHAD



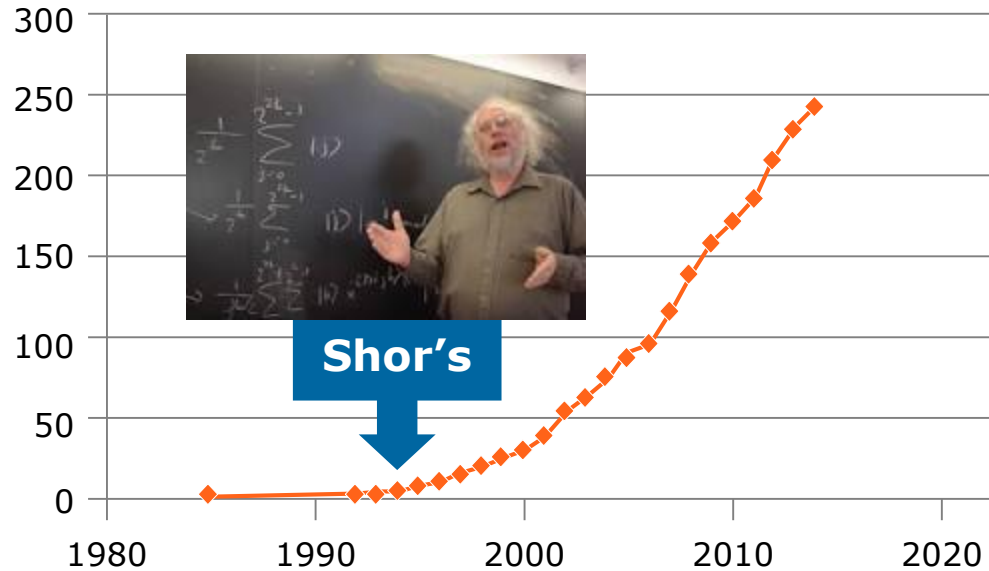
LightOn



OPU?

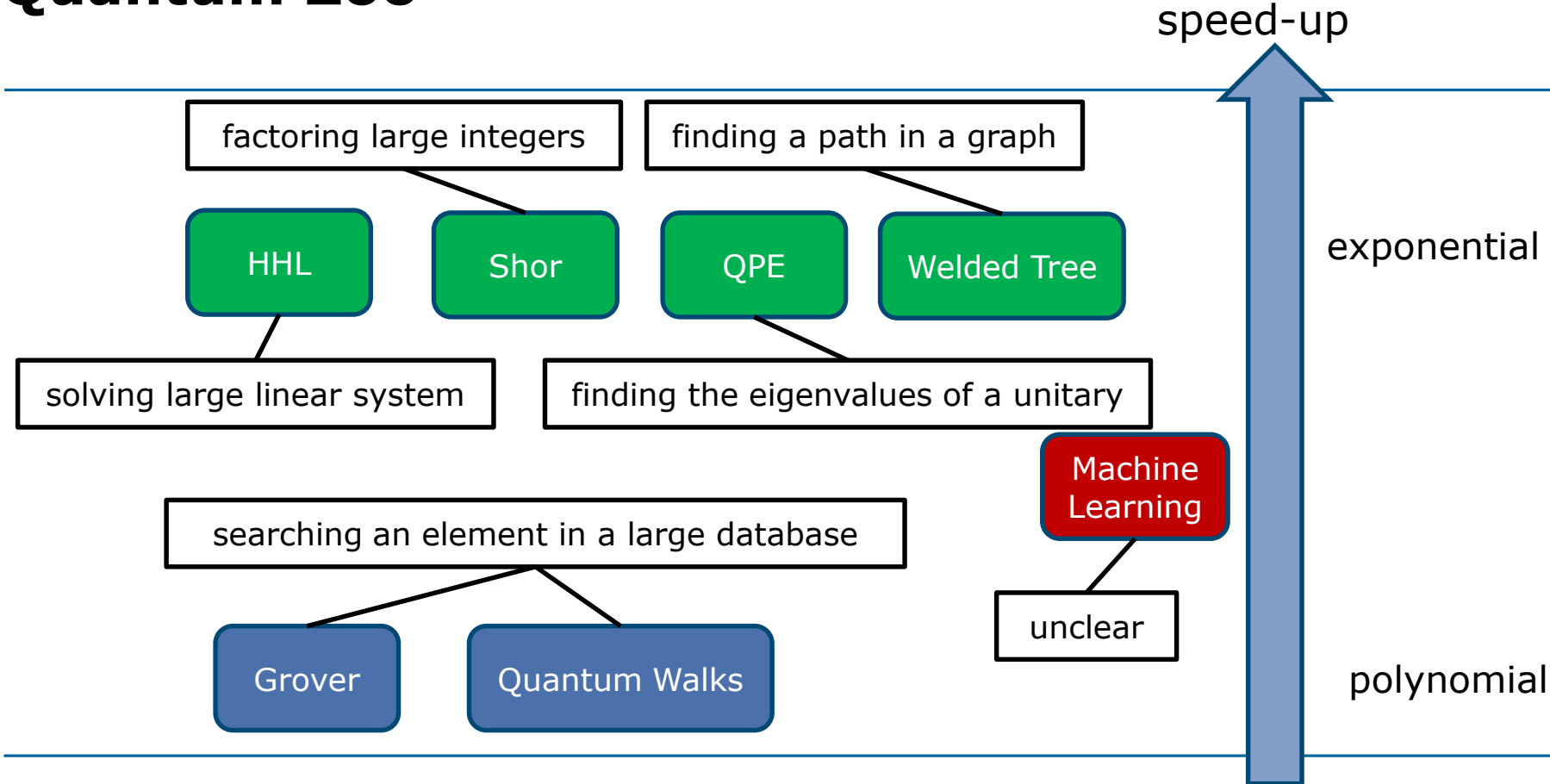
Algorithmic innovation has launched the Quantum Big Race

QC Algorithms



math.nist.gov/quantum/zoo

Quantum Zoo



Atos Quantum : a long-term strategic R&D investment of disruptive innovation, set up in 2016

- ▶ Atos worldwide leader in supercomputing and European leader in cybersecurity

Quantum Computing will affect sooner and later Atos supercomputing customers and cybersecurity customers

- ▶ **Business rationale**
 - **strategic move to keep business leading positions**
 - **aiming mid-term RoI**
 - **in close touch with customers**



Atos Quantum Program

**Atos QLM
Atos Quantum
Learning Machine**

Focus on quantum software, agnostic in quantum hardware: commercialization (since 2017) of **Atos QLM** which is an appliance making easy to develop quantum algorithms (high/low-level programming, optimization and testing via emulation up to 41 qubits)

**Atos Quantum
Accelerator**

R&D program with hardware partners: to deliver in 2023 a **NISQ accelerator** (50 to 100 physical qubits) for hybrid supercomputing and driven by **Atos QLM**

**Atos Quantum-
safe security**

Aligned with NIST call for post-quantum standards: preparing the cryptographies and hardware security modules, resistant to quantum attacks

Atos QLM customers



Hartree Centre

Science & Technology Facilities Council

- ▶ commercial success in a new market
- ▶ huge interest immediately after announcement in July 2017
 - for education (universities)
 - for research (research centers, university labs)
 - for HPC ecosystems (post Moore's law)
 - for industry (first contracts)



UNIVERSITY
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UPPER AUSTRIA



Atos

No quantum business without customers

▶ Why are customers going to invest in quantum computing ?

~~▶ Love of quantum physics ?~~



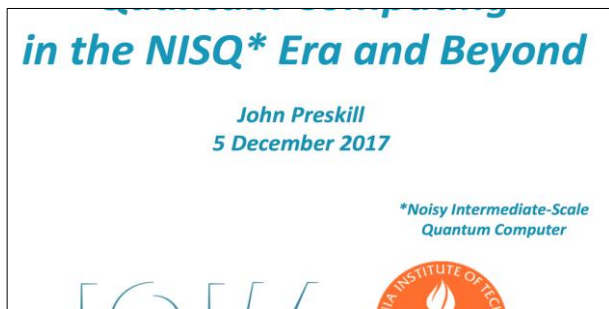
- ▶ To solve **business issues** they cannot solve with traditional IT, for value creation and differentiation
- ▶ By running **business applications** demonstrating quantum advantage
- ▶ Thanks to **quantum algorithms** with significant speedup, implemented in these applications
- ▶ And not too far (3 years max)

Atos response to customers

Priority to **applications and algorithms** with quantum advantages

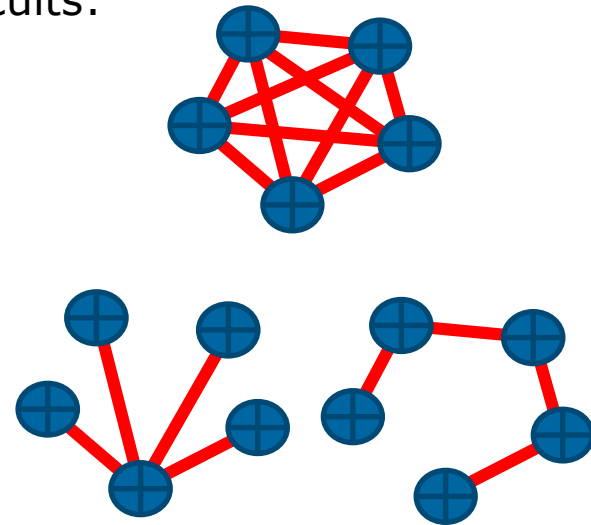
1. We have entered the NISQ era
 - quantum advantage within 3-5 years
 - **Atos Quantum Accelerator** within 3-5 years

2. Develop and optimize NISQ algorithms and applications with **Atos QLM**
 - focus on shallow circuits for hybrid algorithms: chemistry/VQE, machine learning/QAOA
 - focus on DQS: quantum chemistry, material science, nuclear physics
 - POCs already engaged with industrial customers

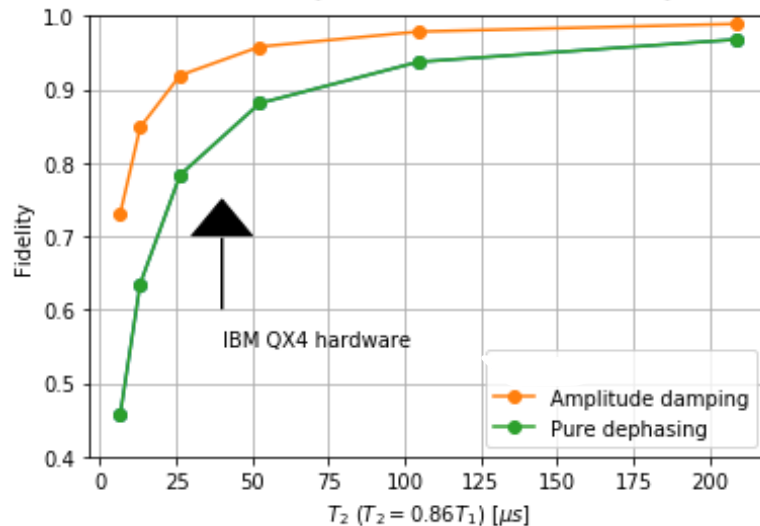
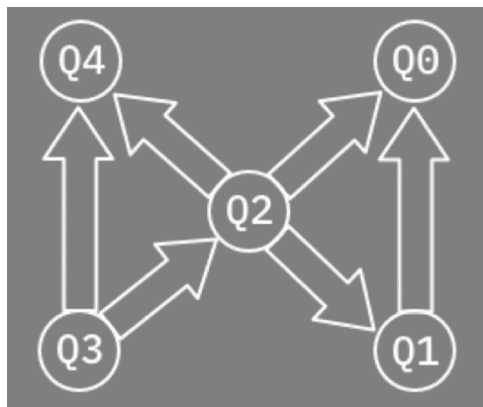
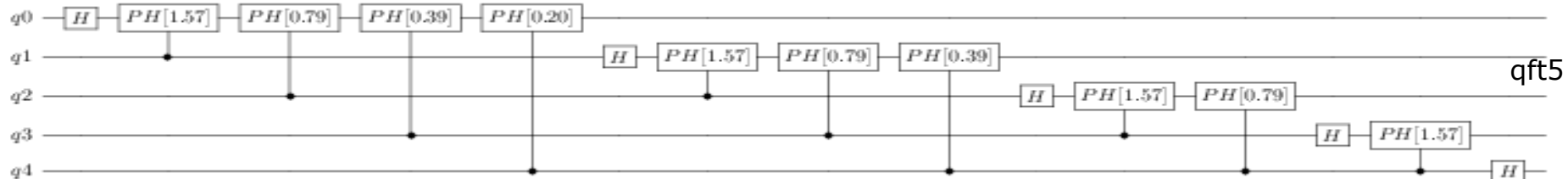


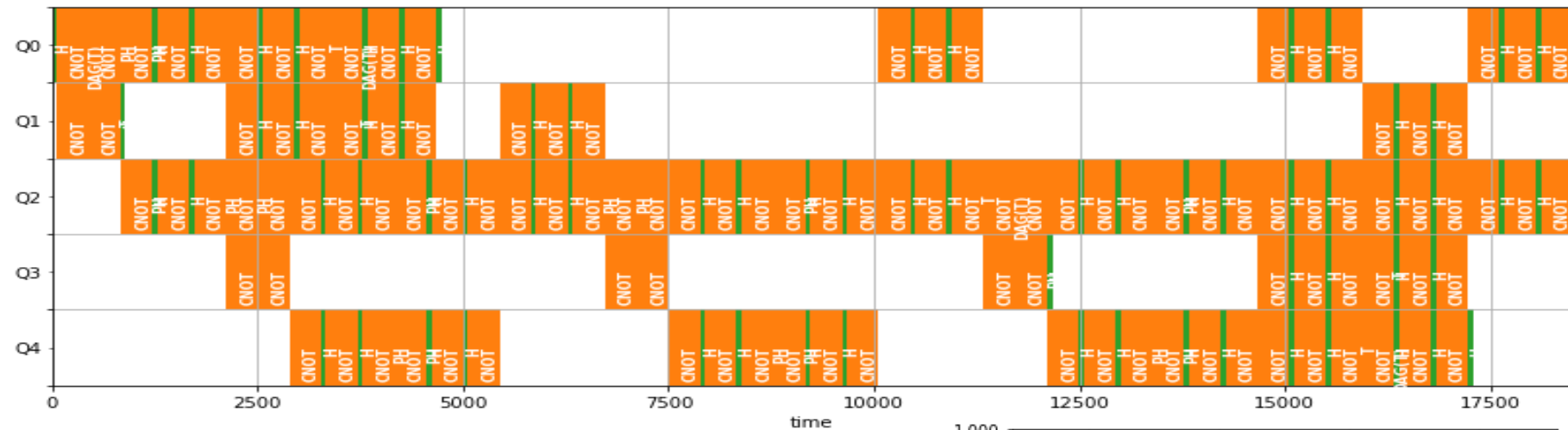
Atos QLM is the perfect tool for designing quantum algorithms

- ▶ leading hardware technologies for qubits-based circuits:
 - trapped ions qubits
 - superconducting qubits
 - semiconducting qubits
- ▶ performances of algorithms are **HW dependent**:
 1. qubit topology, connectivity, gate limitation
 2. stability, quantum noise (decoherence)
 3. speed, shallowness, idling time
- ▶ **Atos QLM** integrates hardware constraints
 - powerful compiler and optimizers
 - testing more realistic (integrating noise models and topology)
 - true performance over present and future accelerators

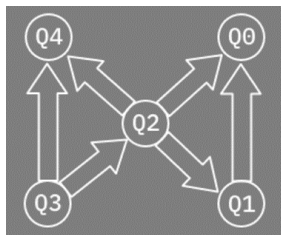


Optimizing fidelity with QLM

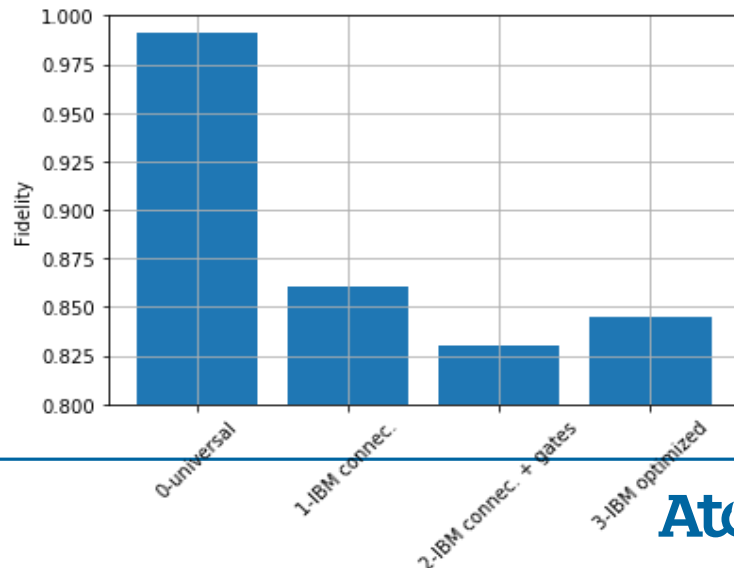




Time representation with QLM



Connectivity constraints
& gate limitations
increase circuit length
& require QLM optimizations



2018, European Flagship funding

▶ AQTION

- scalable, compact 50-ion quantum processor
- led by Innsbruck University
- **Atos** : ion noise modelling & efficient simulation, optimization of circuit with respect to noise, investigation of quantum advantage, **aligned with Atos strategy to offer a NISQ accelerator asap**

▶ PASQuanS

- programmable quantum simulator ($N > 500$ cold atoms)
- led by Institut d'Optique and Max Planck Institute
- **Atos**: coordination of investigation of use cases and industrial end users, industrialization, dissemination, **aligned with Atos focus on applications**



Thanks

For more information please contact: philippe.duluc@atos.net

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