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Statusseminar Quantencomputing

'Villa Flora', Hansastr. 44, 80686 München

QC4DB: Accelerating Relational Database Management Systems via Quantum Computing

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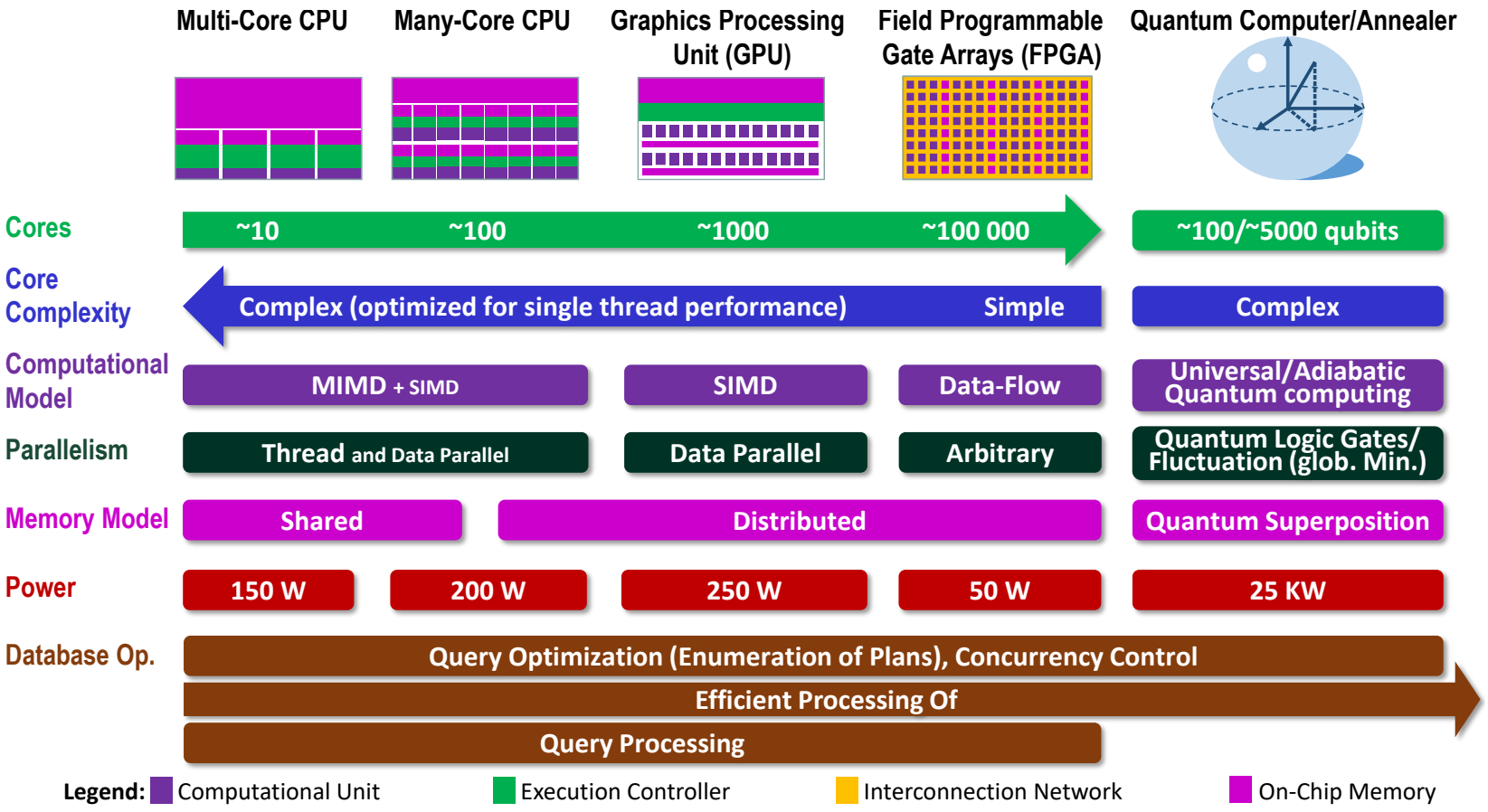
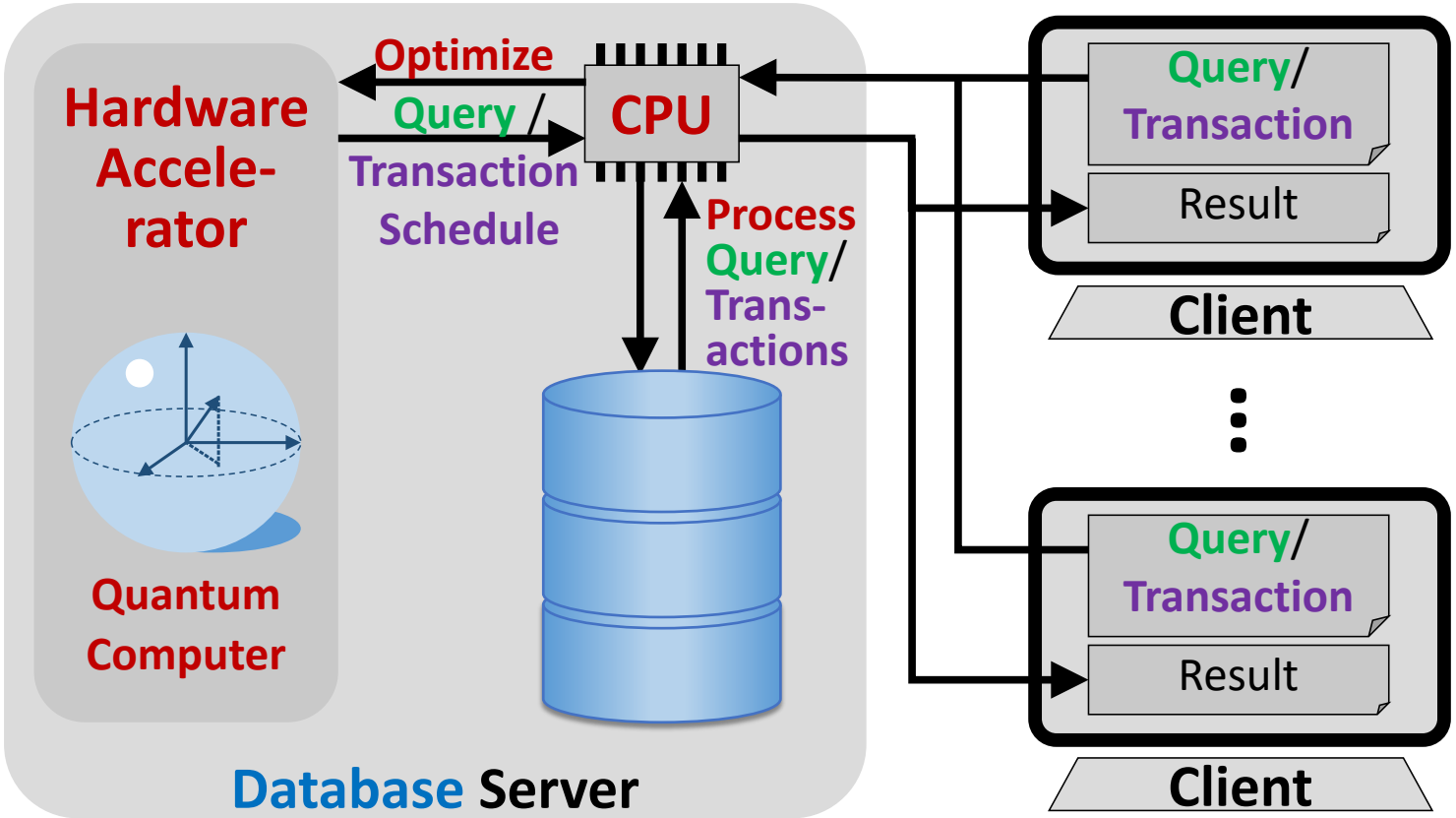
https://www.ifis.uni-luebeck.de/index.php?id=groppe

Architectures of Emergent Hardware



Using Hardware Accelerator for optimizing Queries / Transaction Schedules



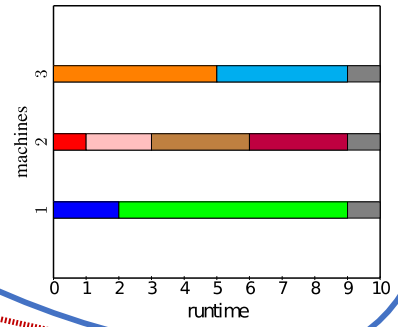
Planned Contributions

Query Optimization:

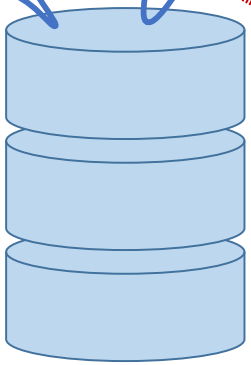
$$\bowtie_{i=1}^{n} R_i \overset{?}{\rightarrow} \begin{matrix} (R_1 \bowtie R_2) \cdots \bowtie R_n \\ \vdots \\ (R_1 \bowtie R_n) \bowtie (\cdots) \end{matrix}$$

Transaction Schedule Optimization:

$$\{T_1, \ldots, T_m\} \overset{?}{\rightarrow}$$



Open Source Relational Database Management System (RDBMS), e.g. PostgreSQL, MySQL



Dynamic Programming
Random Walk
Linear Program-ming
...
Machine Learning
Genetic Algorithm
Simulated Annealing

Algorithms (used e.g. in Query Optimization) and their Quantum Counterparts

Query Optimization Approach	Basic Algorithm	Quantum Computing Counterpart
[S+79]	Dynamic Programming [E04]	[R19] [A+19]
[IW87], QA: [TK16]	Simulated Annealing [KGV83]	[J+11]
[MP18] [Y+20] [W+19] [O+19]	Reinforcement Learning [BSB81]	[S+21] [DCC05]
[GPK94]	Random Walk [BN70]	[ADZ93] [A+01]
[BFI91]	Genetic Algorithm [H92]	[W+13]
[TC19]	Ant Colony Optimization [CDM91] [DBS06]	[WNF07] [G+20]
[TK17]	Mixed Integer Linear [BGG+71] Programming [D02]	[HHL09] [A12] [CKS17] [SSO19] [AL22] [AL22]

This list is not complete...

- Please check my lecture about quantum computing: https://www.ifis.uni-luebeck.de/~groppe/lectures/qc

Open Challenges for QC for Databases

- Are QC counterparts of basic algorithms used in query optimizations suitable for speeding up databases?
- What should be the properties of a quantum computer (e.g. #qubits, latencies of gates) to achieve certain speedups?
- How to combine classical and quantum computing algorithms to achieve good speedups with few qubits?
  (...for running database optimizations on current available quantum computers...)
- What other (database) domains besides query and transaction schedule optimizations benefit from quantum computers?
  (In short: those based on mathematical optimization problems, but also other...?)

QC4DB: Accelerating Relational Database Management Systems via Quantum Computing

Name:	QC4DB: Accelerating Relational Database Management Systems via Quantum Computing	
Proj. Web:	**Project Website@Quantentechnologien**	
Funded by:	BMBF, Fördermaßnahme Anwendungsnetzwerk für das Quantencomputing	
Duration:	3 years	
Volume:	1.8M Euros	
Topics:	Optimizing an open source relational database management system • Queries • Transaction Schedules	
Partners:	UNIVERSITÄT ZU LÜBECK INSTITUT FÜR INFORMATIONSSYSTEME (Coord.)	QUANTUM BRILLIANCE
Expertises:	Hardware-Acceleration of Databases	Room Temperature Diamond Quantum Accelerators/qbOS
Website:	https://www.ifis.uni-luebeck.de/~groppe/	https://quantumbrilliance.com/

We are open for **collaborations**:
Please contact Prof. Dr. Sven Groppe groppe@ifis.uni-luebeck.de