BHADALE GROUP OF COMPANIES
- IT AND REAL ESTATE

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Universal Quantum Computer System Design Catalogue

Bhadale IT Pvt. Ltd. (https://www.bhadaleit.com/)

Bhadale Group of Companies

Bhadale Group of Companies consists of:

1. **Bhadale IT Pvt. Ltd** is an IT and Computer Engineering subsidiary company

   This division provides consultation in areas of cutting edge technologies, research outsourcing, and software consultation related to data center and related engineering practices

2. **Bhadale Engineering Pvt. Ltd** is a multi-engineering subsidiary company

Various divisions under this group provide design, & development of various IT and Engineering programs.

Bhadale Group has aggressive programs in place to serve the niche market. Below is related to cloud ecosystems

Bhadale Group IT Division, Quantum Engineering department

 Building a Universal Quantum Computer is a big project and it needs co-operation, design optimizations, Co-design that ensures the future computer systems are truly of hi-fidelity and that offers greater performance

We offer a range of services for clients to speed up their mission in achieving the required quantum advantage allowing them to reach the goals before the market players end up with their purposes and pose risks for your company.

Details of the above are put in the table below

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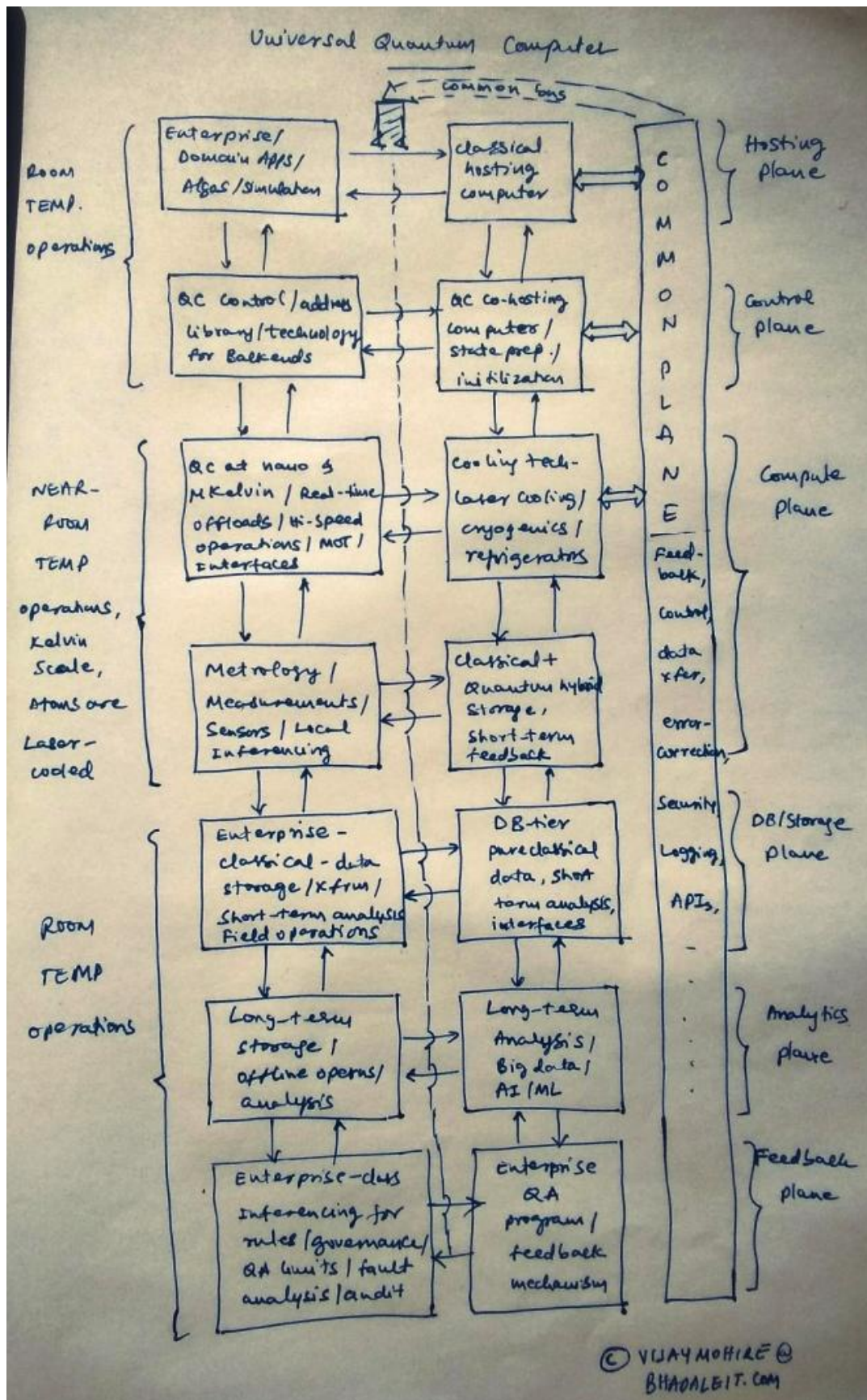
We have a large set of subcategories; few are mentioned below with details tabulated

Service No	Service Name	Key Service features
1	Quantum systems and constituent elements design engineering	We offer a wide range of universal quantum development services for the convenience of our clients based on their business needs, and startup mission : • Design of various planes , their subsystems, modules, elements that are to be integrated in a phased manner • Wireframe design from bare metal, raw quantum material and multi-body qubit planning for scalability using various back-ends like for superconductor based, fermions and bosons based , Bose-Einstein condensates, Fermionic Condensates, etc • Silicon based quantum chips , quantum memory, cryo-electronics • Electrical components for classical and quantum system power interfaces, cryogenic systems, nano-electronic assemblies, etc • Optics and lasers related opto-photonics, laser, microwaves, MOTs, and related setup for experiments in lab and production environments based on AMO physics, and mesoscopic principles • Operating systems for classical hosting, quantum co-hosting, kernels, host process managers, virtualization , real-time schedulers etc • Compilers, transpilers, translators, debugging, logging etc • APIs, Applications , Memory units , common bus architectures Based on our vast experience and expertise in serving the engineering and IT industry, we offer accelerated speedup in adapting to the ecosystem and use IEEE, NIST, ISO standards. We leverage on our tie-ups and partnerships with various institutes, universities and network
2	Quantum software and constituent modules design	• Design for various software packages, modules, containers, dependencies • Design of data at reset, in transit and processing units and final storage of data • Design of software methodologies, processes, tools, apps, deployment methods, testing and operations • Software configuration, master data , dictionary, meta-data , various datasets, and libraries • Software error management, intelligent recovery, time sensitive operations, kernel mode interrupts, preemptive operations, multitasking , parallelism etc • Software languages that ensures quantum paradigm features are fully realizable • Interfaces, APIs design at all the levels of the QC technology stacks and various planes like hosting, control, data , storage etc
3	NISQ design	Aspects specific to NISQ systems design are: • Front end tools needed to create workflows along with the frameworks and libraries required to build quantum circuits (Cirq, Qiskit, PyQuill, etc.). [2] • Hardware layer that can include any of the existing quantum implementations – superconducting qubits, photonic qubits, ion traps – as well as quantum

		annealers and simulation.
		• Analytics or data layer to analyze intermediate and final data from the workflows you run
		• Design of various planes of the QC as per NISQ needs for a flexible error correction and control regime
4	Fault-tolerant quantum computation (FTQC) design	The goal of fault-tolerant quantum computation (FTQC) is to use noisy components to reliably implement quantum circuits of arbitrary size to any desired accuracy Future version and baselines : • Design of fault tolerance thresholds, accuracy as per theory • Design of intermediate layers to detect and manage errors in physical qubits • Design of error correction codes and algorithms to meet the required thresholds and accuracy • Design the required redundancy in the circuits enabling meeting a long term operations and coherence of the logical qubits • Stabilizer codes, Topological codes etc [3] • Required integration/merger of the quantum cryo-electronics, with classical room temperature electronics in the range of 200 Kelvin • Reservoir based design of QC system
5	Design for Transition Roadmap	Transiting from NISQ to FTQC and related improvements, related projects We offer a range of design services for clients to choose that helps them in achieving the quantum advantage: • Analysis of existing capability, readiness, and future plans • Design of the gap fitment roadmap, with clear milestones and deliverables • Mapping of the incremental improvements using QA tools ensuring progress offers increased accuracy • Offering various tools, SDK, testing processes, migration paths, portability issues, upgrades • Key design upgrades to scale from say 100 qubits to 1000 qubits and more • Upgrade design , transform designs from NISQ based various paradigms to a truly multi-body system design using highly precise, highly reliable, logical qubits based out of the high quality physical qubits derived from the closed loop real time NN based polar molecules accurately trapped, arranged , and measured with precision using lasers, MOT and various technologies
6	Quantum-Safe design	Making Quantum systems hacker-proof We offer safety of the entire quantum system that avoids hackers with quantum systems to hack: • Implementation of Quantum safe solutions for various quantum platforms using different backend and paradigms like superconductor cooper pairs, fermions, bosons, photons, and condensates like BEC and Fermionic sea

		• Advise on use of post-quantum cryptography algorithms and features for your assets • Offering you insights of the current state-of-the art applications, and migration paths
7	Co-Design	We offer wide range of services enabling better integration of the hardware, software across multi-engineering, mechanical systems that enable better design based on quantum postulates • Design across various horizontal and vertical slices, layers and shared services [4] • Define standards, interfaces, etc., for hardware, software, theoretical and mathematical models are needed to enable the co-design • Use of various algorithms and strategies for Co-Design[5]
8	Integration and Testing	We offer systematic testing of various system elements across full stack using various atomic scale and nanotechnology based measuring devices Few of the tests are done at : • Unit level, Module level, Element level, Subsystem level, System level with incremental testing ensuring errors are either eliminated or canceled and not accumulated at the end

References:

[1] https://www.ntt-review.jp/archive/ntttechnical.php?contents=ntr202105fa4.html
[2] https://www.hpcwire.com/2020/08/24/building-the-quantum-stack-for-the-nisq-era/
[3] https://www.osti.gov/servlets/purl/1640593
[4] https://www.bnl.gov/quantumcenter/research.php
[5] https://seal.ece.ucsb.edu/sites/default/files/publications/nanocom_codesign.pdf

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