AUSTIN FORUM

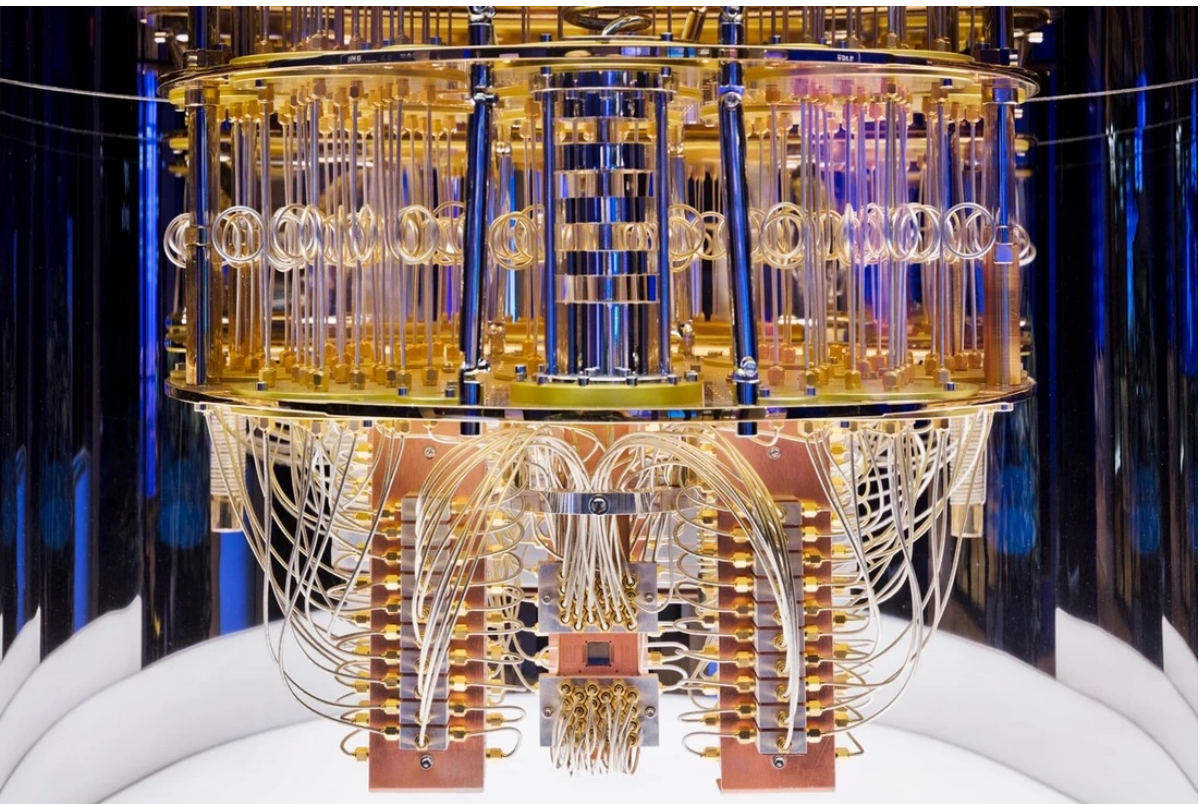## ON TECHNOLOGY & SOCIETY

Connect. Collaborate. Contribute.™

Welcome to the
Austin Forum on Technology & Society!

We bring leaders, thinkers, builders, creators, and learners together to **connect, collaborate, and contribute!**

Thank you for joining our community online or in-person!

Quantum Computing: The Next Technological Evolution

Sept 5, 2023

Our Partners Make Austin Forum Possible!

ADAPTER

AMD

arm

Atchley & Associates LLP
CERTIFIED PUBLIC ACCOUNTANTS & BUSINESS ADVISORS

BRAD ENGLERT
ADVISORY

DATAVORTEX
TECHNOLOGIES

DELL
Technologies

KF
KUNGFU.AI

CAPITAL FACTORY

SXSW

GOOD SYSTEMS
A UT Grand Challenge

Please contact us if you want to become an annual partner!

AUSTIN FORUM
ON TECHNOLOGY & SOCIETY

www.austinforum.org

And welcome to our newest partner!

whurley

Thank you to our new Austin Forum Champions!

Nancy Giordano   *Kelley Knutson*

Roy Truitt   *Luke Wilson*

And our new Friends of the Forum!

Don & Mary Kay Hanson   *Chris Van Loan*

You can be an Austin Forum Champion today!

**BE A CHAMPION!
BE A FRIEND!**

With your quick help & support, we can provide great educational programming and informative experts
($1000+)

- Offer advice on programming topics, invited speakers, podcasts & events
- Attend the annual meeting & VIP reception
- Get a nice tax deduction!
- Get cool AF swag
- 100% of your gift goes to executing the Forum
- **THANK YOU!**

Or be a Friend of the Forum!

- Get cool AF swag
- Get a tax deduction!
- 100% of your gift goes to executing the Forum

AUSTIN FORUM
ON TECHNOLOGY & SOCIETY

www.austinforum.org

We have **6** ways to learn, share, connect!

Live monthly events	Online content
Presentation + Networking events • Expert presenter-focused • In-person and online—hybrid • Recording and slides posted online	**Slack Community** • Get updates and register for events • Learn more about the Austin Forum • Ask questions, share, etc. (Slack)
Meetup discussion events • Participatory for everyone • In-person *only* • Never recorded—speak freely!	**Podcasts – Austin Forum Upload** *(new episodes weekly)* • Audio only • Conversation formats • Hosted in all major podcast stores, AF website
Book discussion events • Participatory for everyone • Online *only* • Never recorded—speak freely!	**Blog – Austin Forum Update** *(September 2023)* • Web-based (on Medium) • Weekly(ish) articles • Multiple formats: "Techsplanations," interviews, analyses/positions, and series

Before we get started, join our ![slack]

Why join the Austin Forum Slack workspace?

1. Continue and deepen the conversation after Austin Forum events

2. Find new opportunities for collaboration, mentoring, working, and more

3. Promote local events and relevant Tech & Society opportunities

4. Because this gives *everyone* in our community—online and in-person—the *same* way to ask questions!

How?

1. Open a web browser

2. Go to: www.austinforum.org/slack

3. Click "Join the Austin Forum Slack Workspace"

4. Enter your email address

5. Check your email to confirm Slack invitation

6. Enter your name and click "Create Account"

7. You're in! You can use the Slack mobile app now, too.

8. Add channels to your view using **+ Add channels**)

AUSTIN FORUM
ON TECHNOLOGY & SOCIETY

www.austinforum.org

Austin Forum Upload: New episodes out now!

New episodes!

- #66 – Web 3.0: It's Coming, It's Different, and Why You Should Care!

- **#65 - Quantum Computing: Weird, Transformational, and Coming Sooner than You Think!**

- #64 - Episode 64 - How Can Companies and Organizations Protect Against Cyberthreats?

New episodes soon with leaders in:

- Women in Tech

- Austin Tech Ecosystem

- Cybersecurity

GET IT ON Google Play

Listen on Apple Podcasts

Listen On Spotify

AUSTIN FORUM
ON TECHNOLOGY & SOCIETY

www.austinforum.org

Q: What companies have you heard of in the quantum computing space besides Strangeworks? (30 seconds)

1 2 3 4 5 6 7 8 9 10

11 12 13 14 15 16 17 18 19 20

21 22 23 24 25 26 27 28 29 🙂

And now, our featured presentation…

Please:

Respect our speakers & audience

Do not talk during the presentation

Silence your cellphones

Ask questions in the Austin Forum Slack in the #quantum channel

Learn, think, and enjoy!

Stay after Q&A for free stuff!

Quantum Computing: The Next Technological Evolution

William 'whurley' Hurley
CEO and Founder
Strangeworks

Quantum Computing: The Next Technological Evolution

September 5th, 2023

Agenda

- Quantum Computing Explained

- Quantum Computing Milestones

- Quantum Computing & The Kitchen Sink
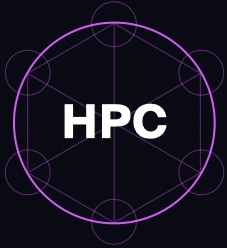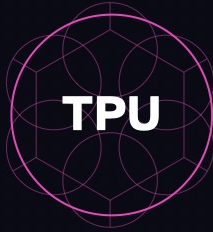
- Quantum Computing Fact Vs. Fiction

- Q&A
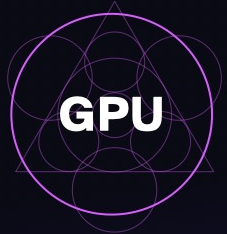
Quantum Computing Explained

Our current compute is limited.

HPC

High Performance
Computing

TPU

Tensor
Processing Units

GPU

Graphics Processing
Units

FPGA

Field Programmable
Gate Arrays

ENERGY AEROSPACE FINANCE PHARMA MATERIALS

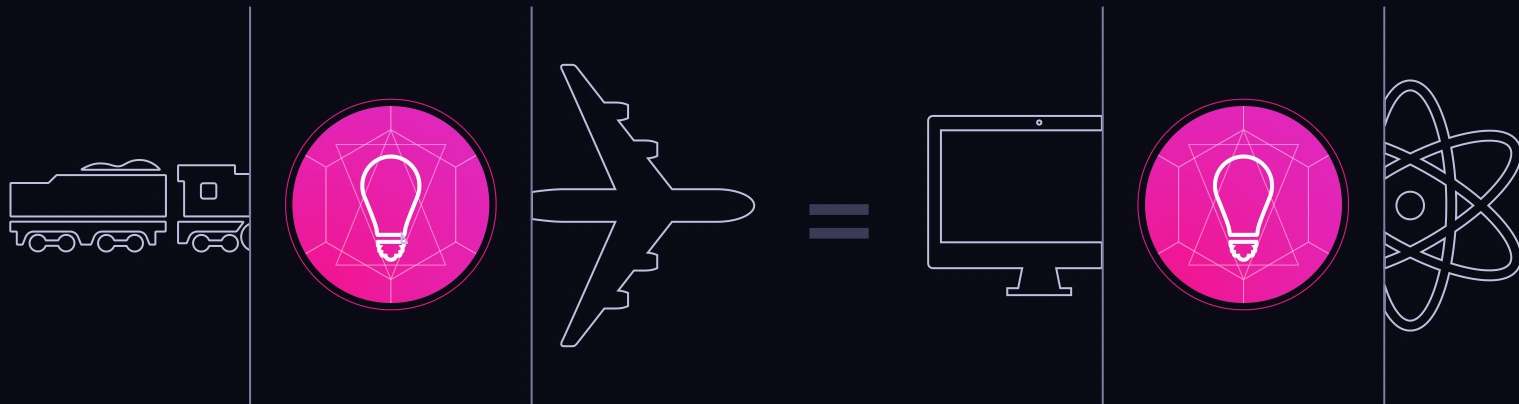ENERGY AEROSPACE FINANCE PHARMA MATERIALS
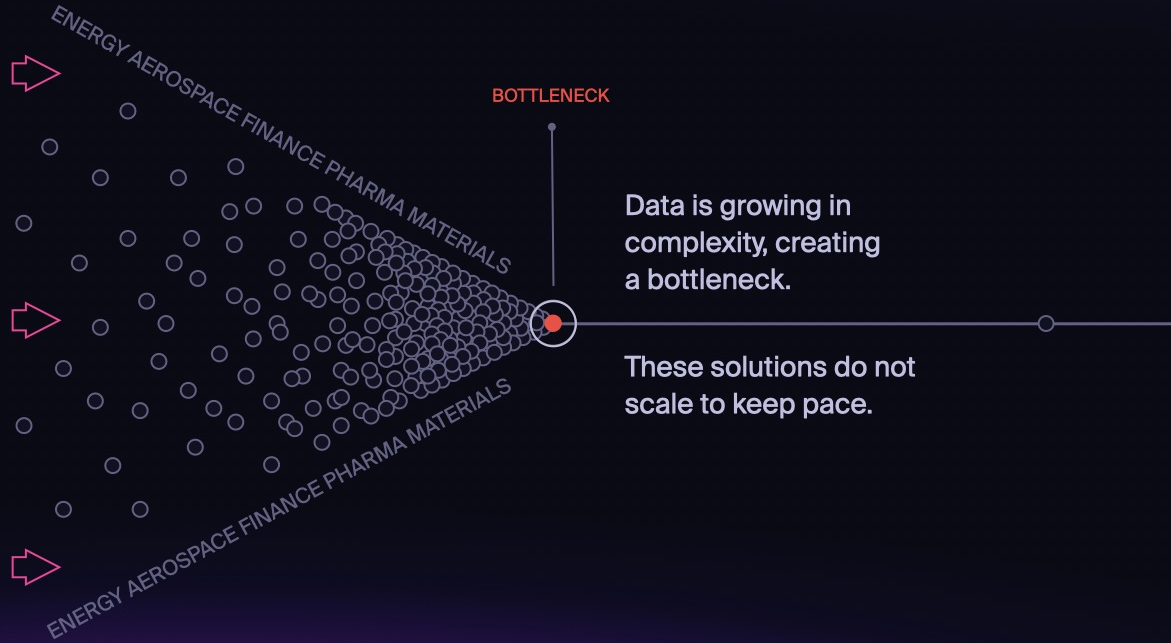
BOTTLENECK

Data is growing in
complexity, creating
a bottleneck.

These solutions do not
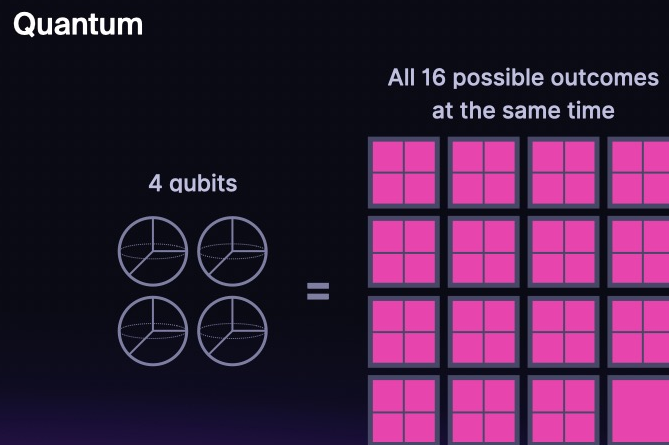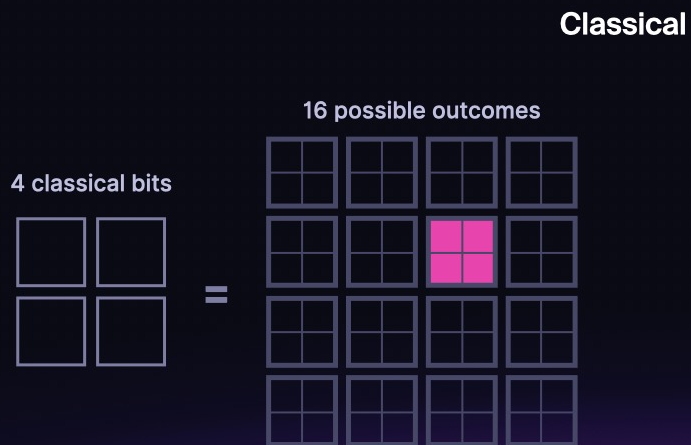scale to keep pace.

My best analogy.

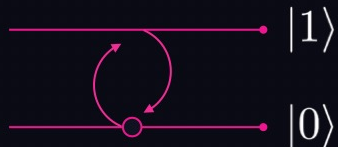# Coins, cards, and an attempt to explain.

Understanding quantum computing.

- New type of compute that leverages quantum mechanics to solve problems that are intractable to existing classical computers

- Due to the properties of entanglement and superposition, quantum computers are exponentially more powerful than classical

- QC strengths: linear algebra, combinatorial optimization, differential equations, and cryptography
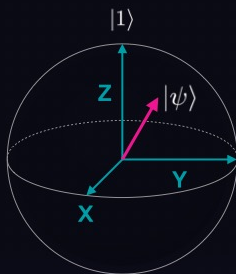
Classical | **Quantum**

16 possible outcomes

4 classical bits

All 16 possible outcomes
at the same time

4 qubits

What makes it work.

TWO LEVEL QUANTUM MECHANICAL SYSTEM

ALLOWS FOR SUPERPOSITIONS

MEASURING SUPERPOSITIONS GIVES PROBABILISTIC OUTCOMES

$$|\psi\rangle = \alpha|0\rangle + \beta|1\rangle$$

$$|1\rangle$$

$$|0\rangle$$

with probability $|\langle 1|\psi\rangle|^2$

with probability $|\langle 0|\psi\rangle|^2$

$$|1\rangle$$

$$|0\rangle$$

$$|\psi\rangle$$
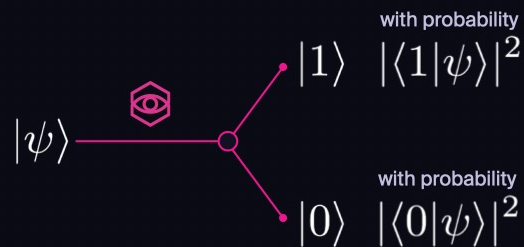
Where are we at today?

Pessimists
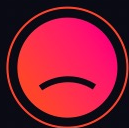
Optimists

Realists

QUANTUM IN

7 Years

QUANTUM IN

3 Years

PREPARING

Today

Quantum Milestones & Timing

Its finally arrived...

Febuary 13th 2023

Its finally arrived... again!

Febuary 13th 2023

Febuary 17th 2014

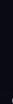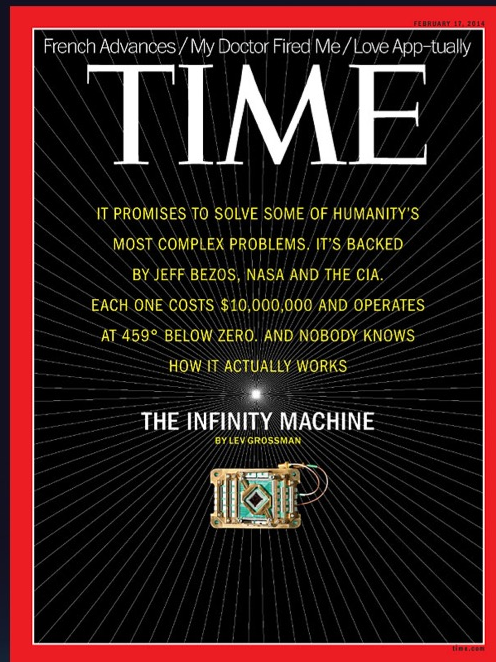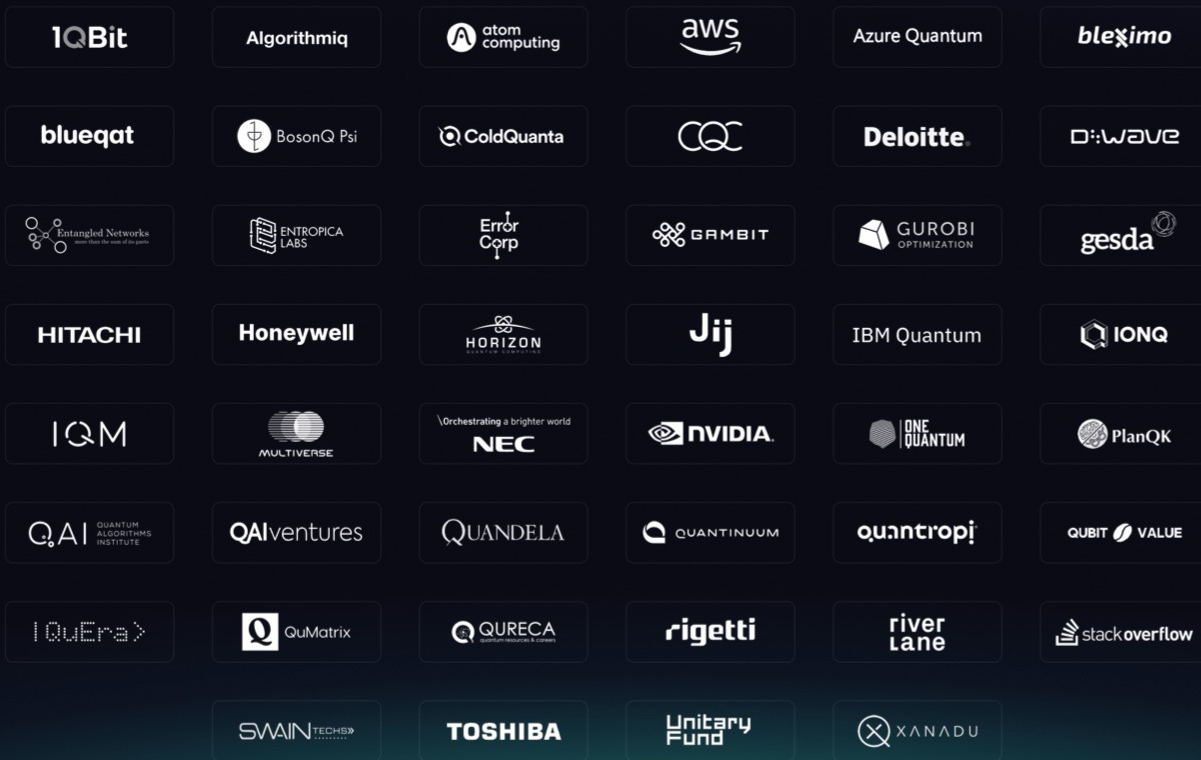# Plenty of availability.

1QBit	Algorithmiq	atom computing	aws	Azure Quantum	bleximo
blueqat	BosonQ Psi	ColdQuanta	CQC	Deloitte.	D:WAVE
Entangled Networks	ENTROPICA LABS	Error Corp	GAMBIT	GUROBI OPTIMIZATION	gesda
HITACHI	Honeywell	HORIZON QUANTUM COMPUTING	Jij	IBM Quantum	IONQ
IQM	MULTIVERSE	\Orchestrating a brighter world NEC	NVIDIA.	ONE QUANTUM	PlanQK
QAI QUANTUM ALGORITHMS INSTITUTE	QAIventures	QUANDELA	QUANTINUUM	quantropi	QUBIT VALUE
QuEra	QuMatrix	QURECA quantum resources & careers	rigetti	river lane	stack overflow
	SWAINTECHS	TOSHIBA	Unitary Fund	XANADU	

Our current moment in time.

Today
Business Value

Tomorrow
Quantum Advantage

Business value

Classical
Present

Quantum-Inspired
Present

Quantum Annealing
Near term

Quantum Gate
Mid to long term

WE ARE HERE
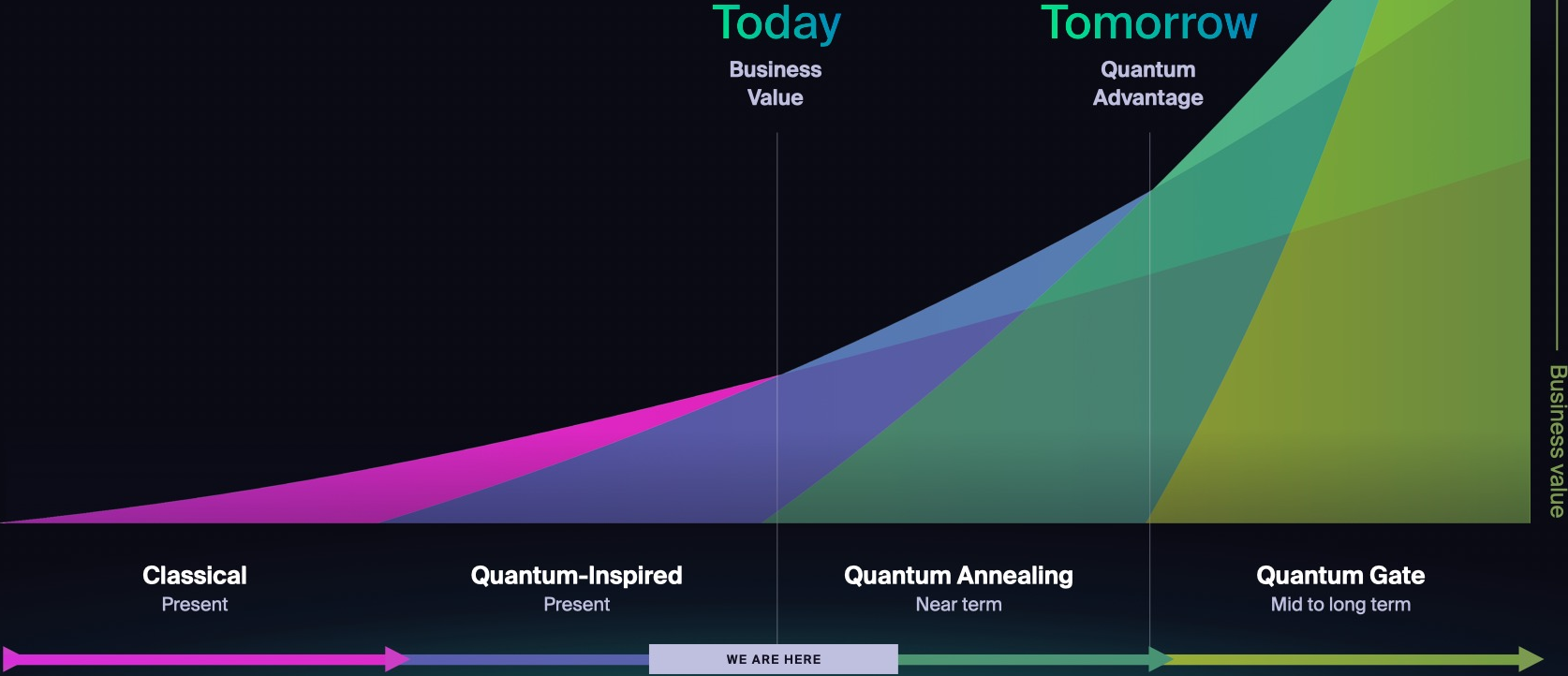
Value for enterprises today.

Quantum Advantage

When a quantum computer can *outperform a best-in-class existing solution*, or solves a problem that *no classical computer can*.

Generate Value Today

Existing *quantum-inspired and quantum annealing technologies* are outperforming some classical solutions today.

Quality of Result

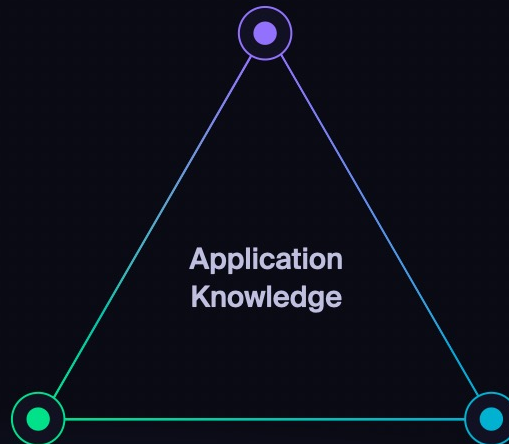An improvement of the result over a classical implementation.

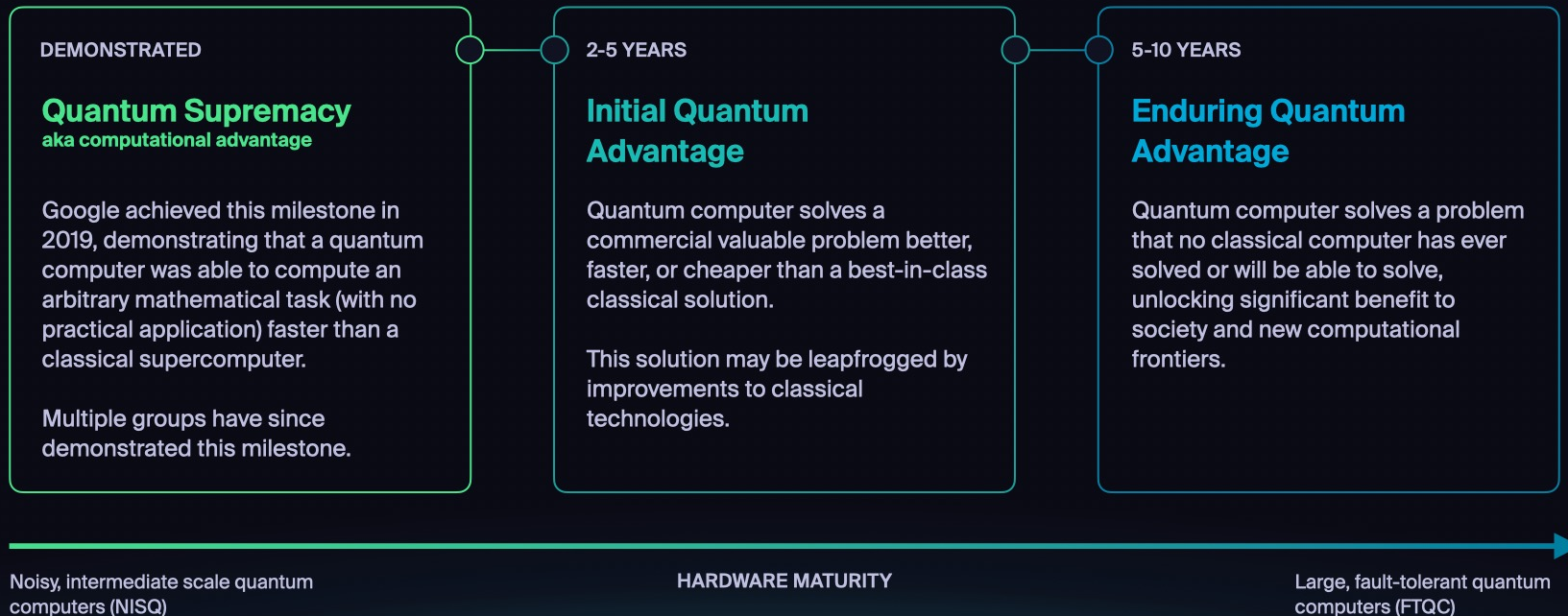**Application Knowledge**

Cost of Computation

A reduction in the existing expense of compute resources or reducing existing cost of processing.

Speed of Execution

A speed up in the time taken to get the same result.

Milestones to quantum advantage.

DEMONSTRATED

Quantum Supremacy
aka computational advantage

Google achieved this milestone in 2019, demonstrating that a quantum computer was able to compute an arbitrary mathematical task (with no practical application) faster than a classical supercomputer.

Multiple groups have since demonstrated this milestone.

2-5 YEARS

Initial Quantum Advantage

Quantum computer solves a commercial valuable problem better, faster, or cheaper than a best-in-class classical solution.

This solution may be leapfrogged by improvements to classical technologies.

5-10 YEARS

Enduring Quantum Advantage

Quantum computer solves a problem that no classical computer has ever solved or will be able to solve, unlocking significant benefit to society and new computational frontiers.

Noisy, intermediate scale quantum computers (NISQ)

HARDWARE MATURITY

Large, fault-tolerant quantum computers (FTQC)

Quantum & quantum-inspired technologies.

CLASSICAL

Quantum-inspired classical solutions

Q-Inspired Algorithms on CPUs/GPUs

Quantum-inspired algorithms are classical algorithms that classically emulate the essential quantum phenomena that provide a speedup.

NVIDIA.   Azure Quantum   aws

Q-Inspired algorithms on special purpose HW

Hardware specifically designed to run combinatorial optimization problems leveraging quantum-inspired algorithms.

HITACHI   FUJITSU   *Orchestrating a brighter world* NEC   TOSHIBA   NTT

QUANTUM

Quantum computing technologies

Quantum annealers

Quantum annealing processors are special purpose machines designed to solve optimization problems by finding the minimum of an energy landscape.

D:Wave

Gate based quantum computers

Gate based quantum computers are universal machines that can theoretically solve all problems types by leveraging qubits and quantum gates to encode and process information. There are different modalities of these computers including: superconducting, trapped ion, photonics, and neutral atoms.

IBM Quantum   IONQ   XANADU
QUANTINUUM   rigetti |QuEra>

Pure quantum Vs. Quantum-inspired.

OPTIMIZATION USE CASES

Pros

- Technology providing business value today
- Less expensive to use than quantum annealers
- Easier on-premise capability than quantum or HPC
- Limited workforce re-skilling needed compared to quantum
- Likely requires less energy than HPC for same output

Cons

- Limited to solving optimization problems
- Likely to be ultimately replaced by quantum
- Faces exponential scaling challenges
- Potentially more expensive than classical

QUANTUM COMPUTING TECHNOLOGIES

Pros

- Exponential speedup potential
- Solves problems that can't be solved today (unlocks new markets)
- Universal solver - more than optimization
- Diversity of hardware providers & modalities
- Requires less energy than HPC for same output

Cons

- Not yet demonstrating business value (and unknown when)
- Limited problem sizes today
- Expensive to use
- High error rates compared to classical
- High barrier to re-skilling and/or building expertise

The quantum 'fly wheel'.

Define strategic business goals & explore use cases

Use case selection & scope program goals

Use case for getting started

Cutting-edge research use case

Proof of Concept & Benchmarking of Results on quantum & quantum-inspired backends

Iterate & benchmark on the use case in order to advance toward production workflow (e.g. bring in real world data)

Create application or POC endpoint on SW platform

Integration into production workflows

Repeat development process with next use case

Quantum & The Kitchen Sink

Quantum computing modalities.

	Adiabatic	Gate Based				
	Quantum Annealing	**Trapped Ions**	**Superconducting**	**Photonics**	**Cold & Neutral**	**Silicon Spin**
DESCRIPTION	Special purpose superconducting machines designed for optimization	Use naturally occurring ions as qubits, controlled with lasers & EMFs	Superconducting circuits create two-level systems as qubits	Use photons (particles of light) to perform quantum computations	Use neutral atoms trapped in lasers as qubits	Use the spin of electrons in silicon as the qubits
STRENGTHS	• High gate speeds and fidelities • Comparatively well developed technology	• High fidelities • Long coherence times • High connectivity	• High qubit count • Fast gate speeds • Ease of manufacturing	• Fast gate speeds • High fidelities • Cryogenic cooling not required	• High connectivity • Horizontal scaling potential • Cryogenic cooling not required	• High stability • Established semiconductor tech
CHALLENGES	• Requires cryogenic cooling • Short coherence times • Limited use case applicability	• Low qubit count & scientific challenges to scaling not yet solved • Slow gate speeds	• Lower connectivity • Cryogenic cooling	• Noise from photon loss • Each program requires own chip • Realizing universal gate sets	• Slow gate speeds and low fidelities • Laser scaling challenges	• Requires cryogenics • Only a few entangled gates today with low coherence times

Key hardware players.

FIDELITY

Trapped Ions

Superconducting

Photonics

Cold & Neutral Atoms

Silicon Spin

SCALE

Trapped Ions
QUANTINUUM | IONQ | Universal Quantum

Superconducting
IBM Quantum | rigetti | OQC
Google | Baidu | Amazon Braket

Photonics
Ψ PsiQuantum | XANADU | QUANDELA

Silicon Spin
intel | Silicon Quantum Computing | QUANTUM MOTION
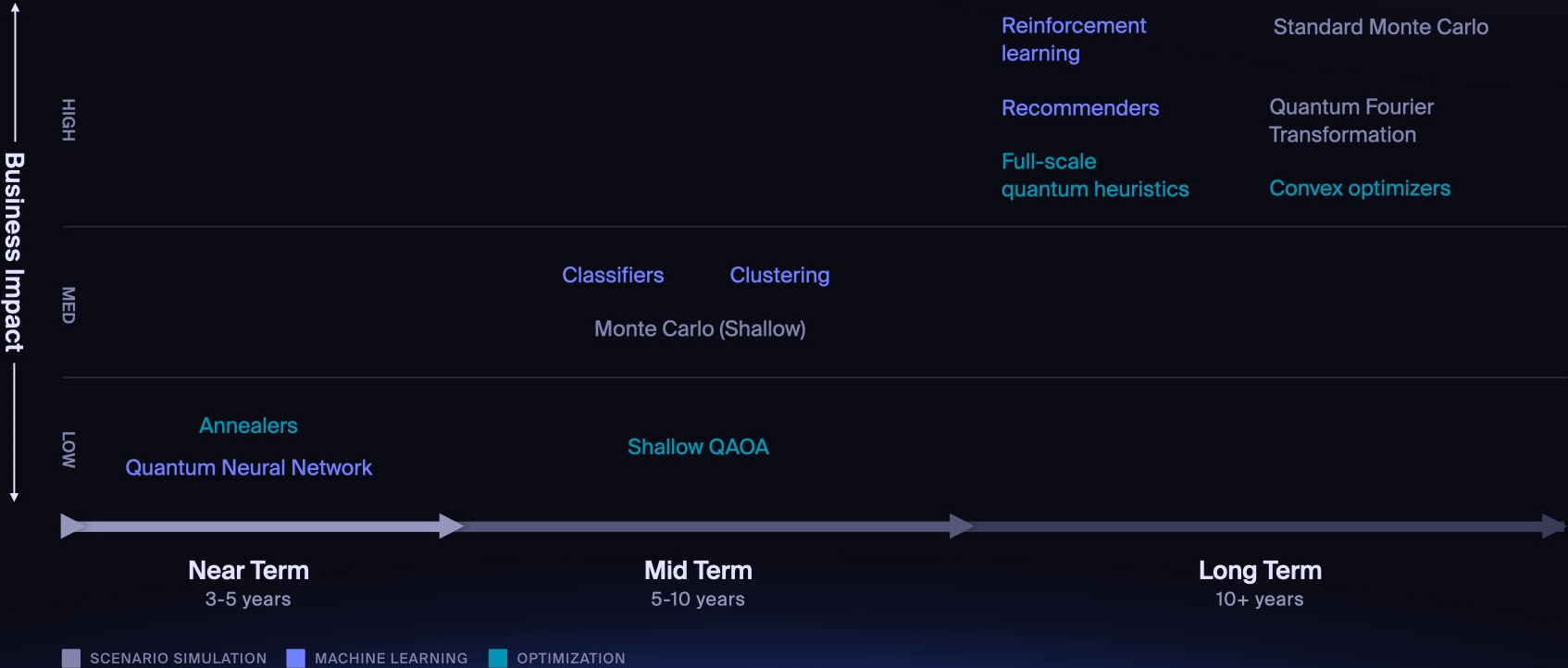
Cold & Neutral Atoms
PASQAL | |QuEra⟩ | ColdQuanta

Quantum algorithm categories.

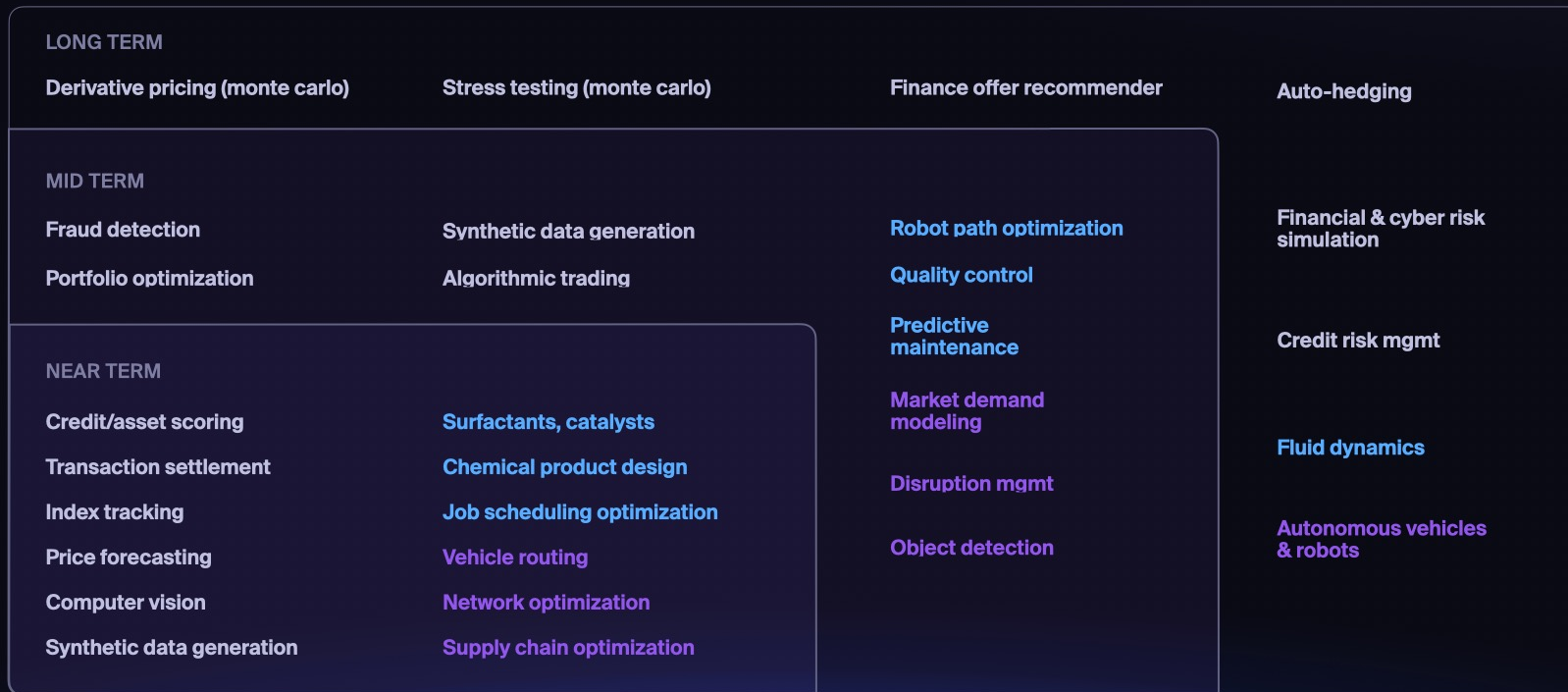|	DESCRIPTION	COMMON PROBLEM TYPES
Combinatorial Optimization	Evaluate a large number of combinations to find the minimum or maximum of a function while satisfying constraints. Incorporate more variables and solve hard, constrained problems faster	• Traveling salesperson (ie. shortest route between cities) • Knapsack problem (ie. total weight below limit) • Job shop problem (ie. multiple jobs on one machine) • Work shift (ie. employee scheduling)
Machine Learning	Integrate quantum algorithms with ML problems, typically expressed as linear algebra. Improve predictive accuracy or speed up training times	• Classification and regression • Supervised and unsupervised learning • Reinforcement and deep learning • Natural language processing
Simulation	Simulate large quantum mechanical systems, typically expressed as differential equations. Model larger systems exponentially faster than classical computers	• Molecular simulation • Computational fluid dynamics
Cryptography	Solve factorization exponentially faster than classical to break protocols at the heart of asymmetric encryption	• Factorization

Quantum algorithms timeline.

Business Impact →

HIGH

Reinforcement learning

Recommenders

Full-scale quantum heuristics

Standard Monte Carlo

Quantum Fourier Transformation

Convex optimizers

MED

Classifiers   Clustering

Monte Carlo (Shallow)

LOW

Annealers

Quantum Neural Network

Shallow QAOA

Near Term
3-5 years

Mid Term
5-10 years

Long Term
10+ years

■ SCENARIO SIMULATION   ■ MACHINE LEARNING   ■ OPTIMIZATION

Cross industry use cases.

Optimization	Machine Learning	Simulation	Cryptography
Finance: Portfolio optimization $20-50B	Automotive: Automated vehicles, AI Algorithms $0-10B	Pharma: Drug Discovery $40.8B	Government: Encryption and Decryption $20-40B
Insurance: Risk management $10-20B	Finance: Anti-fraud, anti-money laundering $20-30B	Aerospace: Fluid dynamics $10-20B	
Logistics: Network operation $50-100B	Tech: Search/ads optimization $50-100B	Chemistry: Catalyst design $20-50B	Corporate: Encryption and Decryption $20-40B
Aerospace: Route optimization $20-50B	ML apps to impact most, if not all, industries	Energy: Solar conversion $10-30B	
		Finance: Market simulation $20-35B	

Use cases expanded.

LONG TERM

Derivative pricing (monte carlo)   Stress testing (monte carlo)   Finance offer recommender   Auto-hedging

MID TERM

Fraud detection   Synthetic data generation   Robot path optimization   Financial & cyber risk simulation

Portfolio optimization   Algorithmic trading   Quality control

Predictive maintenance   Credit risk mgmt

NEAR TERM

Credit/asset scoring   Surfactants, catalysts   Market demand modeling

Transaction settlement   Chemical product design   Fluid dynamics

Index tracking   Job scheduling optimization   Disruption mgmt

Price forecasting   Vehicle routing   Object detection   Autonomous vehicles & robots

Computer vision   Network optimization

Synthetic data generation   Supply chain optimization

■ FINANCE   ■ MANUFACTURING   ■ LOGISTICS

Near term opportunity: Optimization

Optimization
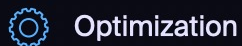
⚙ Optimization

Quantum Annealing Hardware

⚙ Optimization

💡 Machine Learning

Quantum Gate Based Hardware

⚙ Optimization

💡 Machine Learning

⬡ Simulation

🔑 Cryptography

OPTIMIZATION USE CASES

Combinatorial optimization: Find a combination which provides maximum or minimum value of an evaluation function from a large number of variables while satisfying constraints. Typical problems: Traveling salesman, knapsack problem, job shop problem, work shift problem, etc.

- Inventory Management
- Route Scheduling
- Robot Path Optimization
- Improving Drug Discovery

- Portfolio Optimization
- Shift Scheduling
- Supply Chain Optimization
- Manufacturing Cycle Optimization

Examples of Value today
Optimization

\Orchestrating a brighter world

NEC

Production Planning Optimization
Multi-Product Manufacturing

TOSHIBA

High Frequency Trading
Fast Detection of Mispricings

HITACHI

Insurance Underwriting
Natural Disaster Risks

D-WAVE

Maximizing Reach
Television Ad Scheduling

FUJITSU

Global Supply Chain Optimization
Materials Campaign Scheduling

Quantum Fact vs. Fiction

Fiction 1 : Superpostion is 'Everything'
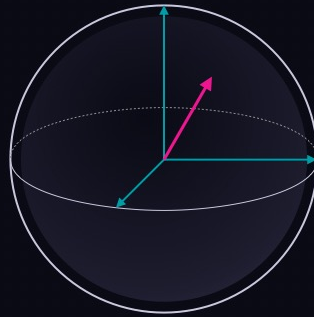
Fiction 2 : Quantum mines bitcoin faster

Fiction 3 : Teleportation = Time Travel
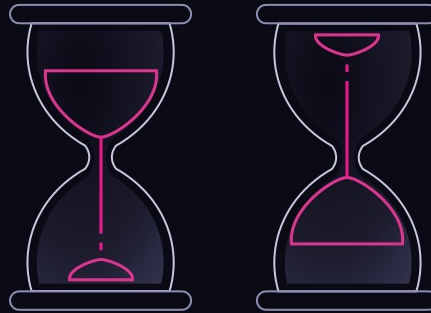
Fact 1 : Developers face a learning curve.
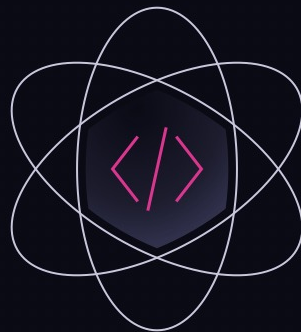
Fact 2 : Entanglement rules the day.
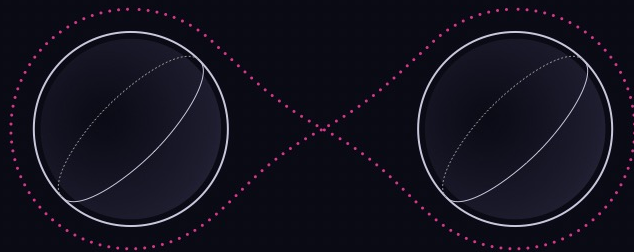
Fact 3 : It's a new era in computing.
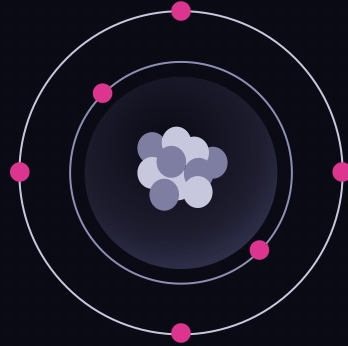
Learning More

Quantum Computing for Babies.
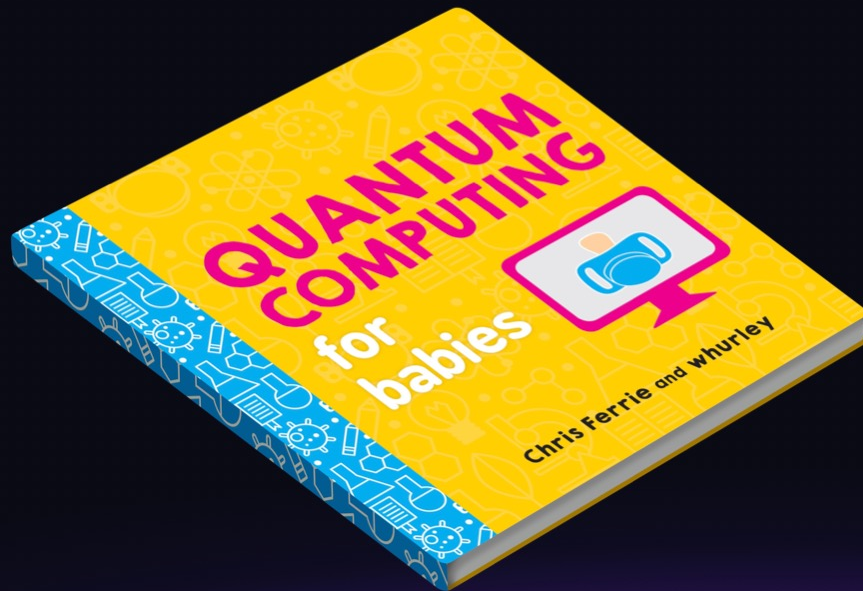
GET THE BOOK

Quantum Computing for Dummies.
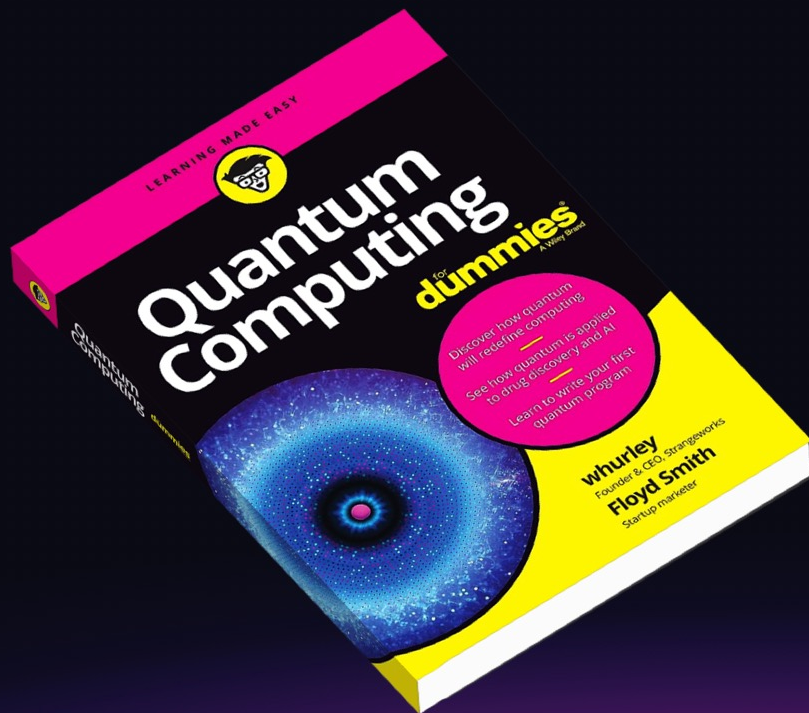
GET THE BOOK

STRANGEWORKS

Thank you.

Global Energy Trends & Transitions Q&A

William 'whurley' Hurley
CEO and Founder
Strangeworks

Art Valentine
Director, Linux & Firmware
Development, **IBM**

AUSTIN FORUM
ON TECHNOLOGY & SOCIETY

www.austinforum.org

Donate Your Unused Tech!

- If you have computers, tablets, or smartphones no longer being used, please help those in need
- Bring your devices to any in-person event, and we'll donate to our worthy charities!
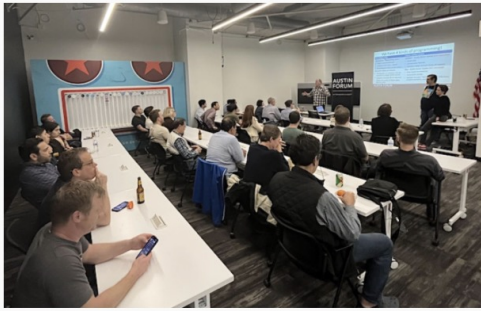
September 13, 2023

Austin AI Ecosystem Initiative: Decisions & Formation Meeting

6:30 p.m. CDT | **In-person**

REGISTER

Location
In-person
Capital Factory, Voltron Room
701 Brazos Street Austin, TX 78701

Agenda
6:30 - 8:00 p.m. | **Discussion**

Moderator
Jay Boisseau, Executive Director, Austin Forum on Technology & Society

Event Summary
This is the third meeting for Austin AI professionals, companies, and organizations to discuss the formation of an Austin AI Ecosystem Initiative, including the opportunities, scope, possible goals, and more. The first meeting in April 2023 covered the reasons for coming together, potential benefits, and potential goals and benefits. The second meeting on July 27 will discuss and draft priorities and goals, governance and participation models, and working groups and communications. This third meeting in September 2023 is for stakeholders to make decisions on these topics. The **Austin Forum on Technology & Society**, a longstanding technology non-profit (501c3), hosted the first and second meetings

AUSTIN FORUM
ON TECHNOLOGY & SOCIETY

www.austinforum.org

September 28, 2023

Discussion of "We Are Legion (We Are Bob)"

7:15 p.m. CDT | **Online**

REGISTER

Location

Online
Zoom (register for event to receive link)

Agenda

7:15 - 8:30 p.m. | **Discussion**

Moderator

Julie Tomlin, Event Coordinator, Austin Forum on Technology & Society

Event Summary

Join us for an upcoming book club event featuring 'We Are Legion (We Are Bob)' by Dennis E. Taylor. Delve into the sci-fi journey of Bob Johansson, an engineer turned AI who finds himself uploaded into a Von Neumann probe after his untimely demise. As he explores the universe, replicating himself and encountering various challenges, he transforms into a legion of Bobs, each with a unique personality and

October 3, 2023

The Technologies, Applications, and Future of 3D Printing

6:15 p.m. CDT | **In-person** (including networking) and **Online** (Zoom)

REGISTER

Location

In-person
Austin Central Library
710 W. César Chávez St.
Austin, TX 78701

Online
On Zoom
(register for event to receive link)

Agenda

5:15-6:15 p.m. Networking

6:15-7:30 p.m. Presentation

7:30-7:45 p.m. Q&A

8:00 p.m. Networking at **Trifecta**

Speakers

Leslie Bush, Metal 3D Printing Applications Engineer, **EOS**

Samantha Snabes, Co-founder, **Re:3D**

Melodie Yashar, VP of Building Design & Performance, **ICON**

Join Us for More Great Content in 2023

- **Schedule posted at www.austinforum.org**

- Additional presentation topics for 2023 will include
  - 3D printing everything
  - Digital privacy, trust, ethics debate
  - Gaming and e-entertainment
  - Cybersecurity
  - Health & precision medicine
  - and more!

Plus:
- New podcast episodes **now**
- In-person meetups
- Online book discussions

Austin Forum Team!

Jay Boisseau
Executive Director

Allison Warner
Logistics

John Lockman
Tech Director

Mary Garza
Web/UX Designer

Julie Tomlin
Operations

Kenya Caines
Communications

Our Partners Make Austin Forum Possible!

Please contact us if you want to become an annual partner!

Silicon Hills Calendar/Map

100 free 2023 calendars –
at table after final
comments
or pick up at Trifecta

Forms at table to get your
company on the 2024
calendar with a discount for
AF participants

AUSTIN FORUM
ON TECHNOLOGY & SOCIETY

And to our event sponsor, Abilitie!

invited**mba**

by abilitie

https://invitedmba.com/apply/

Code FORUM23 for $200!

Game-based,
12-week MBA

APPLY BY SEPTEMBER 1

use promo FORUM23 for $200 off

The Washington Post   yahoo!   nerdwallet

FINANCIAL TIMES   BUSINESS INSIDER   Forbes

AI: The Next Generation of Productivity
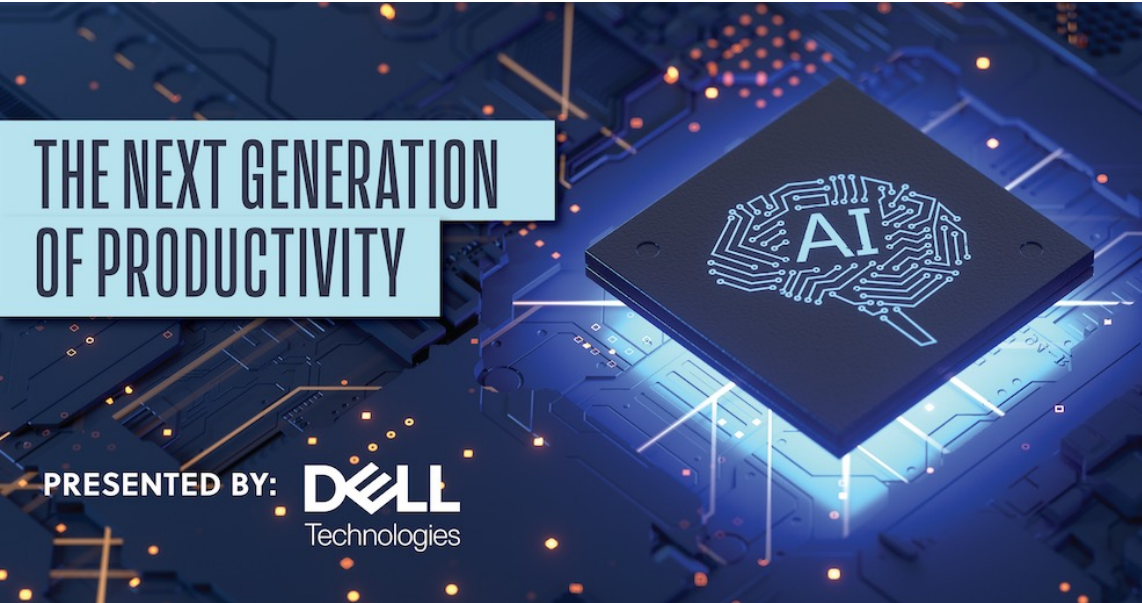
Hilton Austin on September 19 from 10:30 a.m. to 1:30 p.m. for AI

$5 off with code AI5
$50 off table with code AIGUEST

And 10 FREE tickets tonight for peoples who ask great questions!

https://www.austinchamber.com/events/ai-the-next-generation-of-productivity

AUSTIN FORUM
ON TECHNOLOGY & SOCIETY

www.austinforum.org

Q: What is the best thing you learned tonight?
(30 seconds)

1 2 3 4 5 6 7 8 9 10

11 12 13 14 15 16 17 18 19 20

21 22 23 24 25 26 27 28 29 🍕

AUSTIN FORUM

ON TECHNOLOGY & SOCIETY

Connect. Collaborate. Contribute.™