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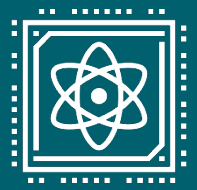
DEEP TECH THESIS | AUGUST 2020

shaping the **future**

5 EMERGING TECHNOLOGIES TRANSFORMING THE WORLD

> Five emerging technologies

01



QUANTUM COMPUTING

02

IOT

03

ARTIFICIAL INTELLIGENCE

04

BLOCKCHAIN

05

CYBER SECURITY

> Quantum Computing: Overview

QUANTUM COMPUTING

WHAT IS IT?

Computers using quantum mechanical phenomena (superposition and entanglement) to exponentially increase compute power and tackle complex problems far beyond the physical limits of today's best supercomputers.

STATE OF PLAY

Hardware: multiple hardware approaches racing to become market standard. Google and IBM leading the pack. Rigetti, Honeywell, Intel, IonQ and QCI following close behind.

Google IBM rigetti Honeywell intel IONQ qci

Software: multiple players starting to proliferate, largely focused on translating traditional software approaches into code that can exploit quantum computers' capabilities.

HORIZON QUANTUM COMPUTING QCWARE ZAPATA ENTROPICA LABS

ENDGAME

Several market leaders manufacturing competing quantum computing chips, plugged into a cloud platform alongside other processors. Software players build quantum algorithm libraries for performing compute tasks best done by quantum computers, that can work alongside traditional software libraries.

DRUG DISCOVERY | FINANCIAL RISK OPTIMIZATION | QUANTUM CHEMISTRY | MATERIALS SCIENCE | LOGISTICS | ENCRYPTION

Developer Platform

Cloud Platform

CPU | GPU | TPU | QPU

QUANTUM COMPUTING

> Quantum Computing: Use Cases

<drug discovery>

1 **IDENTIFYING DISEASE DRIVERS**

Better algos and higher compute power to find signals in large data sets

2 **MOLECULE SELECTION**

Ability to rapidly screen massive virtual libraries of potential molecules

4 **CLINICAL TRIALS**

Ability to simulate and predict drug/patient interactions could reduce failure rates and time

3 **MOLECULE OPTIMIZATION**

Improved modelling accuracy enables significantly improved drug design

<financial markets>

1 **RISK MANAGEMENT**

More detailed, granular and timelier risk scenario simulations enables higher precision risk management

2 **TRADING OPTIMIZATION**

Better algos processing high volume high velocity data enables realtime rebalancing for better returns

4 **MARKET MAKING**

Algorithms for processing high volume high velocity data to optimize pricing decisions in market making

3 **EXOTIC INSURANCE PRICING**

e.g. Pricing political risk using more accurate election forecasting scenarios

<advanced manufacturing>

1 **MATERIALS SCIENCE**

Simulating complex new molecules could create new materials with improved strength : weight ratios or energy-efficient production, etc)

2 **PRODUCT DESIGN**

Higher compute power to simulate component interactions in complex systems, enabling more precise product design

4 **SUPPLY CHAIN OPTIMIZATION**

Accelerate decision making to enable improved control of realtime, complex supply chains

3 **PRODUCTION CONTROL**

Ability to simulate exponentially more variables in production processes result in improved controls and yields

> Internet of Things

INTERNET OF THINGS

WHAT IS IT?

A network of web-enabled sensors, computing devices, and machines capable of directly communicating with each other, either to share data or act on information received from one another

STATE OF PLAY

Hardware and **infrastructure** are well developed, though with room for improvement. Multiple competing technical standards lead to lack of interoperability between multiple ecosystems.

Abundant initial **applications** already live in the market, across **consumer**, **medical**, **insurance**, **manufacturing**, **agriculture**, **smart city infrastructure**, and **energy** (among others.) **Emerging fields** include combining IoT with AI to drive **autonomous IoT e.g. autonomous vehicles**

ENDGAME

Data Tsunami: Internet-connected sensors embedded across a wide range of objects generates a deluge of data

"Smart Everything": embedded AI to drive autonomous decision making: e.g. smart roads, autonomous vehicles

The Edge: edge computing (and 5G) become enabling technologies that allow ever more complex decision making to be performed locally

INTERNET OF THINGS

> Internet of Things: Use Cases

<medtech>

1 **PREDICTIVE HEALTH MONITORS**

Smart sensors combined with AI can give early warning of when wearers may suffer adverse events e.g. heart attacks, COPD

2 **MEDICAL DIAGNOSTICS**

Ability to gather realtime data about the patient at the point of care enables faster diagnostics and personalized care

4 **SMART HOMES FOR IN-PLACE CARE**

Enables historically institutionalized patients to be cared for at home e.g. elderly, cognitively challenged

3 **INGESTIBLE SENSORS**

Allowing new forms of diagnostics and patient health monitoring

<new types of insurance>

1 **AUTONOMOUS VEHICLES INSURANCE**

Enable micro duration insurance for passengers during in-vehicle period, using telematics data to refine pricing

2 **CLIMATE / CROP INSURANCE**

Sensors deployed in agriculture, solar farms, wind farms etc enable dynamic, accurate pricing of climate risk

4 **CHRONIC CONDITION INSURANCE**

Wearables enable improved digital therapeutics for managing chronic conditions, making it affordable for insurers to offer policies e.g. diabetes insurance

3 **SUPPLY CHAIN INSURANCE**

Realtime data from IoT devices enable accurate modelling of supply chains, which can be used to design insurance policies

<agritech>

1 **PRECISION CROP MANAGEMENT**

Sensors measuring mineral content, temperature, rainfall, wind and humidity trigger automatic actions (e.g. fertilisation or watering to maximize crop yields

2 **GREENHOUSE AUTOMATION**

Enables remote monitoring and control of greenhouse environments e.g. urban vertical farms

4 **SUPPLY CHAIN OPTIMIZATION**

Generate data to enable improved realtime control of cold chains, and automate decision making to reduce food waste

3 **PREDICTIVE ANALYTICS**

Realtime data generated by smart sensors allows for prediction of crop yields, optimal harvest time, risk of diseases and infestations, etc

> Cyber Security: Overview

CYBER SECURITY

WHAT IS IT?

The protection of computer systems and networks from theft or damage to their hardware, software or electronic data. Economies that increasingly exist in cyberspace will become increasingly vulnerable to cyber attacks and threats, and security teams risk being overwhelmed.

STATE OF PLAY

Today: Traditional antivirus products have given way to AI-driven behavioural analysis, network monitoring, and endpoint detection and remediation (EDR) solutions. Key players include:

CROWDSTRIKE Carbon Black. cybereason DARKTRACE SentinelOne

Coming up: A shift toward **XDR** (extended detection and remediation across platforms) and **autonomous cyber defense**, capable of judgement to risk assess a threat and deliver a response. Requires proprietary artificial intelligence and deep learning models that are capable of making intuitive leaps on thin data

REAQTA

ENDGAME

Increasingly sophisticated solutions straddle multiple platforms (endpoints, email, servers, clouds, networks) to provide full cyber defensibility, matched by increasingly sophisticated bad actors deploying new and ingenious cyber attacks.

Proliferation of cyber threats leads to heavier reliance on machine intelligence to deploy automated defences, leaving human involvement to a decreasing percentage of instances.

Longer term, information security will be supplemented by quantum computing technologies to create quantum-proof unbreakable encryption protocols

CYBER SECURITY

> Cyber Security: Use Cases

Software famously ate the world, and cyber attacks threaten every aspect of the world that is encoded in software. Thus cyber security touches almost every aspect of modern life. *Instead of highlighting specific use cases of the technology, below we look at some ways in which autonomous cybersecurity will interact with the other emerging technologies that we highlight in this document.*

IOT / Medical Devices / Agritech / Advanced Manufacturing

Connected devices and wearable health trackers contain valuable data targeted by hackers

Digital Identities / Blockchain

Theoretically secure, blockchain protocols have already proven to be vulnerable to hacks. If digital identities become the portal into formal economic and societal services, they become valuable targets for hackers to exploit

Data Troves / Artificial Intelligence

Need to defend data troves acccumulated by the rise of telehealth, electronic health records, embedded finance and embedded insurance

Quantum-Ready defense

Current encryption protocols on the Internet will be easily broken by quantum computers; cybersecurity needs to be ready for the quantum age

ARTIFICIAL INTELLIGENCE

> Artificial Intelligence: Overview

ARTIFICIAL INTELLIGENCE

The development of computer systems that can perform tasks which normally require human intelligence, as well as or better than a human can. Caveat the **AI Effect**, where as soon as AI successfully solves a problem, the general public no longer considers the problem a part of AI

STATE OF PLAY

Hardware: Multiple tech giants and well-funded startups developing next-gen AI chips, available via cloud or in devices. Capital-intensive endeavour but could unlock fields with huge potential e.g. AR/VR, IoT (edge devices).

Tech Giants

Google AMD IBM arm NVIDIA intel

Startups

GRAPHCORE MYTHIC WAVE COMPUTING Cambricon HAILO Empowering Intelligence

Software and Applications: Widely integrated into applications across all sectors and use cases. Proliferation of open-source machine learning models and commodified AI capabilities.

WHERE ARE THE HARD PROBLEMS IN AI NOW?

DEEP REASONING

Expand beyond what deep learning does in image classification and perception into ability to reason

SMALL DATA DEEP LEARNING

Researchers pushing to figure out ways to train systems on less data for more complex and diverse tasks

ARTIFICIAL INTELLIGENCE

> Artificial Intelligence: Use Cases

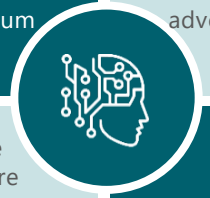
<medtech/pharma>

1 **DRUG DEVELOPMENT**

Rapidly screen likely molecule candidates for certain diseases; especially powerful if coupled with quantum computing

2 **PREDICTIVE DIAGNOSTICS**

Embedded AI in wearable medical devices can help identify patients at risk of adverse events e.g. heart attacks, COPD, etc



4 **PRECISION SURGERY / ROBOTICS**

Microsurgeries where human movements are translated to more precise, minute actions with robotic assistance

3 **HARDWARE OPTIMIZATION**

Increase diagnostic accuracy from lower cost devices, portable devices or lower resolution imaging modalities (e.g. ultrasound replacing MRI)

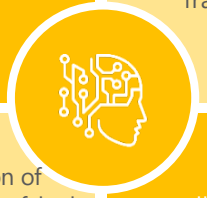
<financial services>

1 **THIN FILE CREDIT UNDERWRITING**

Enables instantaneous decision making using non-traditional underwriting criteria

2 **PAYMENTS FRAUD DETECTION**

Algorithms to detect and block a wide range of fraudulent transactions



4 **INSURANCE CLAIMS PROCESSING**

Automate claims processing with detection of fraudulent claims via deepfaked proofs of identity, images or video

3 **CREDIT MANAGEMENT / COLLECTIONS**

Language and voice analysis to optimise collections strategies for delinquent borrowers

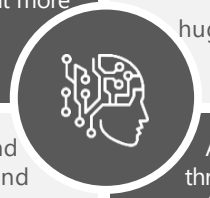
<advanced manufacturing>

1 **QUALITY CONTROL**

Ability to spot subtle manufacturing defects in components can prevent more expensive or systemic problems down the line

2 **PREDICTIVE MAINTENANCE**

Predicting when machines or products will malfunction can save huge costs in inspection or plant downtime



4 **SUPPLY CHAIN OPTIMIZATION**

Predict market demand for product updates and manufacturing volumes

3 **PRODUCT OR PROCESS DESIGN**

Algorithms to maximize throughput or to improve yields through improved manufacturing processes or product design

> Blockchain

BLOCKCHAIN

WHAT IS IT?

A electronic **shared ledger** among disparate users to create an **immutable record** of transactions, updated by **consensus**, each **time-stamped** and linked to the previous one. Every time a set of transactions is added, that data becomes another block in the chain.

STATE OF PLAY

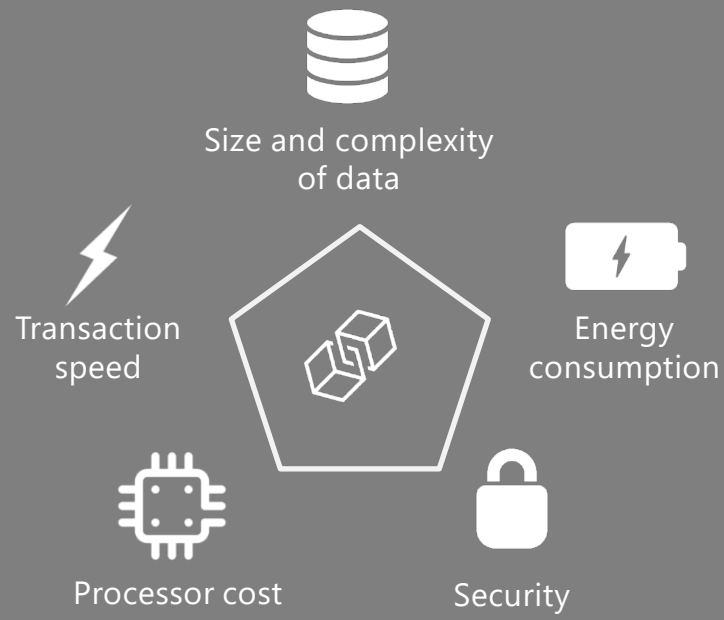
Today: Parallel developments in Blockchain technology in private-permissioned chains vs public-decentralised chains

Ongoing Innovations:

1) **Secondary Chains/ Side Chains –** off-loading transactions to a secondary network to increase transaction speeds
2) **Sharding –** Splitting up transactions to be verified by separate parts of the network to increase transaction speeds
3) Developing **new consensus mechanisms** - Consensus mechanisms (Proof of Work vs Proof of Stake) to improve energy efficiency
4) Improving algorithms to allow for more **complex code operations** on the blockchain
5) Making different blockchains **interoperable**
6) Development of **optimised energy efficient hardware** for blockchain computations

TECHNICAL CHALLENGES

Improving one without sacrificing the other



BLOCKCHAIN

> Blockchain: Use Cases

<medtech/pharma>

1 **E-PHARMACY INFRASTRUCTURE**

Coupled with IoT, immutable ledge to track drug sourcing, transport conditions (e.g. humidity / temp) and prescription fulfilment (preventing patient abuse of controlled drugs)

2 **DATA SHARING FROM WEARABLE DEVICES**

Secure digital identities enables patients to retain ownership of health data from medical devices, and revocable authorization of third party access to data

Permanent and trusted record unifying information (design plans, risk management, design verification and validation, quality control) that is currently stored across multiple conflicting sources

MEDICAL DEVICE DEVELOPMENT

4

Secure digital identities coupled with IoT enables individual control over health data sharing, enabling home participation in drug trials, or post-drug approval tracking of patient outcomes

DISTRIBUTED DRUG TRIALS

3

<financial services>

1 **DIGITAL REALTIME PAYMENTS**

Secure digital identities enables universal digital bank accounts, enabling widespread digital realtime payments

2 **INSURANCE UNDERWRITING**

Coupled with IoT, provides immutable data for dynamic realtime insurance risk pricing across a wide range of policies (auto, health, climate, crop, livestock)

Bypasses existing inefficient middleman to significantly reduces fees, allows for near instance remittance and offers traceability in cross border money movements

CROSS BORDER REMITTANCE

4

Allows for near instant settlement, removes need for reconciliation, allows for continuous markets and provides provenance of trades, and enables liquidity in previously illiquid markets

REAL ASSET TOKENIZATION

3

<advanced manufacturing>

1 **QUALITY CONTROL**

Track counterfeit products and assists businesses in making informed decisions with transparency in raw material provenance

2 **PREDICTIVE MAINTENANCE**

Provides manufacturers visibility into entire global service supply chain in real time to ensure repairs are made just in time

Establishing design provenance to deliver printed products that are verified to industry and regulatory standards, while attributing underlying IP to creators

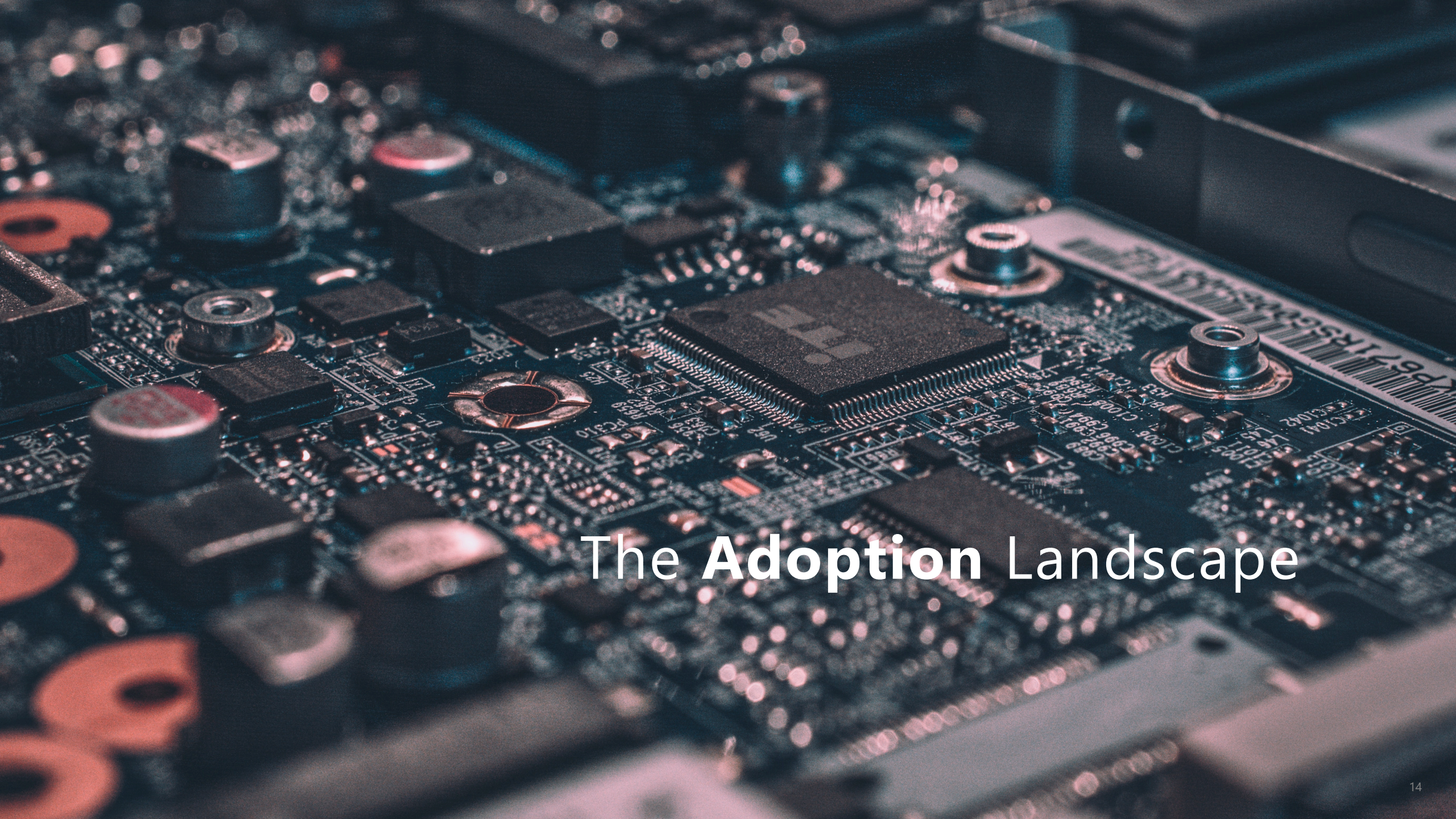
3D PRINTING

4

Allows for secure data sharing amongst the swarm of robots communicating across several channels while maintaining the integrity of informational flow

SWARM ROBOTICS

3



The **Adoption** Landscape

> Covid 19 has exposed and magnified fundamental weaknesses…

finance
insurance

1. Complacency has resulted in **enormous underinvestment** in digital infrastructure…
2. …creating **multiple human points of failure** along entire value chain, including origination, management, and servicing…
3. …Leading to collapse in bank / insurer ability to service their clients properly, **except those that have invested in digital**

healthcare

1. Current stress exposes **decades of underinvestment** and **unwillingness to leverage technology**…
2. …whilst patients have largely been **slow to adopt technology** in lieu of physician / hospital visits
3. Governments and care providers now on a frantic search to provide care, diagnostics, monitoring, and accelerate drug development…

   …while patients become aware of their own health, and the potential impact of lifestyle

industry

1. Global lockdowns have revealed **weak links** in **global supply chains**…
2. …while **multiple layers of complexity obscure** manufacturers' ability to have **instant online visibility** into issues at tier 2 or 3 suppliers
3. Companies are now incentivized to **implement automation solutions** to reduce workers on the factory floor, and **tighter, realtime situational awareness** deeper into supply chains to enable pivots to alternative suppliers if necessary

agriculture

1. Border closures hindering the ability of seasonal workforces to travel have **severely tightened labour markets** in agriculture…
2. …while **demand structurally shifted** from the hospitality sector to supermarkets and households
3. Companies are now incentivized to **automate harvests** and **build agility into supply chains** to meet the different ways of reaching the end consumer

> Necessity now drives key stakeholders to "cross the chasm"

THE STAKEHOLDERS

GOVERN-MENT

INCUMBENTS

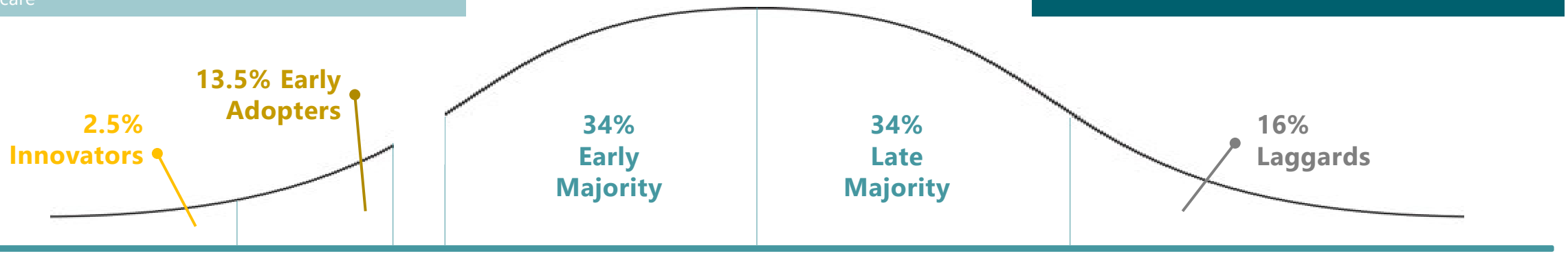
STARTUPS

MERCHANTS

CONSUMERS

Governments and Incumbents have an "aha" moment, and will cross the chasm to embrace and prioritize development of digital ecosystem in financial services as well as healthcare

TECHNOLOGY ADOPTION BELL CURVE



The innovators and early adopters will now be joined by a much larger majority who will embrace technology, see for example growth of Zoom etc.

> A virtuous cycle of data generation and analytical capabilities

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