UNIVERSITY *of* NICOSIA

Session 12

Opportunities and Challenges in a World Powered by IoT, AI and Blockchain

BLOC 514: Emerging Topics in Blockchain and Digital Currency

Session Objectives

- To provide an overview of the 4th industrial revolution

- To present the key characteristics of the following areas: Internet of Things (IoT), Artificial Intelligence (AI), and blockchains

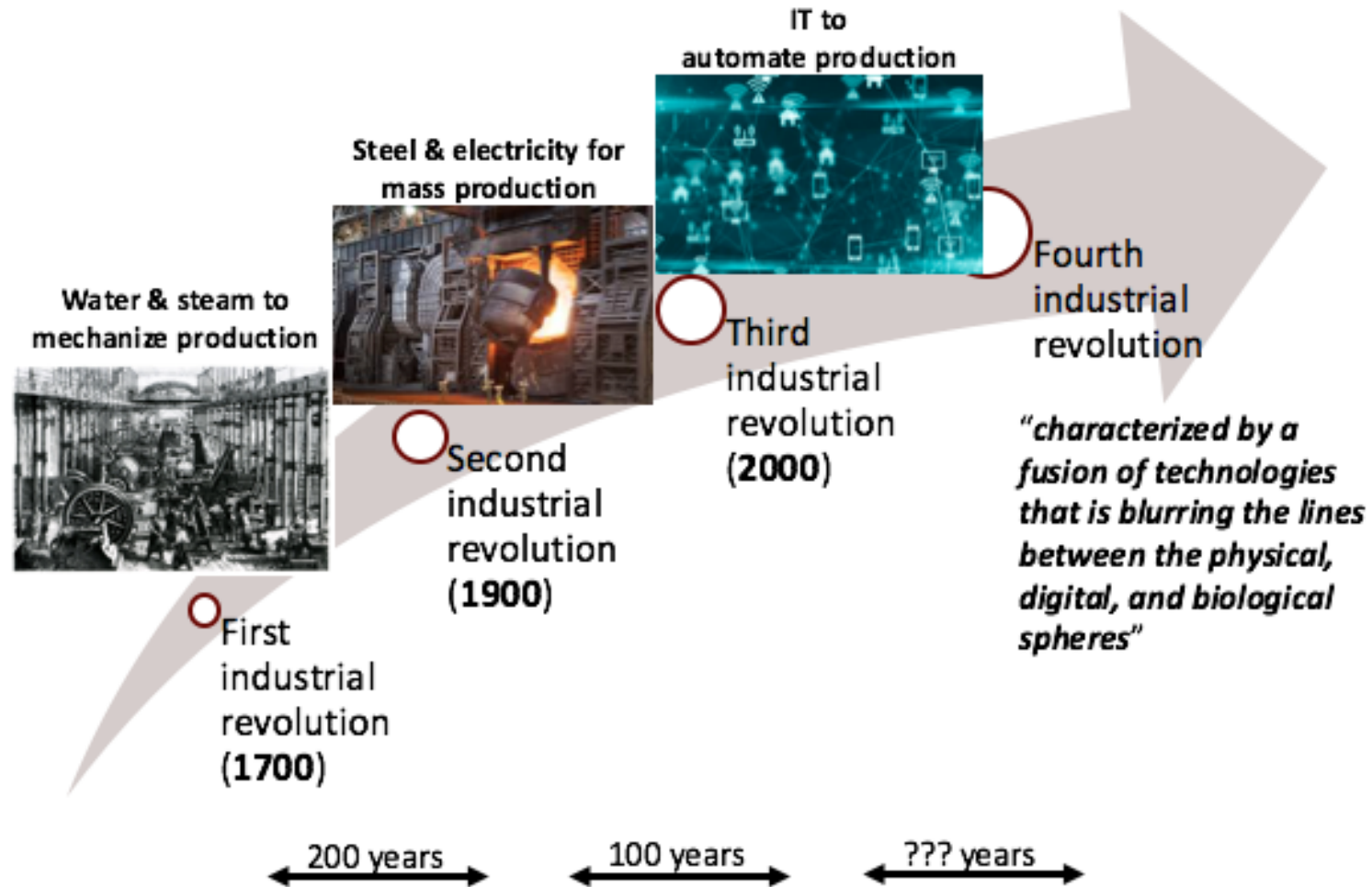- To discuss how the potential synergies of the aforementioned technologies

In this session, we will discuss how a new era for commerce is enabled through the combination of IoT, AI and blockchains. In this context, we will explain the related challenges and implications.
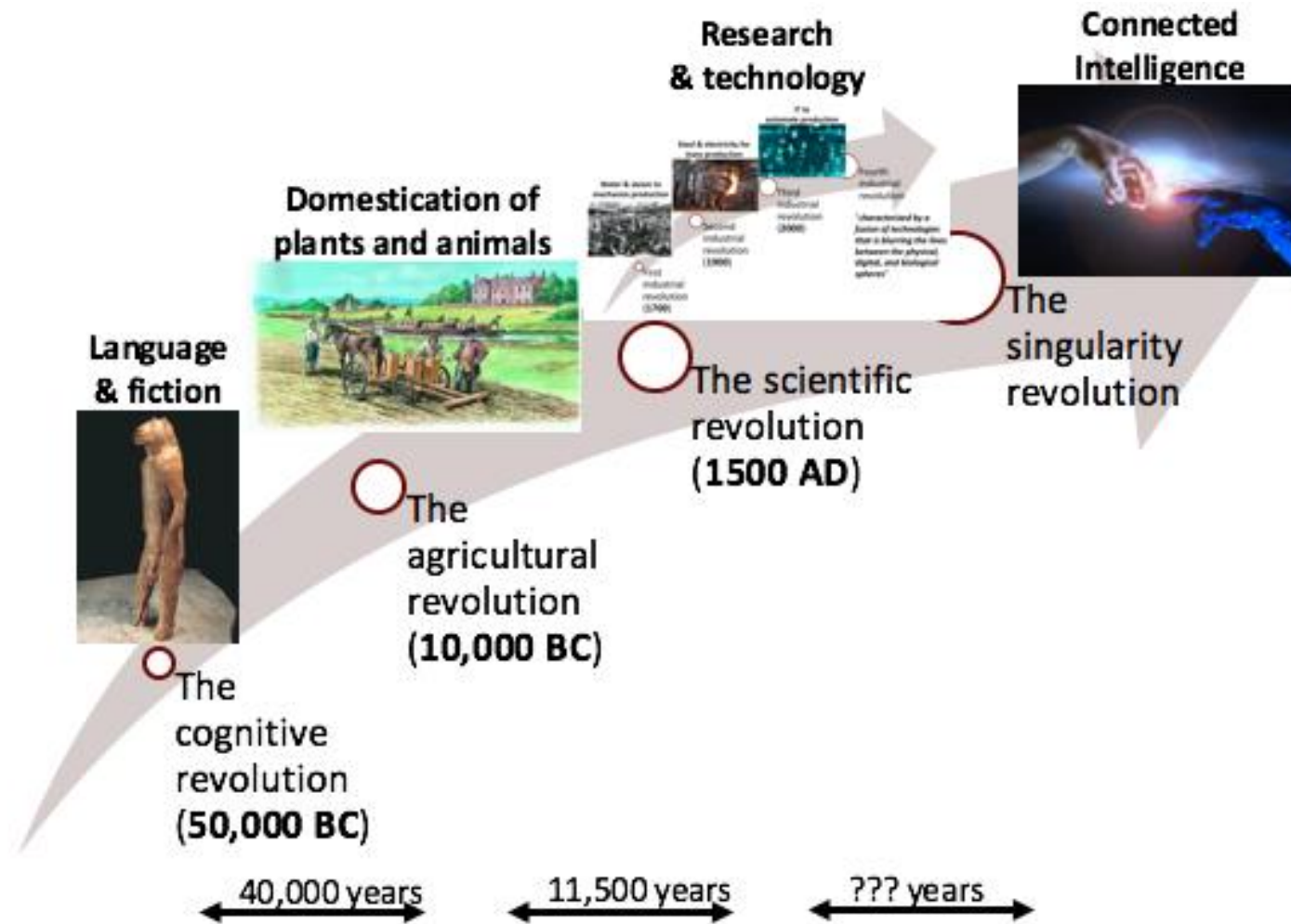
Agenda Slide

- The 4th industrial (and human) revolution

- Internet of things (IoT)

- Artificial intelligence (AI)

- Blockchains

- Convergence of IoT, AI and blockchains; future technology stack

- Conclusions

- References

- *(and an idea integrating neural AI and a generalized form of NFTs)*

The 4ᵗʰ industrial revolution?

IT to automate production

Steel & electricity for mass production

Water & steam to mechanize production

Fourth industrial revolution

"characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres"

Third industrial revolution (**2000**)

Second industrial revolution (**1900**)

First industrial revolution (**1700**)
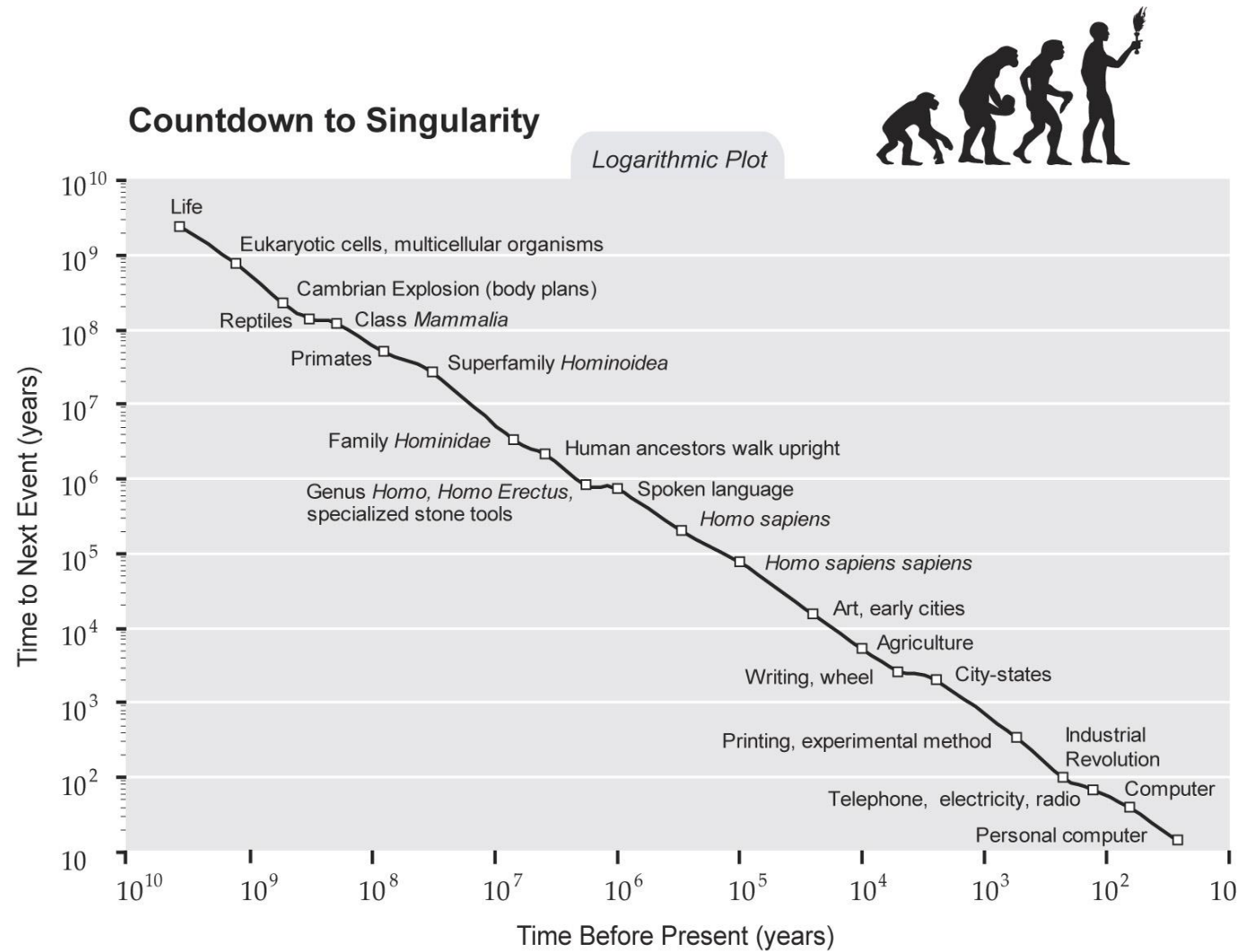
200 years   100 years   ??? years
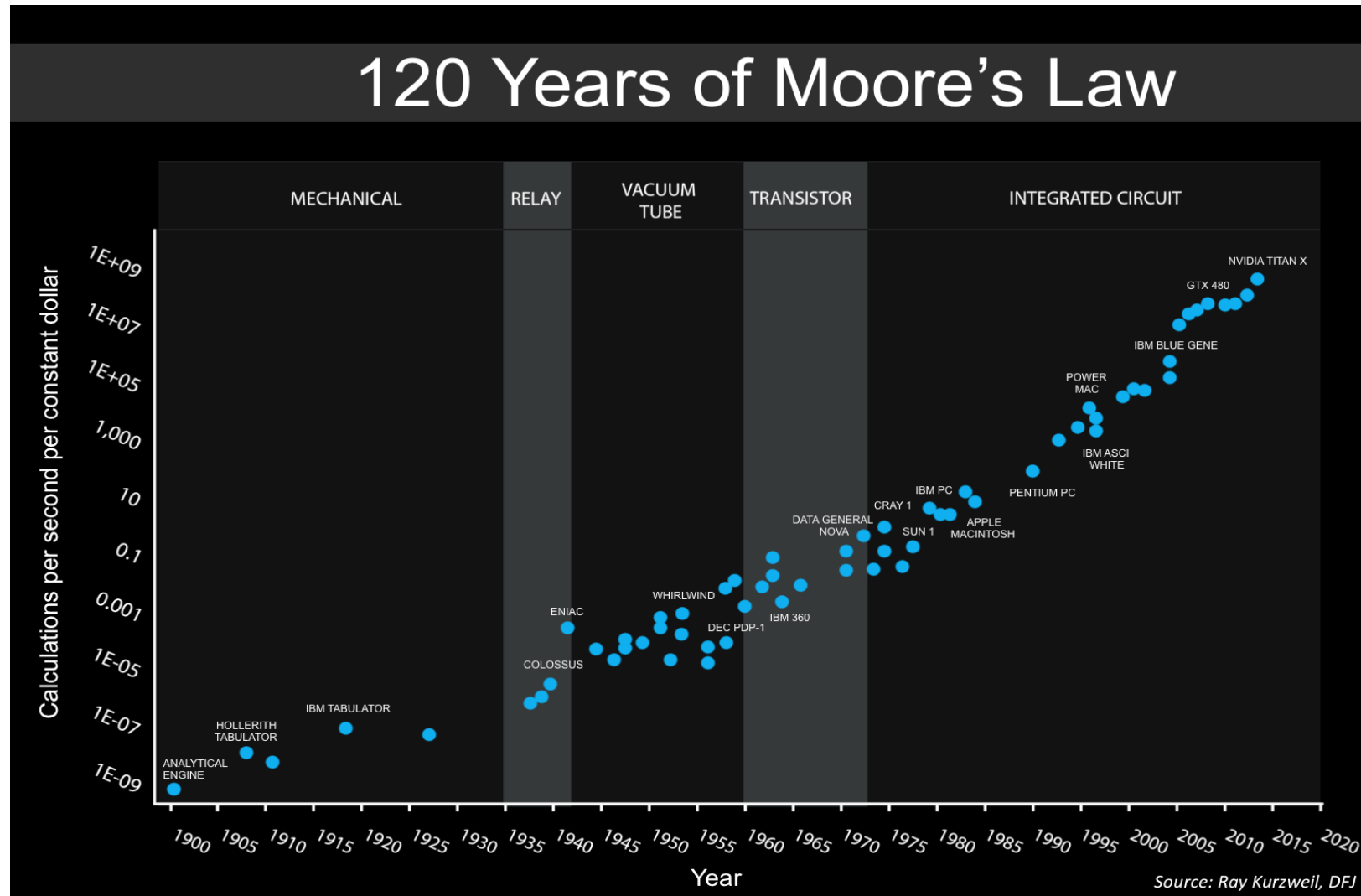
Or the 4th human revolution?

A case for singularity

- **Artificial superintelligence** will trigger **runaway technological growth**, resulting in **unfathomable changes to human civilization**
  - Upgradable intelligent agents will create accelerating self-improvement cycles, causing an **intelligence explosion**
  - As superintelligence continues to upgrade itself, technology would advance at an incomprehensible rate
  - At some point, **machines will be more intelligent than humans**
  - **Singularity**! (we cannot predict the outcome)

- Consequences have been hotly debated:
  - Some (R. Kurzweil) claim that humanity will **transcend the limitations of the human body and brain**
  - Others (S. Hawking, E. Musk) claim that the singularity could lead to **human extinction**
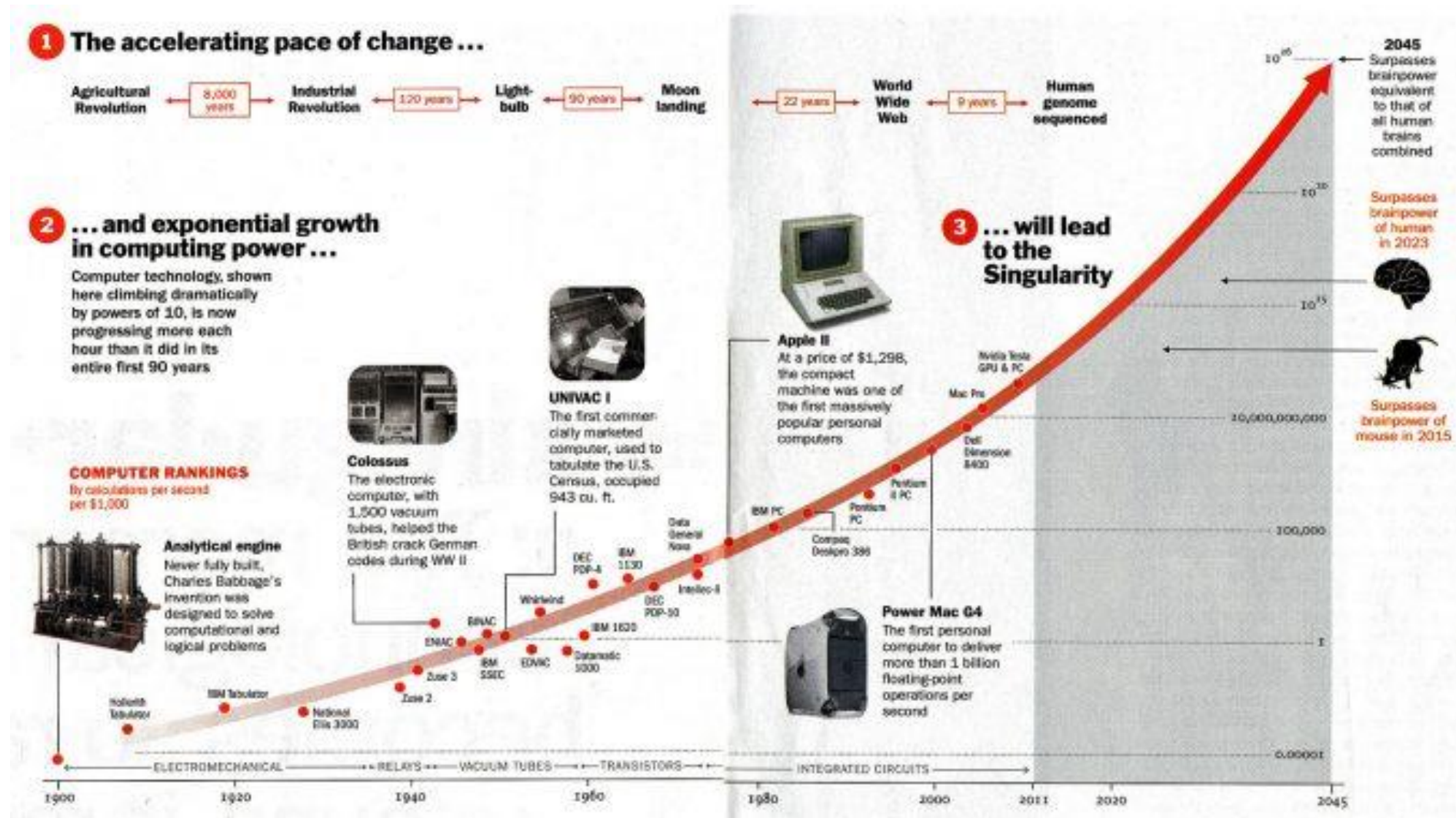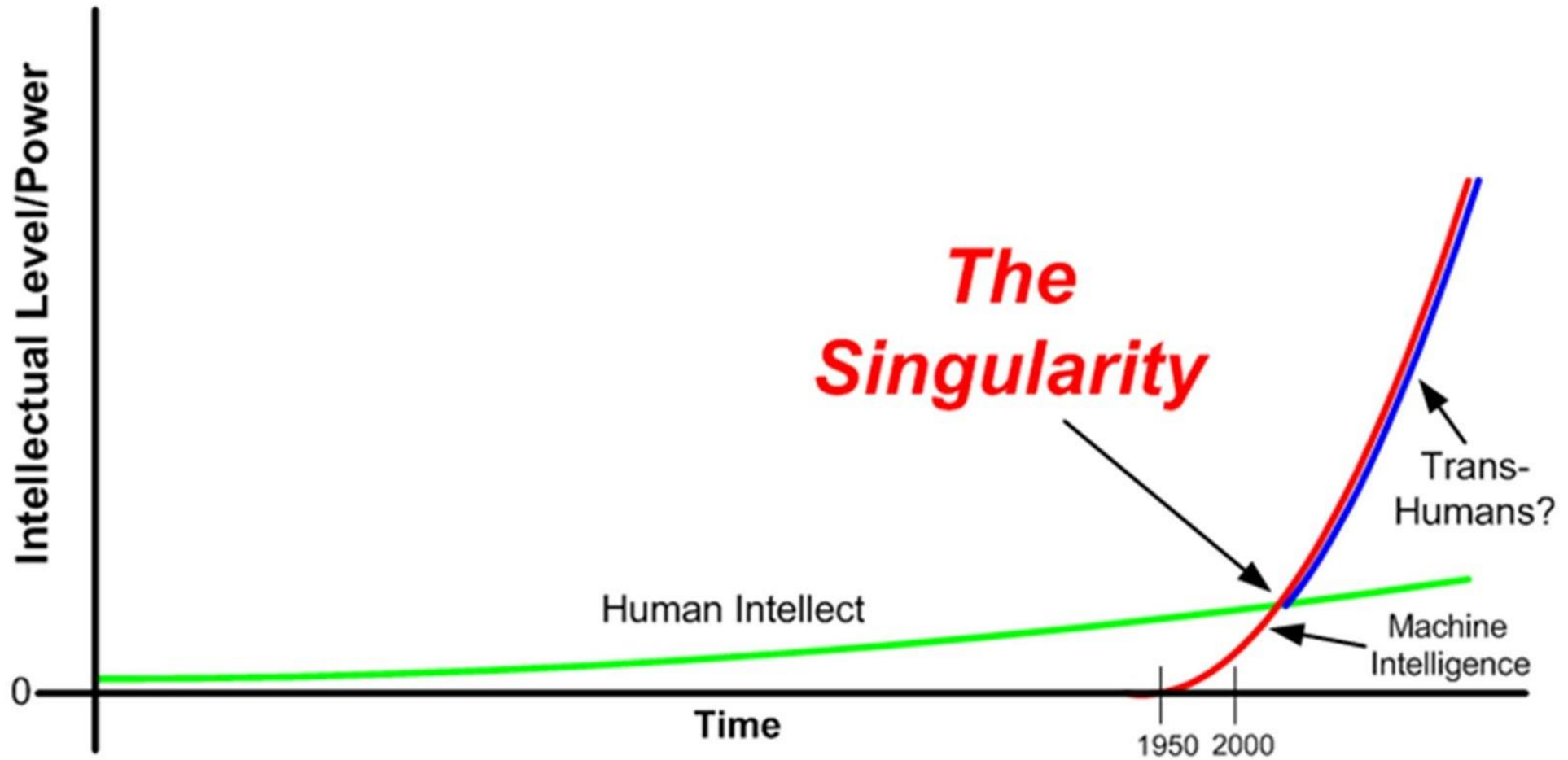
Plausibility

Countdown to Singularity

Logarithmic Plot

Plot of "Time to Next Event (years)" (y-axis, 10 to 10^{10}) versus "Time Before Present (years)" (x-axis, 10^{10} to 10), with labeled events:
- Life
- Eukaryotic cells, multicellular organisms
- Cambrian Explosion (body plans)
- Reptiles
- Class *Mammalia*
- Primates
- Superfamily *Hominoidea*
- Family *Hominidae*
- Human ancestors walk upright
- Genus *Homo*, *Homo Erectus*, specialized stone tools
- Spoken language
- *Homo sapiens*
- *Homo sapiens sapiens*
- Art, early cities
- Agriculture
- Writing, wheel
- City-states
- Printing, experimental method
- Industrial Revolution
- Telephone, electricity, radio
- Computer
- Personal computer

Plausibility

120 Years of Moore's Law

Source: Ray Kurzweil, DFJ

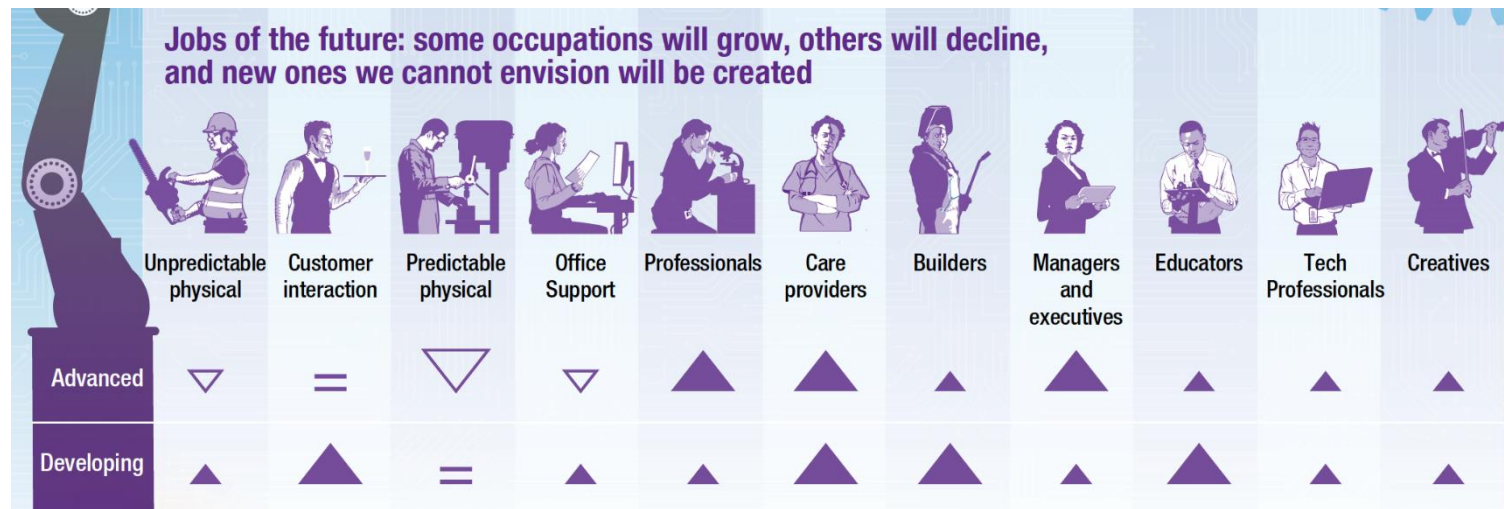# Plausibility - Timeline

A post-singularity future

Social effects-singularity revolution

Job displacement – Mass unemployment – Rising inequality – Social unrest

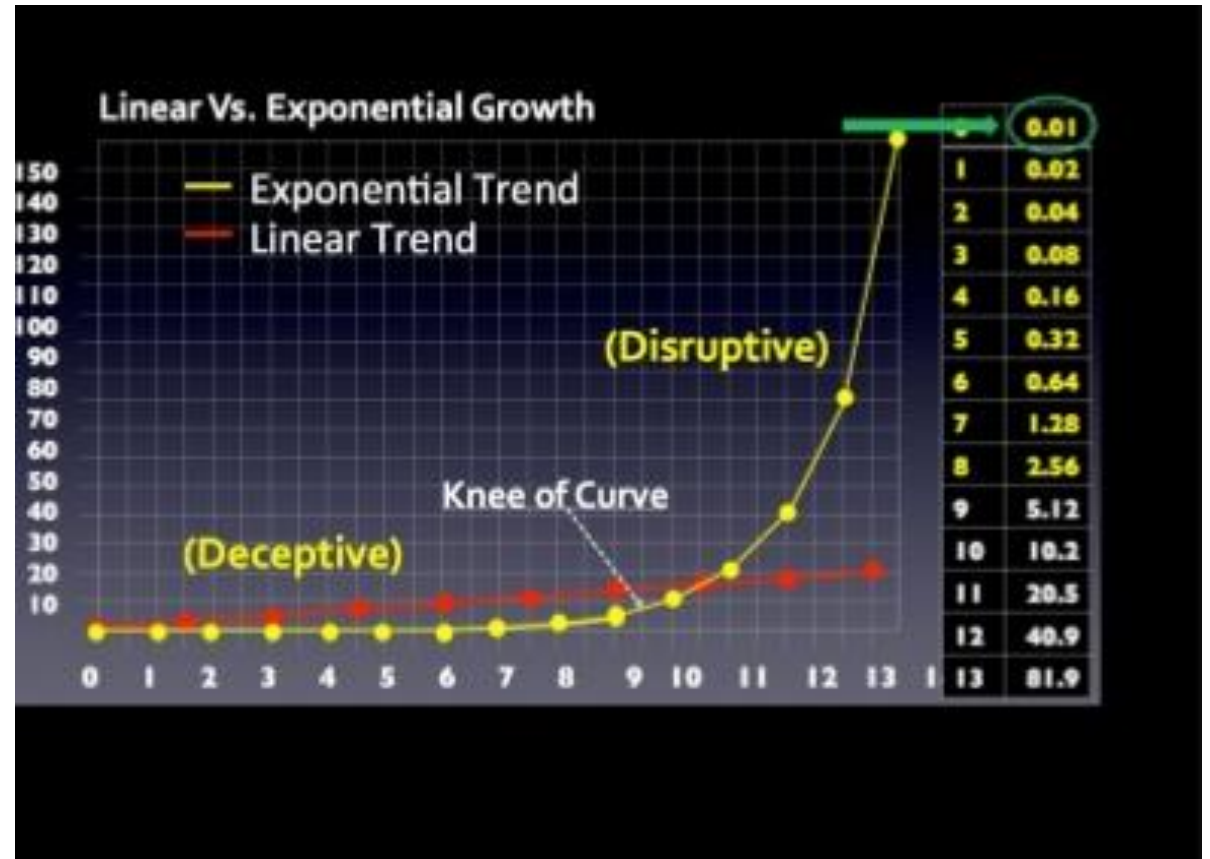"…47 percent of jobs are "at risk" of being automated in the next 20 years."

Carl Frey and Michael Osborne, Oxford University

"The Future of Employment: How Susceptible Are Jobs to Computerisation?"

Exponential technologies

Internet of Things	Artificial Intelligence	Distributed Ledgers (Blockchain)
Robotics	Augmented/Virtual Reality	3D Printing
Molecular nanotechnology	New materials	Energy storage
Autonomous Vehicles	Genetic engineering	Quantum computing

Linear Vs. Exponential Growth

— Exponential Trend
— Linear Trend

(Disruptive)

Knee of Curve

(Deceptive)

	0.01
1	0.02
2	0.04
3	0.08
4	0.16
5	0.32
6	0.64
7	1.28
8	2.56
9	5.12
10	10.2
11	20.5
12	40.9
13	81.9

Internet of Things

- IoT is the **network of physical devices** embedded with **sensors, software** and **connectivity**

- First **M:1** information technology in history
  - Computers **1:M**
  - Mobiles **1:1**
  - Sensors **M:1**
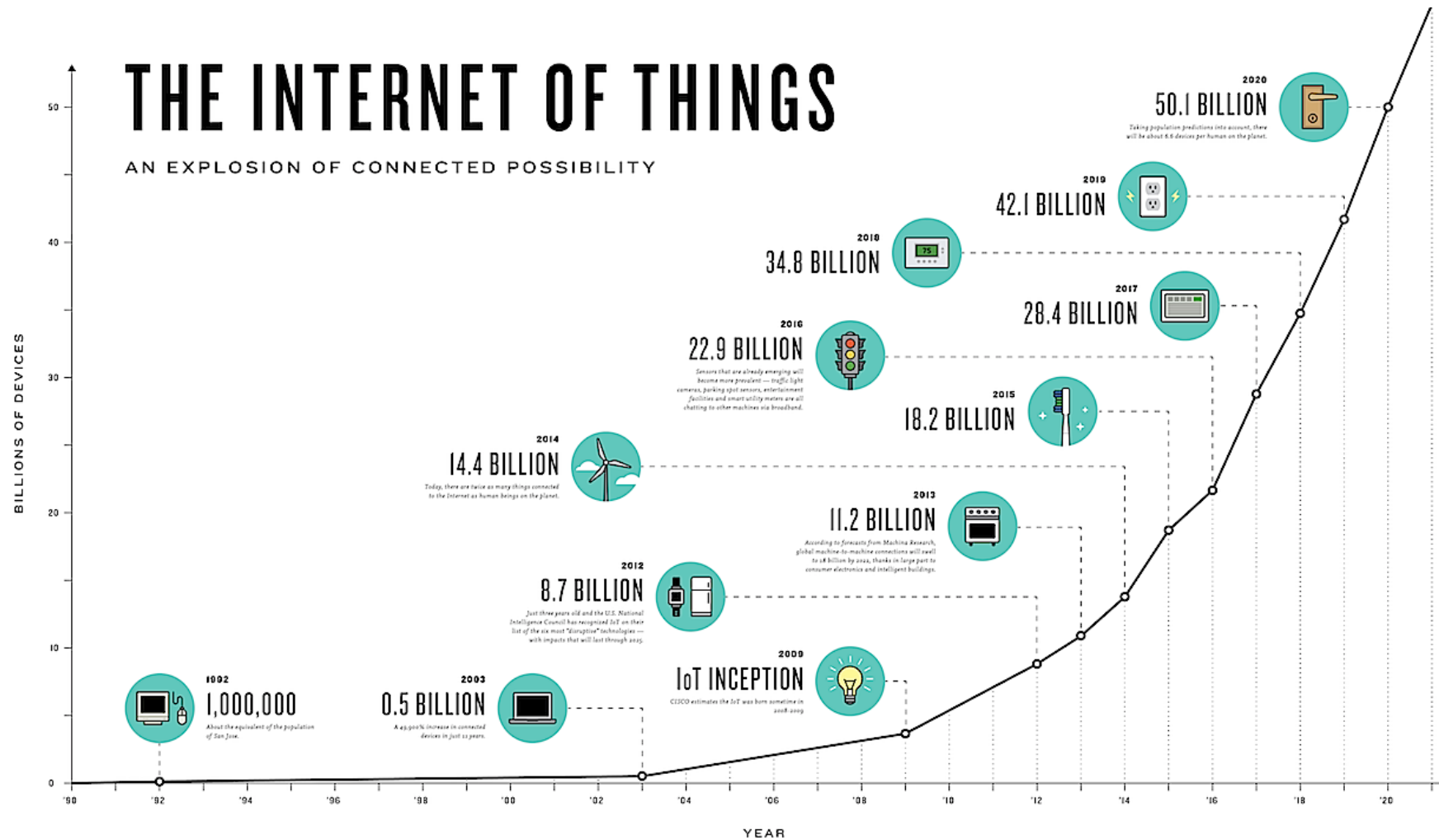
Internet of Things: Applications

- **Consumer**
  - Smart home (home automation, smart appliances)
  - Wearables
  - Lifelogging (quantified self)
  - Connected health

- **Enterprise**
  - Manufacturing (equipment/asset/situation management)
  - Agriculture
  - Energy
  - Building automation
 - Transportation

Internet of Things: Applications

Artificial Intelligence

- AI refers to computer science techniques that enable systems to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision making and language translation.

- **AI is whatever hasn't been done by computers yet** ☺
    - AI in 1998: OCR, playing chess.
    - AI now: autonomous vehicles, robots, etc

- Applications/Challenges:
    - Digital assistants
    - New computer interfaces (e.g. non-invasive brain-machine interfaces)
    - New business models (self-driving supermarkets?)

Facebook's AI Chatbots Developed Their Own Non-Human Language

Artificial Intelligence

Artificial Intelligence
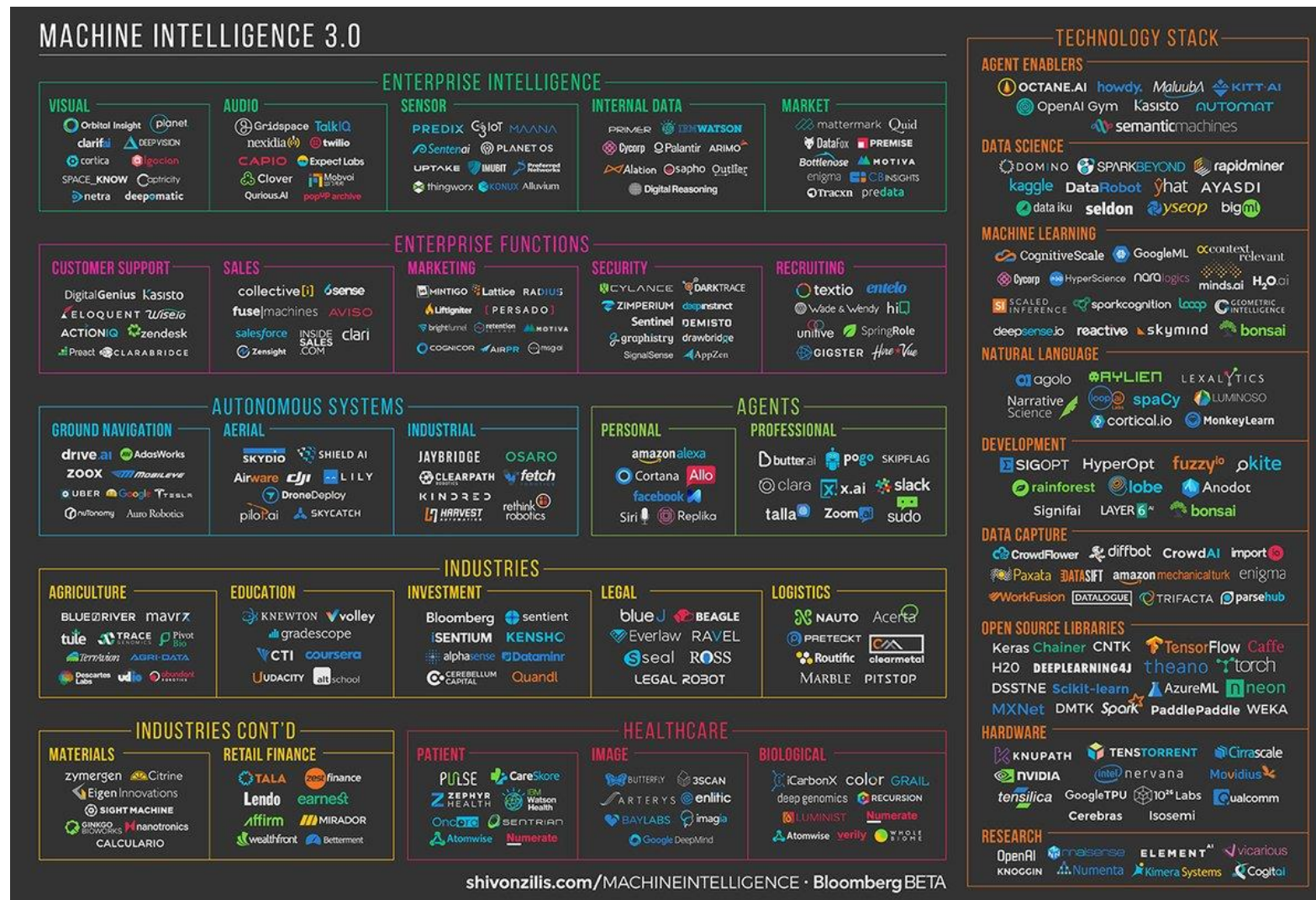
Majors move into artificial intelligence

	Acquisitions	Open source frameworks	Cloud services	AI/ML/DS staffers	User data
Google	✓	✓	✓	8000+	2 trn search / annum
Facebook	✓	✓	✓	2200+	1.8bn+ people
Microsoft	✓	✓	✓	9000+	c 1bn users
amazon	✓	✓	✓	4600+	250m+ buyers
Baidu 百度	✓	✓	✓	500+	660m MAU
Apple	✓			2000+	>1bn devices

Personal views @azeem

The blockchain

- A blockchain is a **shared, time-stamped, append-only, immutable, cryptographically-secured** ledger of transactions

  - **Shared:** blockchains do not make much sense unless two or more parties (or systems) are involved.

  - **Time-stamped:** transactions are stored in chronological order.

  - **Append-only**: you can only add new transactions to a blockchain.

  - **Immutable**: Once written, a transaction cannot be erased or altered.

  - **Cryptographically-secured**: advanced cryptography enables all the above

Why is this important

- Think of a blockchain as **an Internet-wide system of trust**:

  - Anyone can buy in or sell out of its ledger

  - Anywhere in the world

  - Without anyone's permission or intervention

  - At virtually no cost

  - **Without needing to know or trust one's counterparty!**

A blockchain allows **untrusted parties** to reach **consensus** on a shared digital history, **without a middleman**.

A Second Internet, Coming Soon, Courtesy of the Blockchain

Why is this important (enterprise blockchains)

- Think of an **enterprise** blockchain as **a <u>networked system of trust</u>:**
  - **No third party** is required to clear/settle transactions
  - **No data reconciliation** is needed between systems
  - Transactions are secure and final in almost **real time**

- Compared to a public blockchain:
  - **High privacy; Lower costs**
  - But, easier to attack as fewer participants

Smart contracts

- **Smart Contracts** are **self**-**executing** contractual states, stored on the blockchain, which **nobody controls and therefore everyone can trust**.

- Smart contracts allow users to create their own systems and applications, such as
    - Custom financial instruments (**tokens**)
    - Records of the ownership of an underlying physical asset (**smart property**)
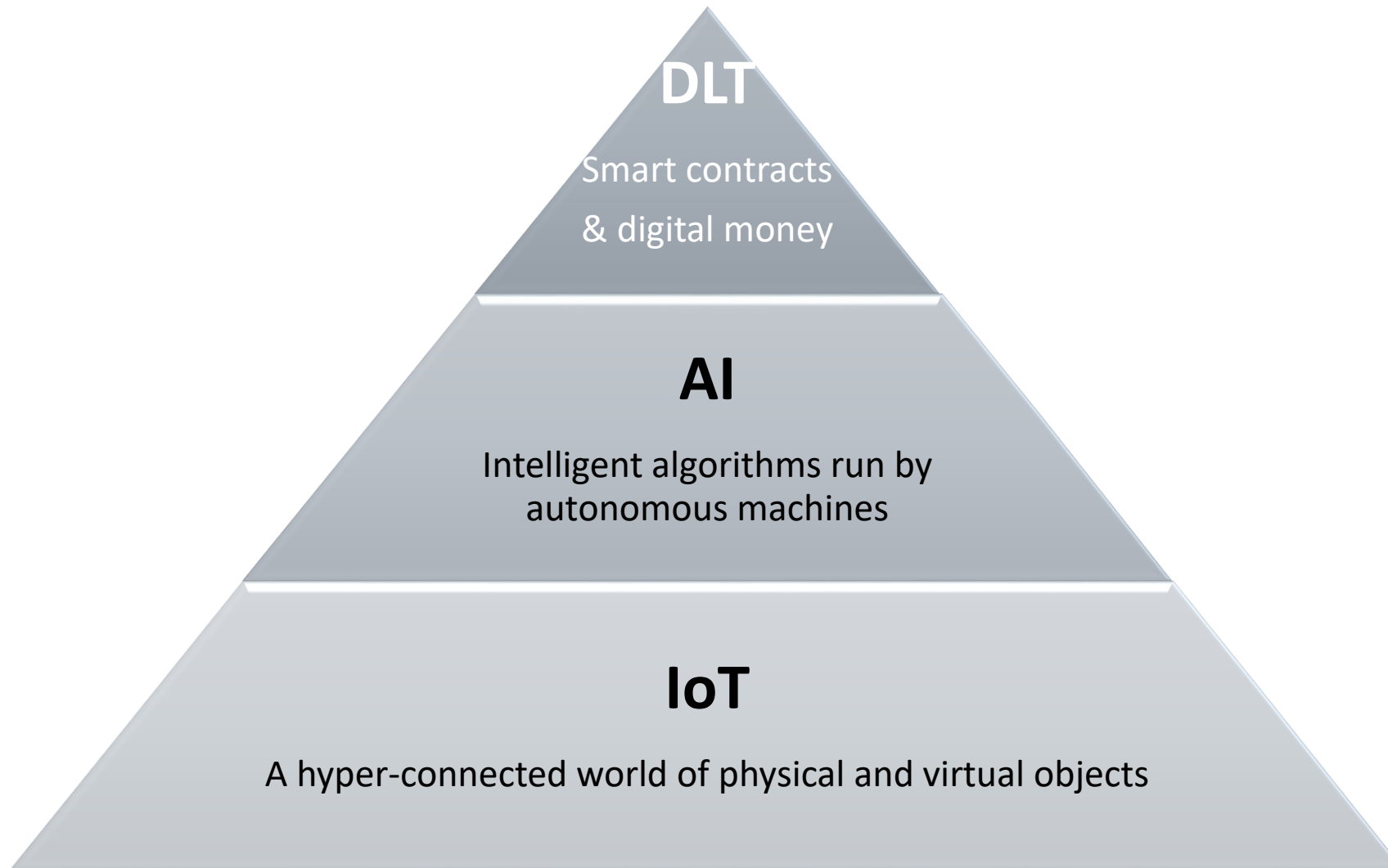   - Any complex **business logic** that can be programmable

AI, IoT and DLT converging?

- Individually, these technologies deserve all the attention they're getting as enablers and disruptors

- But, taken together?

- Their transformative effect becomes multiplicative, almost demanding that we reimagine the art of the possible.

- **A future driven by data:**
  - **IoT**: generate data
  - **AI**: act on data, trigger services
  - **Blockchain**: record data, settle payment for services
  - **Advanced analytics**: will empower this all

Future trend: decentralization

- **IoT:**
  - **Sensors** allow us to cost-effectively gather zillions of data points.
  - **Connectivity** allows us to transmit/broadcast these data.
  - But, what about **software**?

- **AI:**
  - Intelligence at the very edges of the network (**mini-brains**).
  - **Combine with IoT** and you have the ability to recognize meaningful patterns buried in mountains of data in ways that would be impossible for most humans, or even non-AI algorithms, to do.
  - But, what about acting upon this knowledge?

- **DLT:**
  - Decentralized governance, coupled with no single point of failure, dis-intermediation, unalterable and searchable records of events.
  - **Combine with AI and IoT** and you have a new world of autonomous systems interacting with each other, procuring services from each other and settling transactions.

The future technology stack

DLT
Smart contracts
& digital money

AI
Intelligent algorithms run by
autonomous machines

IoT
A hyper-connected world of physical and virtual objects

Toward a new era for commerce

- Digital currencies create new forms of money
  - **Programmable** and **active** ☛ money for machines?

- Blockchains create a new Internet layer
  - Internet of trust ☛ **Dis-intermediation across industries, esp. finance**

- Consequences will be vast:
  - Money transacted in nano-quantities will lead to **M2M & H2M commerce**
  - **Autonomous, AI-based, economic agents** will emerge
  - Cloud-based, **autonomous corporations** will be made possible

Main challenges

- **New/upgraded system architectures**
  - From legacy to blockchain/AI/IoT-native systems
  - Integration, **interoperability**, backward compatibility
  - ROI obvious ex post, difficult ex ante – **Bootstrapping**

- **Advanced analytics capabilities**
  - As devices at the edge become smarter, the smart contracts enabled by blockchain platforms will require more advanced data **analytics** capabilities and **gateways** to the physical world.

- **New business models**
  - **Disruptive innovation** will dominate – but not without boom-and-bust cycles and big failures along the way.
  - **Winners will NOT be the ones focusing on efficiency gains.**

Implications

- **Study up – stay aware!**
  - Most losers will come from the ranks of the unaware, the myopic and the reckless.

- **Develop future-ready corporate vision and strategy**
  - Pivot your organization to the right direction at the right time

- **Time your tactical decisions carefully**
  - In an era of fat protocols, much value will be created early on (high risk – high return)
  - Avoid investments in hyper-hyped technological junctures

Conclusions

Conclusions: Key takeaways

#1 We are at a historical juncture

- 4th (industrial) revolution
- Singularity?

#2 IoT, AI and DLT lead the way

- From the Internet of information to the Internet of value
- M2M/H2M commerce
- New forms of corporations (code-only, autonomous)

#3 Implications for economic growth & social disruption

Bibliography

References (optional)

S. Makridakis, A. Polemitis, G. Giaglis and S. Louca. "**Blockchain: The Next Breakthrough in the Rapid Progress of AI**",
Robotics & Automation Engineering Journal

Abstract. This paper investigates blockchain and the technologies behind it, including bitcoins and other crypto currencies, and explain their technological might and outstanding potentials not only for transactions but also as distributed databases. It also discusses its future prospects and the disrupted changes it promises to bring while also considering the challenges that would need to be overcome for its widespread adoption. Finally, the paper considers combining blockchain with Artificial Intelligence (AI) and discusses the revolutionary changes that would result by rapidly advancing the AI field.

Nikos Athanasiou, Elias Iosif, Alexandros Potamianos. **"Neural Activation Semantic Models: Computational lexical semantic models of localized neural activations"**

Summary of main idea. A machine learning (ML) model that can be used for mapping lexical content to brain signals (learnt from fMRI scans). This constitutes one of the building block of brain interfaces, a new form of human-computer interactions.

And, before closing this session...

Bringing together neural AI and NFTs

(Consider the second, optional reference a couple of slides back)

<u>The idea in a nutshell:</u>

Instead of having images (and/or something similar),

consider

the NFTokenizaton of (unique) experiences

<u>What is needed:</u>

1. A generalized definition of NFTs (as multimedia/mutlimodal digital objects)

2. ML models

3. Hardware for encoding (digitazation), storage, retrieval/reproduction

4. New forms of digital economy (plus, digital identities, spaces like "metaverses")

Instructor's Email:
iosif.e@unic.ac.cy