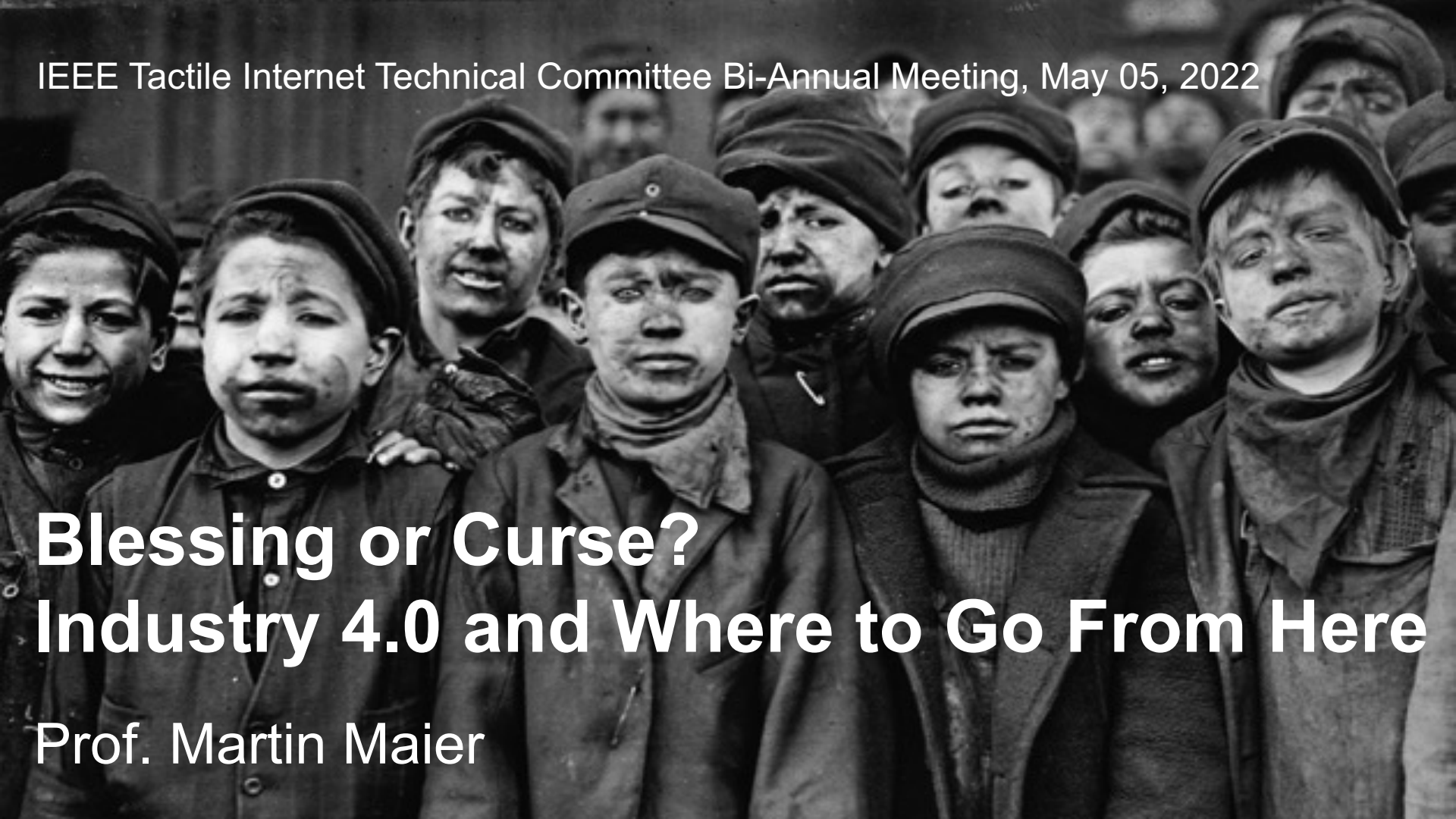


IEEE Tactile Internet Technical Committee Bi-Annual Meeting, May 05, 2022

Blessing or Curse? Industry 4.0 and Where to Go From Here

Prof. Martin Maier

Industrial Revolution: Blessing or Curse?

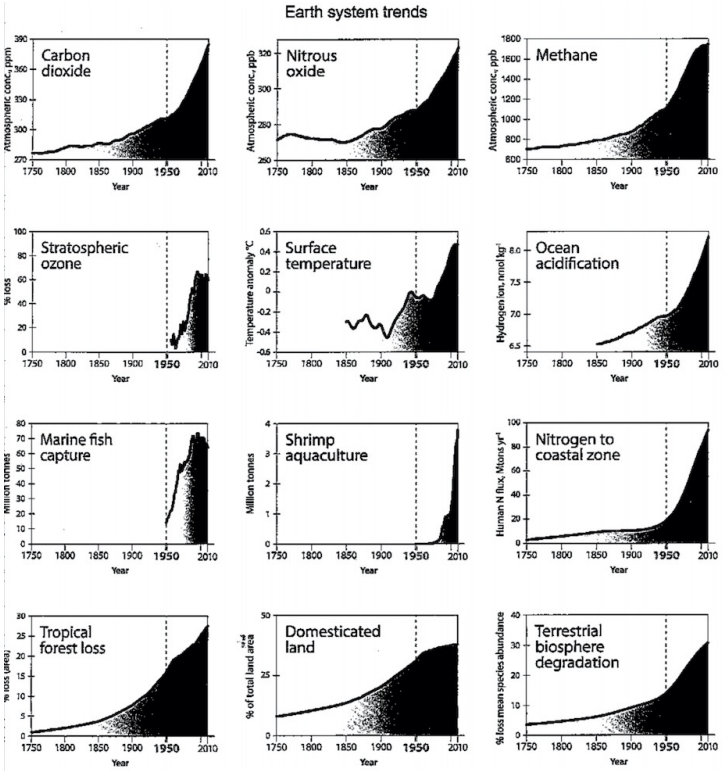


Figure 3.1
The great acceleration of pressures on our planet.
Source: Azote image for Stockholm Resilience Centre

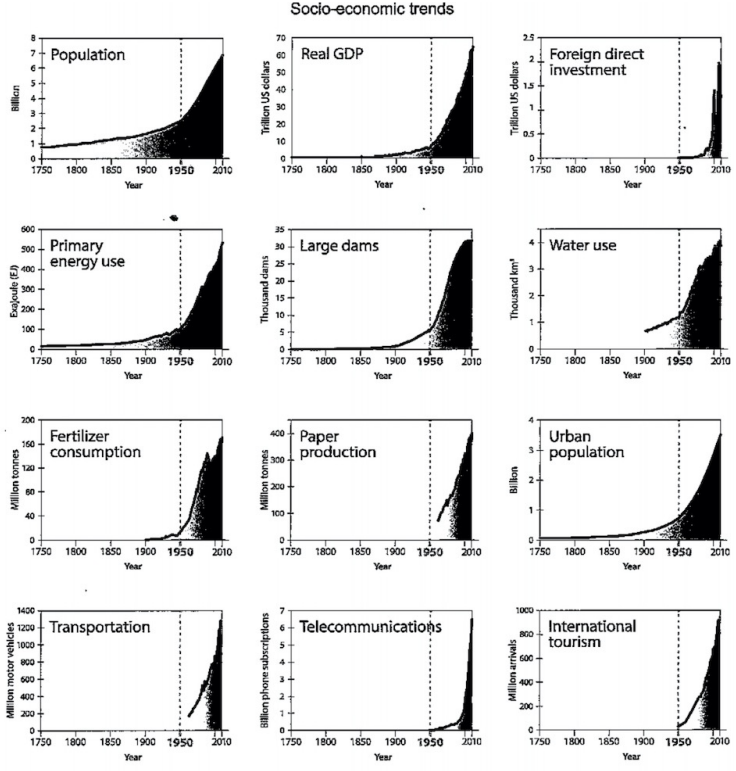
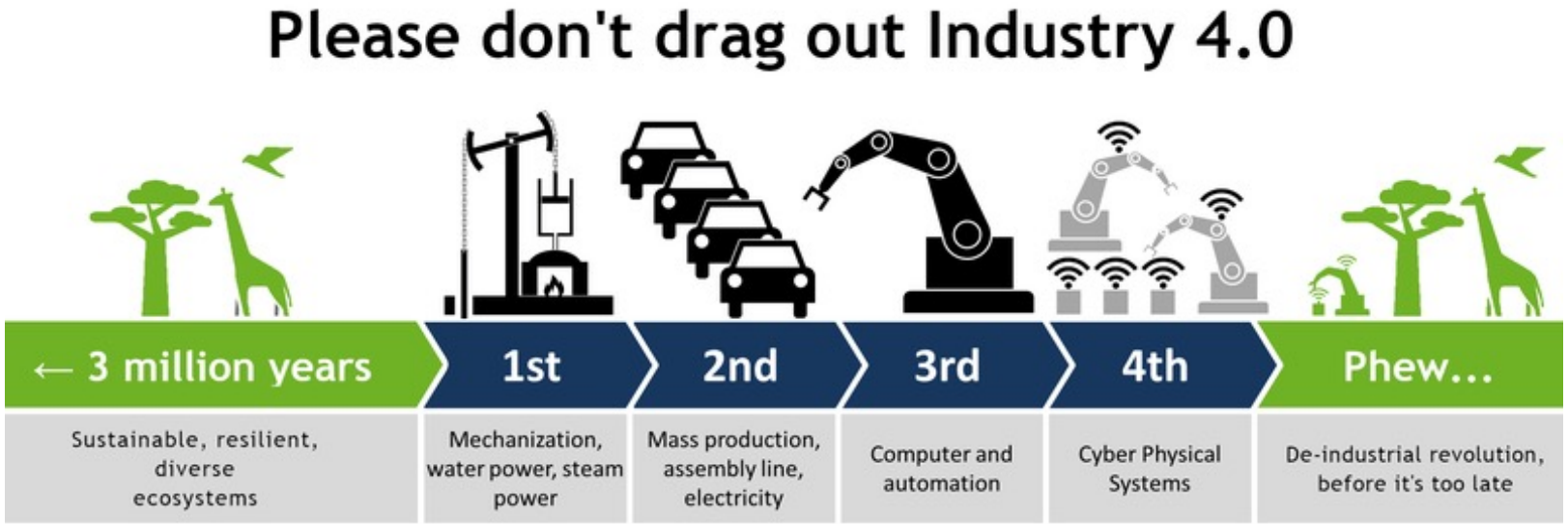
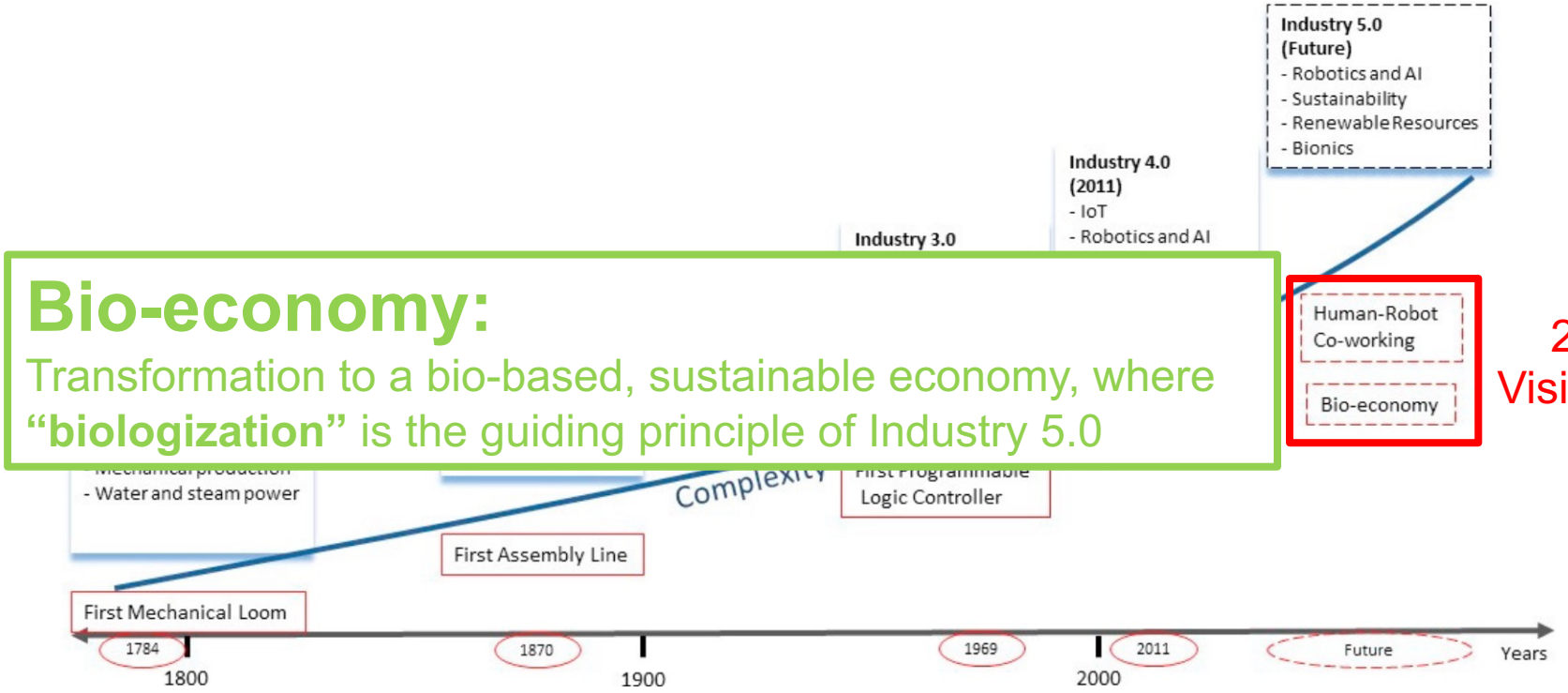


Figure 3.1
(continued)

Call For Papers



Industry 5.0

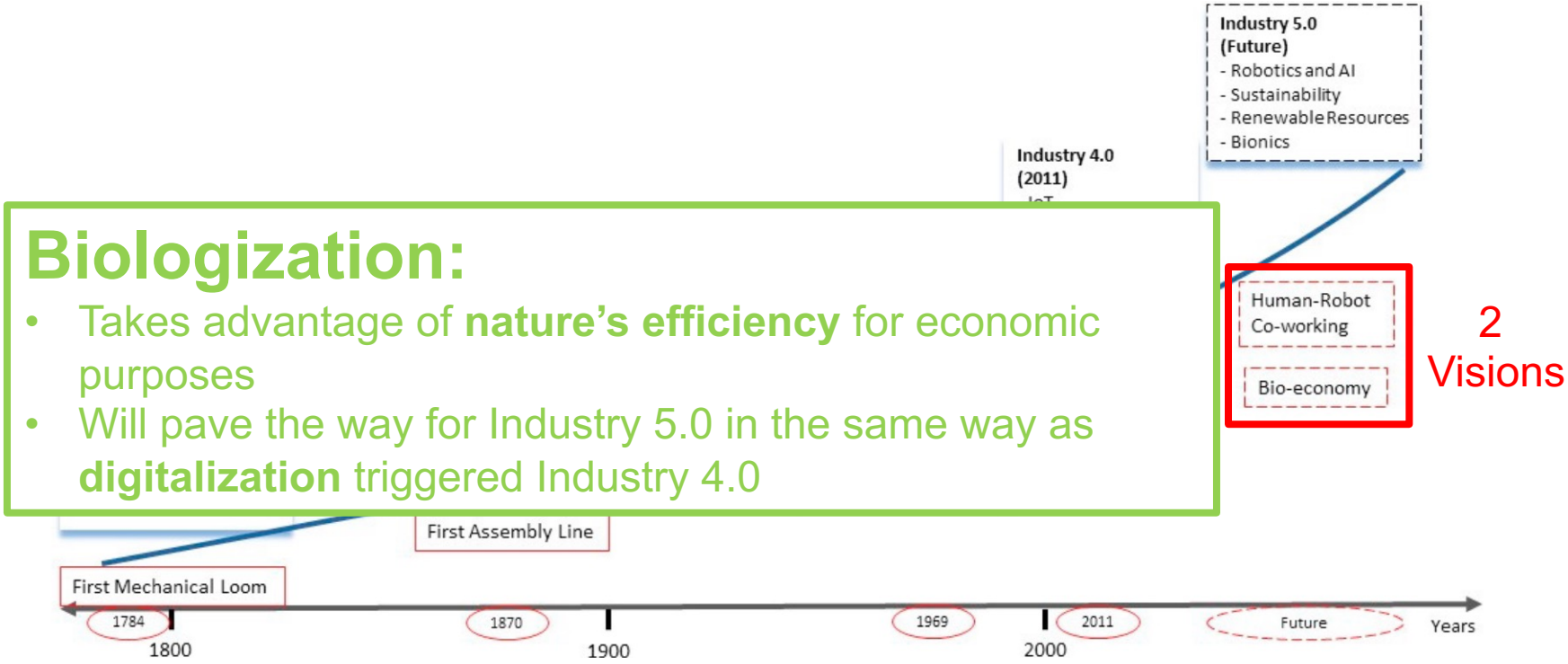


Bio-economy:

Transformation to a bio-based, sustainable economy, where **"biologization"** is the guiding principle of Industry 5.0

K. A. Demir, B. Döven, and B. Sezen, "Industry 5.0 and Human-Robot Co-working," Procedia Computer Science, 158:688-695, Jan. 2019.

Industry 5.0

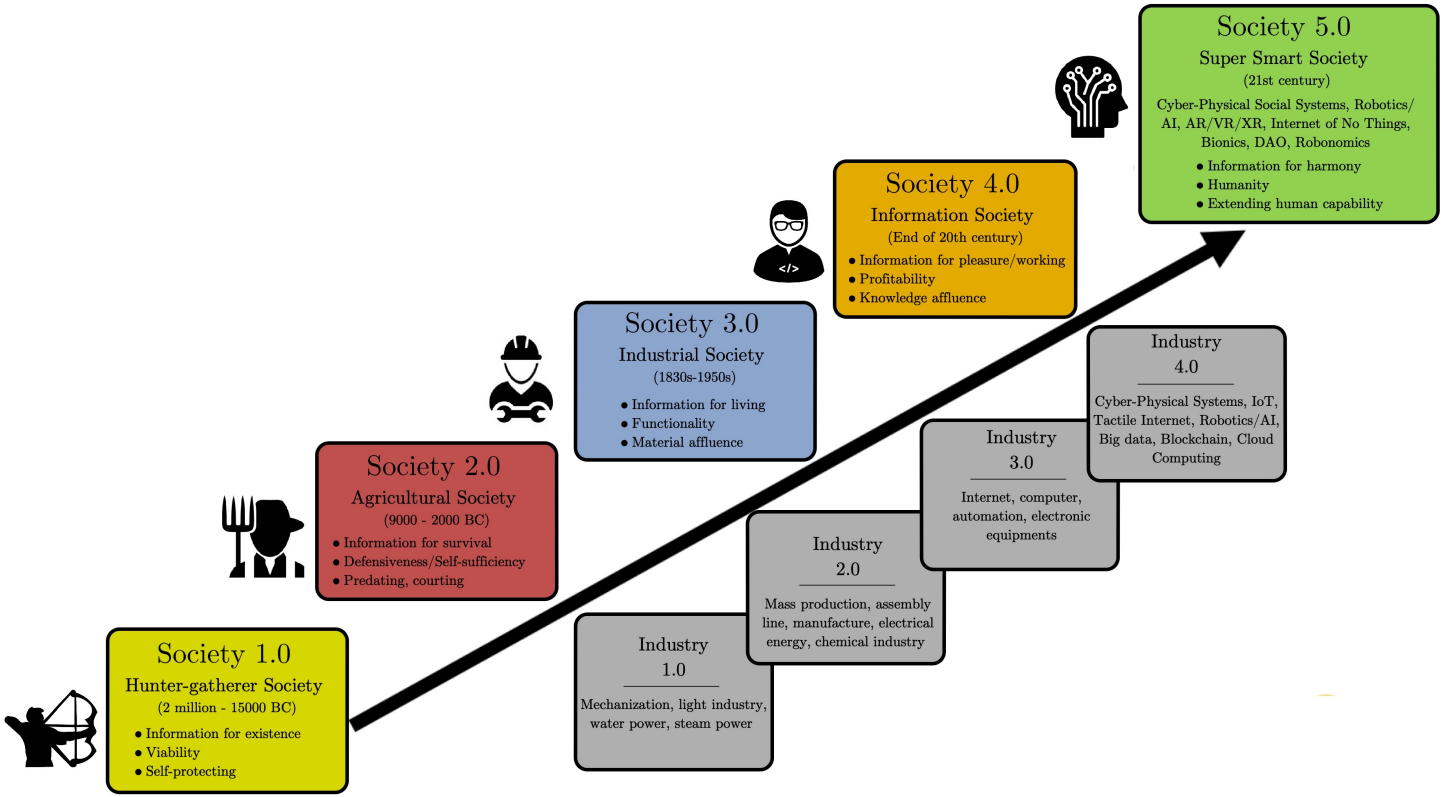


Biologization:

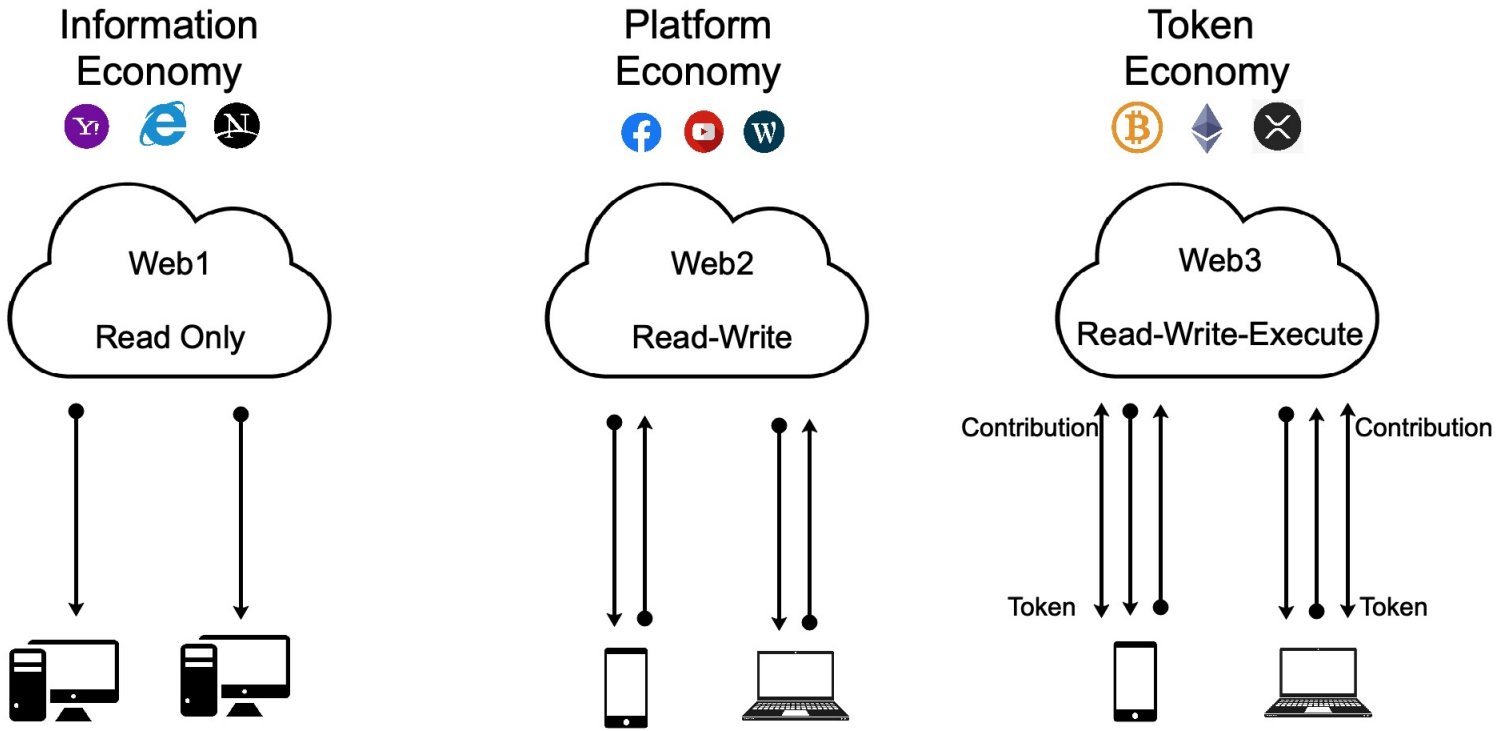
- Takes advantage of **nature's efficiency** for economic purposes
- Will pave the way for Industry 5.0 in the same way as **digitalization** triggered Industry 4.0

K. A. Demir, B. Döven, and B. Sezen, "Industry 5.0 and Human-Robot Co-working," Procedia Computer Science, 158:688-695, Jan. 2019.

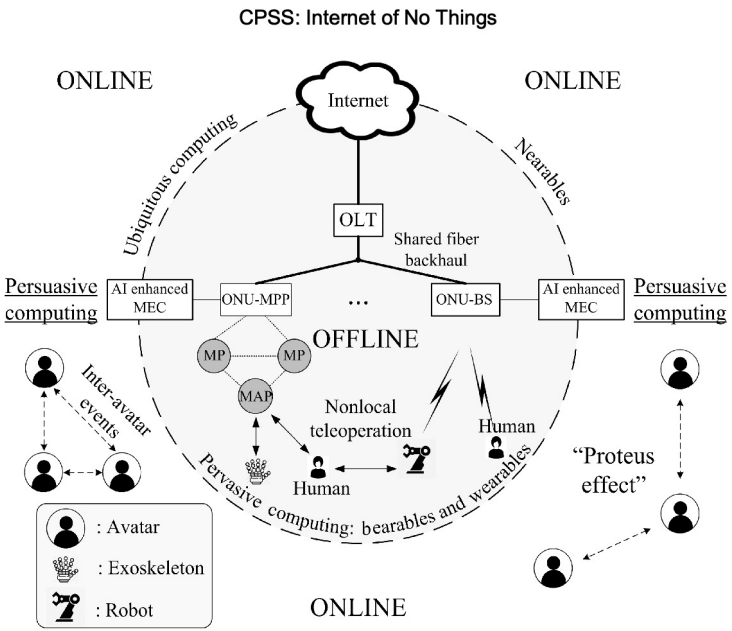
Society 5.0: “Brand New and Very Ancient”



Web3 Token Economy

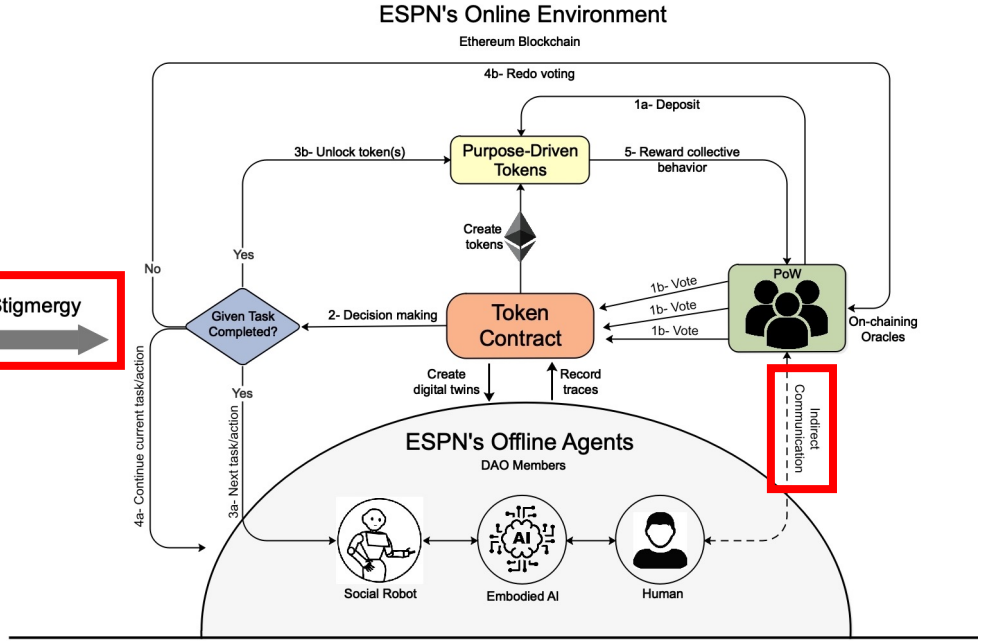


Stigmergy Enhanced Internet of No Things



Extrasensory Perception Network (ESPN) Architecture

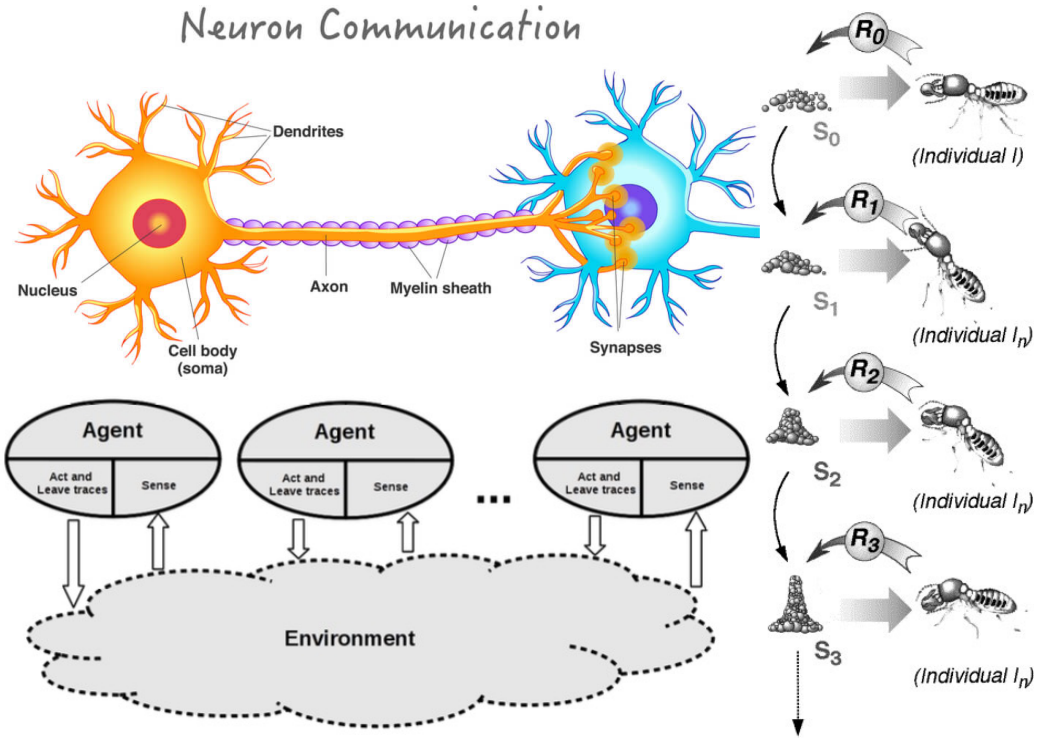
Stigmergy



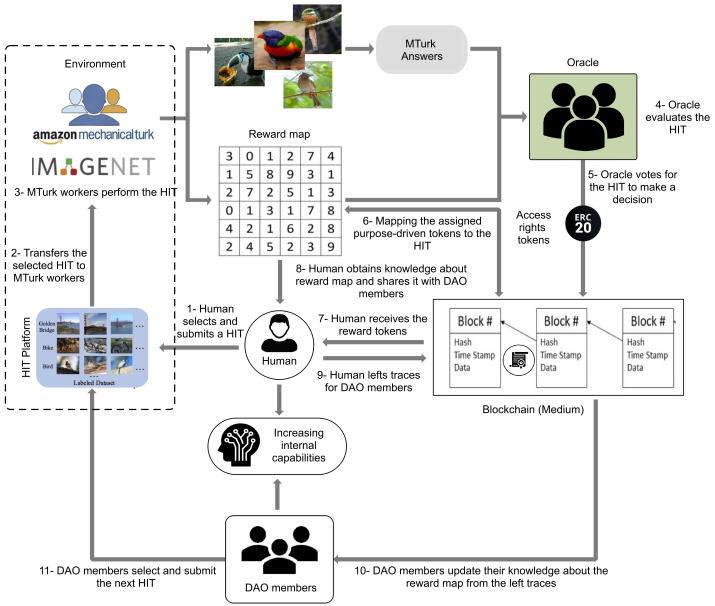
Society 5.0
CI through Tokenized Digital Twins

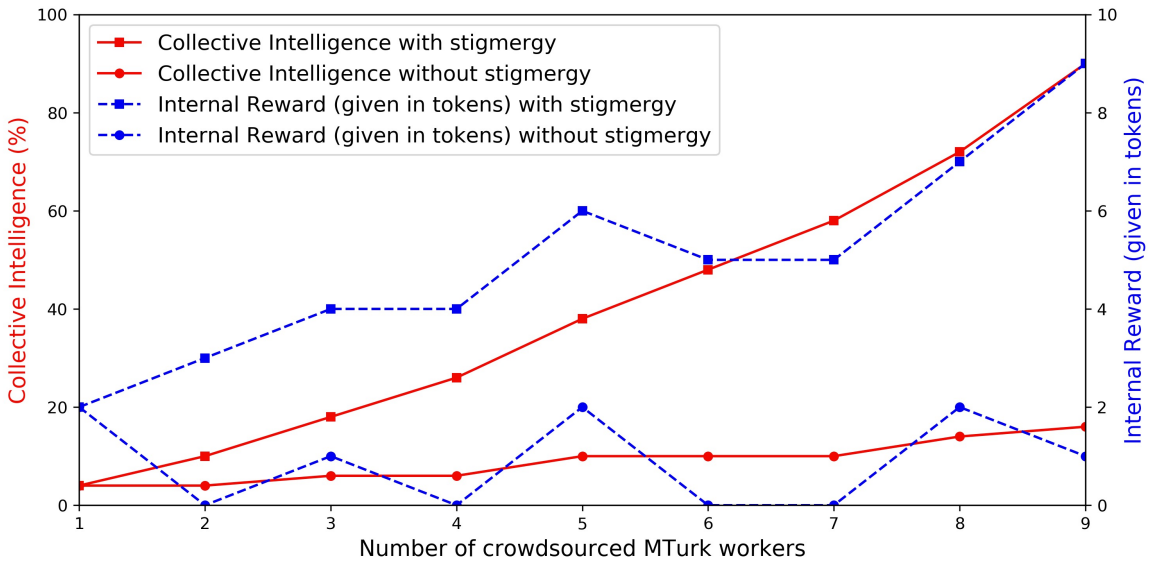
Stigmergy: Nature's Indirect Communication

- **Stigmergy (Greek)**: *Stigma* "sign" and *ergon* "work"
- **Nature's unifying concept** of producing cognition in human brain & natural societies (e.g., ant colonies)
- **Indirect communication** between agents via environment (e.g., ESPN)



Raising Our Collective Intelligence





Further Reading

Society 5.0: Internet as if People Mattered

Abdeljalil Beniiche, Sajjad Rostami, and Martin Maier

***Abstract*—While the primary focus of 5G has been on industry verticals, future 6G mobile networks are anticipated to become more human-centered. Emerging cyber-physical-social systems (CPSS) aim at functionally integrating human beings into today's cyber-physical systems at the social, cognitive, and physical levels. CPSS are instrumental in realizing the human-centered *Society 5.0* vision. Society 5.0 envisions human beings to increasingly interact with social robots and embodied artificial intelligence in their daily lives. In this paper, we build on our recent work on robonomics in the 6G era. Robonomics is an emerging field, which investigates social human-robot interaction and its sociotechnical impact as well as blockchain technologies and cryptocurrencies, not only coins but—more interestingly—also tokens. Specifically, we study the tokenization process of creating *tokenized digital twins* of assets and access rights in the physical and digital world, paying close attention to its central role in ushering in the future Web3 and its underlying token economy, the successor of today's information and platform economies. After introducing our CPSS based bottom-up multilayer token engineering framework for Society 5.0, we experimentally demonstrate how the collective human intelligence of a blockchain enabled decentralized autonomous organization (DAO) can be enhanced via purpose-driven tokens.**

I. Introduction

THE current fourth industrial revolution has been enabled through the Internet of Things (IoT) in association with other emerging technologies, most notably cyber-physical systems (CPS). CPS help bridge the gap between manufacturing and information technologies and give birth to the smart factory. This technological evolution ushers in the Industry 4.0 as a prime agenda of the High-Tech Strategy 2020 Action Plan taken by the government of Germany, the Industrial Internet from General Electric in the USA, and the Internet+ from China. Recently, in January 2021, the European Commission released the first edition of their policy brief on Industry 5.0 [1]. One of the most important paradigmatic transitions characterizing Industry 5.0 is the shift of focus from technology-driven progress to a thoroughly human-centric approach. An important prerequisite for Industry 5.0 is that technology serves people, rather than the other way around, by expanding the capabilities of workers (upskilling and re-skilling) with innovative technological means such as virtual/augmented reality (V/AR) tools, mobile robots, and exoskeletons. Note that while Industry 4.0 implies minimum human intervention due to automation, Industry 5.0 prioritizes augmentation of the human over automation of the human.

It is interesting to note that in [1], the authors also elaborate on the relation between the concepts of Industry 5.0 and *Society 5.0*. While both concepts are related in the sense that they refer to a fundamental shift of our society and economy towards a new paradigm, Society 5.0 is not restricted to the manufacturing sector but addresses larger social challenges based on the integration of physical and virtual spaces.

According to [2], Society 5.0 seeks to create a sustainable society for human security and well-being, which is aligned with the United Nations' Sustainable Development Goals (SDGs), and to create new values by making connections between people and things and between the real and cyber worlds through digitalization. The authors of [2] emphasize that digitalization is only the means and that it is essential that we humans remain the central actors so that a firm focus is kept on building a society that makes us happy. More specifically, the authors of [3] provide the following definition of Society 5.0: "A human-centered society that balances economic advancement with the resolution of social problems by a system that highly integrates cyberspace and physical space, a system which consists of physically controllable technologies such as AI, robots, and IoT integrated into cyberspace." To better understand the differences between Industry 4.0/5.0 and Society 5.0, the authors of [4] compare them in terms of involved technologies, research areas, power source, motto as well as their underlying motivation. They argue that while the main motivation behind Industry 4.0 and Industry 5.0 is mass production and a smart sustainable society, respectively, Society 5.0's main motivation is that humankind live in harmony with nature.

Society 5.0 is an initiative of the 5th Science and Technology Basic Plan taken by the government of Japan to facilitate a human-centered approach that puts humans in the loop of today's CPS [5]. By functionally integrating human beings at the social, cognitive, and physical levels, CPS become so-called *cyber-physical-social systems (CPSS)* [6]. Members of CPSS may engage in a wide variety of cyber-physical-social behaviors. The human-centeredness of Society 5.0 was recently investigated in technically greater detail in [7]. The author of [7] describes the goal of Society 5.0 as the ability to create equal opportunities for all and to provide the environment that helps unleash the full potential of each individual. To do so, Society 5.0 will leverage on emerging ICT technologies to its fullest such that social barriers to each individual's self-realization are removed.

For illustration, Fig. 1 depicts the transition from past to future societies and their co-evolution with industry [7]. The relationship between Society 5.0 and past societies on the one hand and Industry 4.0 on the other hand was described in more detail in [8]. While the focus of Society 4.0 was on building an information society via ICT for the purpose of increasing profitability, Society 5.0's main goal is to merge cyberspace and physical space for the purpose of advancing humanity. Society 5.0 seeks to revolutionize not only the industry through ICT but also the living spaces and habits of the public. Society 5.0 focuses heavily on the public impact of technology and aspires to create a supersmart society, thus requiring metrics that are much more complex than those used in Industry 4.0, whose

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