NEXT Federation
国际展望联合会

*"Promote Global Innovation, Cooperation and Sustainability"*

**Helmut Dispert**
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**Faculty of Computer Science and Electrical Engineering**
**Kiel, Germany**

# The evolution of IoT, AIoT, and BIoT in light of Mark Weiser's vision of Ubiquitous Computing.

## The link between the past and the future of a new group of interconnected innovative technologies.

**Keynote Lecture:**
**A Review and critical outlook**

Helmut Dispert
Kiel University of Applied Sciences
Faculty of Computer Science and Electrical Engineering
Kiel, Germany

# Content

- Introduction
- Advances in IT Technology
- Enabling Technology
- The origin of Ubiquitous Computing
- Mark Weiser, Xerox Parc
- Smart devices
- Development and important persons
- Internet of Things (IoT)
- Artificial Intelligence (AI)
- Blockchain (BC)
- Use Cases / Example Applications of IoT, AIoT, BIoT
- Critical Summary and Outlook
- Northern Germany: Research and Development, Cooperation

Disclaimer: This presentation makes no claim to completeness.

# Location - Germany

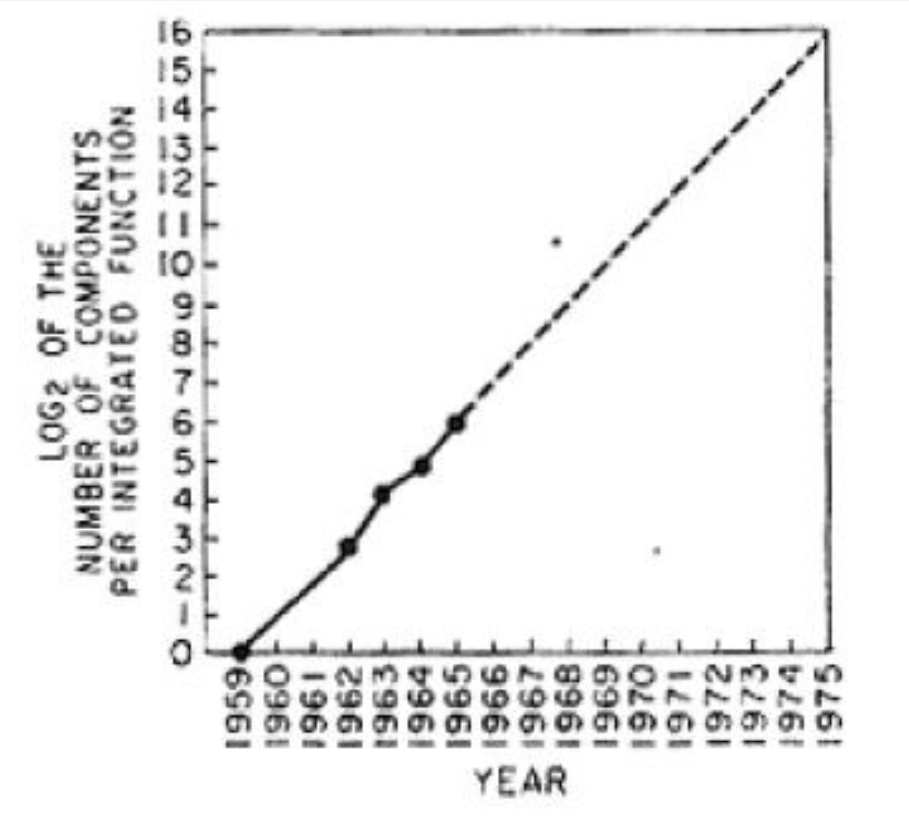

## Kiel
## State Capital of Schleswig-Holstein

## Institution:
## Kiel University of Applied Sciences (KUAS)

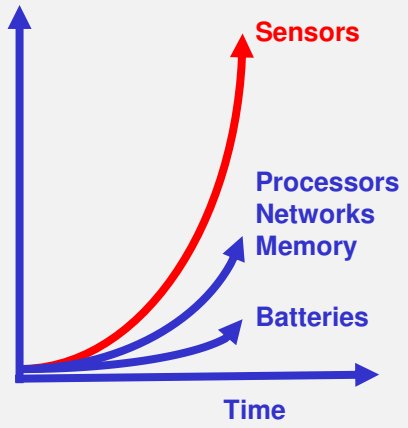
Maps Source: https://d-maps.com/

# Enabling Technology

## Moore's Law
(early version)




**Gordon Moore**
Co-founder of Intel in 1968.

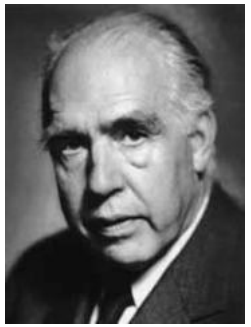



Ref.: http://www.intel.com/research/silicon/mooreslaw.htm

# Ubicomp

"Prediction is very difficult, especially about the future"

(?) Niels Bohr (1885-1962)



## Predictions

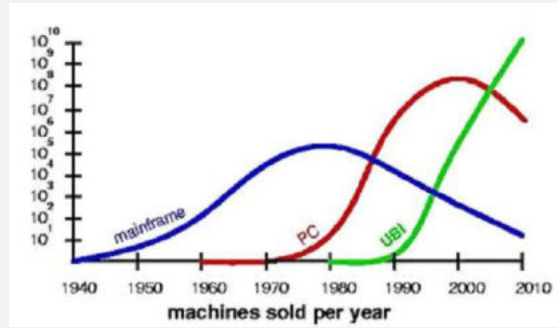
"I think there is a world market for maybe five computers"

Thomas Watson, CEO IBM, **1943**

"Picture a day when a billion people will interact with a million e-businesses via a trillion interconnected, intelligent devices"

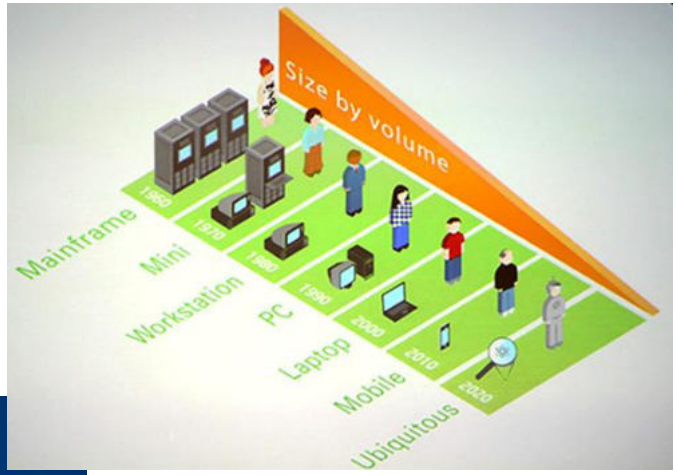
Louis V. Gerstner Jr., CEO IBM, **2005**

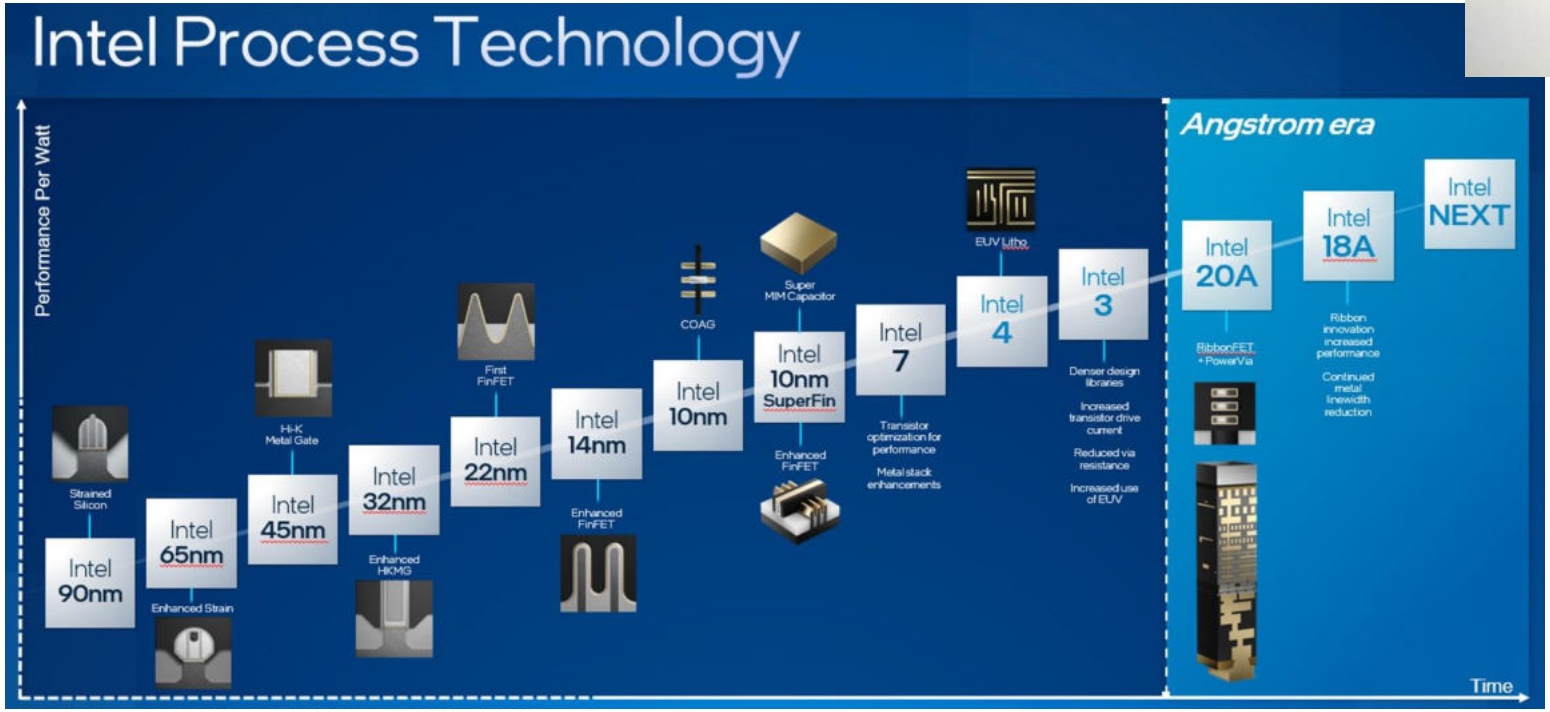
## Early Reality (2010)



# Ubicomp

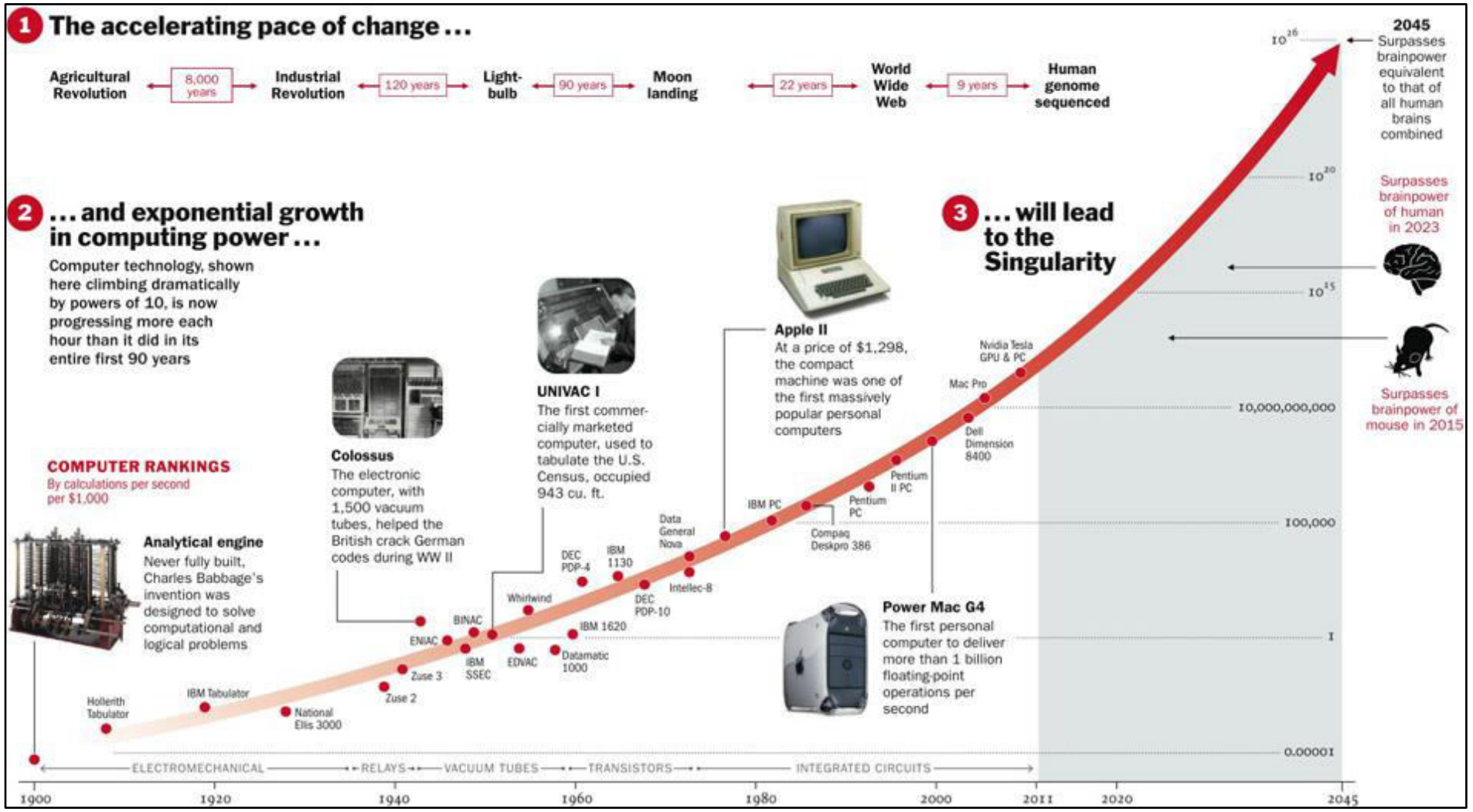
## Intel:
## Compute moves to zero




Ref.: Brian David Johnson, Intel, 2012

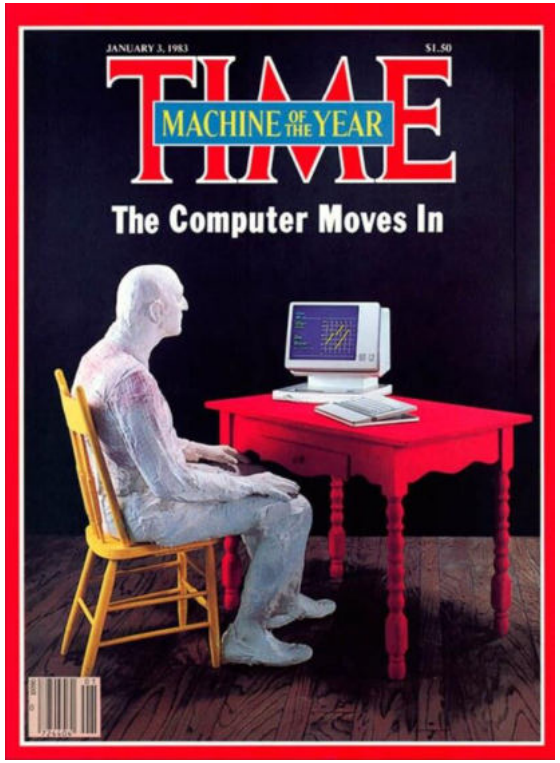
# Content




Ref.: TIME USA 2019 - http://content.time.com/time/interactive/0,31813,2048601,00.html

## Exactly 40 Years ago:
## A big step for mankind?

The computer is named Time's person of the year.




**TIME MAGAZINE**

**1982**
**MACHINE OF THE YEAR**
**THE COMPUTER**

Comparison:

1982: 621,000 home computers in the U.S.

40 years later:

2021: 621,000 computers sold in the U.S. every 3 days.

Ref.:
Time Magazine

# Ubiquitous Computing: The Roots

The idea of ubiquitous computing as invisible computation was first articulated by **Mark Weiser** in 1988 at the **Computer Science Lab at Xerox PARC.**

**Mark Weiser**
**July 23, 1952 - April 27, 1999**

**Xerox PARC:**
**"*Palo Alto Research Center*"**
**(now "*Palo Alto Research Center Incorporated*")**
http://www.parc.xerox.com/

"Ubiquitous computing names the third wave in computing, just now beginning. First were mainframes, each shared by lots of people. Now we are in the personal computing era, person and machine staring uneasily at each other across the desktop. Next comes ubiquitous computing, or the age of calm technology, when technology recedes into the background of our lives."

→ **Calm Technology**

"Ubiquitous Computing is fundamentally characterized by the connection of things in the world with computation"

Ref.:
http://www.ubiq.com/hypertext/weiser/weiser.html

# Scientific American Ubicomp Paper

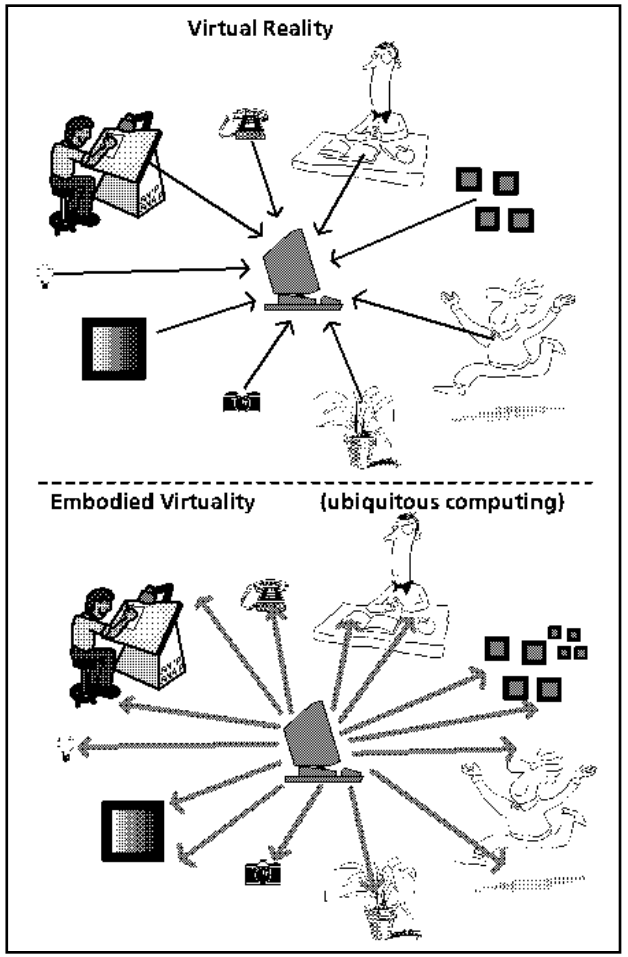
SCIENTIFIC AMERICAN.COM

**Mark Weiser:**
**The Computer for the 21st Century,**
**Sci. Amer., 265 (3), 94-104, September 1991**

**"The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it."**

**Mark Weiser, March 23, 1993**

**"Ubiquitous computing is the method of enhancing computer use by making many computers available throughout the physical environment, but making them effectively invisible to the user."**




**Ubiquitous Computing:**
**Virtual Reality vs. Embodied Virtuality**

# Mark Weiser and Big Data

SCIENTIFIC AMERICAN.COM

## Mark Weiser:
## The Computer for the 21st Century

"*Most important, ubiquitous computers will help overcome the problem of information overload.*

*There is more information available at our fingertips during a walk in the woods than in any computer system, yet people find a walk among trees relaxing and computers frustrating. Machines that fit the human environment, instead of forcing humans to enter theirs, will make using a computer as refreshing as taking a walk in the woods."*

→ We will come back to this.

# Trends in Computing: persons involved and new paradigms

| | |
|---|---|
| Nicholas Negroponte, 1995<br>MIT Media Labs | "Things that think want to link"<br>"Things That Think also includes Things That Link"<br>This is the doctrine on which pervasive computing is based! |
| David Culler, 1999<br>University of California Berkeley | "New eras of computing start when the previous era is so strong it is hard to imagine that things could be different" |
| Neil Gershenfeld, 1999<br>MIT's Media Lab., Things That Think consortium. | "When things start to think"<br>Hardware-architecture definition of "Smart Devices"<br>BILL of Things' rights (Things have right to):<br>Have an identity, Access other objects<br>Detect the nature of their environment. |
| Adam Greenfield, 2006 | "Everyware" |

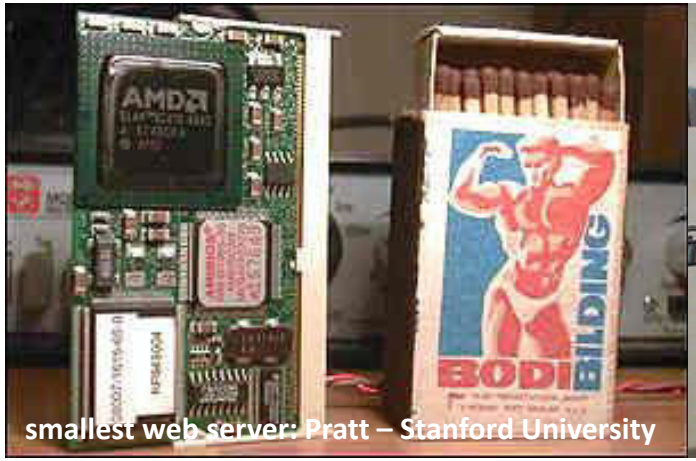
→ **Smart devices** → **The Internet of Things**

(not related to AI)

**Smart device:**
**A physical object with an embedded processor, memory, sensors and/or actuators, and a network connection.**

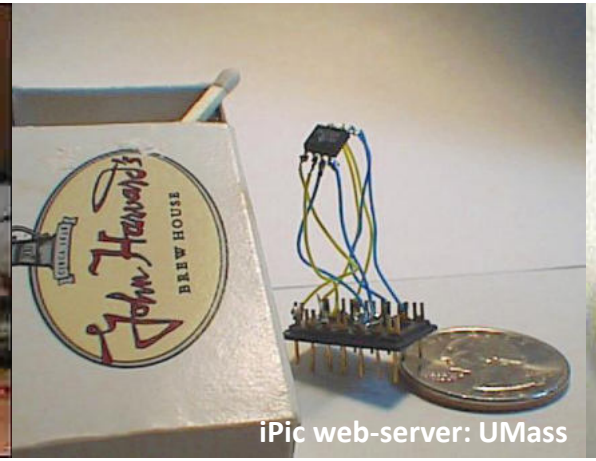

Ref. Photo Negroponte: Spiegel.de; Photo Culler, Gershenfeld, Greenfield: wikimedia.org

# Smart Devices and basic technologies: Early entries (1999+)



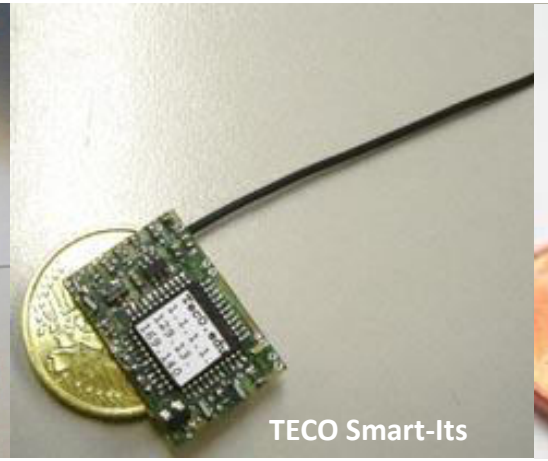
smallest web server: Pratt – Stanford University

Ref. http://news.bbc.co.uk/1/hi/sci/tech/276762.stm



iPic web-server: UMass

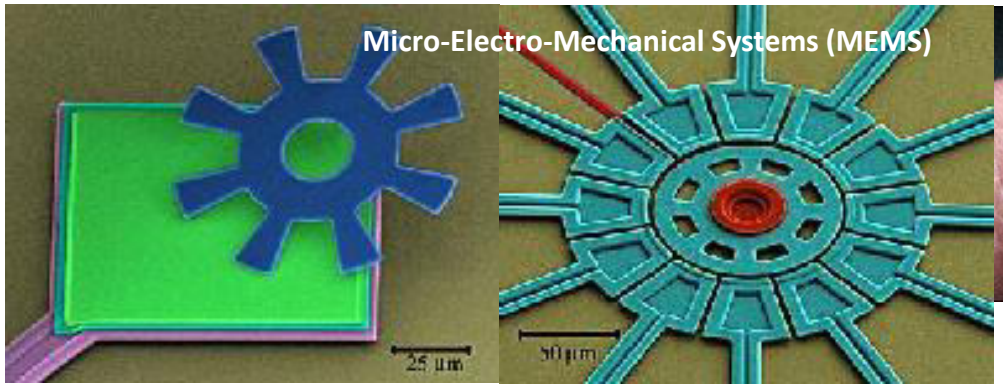
Ref.: http://www-ccs.cs.umass.edu/~shri/iPic.html


TECO Smart-Its

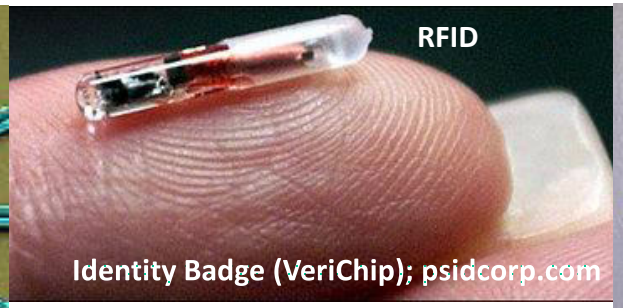

TECO µPart
Particle Computer

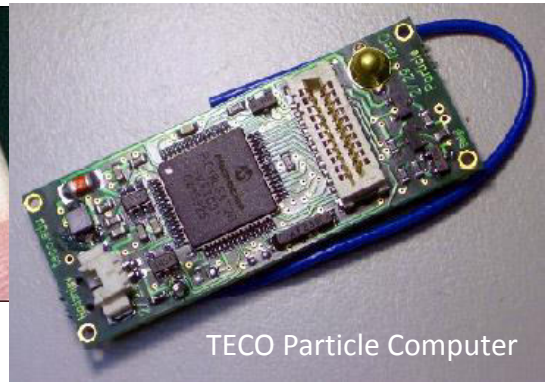
Ref.: http://particle.teco.edu/, http://www.smart-its.org/

→ European initiative "The Disappearing Computer"

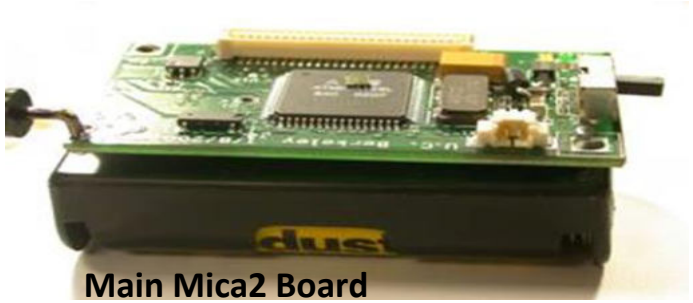


Ref.: http://www.mems-exchange.org/

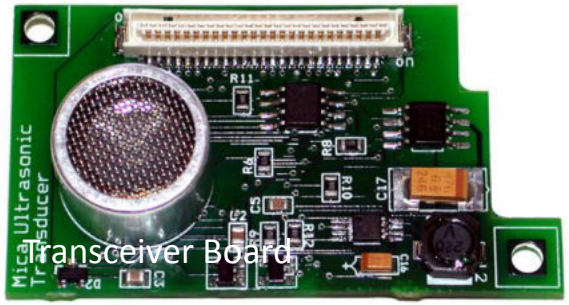




TECO Particle Computer

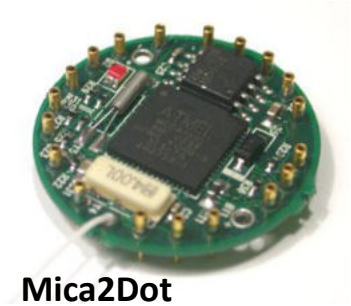
# New computing concept: Motes, Smart Dust, Sensor Networks

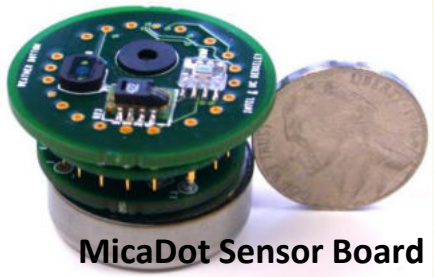

Main Mica2 Board

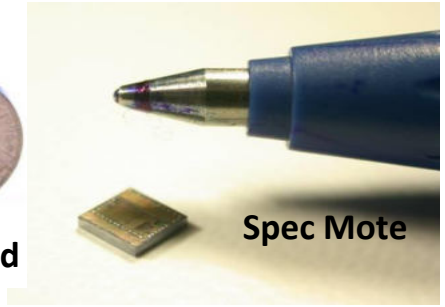

Mica2



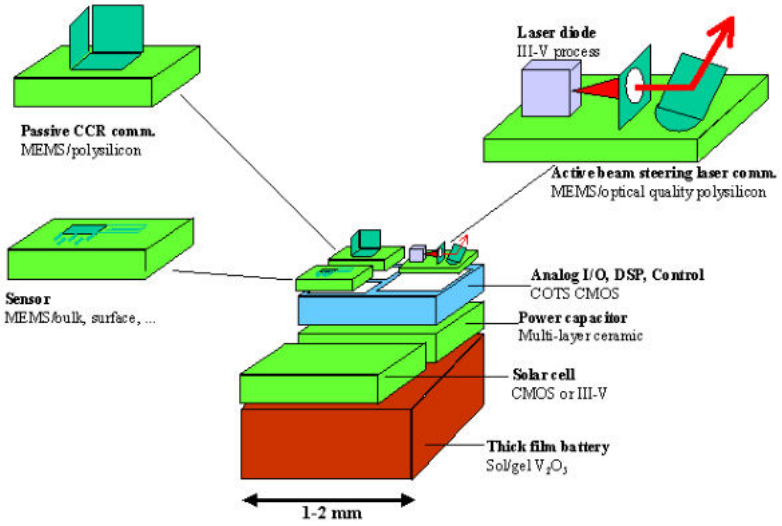
Transceiver Board

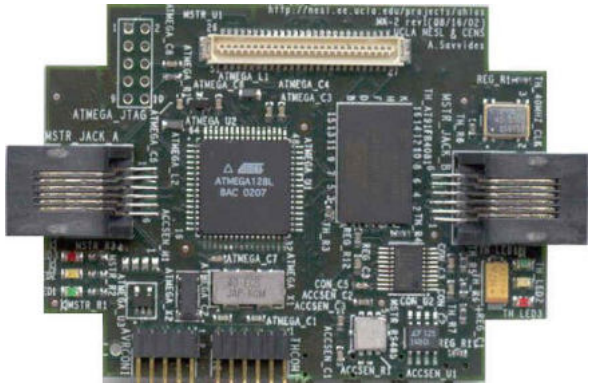

Mica2Dot

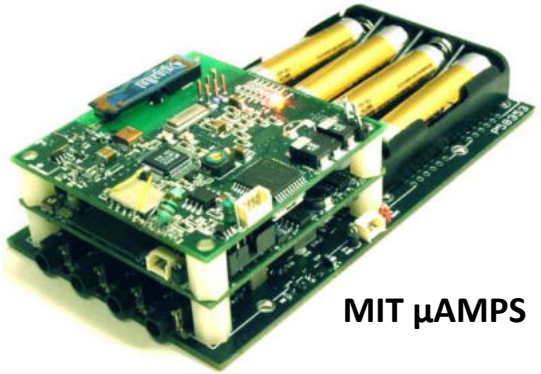

MicaDot Sensor Board


Spec Mote

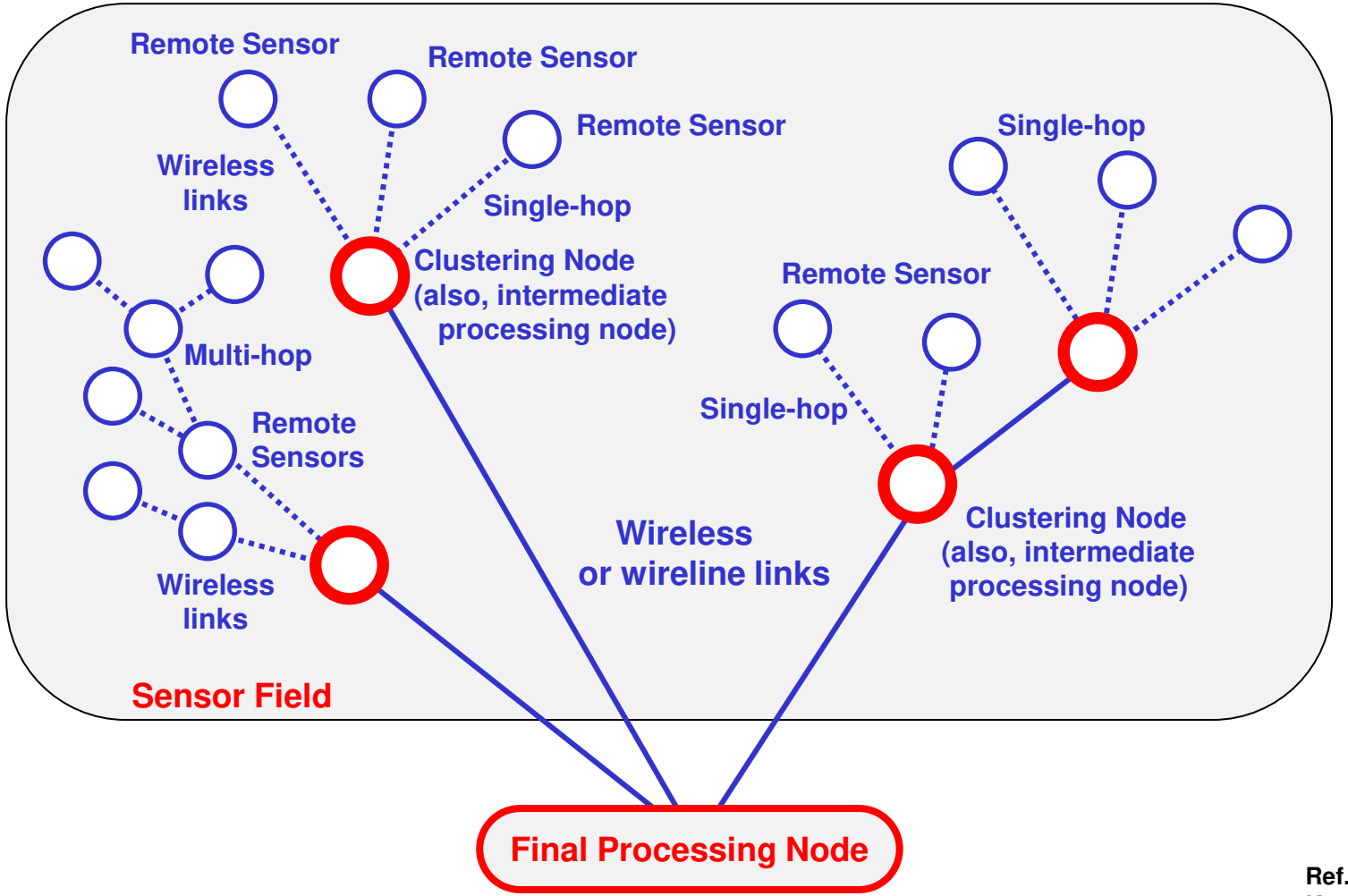
Smart Dust Components





UCLA Medusa


MIT µAMPS

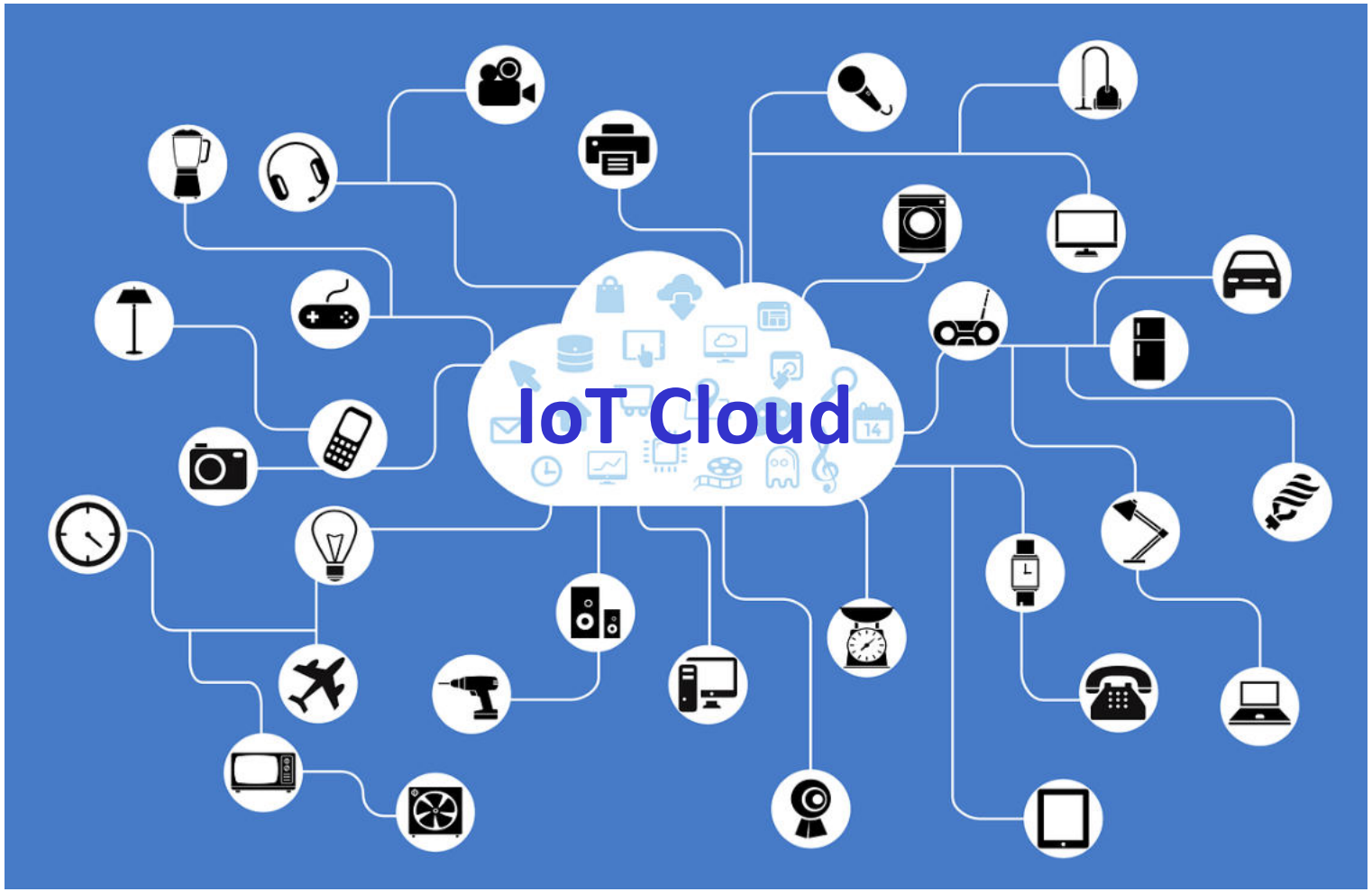
# Typical sensor network arrangement




leading to

Ref.: adopted from
Kazem Sohraby, Daniel Minoli, Taieb Znati.
"Wireless sensor networks", 2007

# Transformation to IoT Cloud



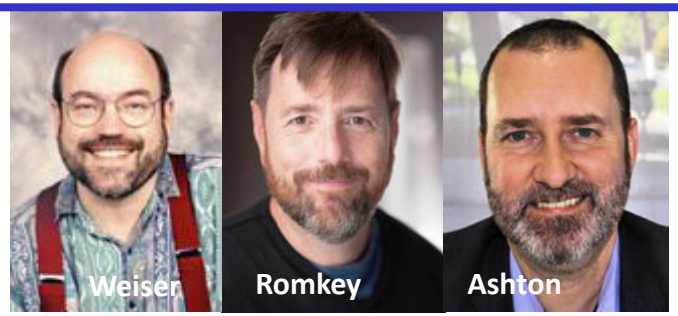

Picture Ref.: PIxabay

# The Internet of Things - IoT

## Future Computing – Today Innovation Terminology

- Post-PC Era
- Dissappearing Computer
- Ubiquitous Computing (UbiComp)
- Pervasive Computing
- Nomadic Computing
- Proactive Computing
- Mobile Computing
- Wearables
- Ambient Intelligence (AmI)
- Embedded Systems
- Wireless (Sensor/Actuator) Networks
- Physical Computing
- Tangible Media
- Cyber-Physical Systems (CPS)
- Smart Dust, Smart Devices, Smart Appliances
- Cloud Computing
- Big Data
- Industry 4.0

# Development of the Internet of Things (IoT)




1988
Mark Weiser
Xerox PARC
"UbiComp"

1999
Kevin Ashton (at P&G)
coins "Internet of Things"

2009
Cisco
IoT officially adopted

IoT

1993
Quentin Stafford Fraser
coffee pot

2005
Arduino
Hardware

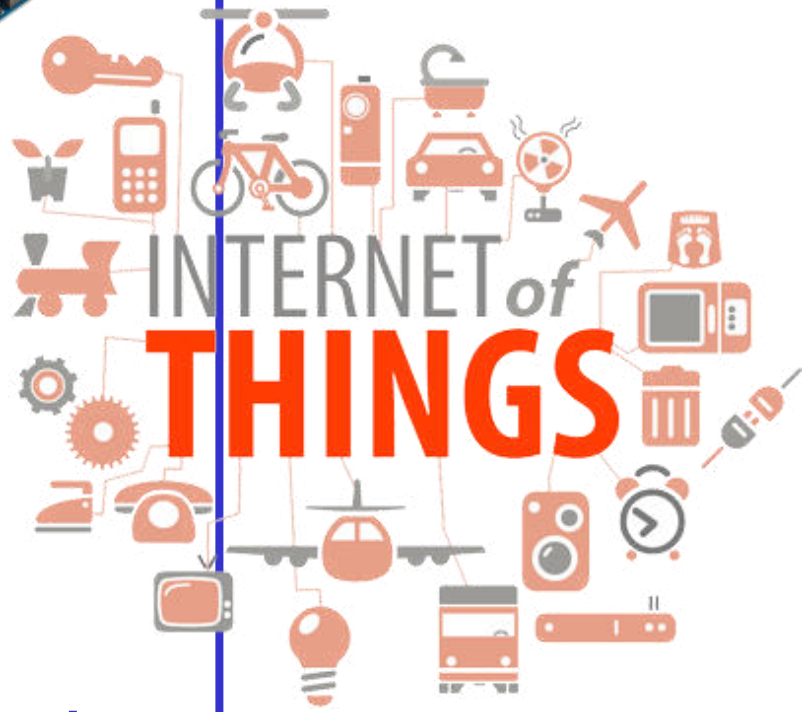
2012
Raspberry PI

1982
Carnegie Mellon
The "Only" Coke
Machine on the
Internet

1990
John Romkey
Internet (Sunbeam)
Toaster
(at Interop)

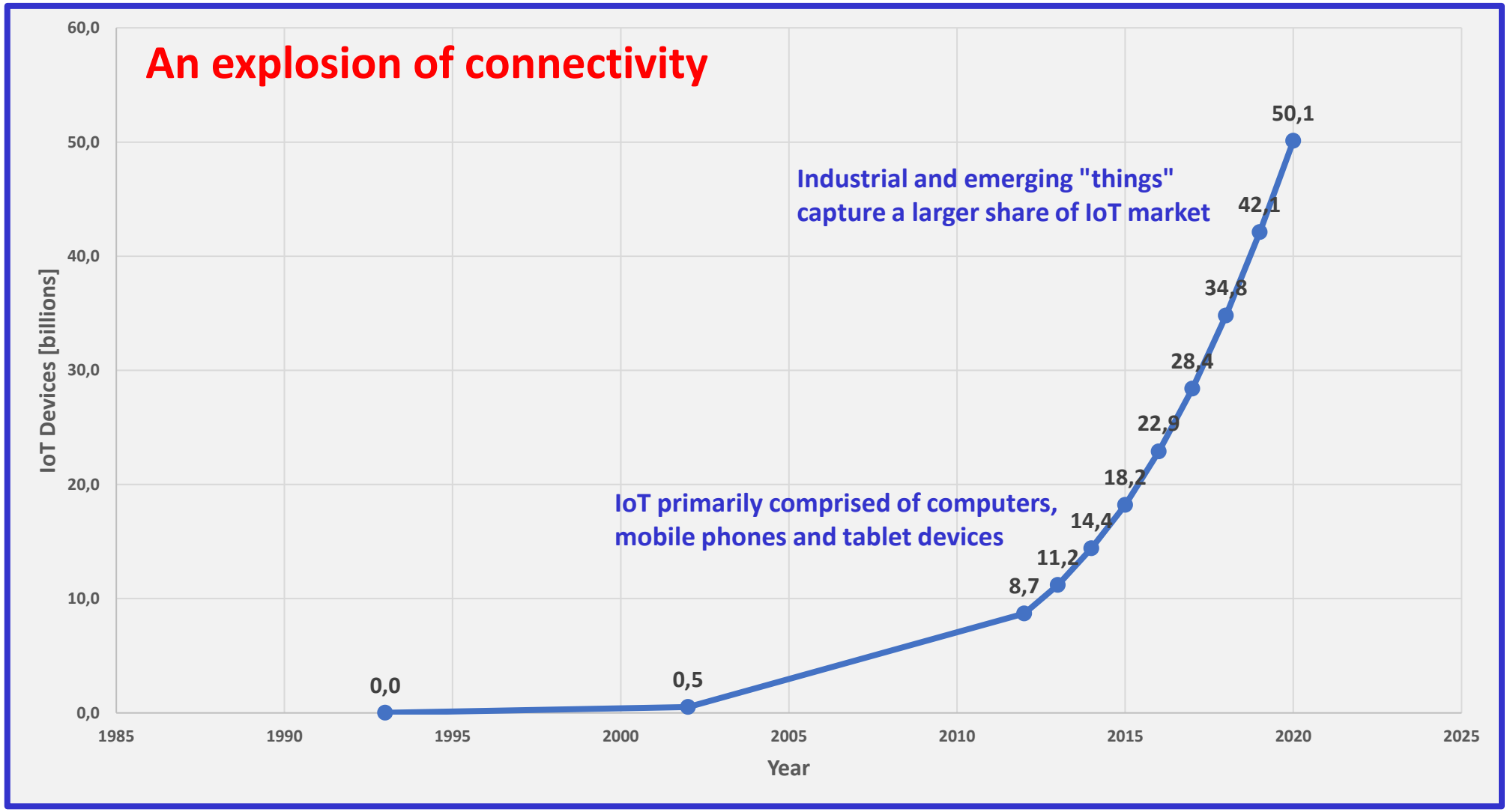
2014
IIoT starts

1980 1990 2000 2010 2020




Ref.: Mark Weiser photo: https://alchetron.com/Mark-Weiser; Kevin Ashton photo: Larry D. Moore, CC BY-SA 4.0, Wikimedia Commons;
John Romkey photo: romkey.com

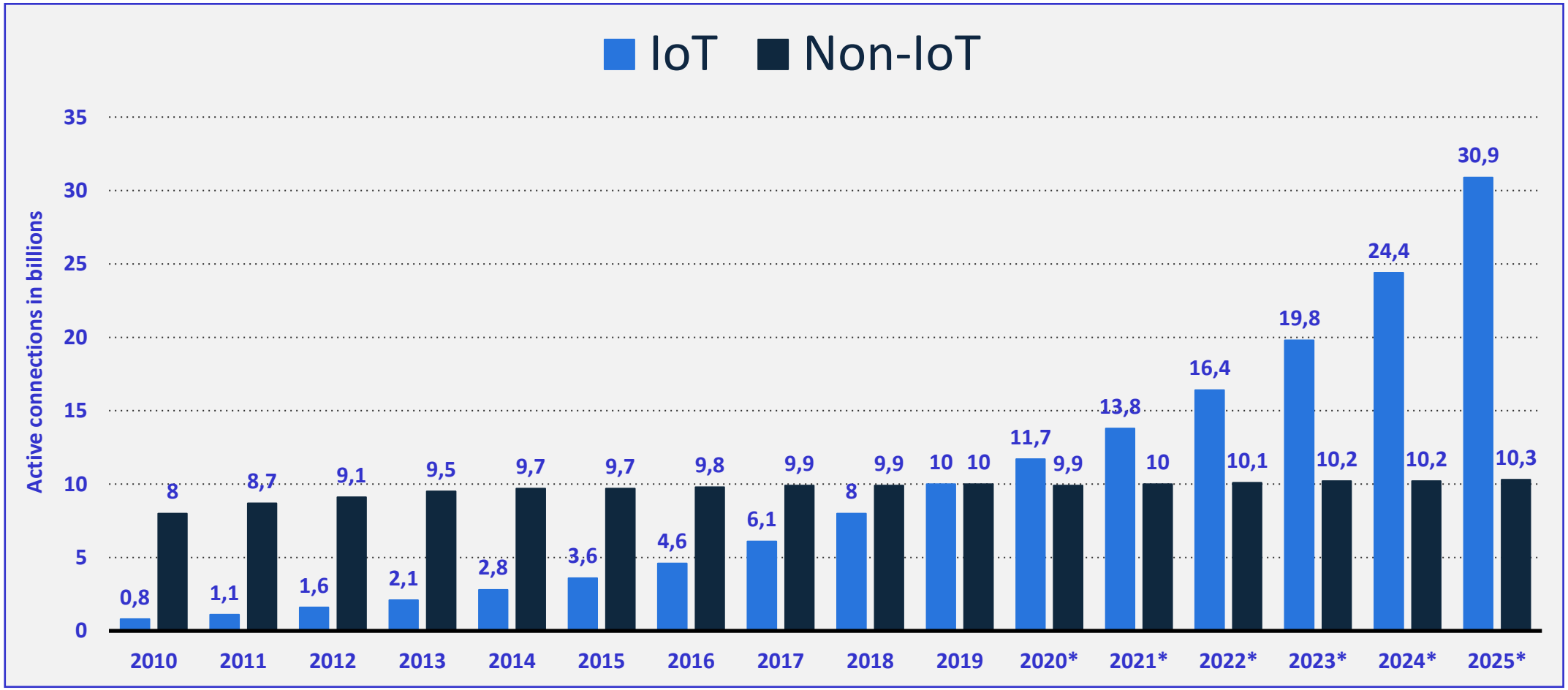
# Electronic Devices – global development *




* including projected data

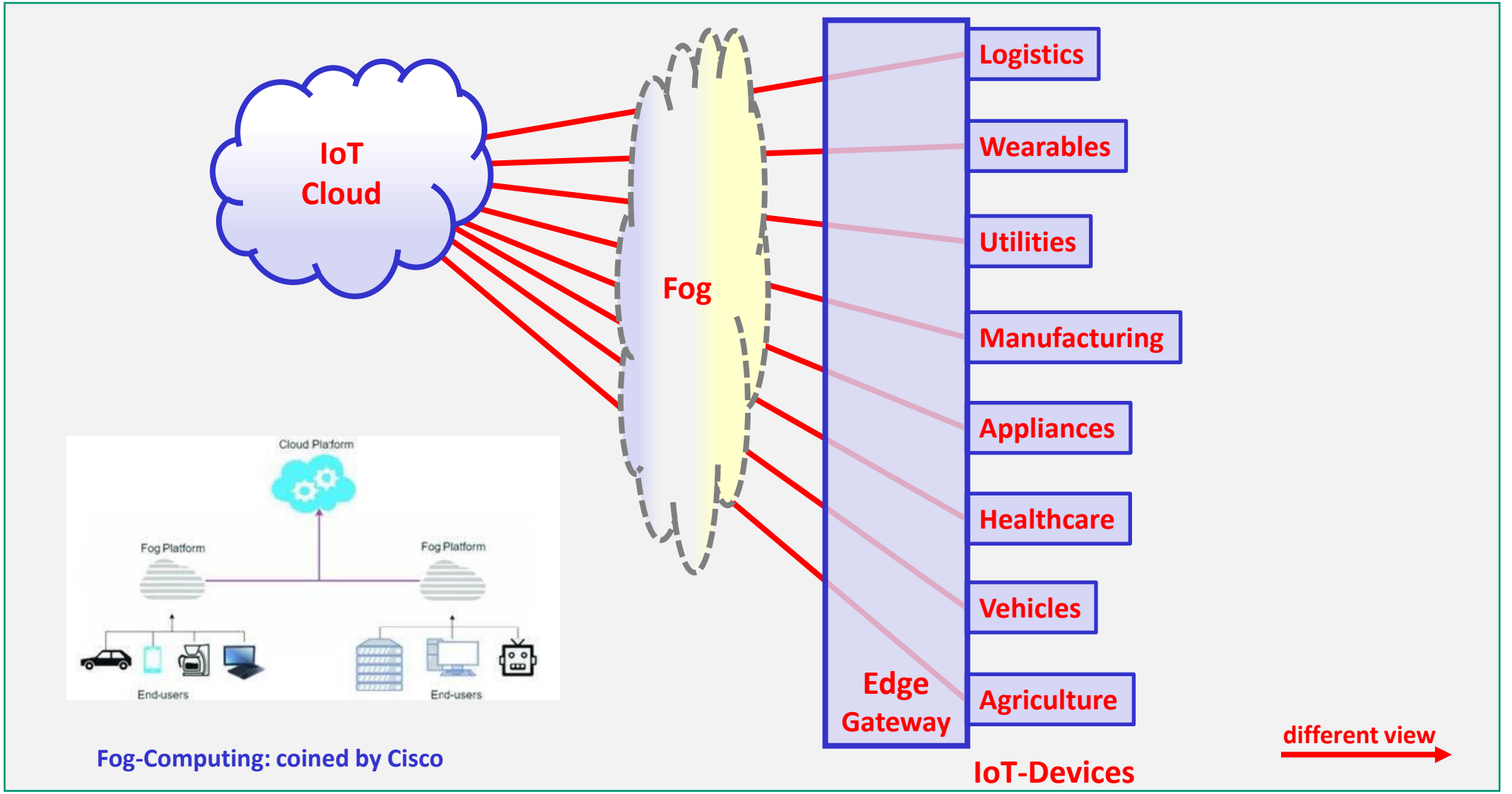
Ref.: IHS, Forbes

# Internet of Things (IoT) and non-IoT smart (consumer) appliances active device connections worldwide from 2010 to 2025 (in billions)



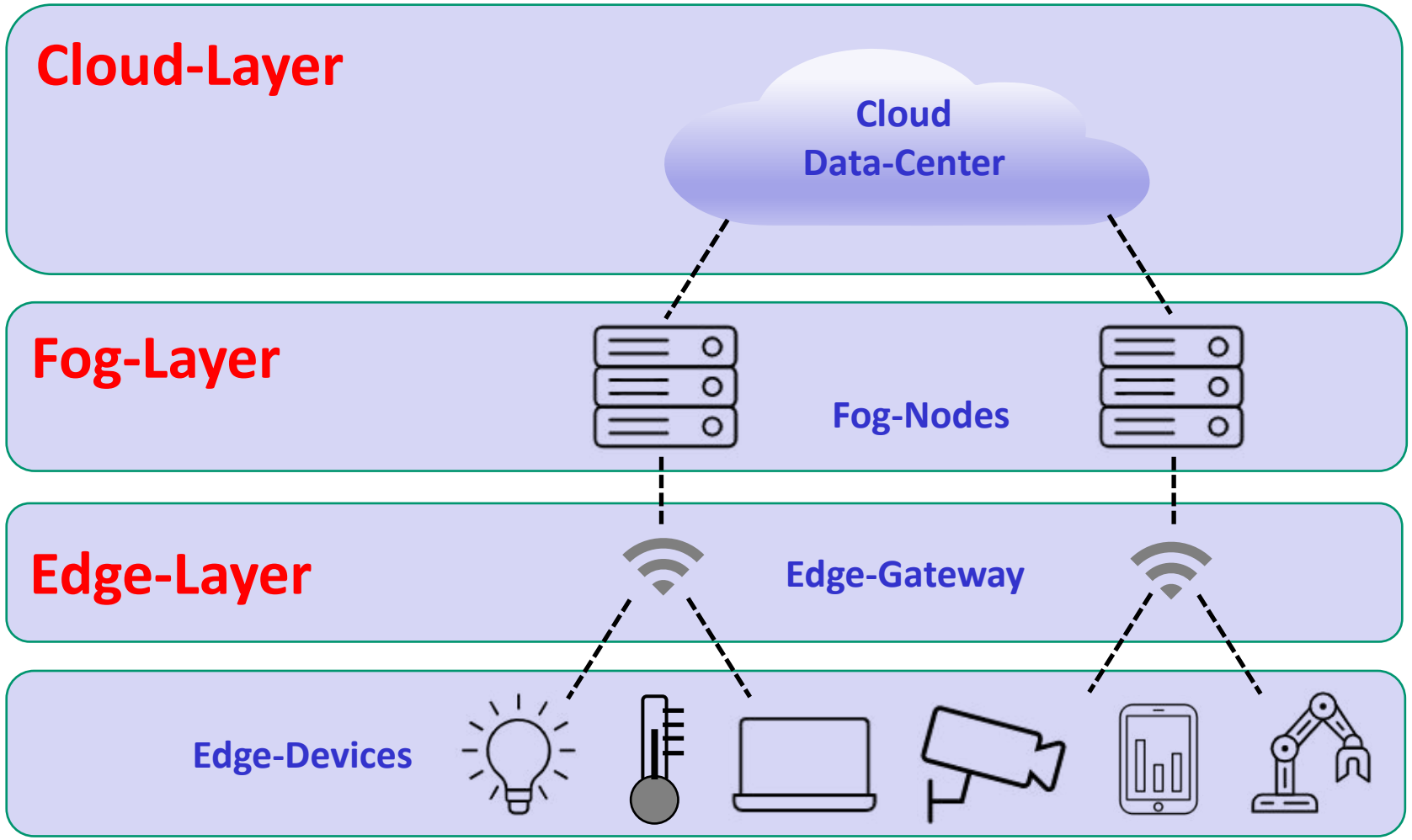

**Description:** The total installed base of Internet of Things (IoT) connected devices worldwide is projected to amount to 30.9 billion units by 2025, a sharp jump from the 13.8 billion units that are expected in 2021. Read more
**Note(s):** Worldwide; 2015 to 2019; * Estimate. According to the source, non-IoT includes mobile phones, tablets, PCs, laptops, and fixed line phones. IoT includes all B2B and consumer devices connected. Read more
**Source(s):** IoT Analytics

# Typical IoT Architecture (current status)




Fog-Computing: coined by Cisco

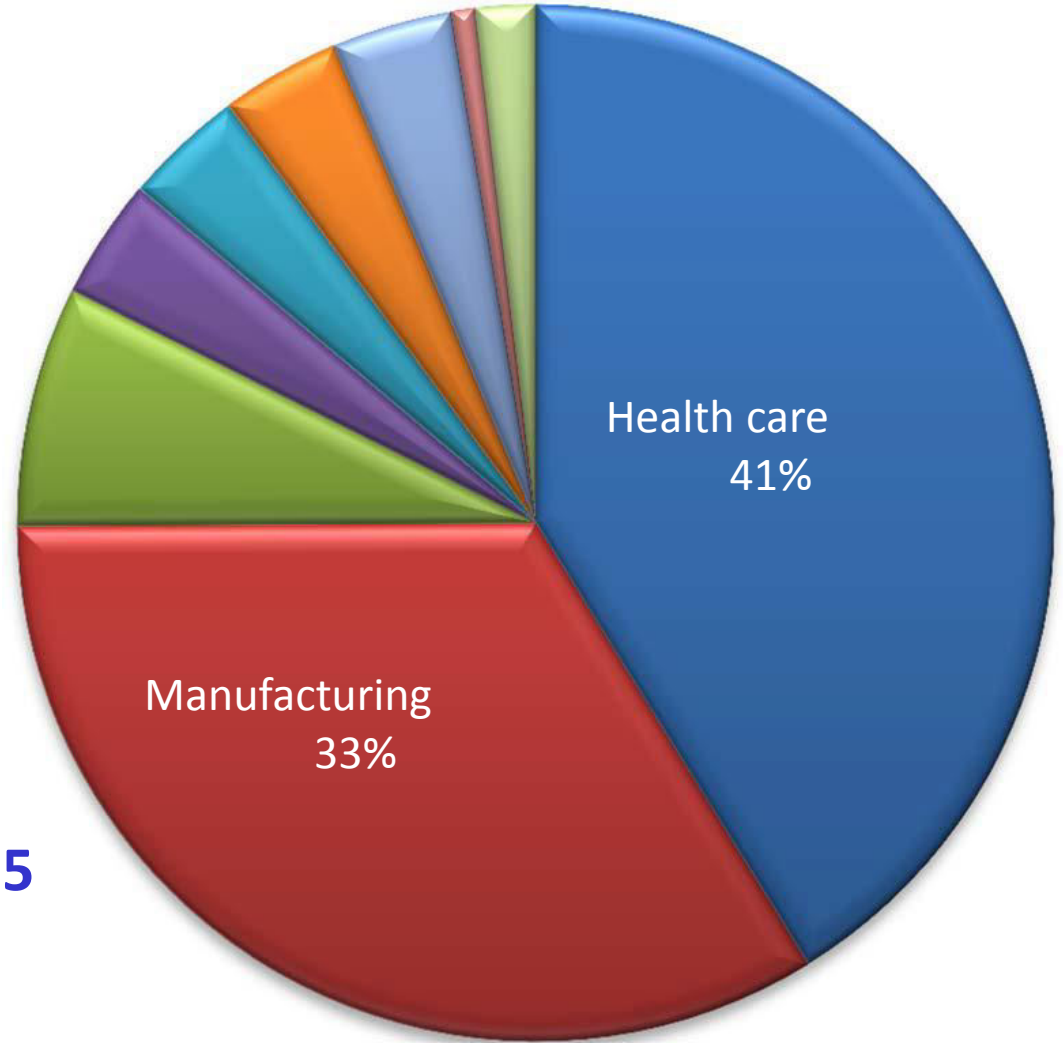
# Typical IoT Architecture (current status)




Edge-Devices:

- energy efficient
- supporting AI/ML/DL
- low latency
- green technology
- ...

# Potential Economic Impact of Sized IoT Applications

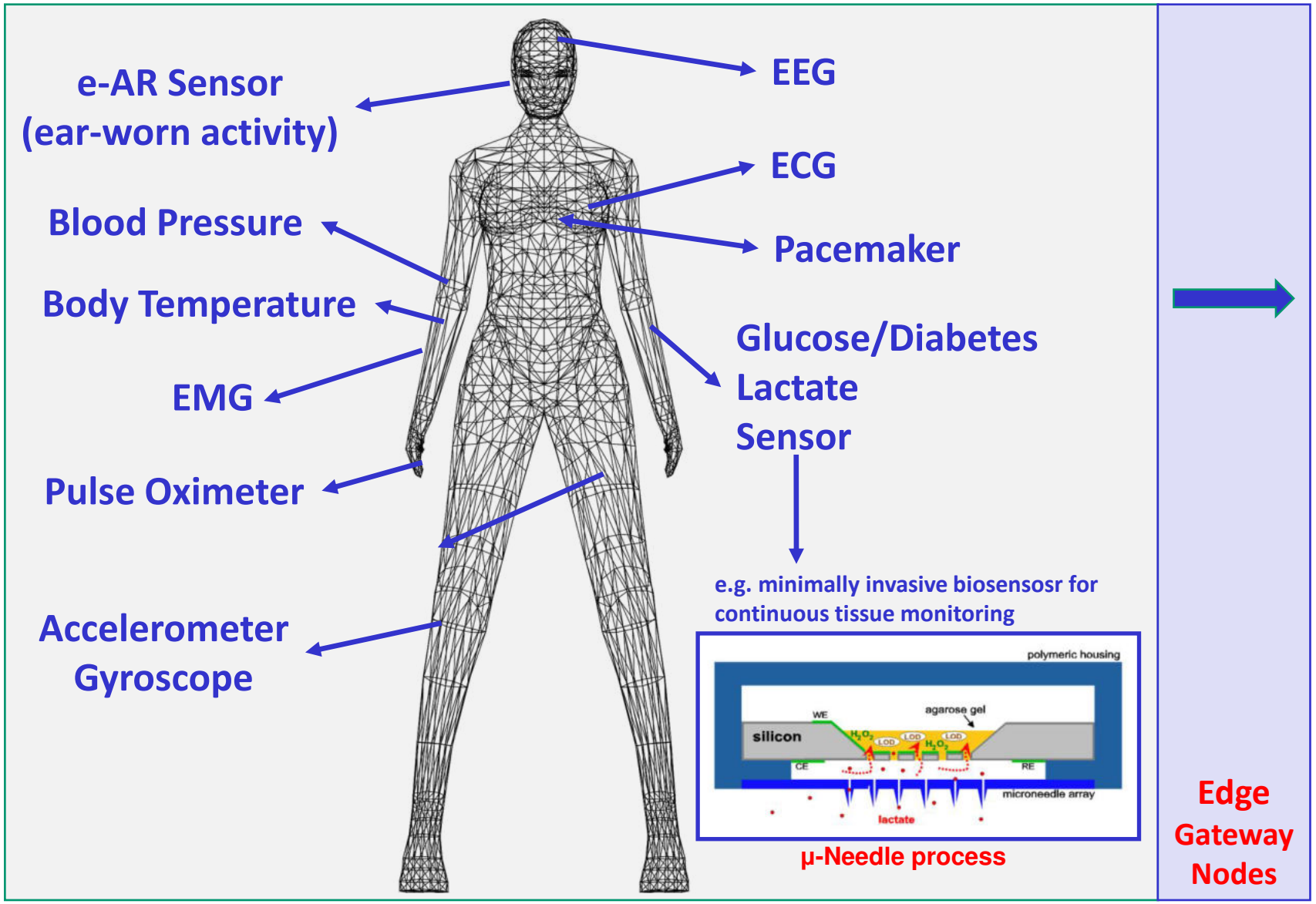



## Projected market of IoT by 2025

Case Study

Ref.: Ala Al-Fuqaha et al., Internet of Things: A Survey on Enabling Technologies, Protocols, and Applications

# Case Study: IoT – BAN/BSN




**Sensor nodes:**

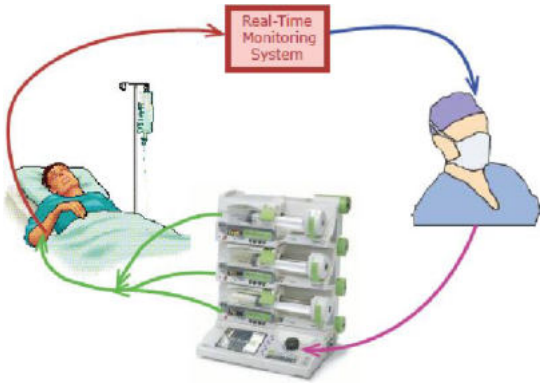
- **e-AR (ear-worn Activity Recognition) sensor** (for capturing the posture, gait and activity of the patient)
- **Wound healing sensor** (for monitoring the progress of healing for burn patients)
- **Blood pressure sensor** (for measuring the blood pressure for patients with hypertension)
- **EMG (electromyography) sensor** (for capturing the muscle activities of orthopaedic patients)
- **Blood glucose sensor** (for measuring the glucose level of diabetic patients)
- **Heart rate sensor** (for detecting abnormal heart conditions of cardiac patients).

# Case Study: IoT and Telemedicine for anesthesia practices *

## Medical Internet of Things (mIoT)
## From remote monitoring to smart hospital

## MIoT cloud-based network for anesthesia on-line monitoring

Application:
Continuous Monitoring in Anesthesia




Cloud

Secure data storage and remote visualization

Raspberry Pi
USB
USB

Arduino UNO

Laptop

Mobile

**ECG Sensor**
Bispectral index (BIS)

**DOA**
Depth of Anesthesia

**TDM**
Therapeutic Drug Monitoring

Simultaneously monitoring different physiological parameters

Blood pressure and heart rate, Drug Concentration Monitoring (control level of sedation)

Block Diagram: based on proposal for distant ECG monitoring IoT architecture by P. Singh and A. Jasuja, IoT Based Low-Cost Distant Patient ECG Monitoring System, 2017 International Conference on Computing, Communication and Automation (ICCCA)

* Ref.: Nadia Tamburrano, IoT and Telemedicine for anesthesia practices enabled by an Android application with cloud integration, Master Thesis, Polytechnic of Turin, 2018

# Going beyond Internet of Things

Already before and parallel to the development of Ubiquitous Computing (Ubicomp) and finally the Internet of Things (IoT), another very important innovation has taken place:

## The development of


Picture Ref.: PIxabay

# Thinking about Mark Weiser's dream

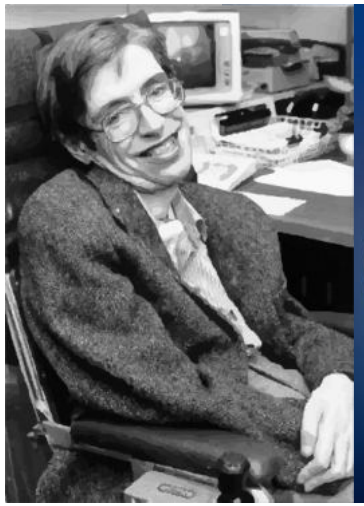
## Some remarks of Stephen Hawking:

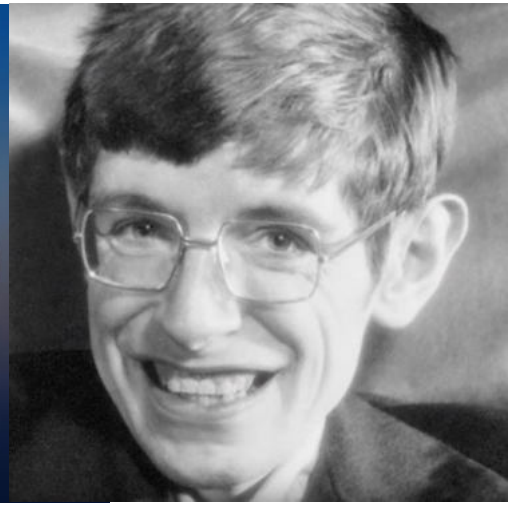
"The development of full artificial intelligence could spell the end of the human race … It would take off on its own, and re-design itself at an ever-increasing rate. Humans, who are limited by slow biological evolution, couldn't compete and would be superseded."

From an interview with the BBC, December 2014

AI will be 'either best or worst thing' for humanity.

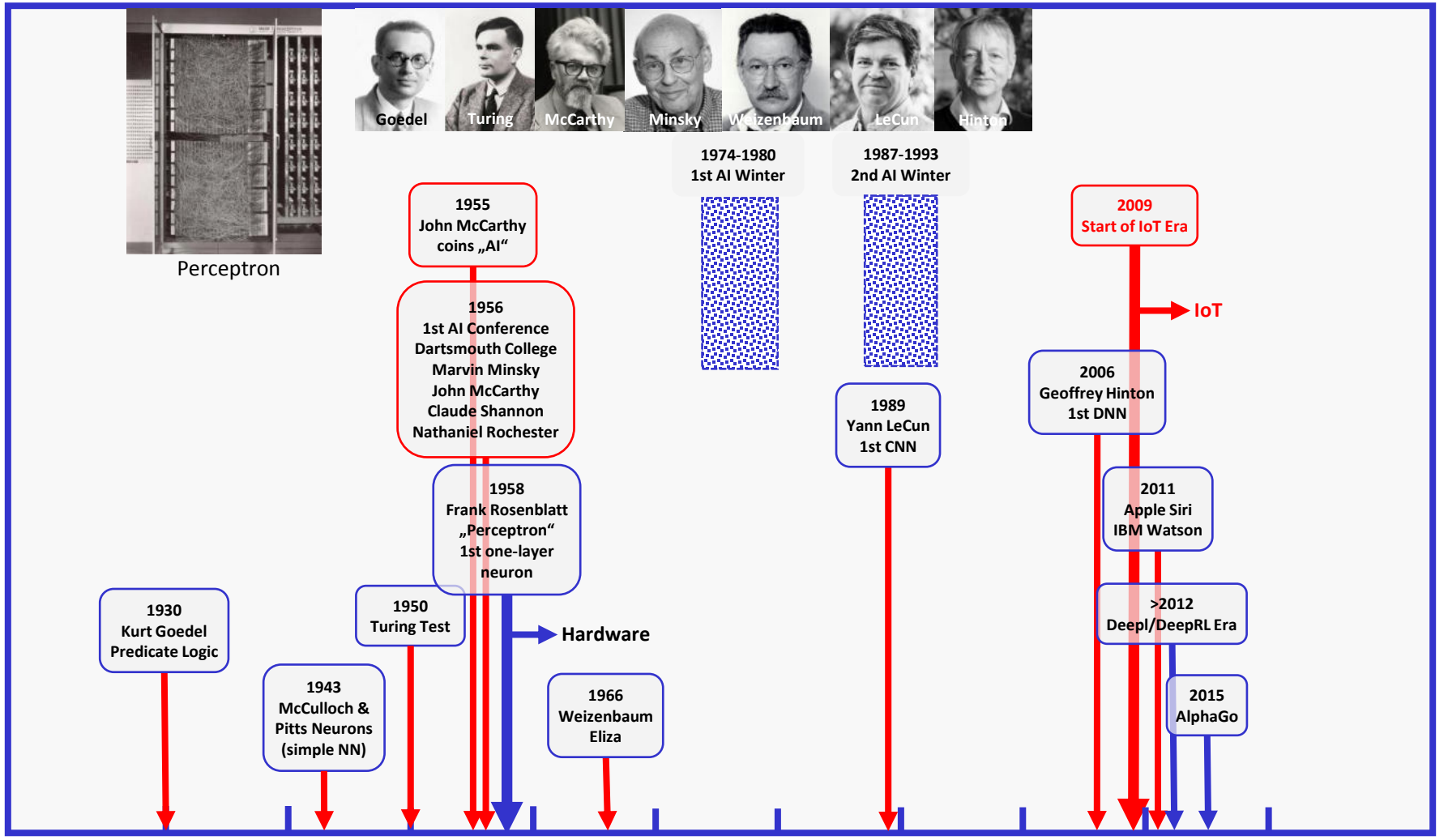
The Guardian, October 2016





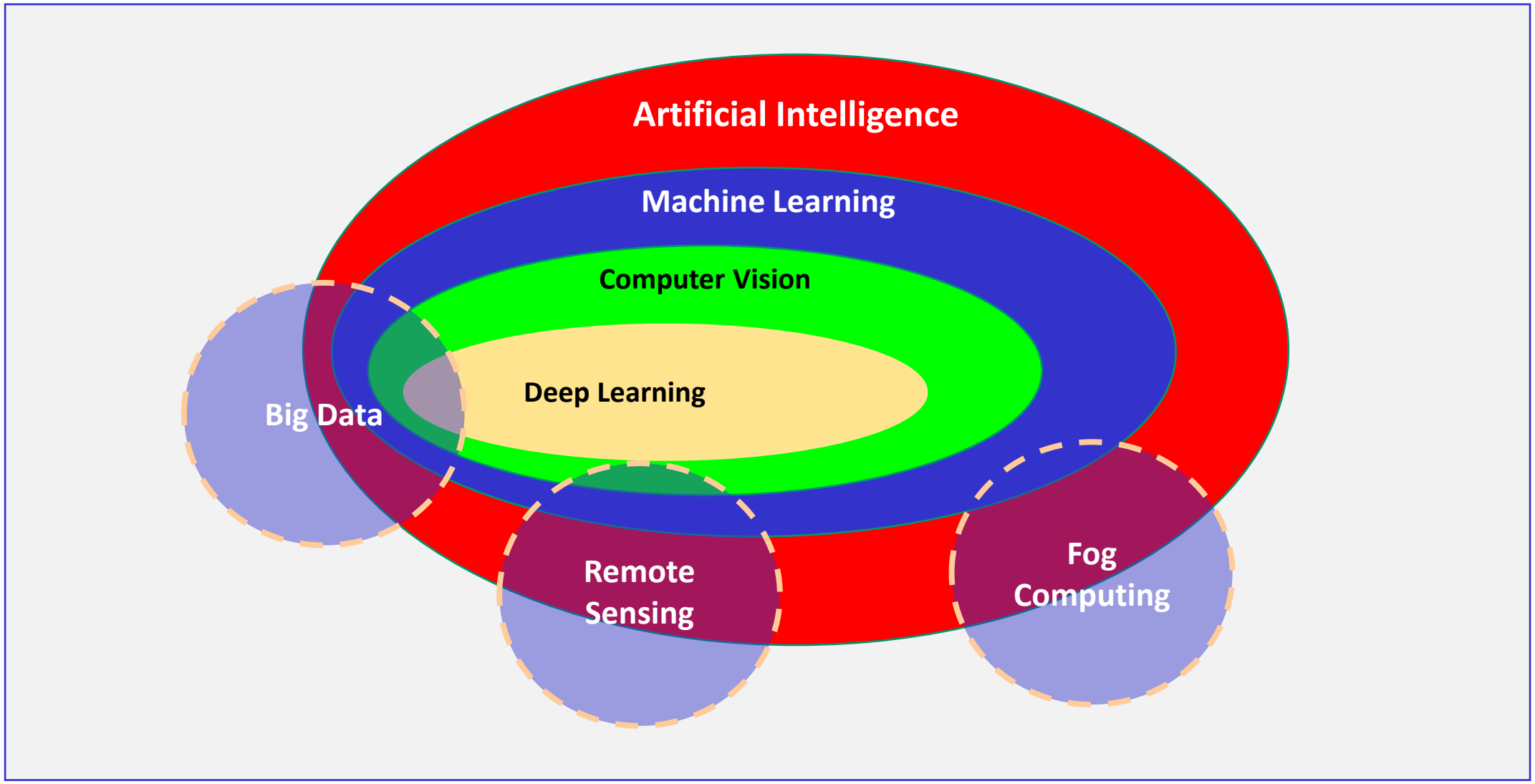
Ref.:
Stern.de

# Development of Artificial Intelligence (AI)




Ref.: Goedel-Wikipedia.org, Turing-National Portrait Gallery, John McCarthy-The Franklin Institute, Minsky-Royal Society of Chemistry, Weizenbaum-MIT, Yann LeCun-TED.com, Geoffrey Hinton-acm.org

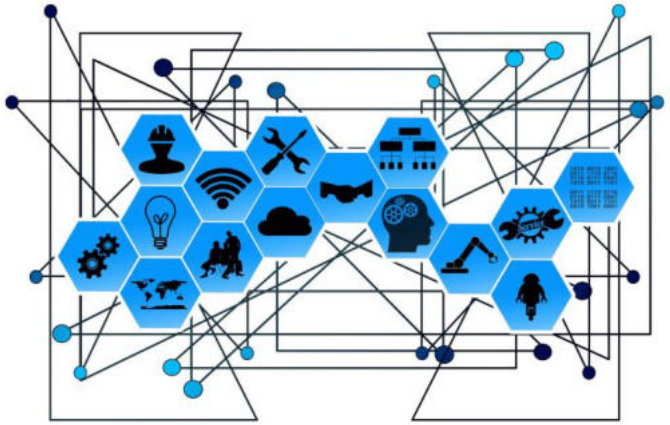
# Hierarchies of Artificial Intelligence



# Two worlds united, two have waited for each other.

## A co-evolution and perfect symbiosis: the combination of IoT and AI

→ Result: **The Artificial Intelligence of Things: AIoT**



### Why symbiosis?

**AI needs IoT:**

an important prerequisite for AI (and its subsection Machine Learning) is the availability of (big) data. Big data has applications in every business: industry, manufacturing, agriculture, healthcare, government, financial services. Data is the Lifeblood of AI.

**but also:**

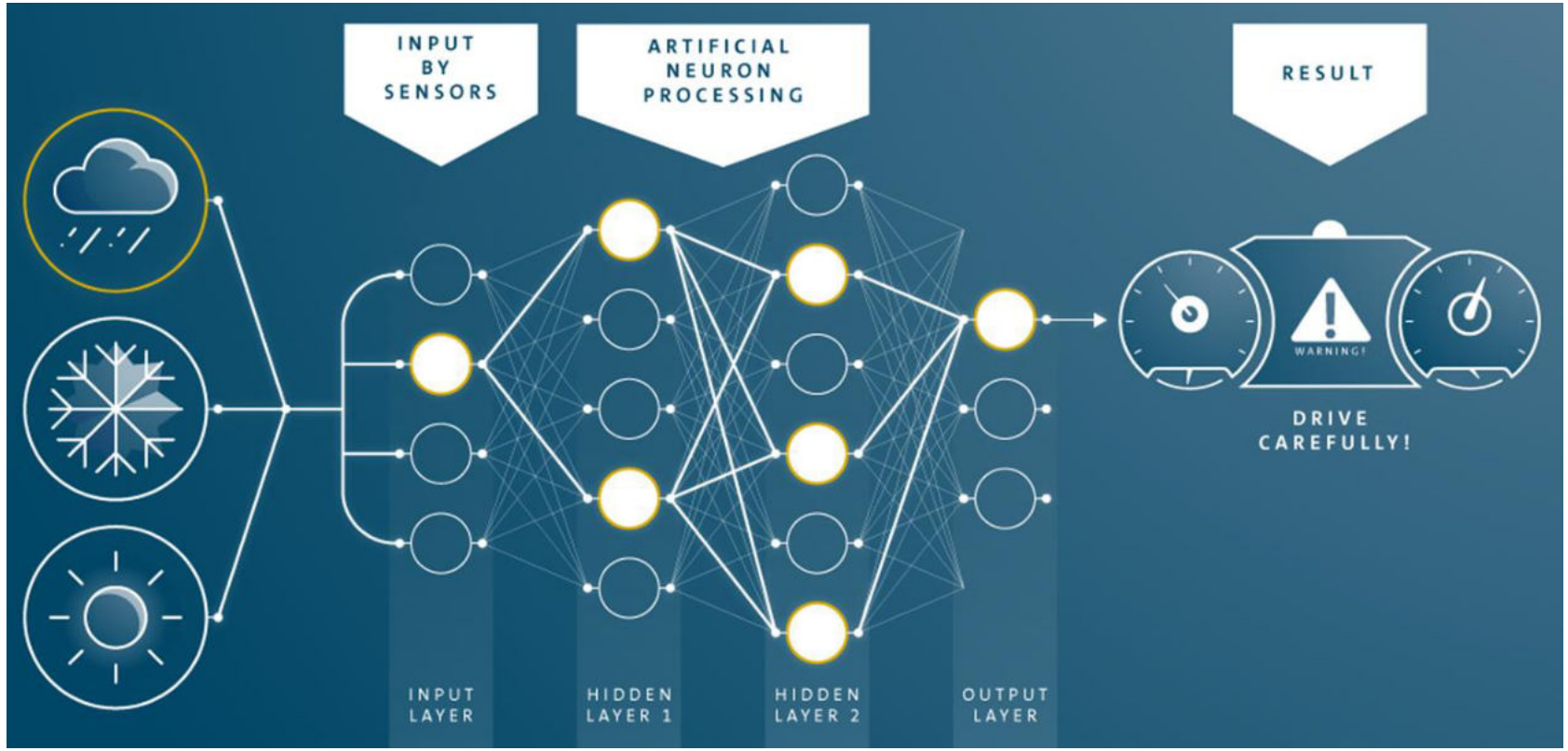
**IoT needs AI:**

The Internet of Things started with few sensor nodes, but comprises nowadays a very high number of connected and collaborating multimodal (smart) elements. A manual analysis is not possible anymore, IoT needs cloud services to work efficiently. AI is the ideal partner technology for a comprehensive system evaluation. Data-driven decision making.

Picture Ref.: PIxabay

# Case Study - Application Example:
# Internet of Things and Artificial Neural Network (ANN)

## Volkswagen Neural Networks (Cooperation Volkswagen-Stanford University)




**IoT Sensor Input (weather data)**

**Artificial Intelligence (data processing)**

**AIoT Output (driver information)**

**Application Area: Development of autonomous and assisted driving, in this case especially the detection of slippery roads.**

Ref.: https://www.volkswagenag.com

# IoT and AI: Frameworks for AI application

**Many (open-source) frameworks and libraries available for AI Machine Learning and Deep Learning are based on Python.**

- TensorFlow (Google Brain)
- PyTorch (Facebook AI)
- Keras
- Orange3 (originally C++)
- NumPy - Numerical Python
- SciPy
- Scikit-Learn (based on SciPy)
- Pandas
- Matplotlib
- Theano (MILA, University of Montreal)
- Spark MLlib (Apache)
- MXNet
- NLTK - Natural Language ToolKit
- NeuroLab
- ffnet (feedforward neural network)
- Lasagne
- pyrenn (recurrent neural network)

# AIfES - Artificial Intelligence for Embedded Systems

## Embedded AI – Artificial Intelligence for microcontrollers and embedded systems

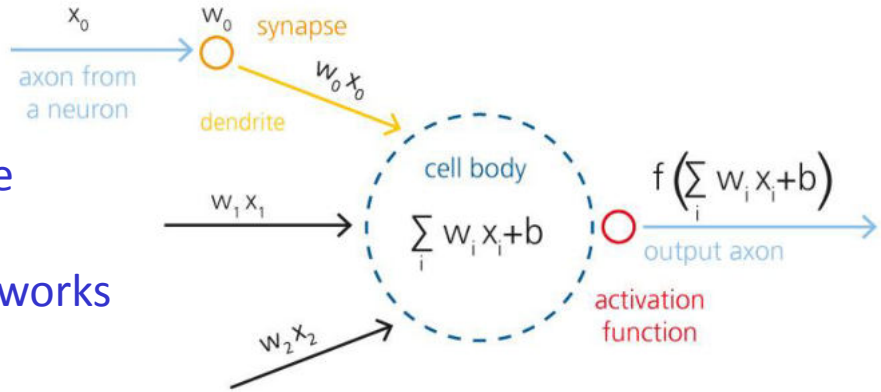
**AIfES comprises a platform-independent machine learning library implementing a fully configurable Feedforward Neural Network (FNN).**

**The artificial neuronal network in AIfES:**

AIfES includes a Feedforward Neural Network (FNN), which is configurable in almost all parameters and also allows deep network structures. The network structure can be individually adapted to the actual technical task.

**Features:**

– Number of inputs and outputs are freely definable
– Number of hidden-layer and neurons per layer are configurable
– Different activation-functions with additional parameters
– Prepared to import already trained FNNs from other ML frameworks




Legal issues for using AIfES :

– Free of charge: Private projects or developers of Free Open Source Software (FOSS) under the GNU Affero General Public License (AGPL) version 3.
– Commercial without distribution under GNU AGPL V3: license agreement required with Fraunhofer IMS

Ref.: https://www.ims.fraunhofer.de/en.html

Fraunhofer IMS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# AIfES - Artificial Intelligence for Embedded Systems

## Selected platforms and microcontrollers supported by AIfES :

- Windows (DLL)
- Raspberry Pi with Raspbian
- Arduino UNO
- Arduino Nano 33 BLE Sense
- Arduino Portenta H7
- ATMega32U4
- STM32 F4 Series (ARM Cortex-M4)

Ref.: https://www.ims.fraunhofer.de/en.html

## Intermediate Thoughts (or Questions):
## What happened to Mark Weiser‘s "walk in the woods"?

Calm technology should recede into the background of our lives. Using computers should be as refreshing as taking a walk in the woods.

Today we are not just walking in a calm IoT world. IoT and AIoT/BIoT have entered our environment, our nature, our forests.

**Two example projects show how well this symbiosis is working today:**

1. **The "Beewise/Beehome“ project (and others)**
2. **The "Tree Projects 4.0 (Baum 4.0)“ (and others)**

# "Walk in the woods"

## On the way to Mark Weiser‘s forest dream: Taking care of our bees

The Forests:

- Habitats for our bees and wild bees
- More than 20.000 bee species mapped worldwide
- Problem:
  every year 30 to 40% of the bees are dissapearing *

Solution:

AIoT/BIoT entering our environment, our nature, our forests.

❖ Abnormally high die-offs (30–70% of hives) of honey bee colonies in North America ("colony collapse disorder" - CCD)

# ... in order to prevent

## A WORLD WITHOUT BEES


**TIME Magazine**
**2013**

Ref.: TIME Magazine A World Without Bees, Aug. 19, 2013

# Case Study IoT: IoBee
# Beehive health IoT application to fight Honey Bee Colony Mortality

**EU Project 2017 to 2020**
**Funded under Horizon 2020 Framework Programme**
**https://cordis.europa.eu/project/id/760342**

**Purpose:**
**Development of in-hive and in-field monitoring and implementation of satellite imagery and Spatial Decision Support Systems (SDSS).**

IoBee

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## The consortium

**The consortium has the complementary business capabilities, commercial networks and research expertise to guarantee a quick route to market for the technology, driven by: IRIDEON expert in IoT Sensor Applications, Avia-GIS expert in Insect Spatial Decision Support Systems and Arnia expert in smart beehive systems. These will be supported by TEIC, expert in Insect Bioacoustics, Pattern Recognition and Acoustic Surveillance, and Bee Life European Beekeeping Coordination.**

irideon innovation partners

**IRIDEON SL (Coordinator) – Spain**
**Spanish-German company**

BeeLife European Beekeeping Coordination

**Bee Life European Beekeeping Coordination – Belgium**

AVIAGIS

**Avia-GIS BVBA – Belgium**

HELLENIC MEDITERRANEAN UNIVERSITY

**Hellenic Mediterranean University**
**Greece**

Canetis

**Canetis – Italy**

Ref.: https://io-bee.eu/

IoBee

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**Purpose: explain why bee populations are crashing.**
**Two novel superior environmental sensors help fill in the knowledge gaps, monitoring environmental threats to bees.**

1. **Sensor placed in beehives: Bee Counter**
   **Beehive sensor installed at the hive entrance counts bees entering and leaving the hive in real time. Determines mortality rates in the field, and identifies deviations in flight duration and nectar availability. The sensor can also identify types of bees and hive pests.**
   **One way the sensor does so is via a technique called light extinction, which measures the size of an insect's shadow. The sensor also measures light scattering in various colour bands, identifying species by colouration.**
2. **Sensor placed in nearby fields:**
   **Optoelectronic sensor counts and identifies insects flying outside the hive (density and diversity of pollinators in the field). As insects fly through the sensor field, the sensor automatically identifies their flight pattern and matches it with species in the database. So insects can be efficiently identified without need for trapping and manual counting.**

**Together, the sensors monitor environmental changes and provide early warnings of threats.**

Ref.: https://io-bee.eu/

IoBee

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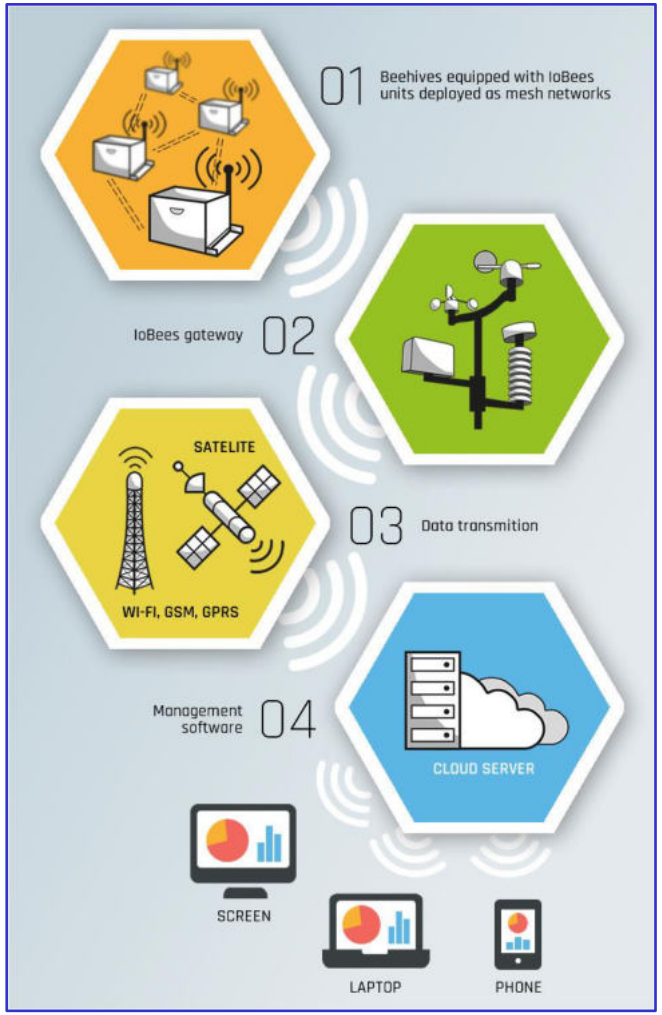
Automatically count bees entering / exiting the hive, with higher accuracy.

Profile bees' bioacoustic fingerprint as normal (healthy) or abnormal (unhealthy) and assess the potential risk of abnormal mortality.

Automatically detect the potential presence of invasive species (wasps, moths, flies, beetles, Africanized bees, etc.) that may harm the colony or bring diseases.

Collect, share data and analyze information of importance, and simulate the spread of infectious bee diseases / pests.

Provide a space-time information system that integrates data in one information environment for planning and decision.




Ref.: https://io-bee.eu/

# Case Study AIoT: BEEWISE (Beehome)
# Earth's first robotic beehive

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BEEWISE

## Automated beekeeping platform based on precision robotics, AI/ML, and IoT

TEL AVIV UNIVERSITY
Pursuing the Unknown

Ref.:
Ms. Netaly (Zelcer) Harari, Beewise: Automated Beekeeping, Tel Aviv University, Israel

partially funded by European Commission

# TO BEE OR NOT TO BE.

## Earth's first robotic beehive

## Automated beekeeping platform based on IoT & AI


BEEWISE

TEL AVIV UNIVERSITY
Pursuing the Unknown

partially funded by European Commission

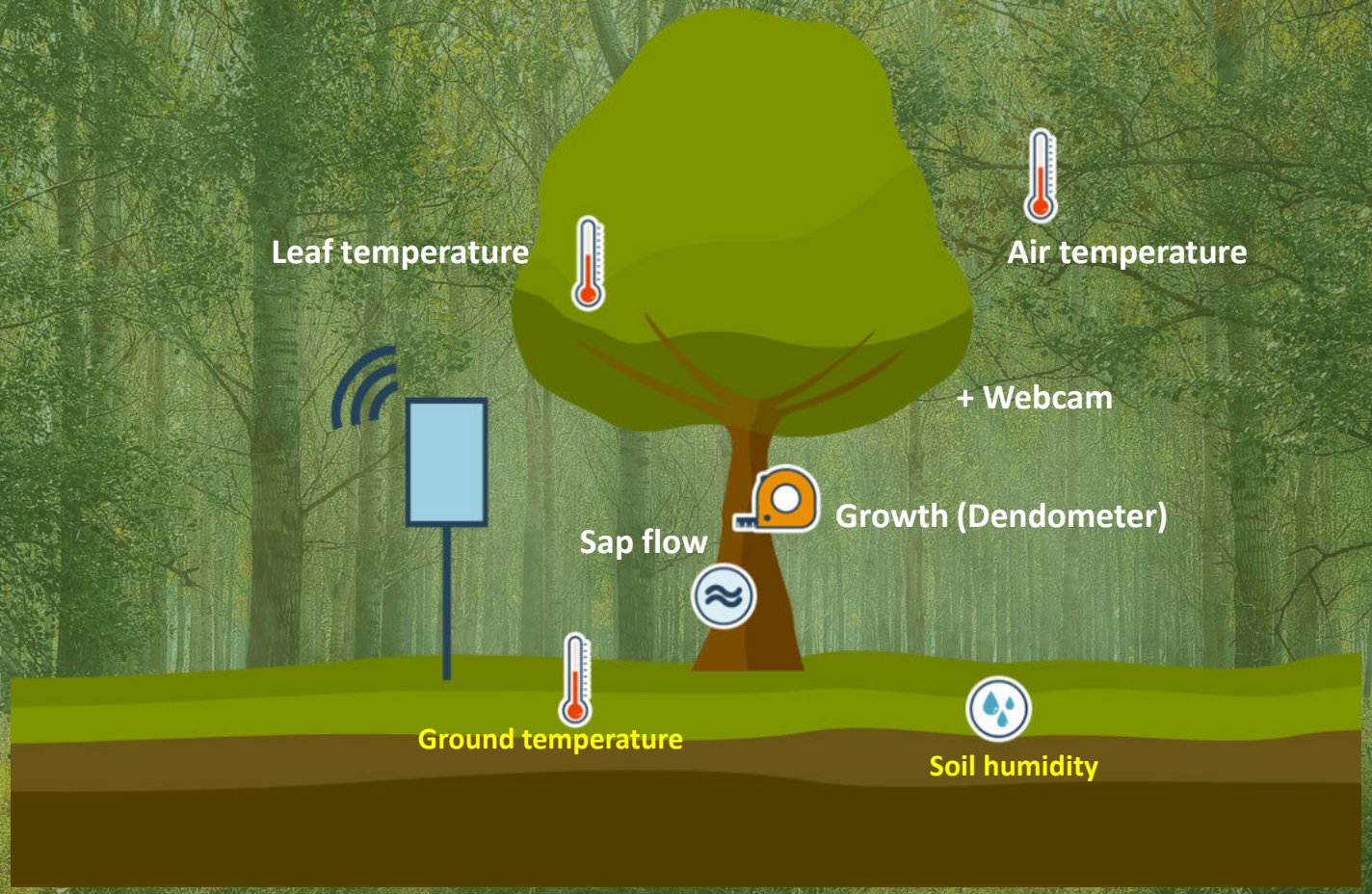
AWS Lambda
Amazon SageMaker
Amazon AWS IoT Core

Ref.:
Ms. Netaly (Zelcer) Harari, Beewise: Automated Beekeeping, Tel Aviv University, Israel

Mark Weiser

# Walking in the Woods

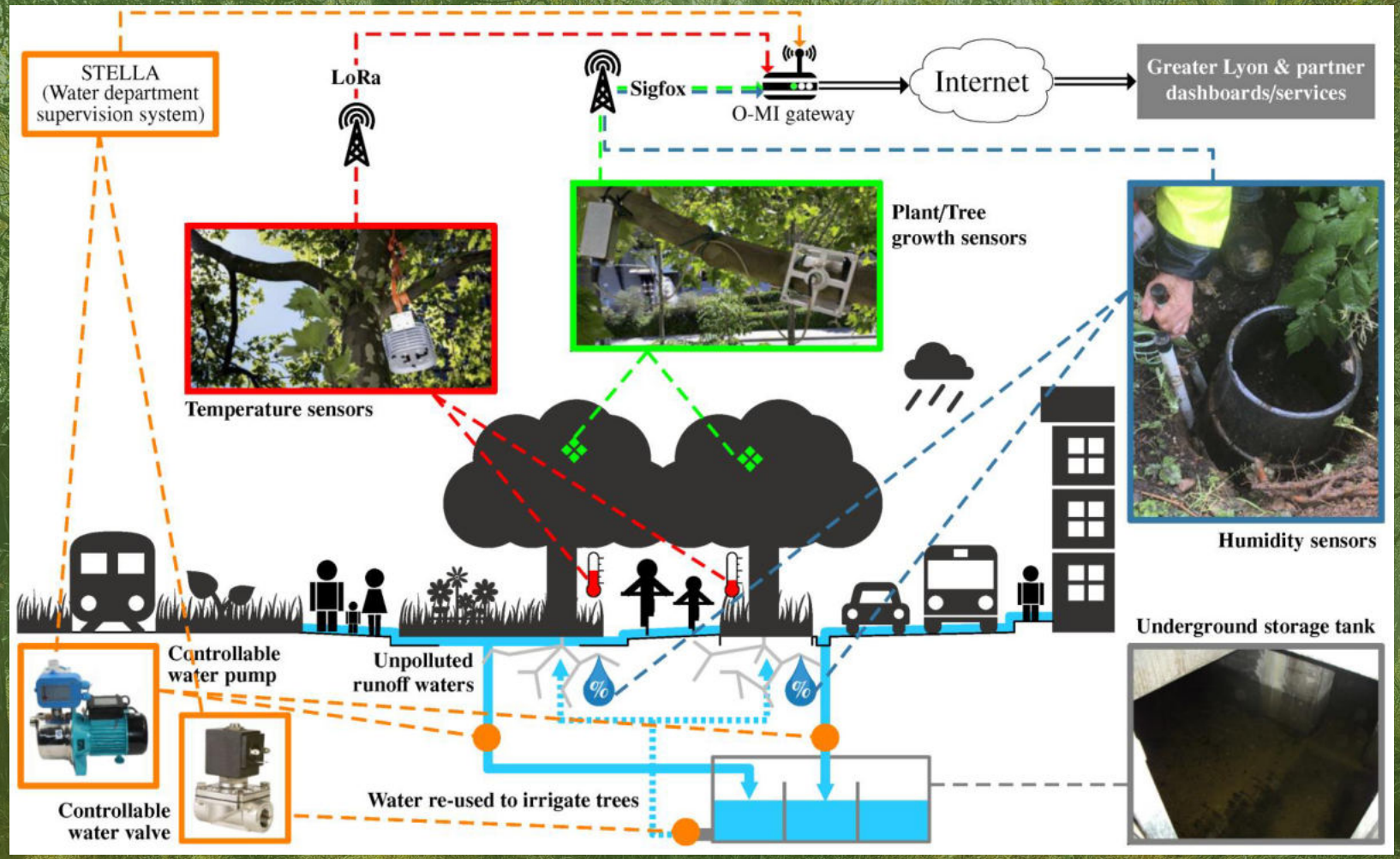
# Case Study: IoT Tree Example Application 1: Tree Projects 4.0 (Baum 4.0) – The Talking Tree




Ref.:Technical University Munich (TUM), Eichstätt-Ingolstadt (KU)
Project coordinated by Prof. Dr. Annette Menzel (TUM),
Dr. Marvin Lüpke, M.Sc. (TUM), and Prof. Dr. Susanne Jochner-Oette (KU)

https://www.portal.baysics.de/wiki/baum40story/
Live data: https://www.baysics.de/Baum4/trees.html

# Case Study: IoT Tree Example Application 1: Smart Métropole de Lyon Reducing urban heat-island (UHI) effects: by increased the planting of new



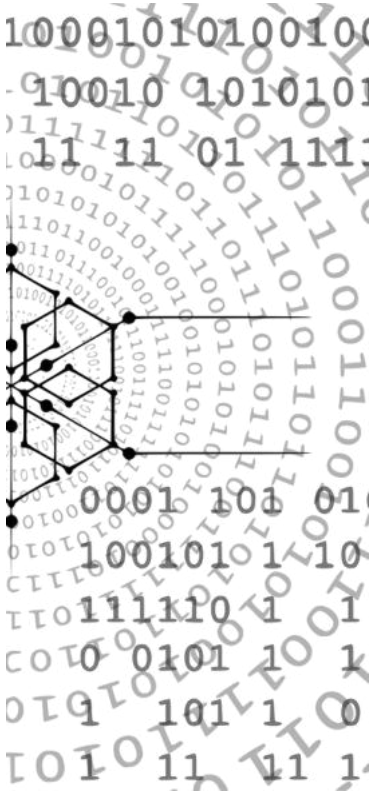

Ref.:Jérémy Robert et al., Open IoT Ecosystem for Enhanced Interoperability in Smart Cities—Example of Métropole De Lyon, Sensors 2017

# Further development after IoT and AI

## The introduction and integration of the Blockchain Technology *

**Blockchain IoT (BIoT):**
**Foundation of high-trust computing (distributed trusted information technology)**

**A New Direction for Solving Internet of Things Security and Trust Issues.**



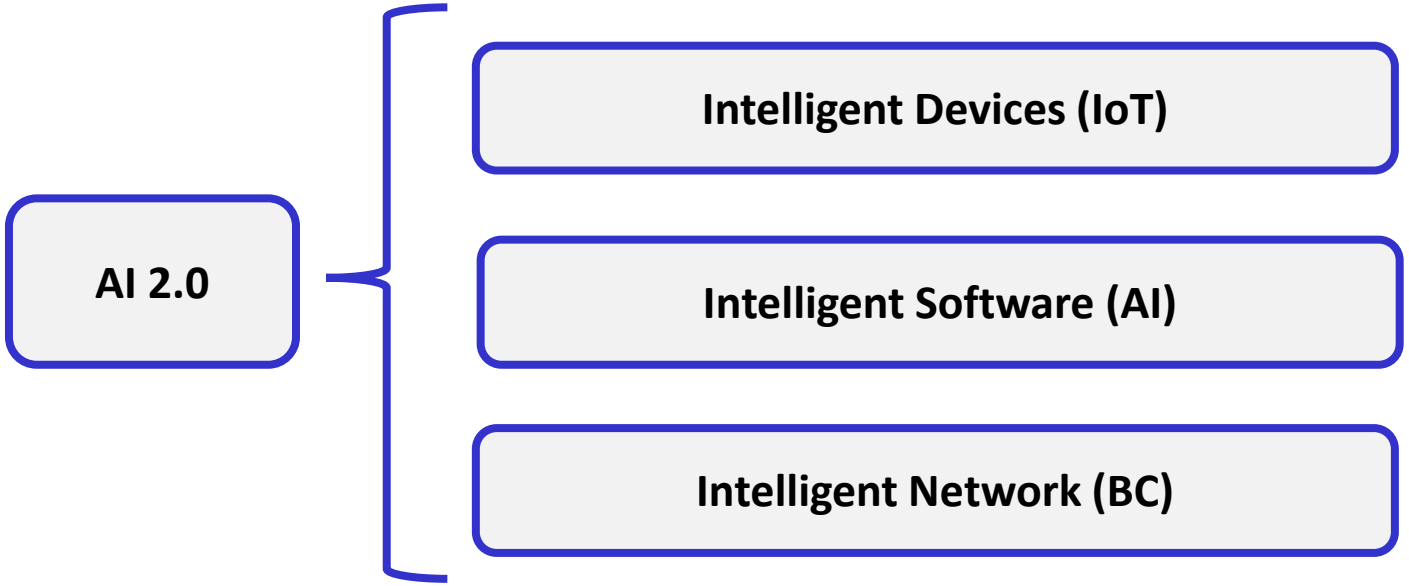
**Benefits of BIoT:**

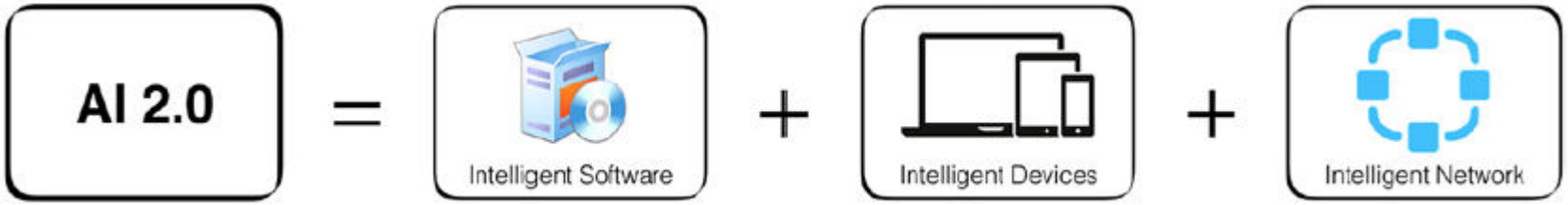
1. Publication/duplication of sensors data in public and distributed ledgers
2. Time stamping by the blockchain infrastructure
3. Data authentication
4. Non repudiation.

**A blockchain uses a distributed peer-to-peer (P2P) network to keep an unalterable record of every exchange.**
**Consequence: no need for trusted, third-party intermediaries in digital transactions.**

*** well known from Bitcoins, but much more**

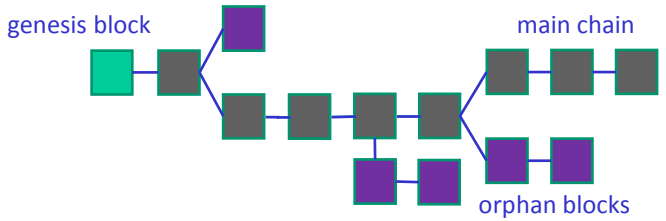
# AI 2.0
# Combination of AI, IoT, and Blockchain

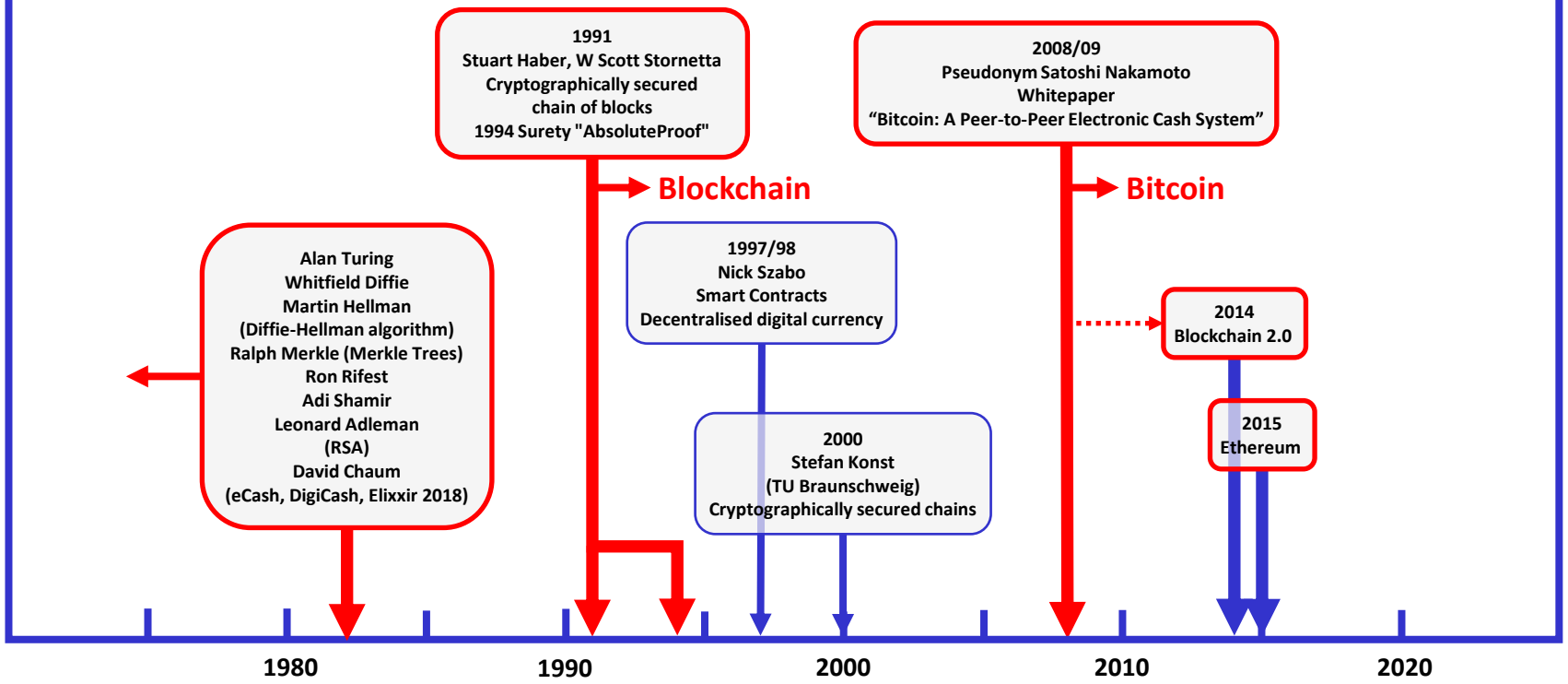



Ref.: Apress.IoT.AI.and.Blockchain.for.NET.www.EBooksWorld.ir

# Development of the Blockchain Technology

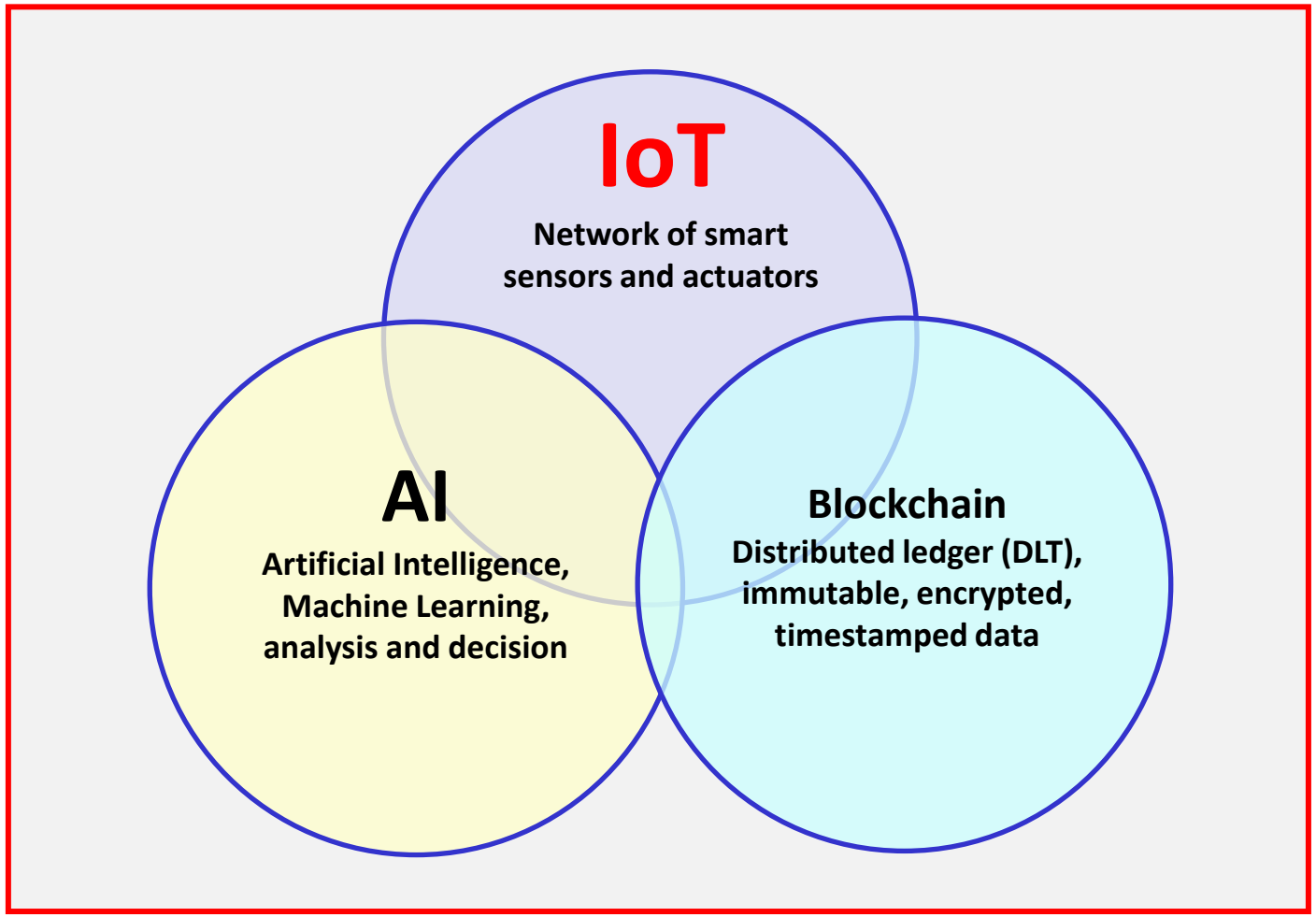




1982 Cryptographer David Chaum: proposed a blockchain-like protocol in his dissertation "Computer Systems Established, Maintained, and Trusted by Mutually Suspicious Groups."

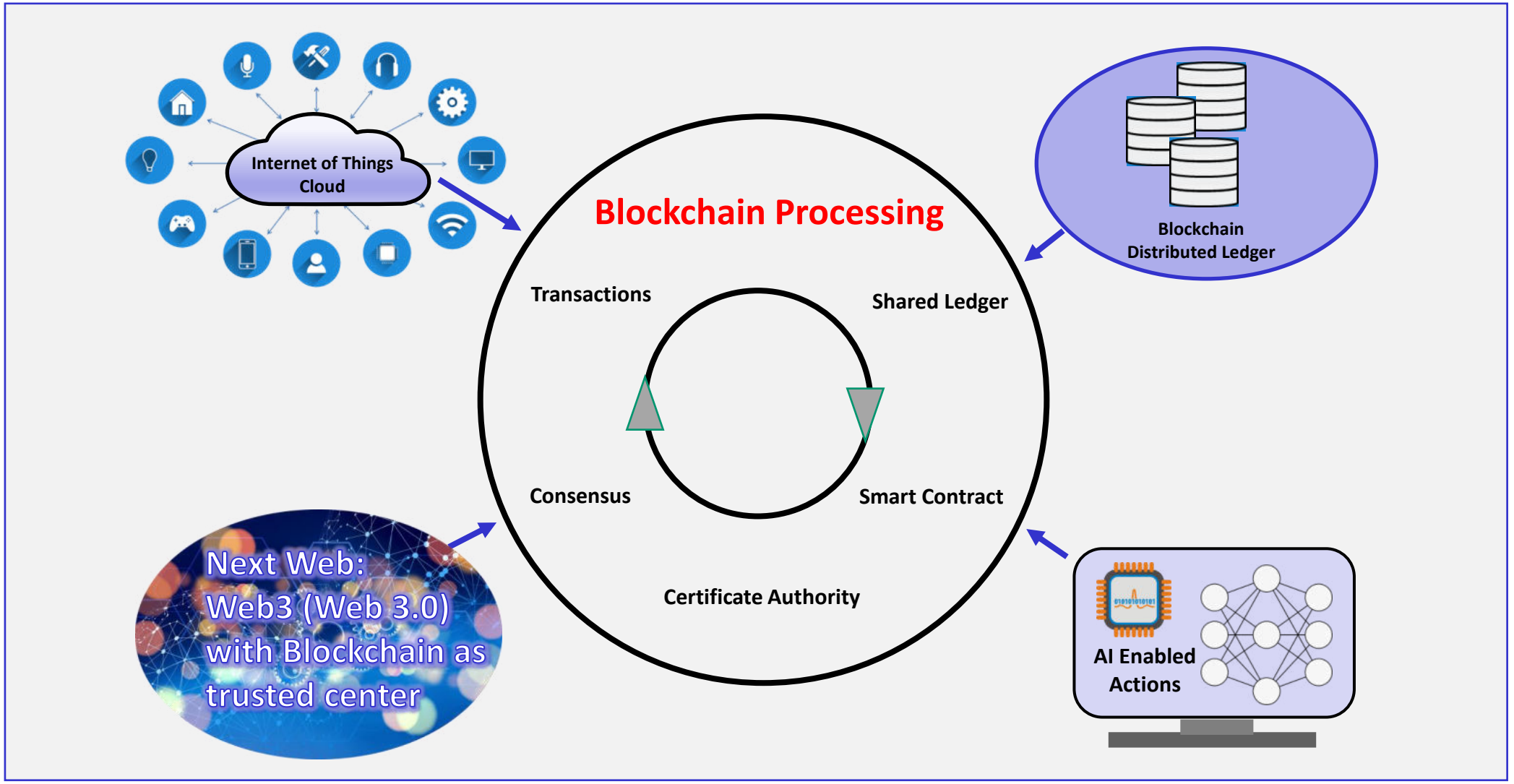
Ref.: Stuart Haber photo: https://mobile.twitter.com/StuartHaber/photo; Nick Szabo photo: https://blockchain.uark.edu/nick-szabo/;
Scott Stornetta photo https://timesofmalta.com/articles/view/meet-blockchains-co-inventor.683308; David Chaum photo: KuppingerCole Analysts

# Merging IoT, AI and BC




**IoT feels, and AI thinks. Blockchain remembers and protects.**

# IoT, AI and Blockchain integrated



# The Internet of Things: Data Flow

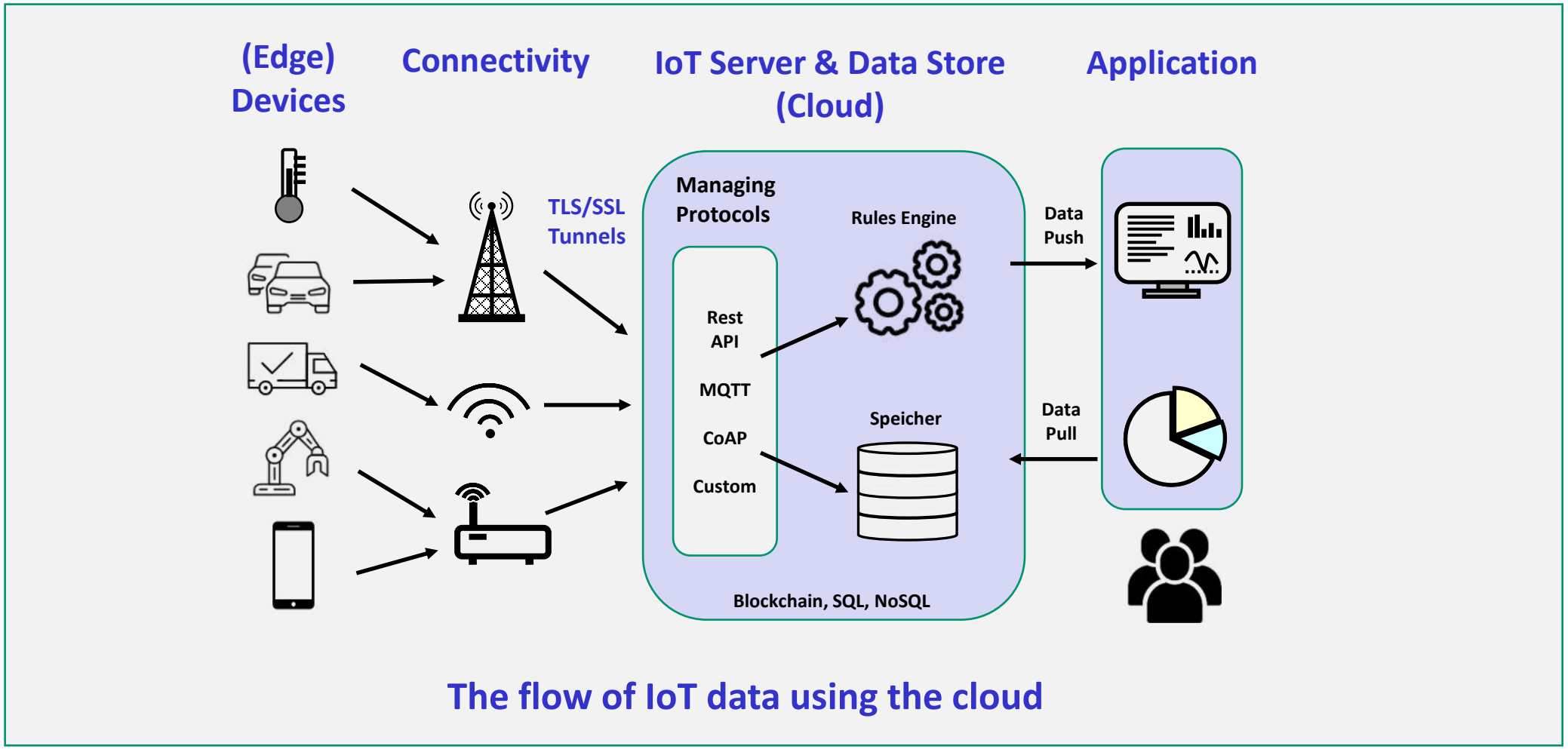
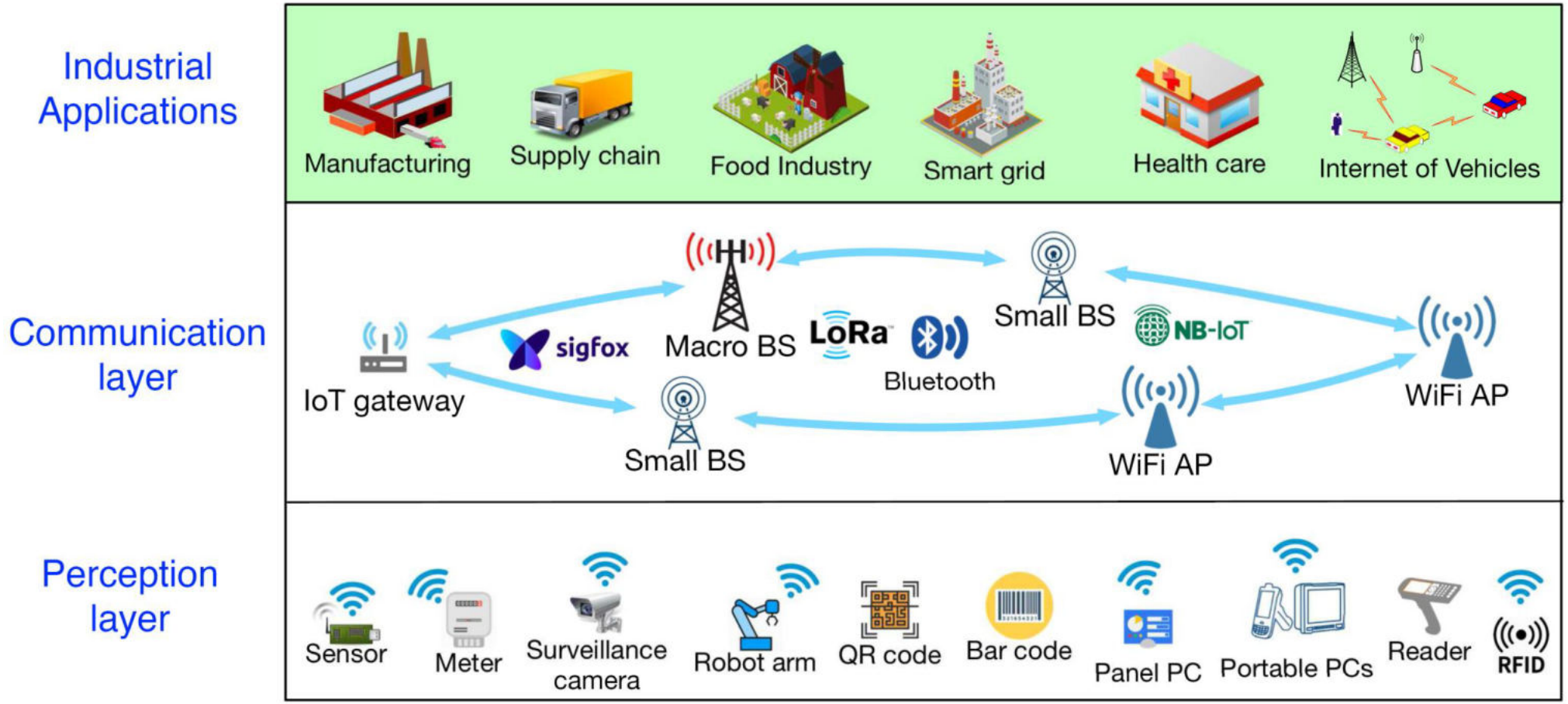



Figure based on: AI, IoT and the Blockchain

# Architecture of Internet of Things - IoT

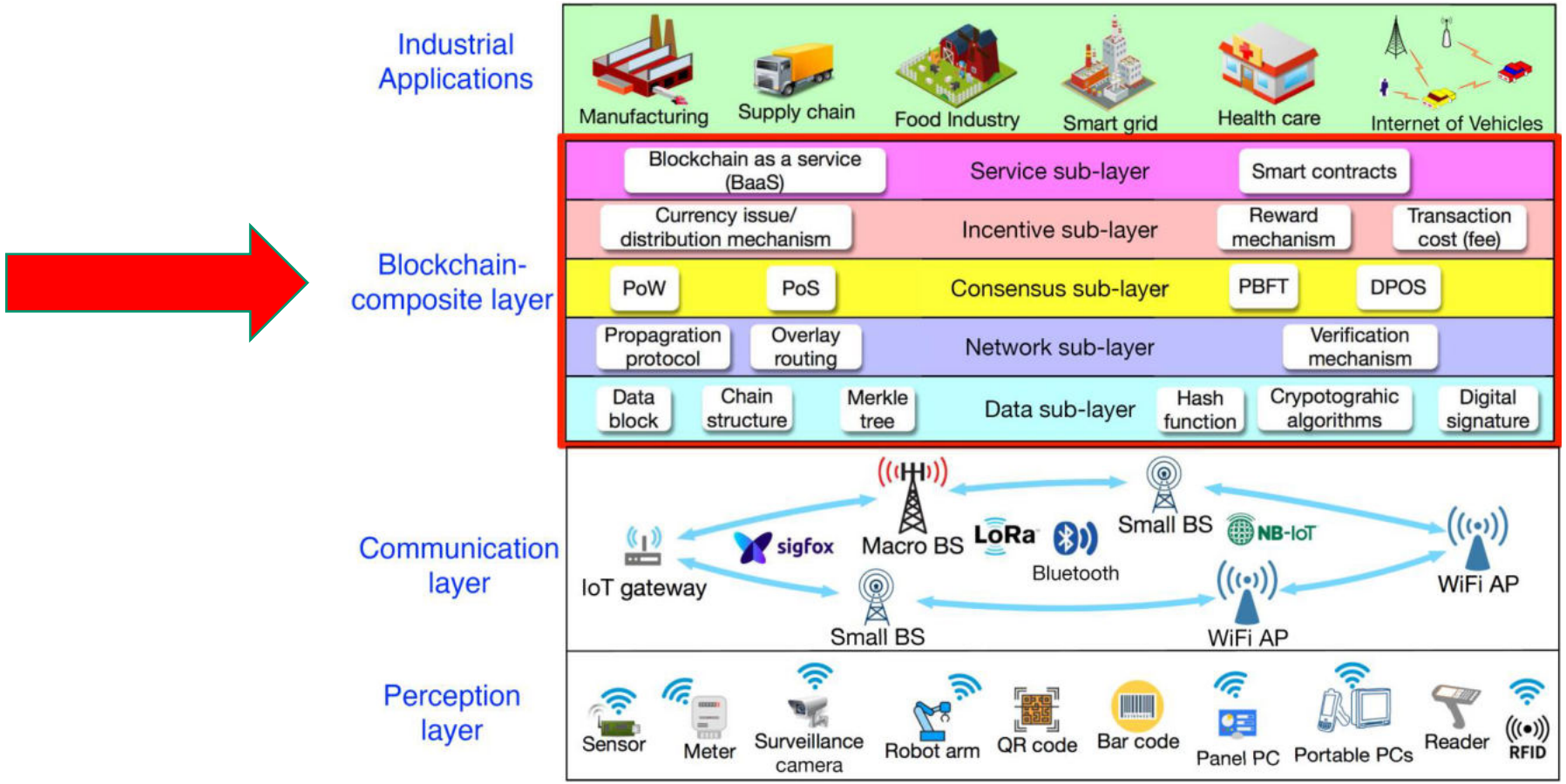




Ref.:
Hong-Ning Dai, Zibin Zheng, Yan Zhang, "Blockchain for Internet of Things: A Survey,,,
in IEEE Internet of Things Journal, vol. 6, no. 5, pp. 8076-8094, Oct. 2019, doi: 10.1109/JIOT.2019.2920987

# Architecture of Blockchain of Things - BCoT

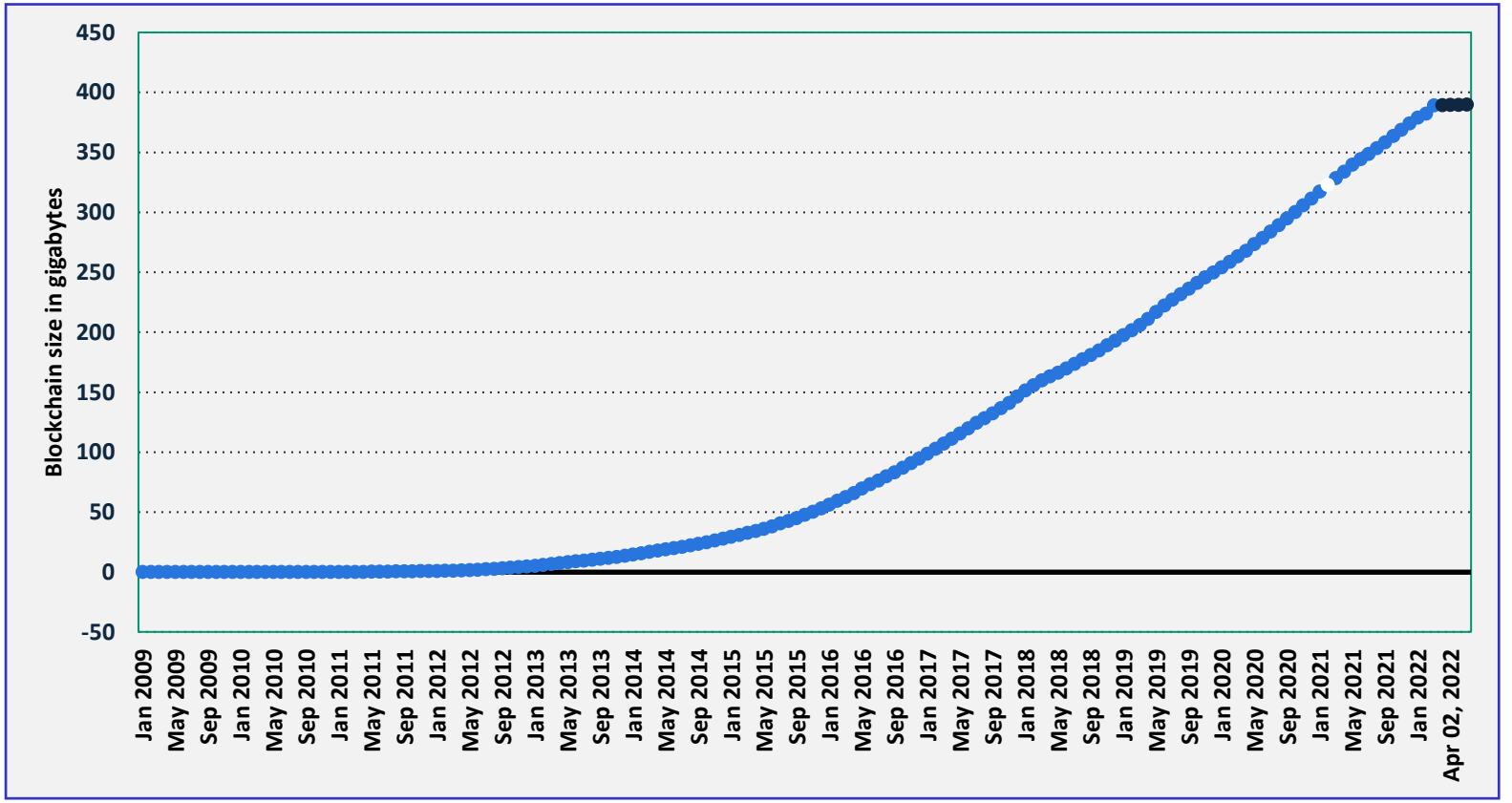
## as proposed by Hong-Ning Dai, Zibin Zheng, Yan Zhang, with blockchain-composite layer as a middleware between IoT and industrial applications.




Ref.:
Hong-Ning Dai, Zibin Zheng, Yan Zhang, "Blockchain for Internet of Things: A Survey,„
in IEEE Internet of Things Journal, vol. 6, no. 5, pp. 8076-8094, Oct. 2019, doi: 10.1109/JIOT.2019.2920987

# Blockchain Example

## Size of the Bitcoin blockchain from January 2009 to April 4, 2022 (in gigabytes).

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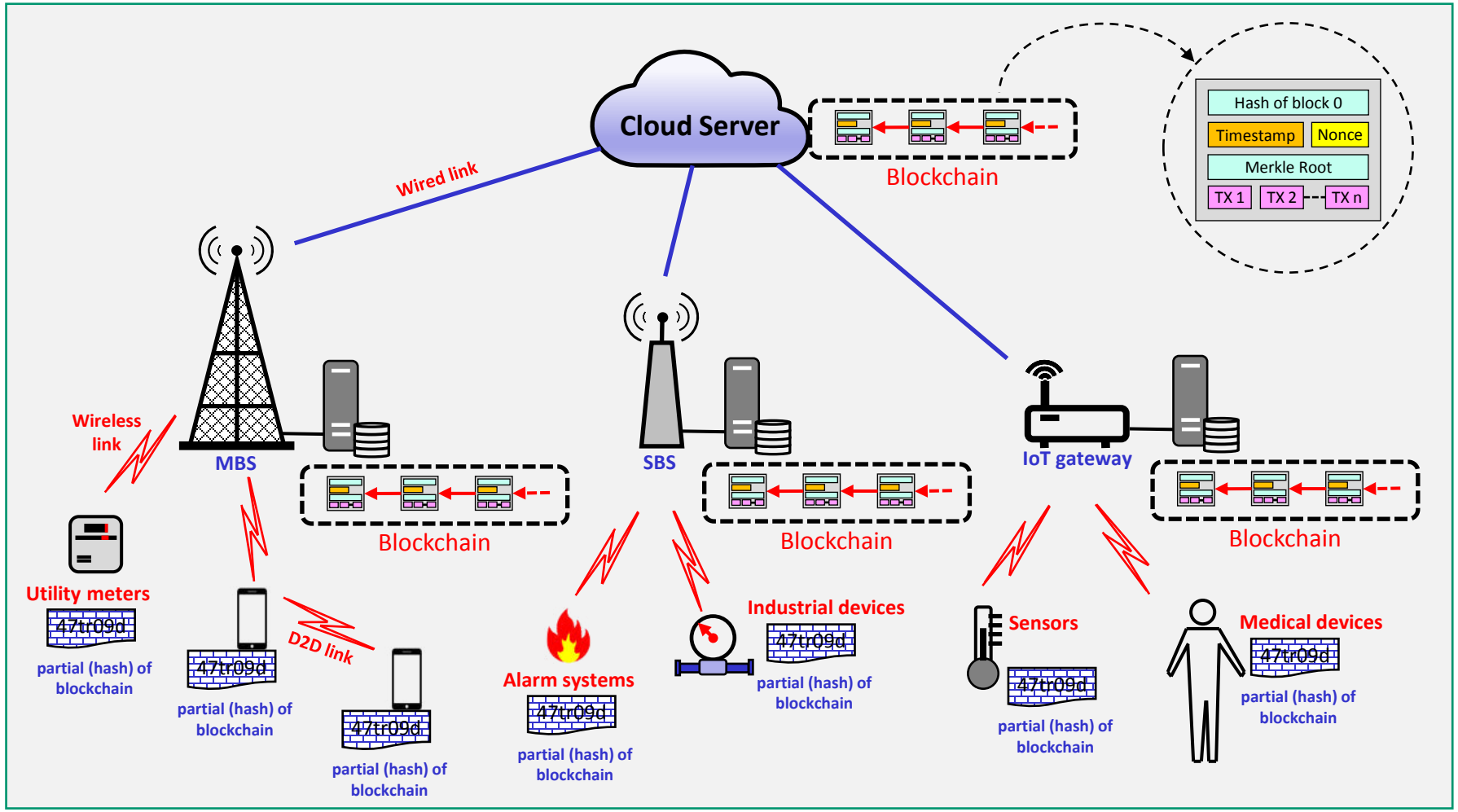
# Blockchain Example




MEC-Server (Multi-access edge computing)

Figure based on:
Hong-Ning Dai, Zibin Zheng, Yan Zhang, "Blockchain for Internet of Things: A Survey,,,
in IEEE Internet of Things Journal, vol. 6, no. 5, pp. 8076-8094, Oct. 2019, doi: 10.1109/JIOT.2019.2920987

# The IoT World of Definitions and Akronyms (a selection)

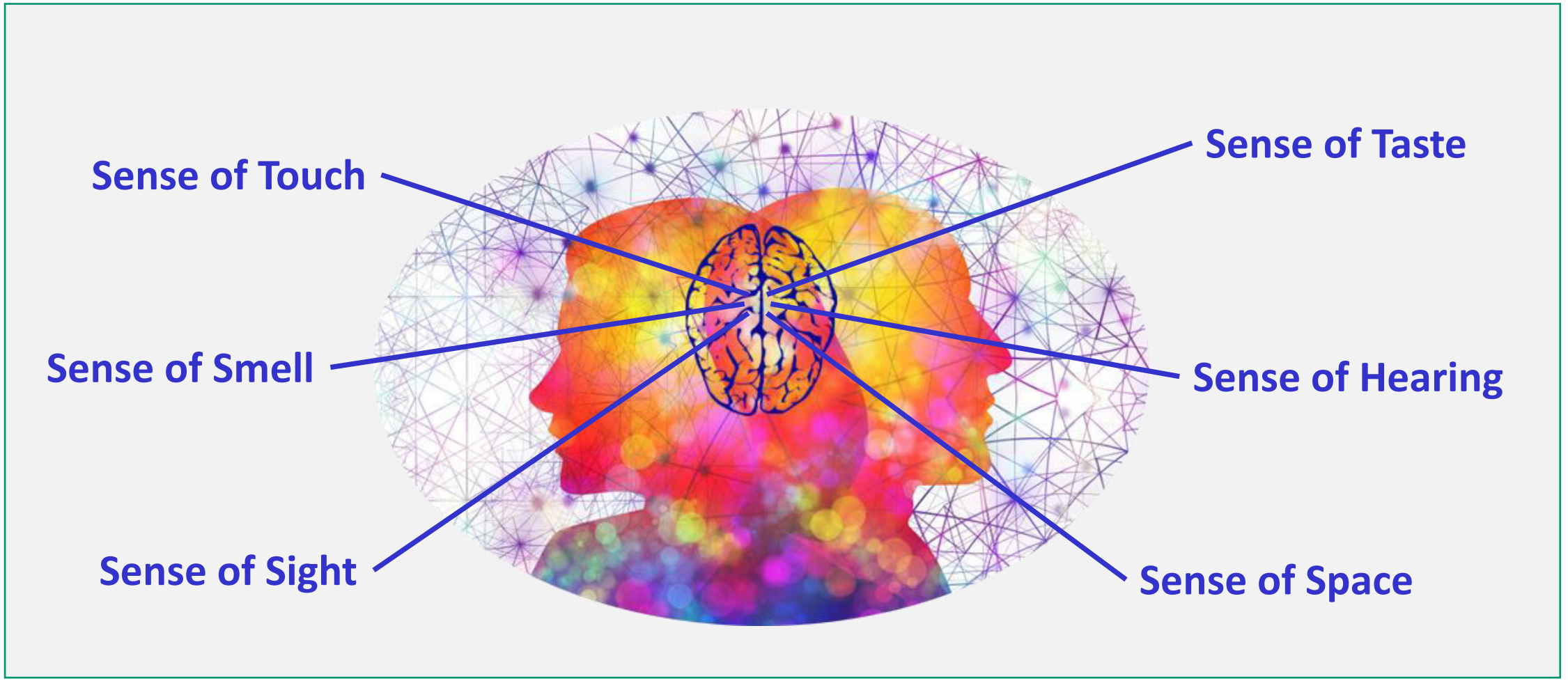
## IoT Main groups

| | |
|---|---|
| IoT | Internet of Things (2G-3G-4G) |
| IIoT | Intelligent / Industrial Internet of Things (5G) |
| IoIT | Intelligent Internet of Intelligent Things (6G) |
| IoT 2.0 | Intelligence of Things (or simply IoT) |
| XIoT | Extended Internet of Things |
| AIot | Artificial Intelligence of Things |
| BIot | Blockchain IoT (other meanings exist) |
| BCoT | Blockchain of Things |
| CIoT | Cloudification of the Internet of Things |

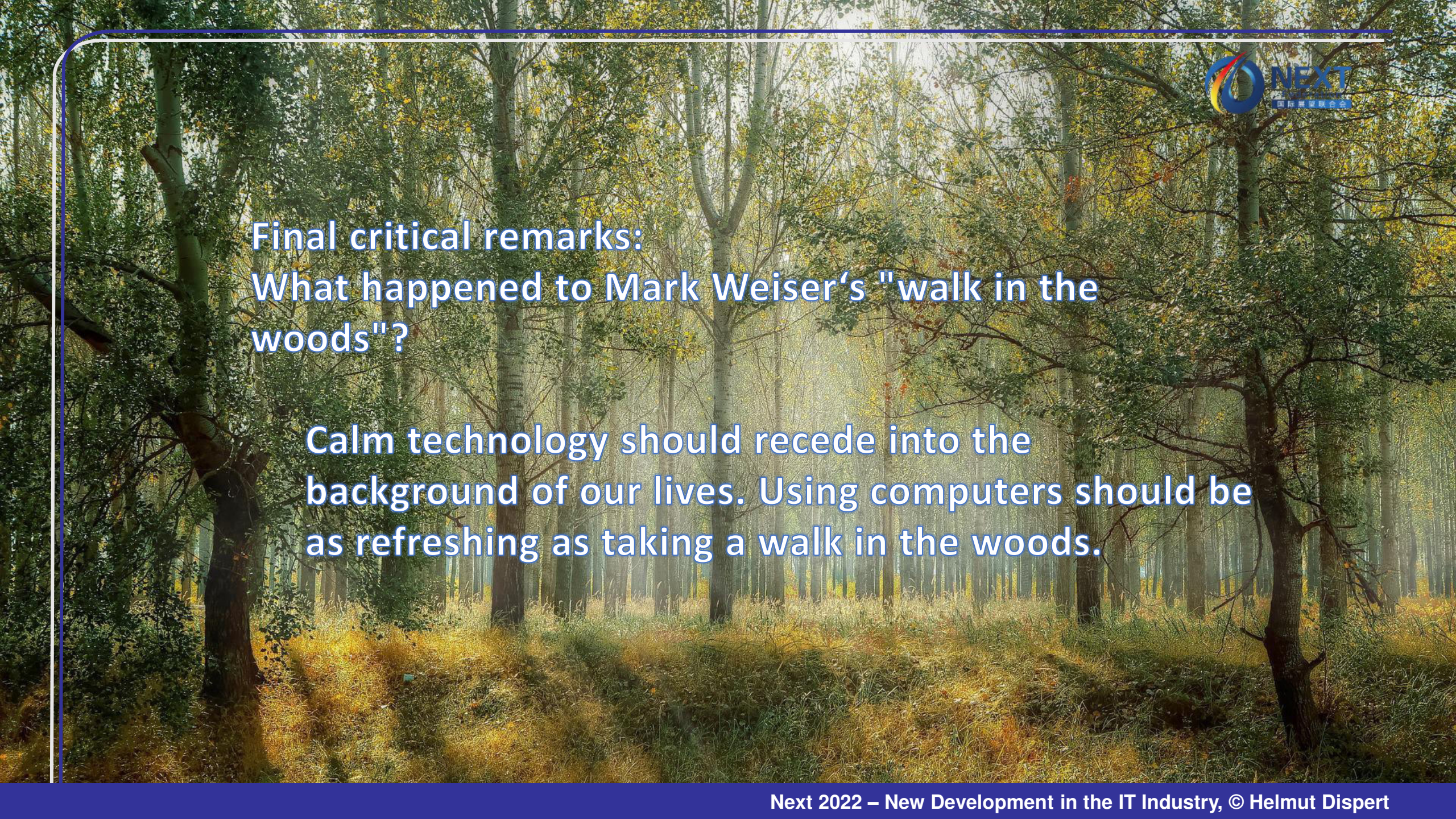
## IoT subgroups (examples)

| | |
|---|---|
| IoTS | Internet of Things Senses |
| TIoT/TIIoT | Tactile IoT/IIoT |

# Internet of Things Senses (IoTS) overview

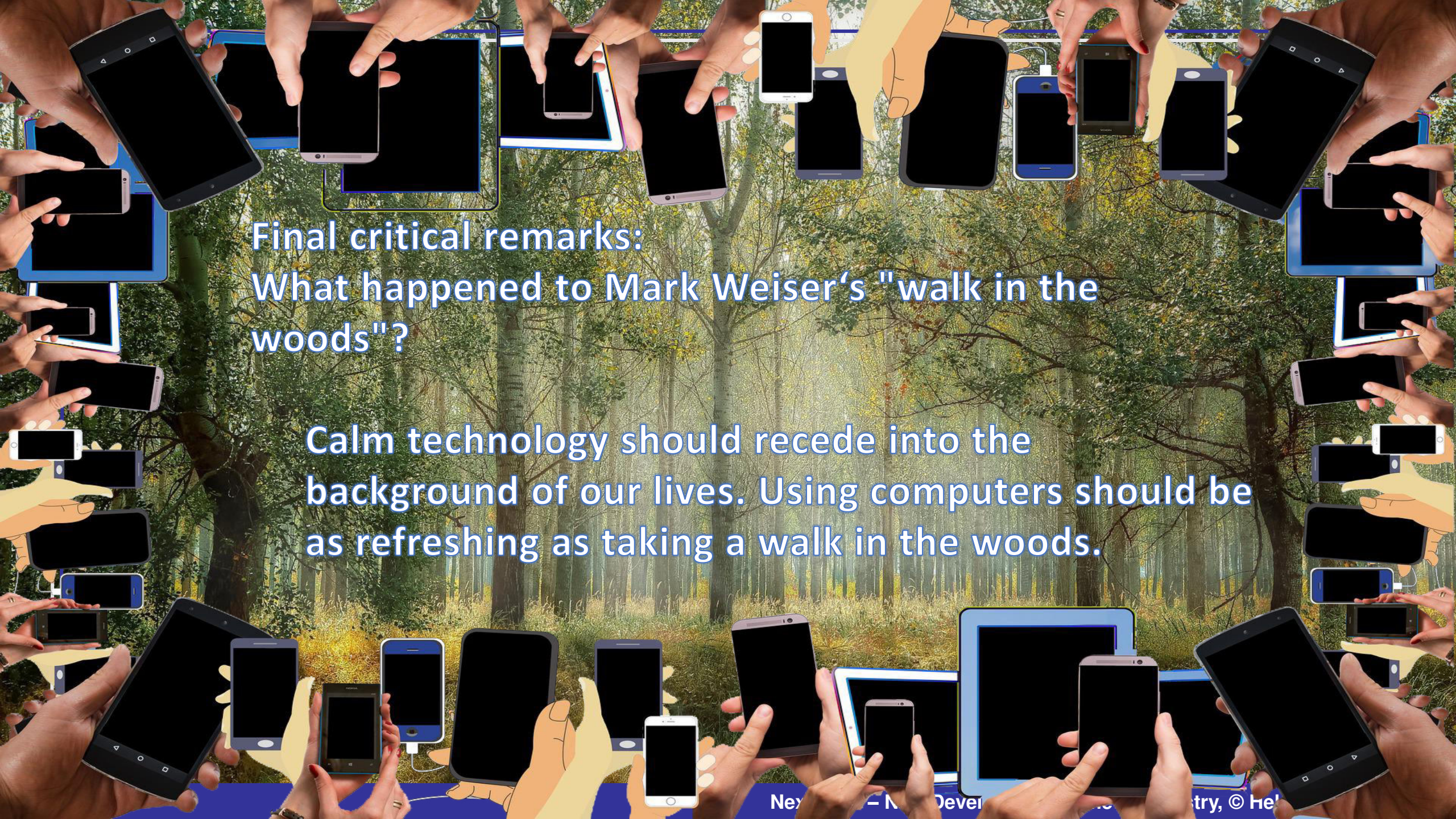



Ref.: Editors: Ovidiu Vermesan, Joël Bacquet, 2020
Internet of Things – The Call of the Edge, Everything Intelligent Everywhere
based on:
Ovidiu Vermesan et al. (incl. George Kornaros), New Waves of IoT Technologies Research – Transcending Intelligence and Senses at the Edge to Create Multi Experience Environments



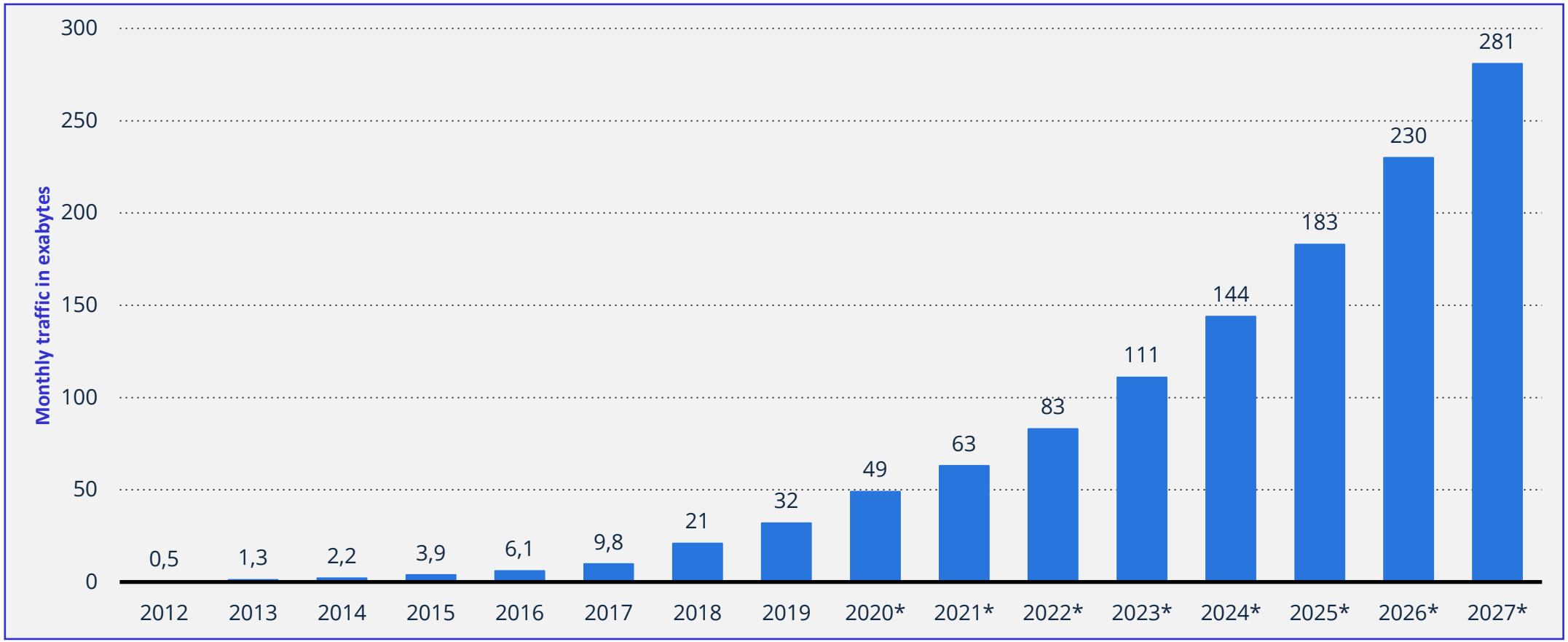
## Final critical remarks:
## What happened to Mark Weiser‘s "walk in the woods"?

Calm technology should recede into the background of our lives. Using computers should be as refreshing as taking a walk in the woods.


Final critical remarks:
What happened to Mark Weiser‘s "walk in the woods"?
Calm technology should recede into the background of our lives. Using computers should be as refreshing as taking a walk in the woods.

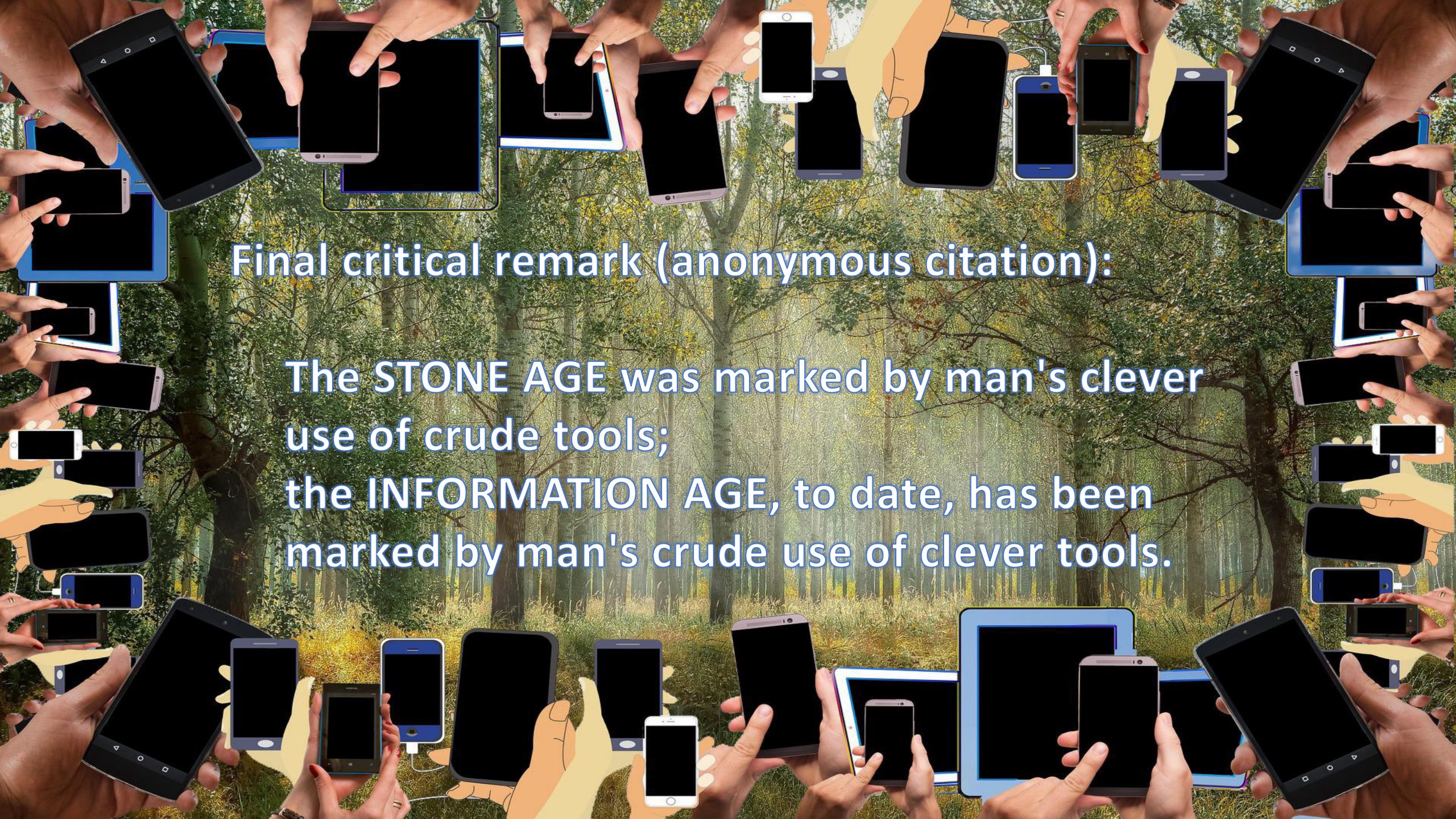
# Example of Calm Technology

## Average monthly smartphone traffic worldwide from 2015 to 2027 (in exabytes - $10^{18}$)




**Description:** The forecast illustrates the average monthly smartphone traffic worldwide from 2012 to 2027. By 2027, the average monthly data traffic from smartphone devices worldwide is projected to amount to 281 exabytes. Read more
**Note(s):** Worldwide; 2015 to 2021; * Forecast. Read more
**Source(s):** Ericsson

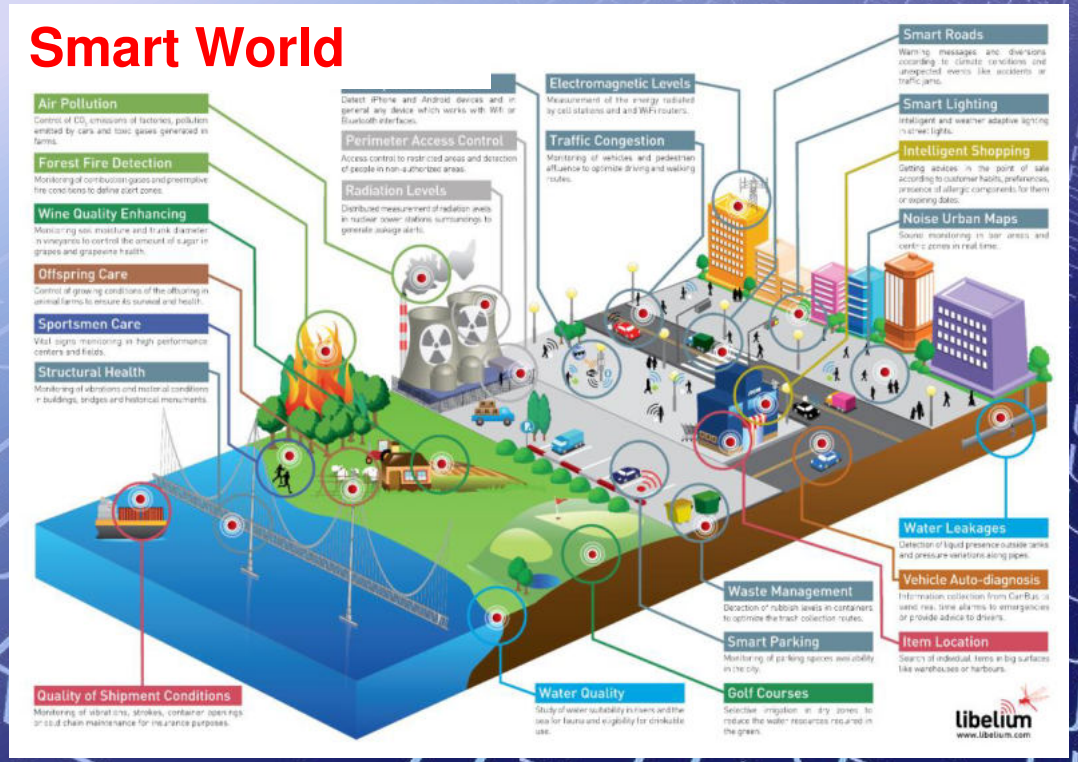
statista


Final critical remark (anonymous citation):
The STONE AGE was marked by man's clever use of crude tools;
the INFORMATION AGE, to date, has been marked by man's crude use of clever tools.

# What comes next?

## Convergence into Smart City (with 5G and/or 6G)?

## Not enough!




## Maybe Smart World.

## But that needs more than just intelligent technologies!

## The Future

And how would Mark Weiser judge the current development and see the future?

Obviously, the computer is not being used the way he envisioned and hoped for.

Will he accept the state-of-the-art or will he use the words that Ted Nelson used when he compared the Internet with his ambitious Xanadu Project: "I do not buy in! "?

Very likely:

Mark Weiser would approve and be surprised how far his idea of Ubiquitous Computing has advanced us.

→ Technology Assessment

# Let us go back to the beginning:

Back to Kiel

# Back to Kiel and Schleswig-Holstein


## Kiel Sailing City (Kiel Week, Olympic Games)

# Outlook and Collaboration

## Universities and Reseach Institutes (selected, limited to the city of Kiel):

- University of Kiel
- Kiel University of Applied Sciences
- GEOMAR Helmholtz-Centre for Ocean Research Kiel
- Leibniz Institute for Science and Mathematics Education – IPN
- Faculty of Engineering of the Kiel University (CAU)
- University Medical Center Schleswig-Holstein (UKSH)
- ZBW – Leibniz Information Centre for Economics
- Kiel Institute for the World Economy (IfW)
- Max Rubner Institute (Consumer health protection in the nutrition sector)
- Science Center - Wissenschaftszentrum Kiel

## Strong background Research, education and knowledge transfer

- Internet and Internet of Things, Data Science Research and Development, Embedded Systems, Renewable Energies, Wind Engineering, Naval/Maritime Engineering
- Technology Transfer Universities-Industry
- International Cooperations and Exchange Programs

# Outlook and Collaboration (State of Schleswig-Holstein)

## Important Business Sectors:

- **Digital economy**

  Comprises the areas of information technology (IT), telecommunications (TC), ICT hardware, ICT trade, e-commerce, media-related areas and media, with a clear focus on the areas of information technology with software development, media-related areas and e-commerce.

- **Renewable energies**

  Export country for clean green electricity. Around 2,981 wind turbines rotate here on land with a total output of 6,916 megawatts (MW).

- **Life sciences**

  Approximately 110,000 people in about 260 companies in the fields of medicine and medical technology

- **Maritime economy**

  The maritime economy includes research, development and production activities related to the sea. In terms of turnover and employment, shipbuilding and its suppliers form the core of the industry. With an annual turnover of around 8.5 billion Euros, this sector of the economy has a 12 percent share of Schleswig-Holstein's gross domestic product. 15 educational and research institutions are active in the maritime sector in the state and more than 2,100 companies employ around 40,000 people.

- **Mechanical Engineering**

  Companies in the mechanical have an above-average export share of around 64 percent. World market leaders:Sauer-Danfoss and Vossloh, Caterpillar and Jungheinrich benefit, among others.

- **Tourism/Hospitality industry**

  With 1,190 kilometres of coastline and countless beaches on two seas, around 300 lakes, 32,000 kilometres of rivers, Schleswig-Holstein is a true holiday paradise. Sports: sailing, surfing or rowing, riding or golfing, cycling or hiking. International cultural offers: Kiel Week, Wacken Open Air, Schleswig-Holstein Music Festival

Ref: https://wtsh.de/en/schleswig-holstein-strong-industries

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*“Promote Global Innovation, Cooperation and Sustainability”*

**Obviously there are plenty of opportunities in Germany, Schleswig-Holstein, and Kiel.**

**You are always welcome to visit us!**

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*"Promote Global Innovation, Cooperation and Sustainability"*

# Thank you very much for your attention!


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**Faculty of Computer Science and Electrical Engineering**
**Kiel, Germany**

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**Private:** http://dispert.international-university.eu/