IEEE Future Directions: An Overview

Kathy Grise, Senior Program Director
May 6, 2021
Bowie Seniors Computer Club

What is I-E-E-E?

Institute of Electrical and Electronics Engineers

▸ IEEE is the world's largest technical professional organization dedicated to advancing technology for the benefit of humanity.

▸ Roots go back to 1884 when electricity began to become a major influence in society. There was one major established electrical industry, the telegraph, which since the 1840s had come to connect the world with a data communications system faster than the speed of transportation. The telephone and electric power and light industries had just gotten underway.

IEEE's History – Part I

Foundation of the American Institute of Electrical Engineers (AIEE) in 1884

April, small group in the electrical professions met in New York and formed a new organization to support professionals in their field and to aid them in their efforts to apply innovation for the betterment of humanity

October, AIEE held its first technical meeting in Philadelphia

Early leaders

▸ Founding President Norvin Green of Western Union, came from telegraphy

▸ Thomas Edison, came from power

▸ Alexander Graham Bell represented the telephone industry

Key drivers

▸ Electric power spread rapidly, enhanced by innovations such as AC induction motors, long-distance AC transmission, and larger power plants

▸ AEG, General Electric, Siemens & Halske, and Westinghouse underwrote its commercialization

▸ AIEE became increasingly focused on electrical power and its ability to change people's lives

▸ Secondary focus on wired communication, both the telegraph and the telephone

IEEE's History – Part II

Foundation of the Institute of Radio Engineers (IRE) in 1912

A new industry arose, beginning with Guglielmo Marconi's wireless telegraphy experiments in 1895-1896

▸ "Wireless" telegraphy became radio with the electrical amplification possibilities inherent in the vacuum tubes that evolved from John Fleming's diode and Lee de Forest's triode

▸ IRE modeled on the AIEE but devoted to radio, and then broadly to electronics

IEEE's History – Part III

AIEE and IRE merged to become the Institute of Electrical and Electronic Engineers, or IEEE

January 1, 1963

Just a Few of our Nobel Laureates
- Guglielmo Marconi 1909
- William Shockley 1956
- Charles Townes 1964
- Jack Kilby 2000
- Willard Boyle 2009
- Isamu Akasaki 2014
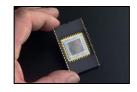- Hiroshi Amano 2014
- Shuji Nakamura 2014

Wireless Telegraphy

Transistor

MASER

Integrated Circuit

Charge Coupled Device

Blue LED

IEEE Today

21st Century by the numbers

▸ Computers evolved from massive mainframes to desktop appliances to portable devices, linked to global networks connected by copper wire, microwaves, satellites, or fiber optics. IEEE's fields of interest expanded well beyond electrical and electronics engineering and computing into areas such as micro- and nanotechnologies, ultrasonics, bioengineering, robotics, electronic materials, and many others

▸ Electronics became ubiquitous, integrated in everything from jet cockpits to industrial robots to medical imaging.

▸ 39 Societies and 7 Councils

▸ 130 journals, transactions, and magazines

▸ 1,000 conferences annually

▸ 1,300 active standards

▸ Global organization leveraging innovations of practitioners, academics, scientists, engineers, physicists, ethicists, lawyers, and more
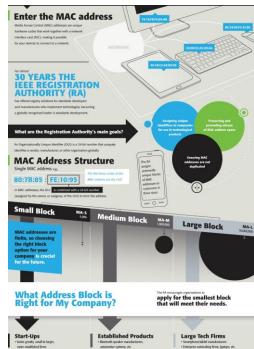
IEEE Portfolio

Focus Areas

- ▸ Communities
- ▸ Conferences
- ▸ Education
- ▸ Membership
- ▸ New Initiatives
- ▸ Publications
- ▸ Standards

Standards

Most widely known: 802

▸ The founders of the IEEE Local Area Network Standards Committee began discussing standardization opportunities in 1979, submitting a project proposal "Local network for Computer Interconnection" through the IEEE Computer Society to the IEEE in August 1979

▸ Formally approved 13 March 1980

▸ Today 802 Committee develops and maintains networking standards and recommended practices for local metropolitan, and other area networks using an open, consensus-driven standards development process, and advocates them on a global basis

▸ 802 family
  - 71 published standards with 54 under development
  - Most widely used IEEE 802 standards: Ethernet, Bridging and Virtual Bridged LANs Wireless LAN, Wireless PAN, Wireless MAN, Wireless Coexistence, Media Independent Handover Services, and Wireless RAN

▸ Coordinates with other national and international standards bodies, including ISO

▸ IEEE 802.11 Wireless Networking

IEEE Portfolio

Focus Areas

- ▸ Communities
- ▸ Conferences
- ▸ Education
- ▸ Membership
- ▸ New Initiatives
- ▸ Publications
- ▸ Standards

IEEE

What is the IEEE Future Directions

- Anticipates the direction of new and emerging technologies and world challenges that IEEE can impact

- Coordinates resources across an unmatched array of IEEE technical expertise globally

- Scouts out and nurtures ways IEEE as a whole can provide an impact through its broad and deep volunteer base

- Bridges across IEEE Operating Units (OUs) to ride fast-rising waves of innovation

- Provides a valuable collaborative view and fosters engagement, enabling IEEE OUs to develop new offerings

Goals

- Actively engage Future Directions Committee to ensure success of its initiatives from incubation to transition

- Promote and enable incubator projects

IEEE Future Directions Coverage for 2021

Graduated Initiatives

Plus Public Safety

Plus AI/ML

Digital Privacy

Small Project: Low-Earth-Orbit (LEO) Satellites & Systems

Small Project: Smart Lighting

Small Project: Telepresence

IEEE Roadmaps Committee (IRC)

TechNav AI
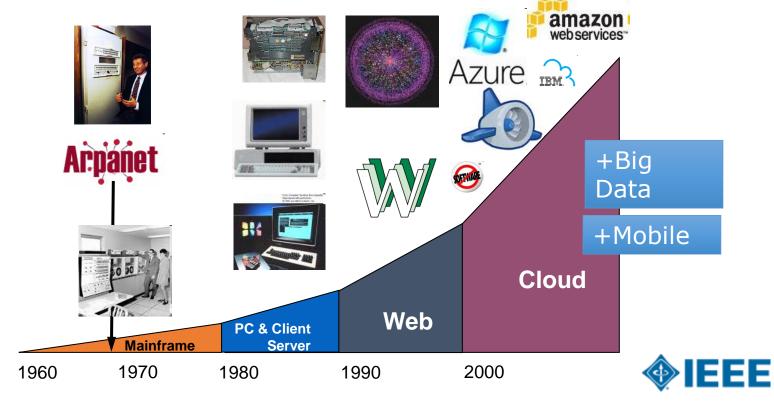
Technological Evolution

Computing Waves

2000-2020 Cloud Computing

+Big Data

+Mobile

Cloud

Web

PC & Client Server

Mainframe

1960　　1970　　1980　　1990　　2000

Bowie Seniors Computer Club　　　IEEE Future Directions　　　May 6, 2021

Big Data Directions

1 — Traditional Services TP, DW, Analytic Reports

2 — Info in Flight
Real Time Stream Mining
Mining Unstructured Data
Mobility , Analysis @Scale,
BD in Cloud

3 — Next-Generation Value from Data

Data Stream Mining

Speech/Text Mining

Anywhere, AnyDevice

Networked & Programmable World

Pervasive Monitoring/Control

COSM Xively

Internet of Things

OPEN DATA

Immersive, Augmented Reality Interfaces
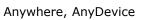
Diversification of Applications & Users

Next Gen Analytics, Prediction

Multiple RT Streams / Integration

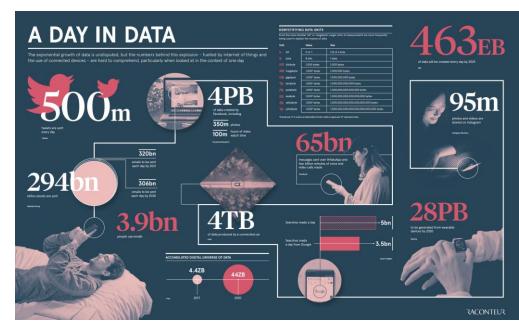# 90% of the Data in the World was Generated in the last two years, accelerated by IoT

Every Day:

➢ 500 million tweets are sent

➢ 294 billion emails are sent

➢ 4 petabytes of data are created on Facebook

➢ 4 terabytes of data are created from each connected car

➢ 65 billion messages are sent on WhatsApp

➢ 5 billion searches are made

By 2025, it's estimated that 463 exabytes of data will be created each day globally – that's the equivalent of 212,765,957 DVDs per day!

COVID-19

Sources:
https://www.forbes.com/sites/bernardmarr/2018/05/21/how-much-data-do-we-create-every-day-the-mind-blowing-stats-everyone-should-read/#699c81a860ba
https://www.visualcapitalist.com/how-much-data-is-generated-each-day

We are drowning in data

+

Complexity

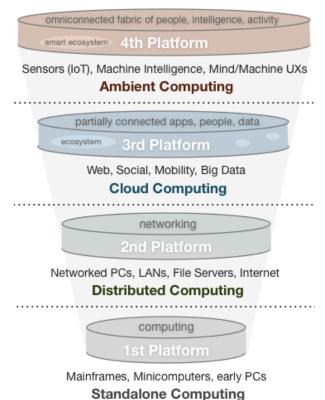→ **Opportunities to leverage new and "old" technologies**

IEEE

The Top 10 Strategic Technology Trends for 2020

People-Centric	Smart Spaces
Hyperautomation	Empowered Edge
Multiexperience	Distributed Cloud
Democratization	Autonomous Things
Human Augmentation	Practical Blockchain
Transparency and Traceability	AI Security

Gartner

2021 Theme: Towards Massively Distributed Intelligence

omniconnected fabric of people, intelligence, activity

smart ecosystem **4th Platform**

Sensors (IoT), Machine Intelligence, Mind/Machine UXs
Ambient Computing

partially connected apps, people, data

ecosystem **3rd Platform**

Web, Social, Mobility, Big Data
Cloud Computing

networking

2nd Platform

Networked PCs, LANs, File Servers, Internet
Distributed Computing

computing

1st Platform

Mainframes, Minicomputers, early PCs
Standalone Computing

An Introduction to Digital Reality

How does Digital Reality help?

IEEE

IEEE's Digital Reality Initiative

Part of IEEE Future Directions

In early 2019, the IEEE Digital Reality Initiative was officially launched in support of the Digital Transformation.

Digital Transformation is fueled by advances in technology, such as sensors and actuators, artificial intelligence (AI), and machine learning (ML).
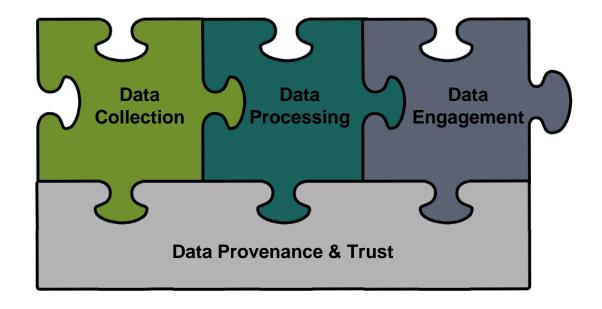
By leveraging these technologies and others being developed, such as augmented reality (AR), virtual reality (VR), and Digital Twins, the line between the physical world and the digital world will be increasingly less distinct.
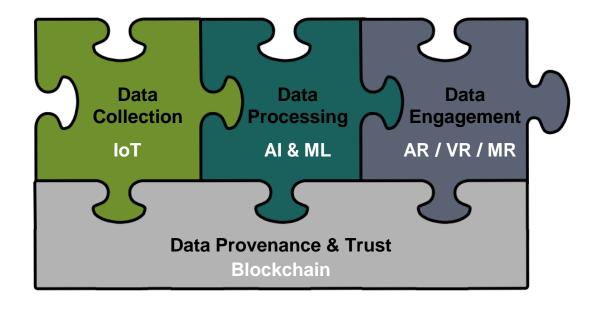
The Digital Reality Jigsaw

The Digital Reality Jigsaw diagram showing four interlocking puzzle pieces: Data Collection, Data Processing, Data Engagement, and Data Provenance & Trust.

Bowie Seniors Computer Club   IEEE Future Directions   May 6, 2021

The Digital Reality Jigsaw

The Components of Digital Reality

A deeper dive into the primary components

IEEE

IoT   + AI / ML   + AR / VR / MR

Internet of Things

Basic Properties

▸ Some type of sensor, actuator, or both

▸ Network connection

Likely considerations:

▸ Use cases

▸ Functionality

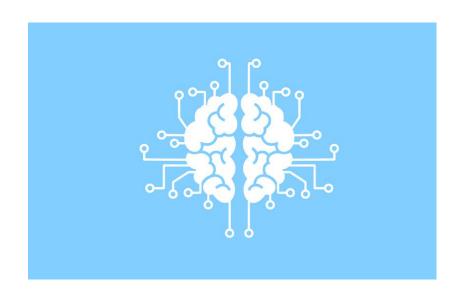▸ Size & shape

Artificial Intelligence & Machine Learning

Basic Properties

- ▸ Large data set
- ▸ Good reference data

Likely considerations:

- ▸ Use cases & goals
- ▸ Functionality
- ▸ Cost

Augmented, Virtual & Mixed Reality

Basic Properties

▸ Viewing platform/device

▸ Type of usage
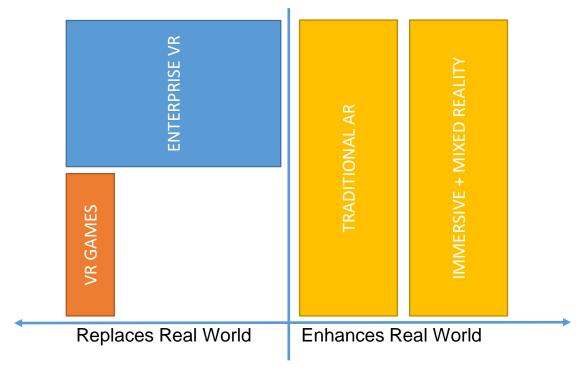
▸ Controls and input devices

Likely considerations:

▸ Use cases & goals

▸ Functionality

▸ Cost

Augmented, Virtual & Mixed Reality

ENTERPRISE VR

VR GAMES

TRADITIONAL AR

IMMERSIVE + MIXED REALITY

Replaces Real World | Enhances Real World

Bowie Seniors Computer Club   IEEE Future Directions   May 6, 2021

Examples of Digital Reality

Real world implementations of Digital Reality

Singapore's Digital Twin

Full digital model of Singapore that incorporates real time information about demographics, climate, traffic, energy use

Also used to monitor Greenprint sustainable energy project

https://www.nrf.gov.sg/programmes/virtual-singapore

IEEE

Microsoft Mixed Reality Avatar with Language Translation

Microsoft combined volumetric scanning, MR, and AI-based text-to-speech language translation and voice synthesis to create a unique, multi-lingual avatar

https://www.youtube.com/watch?v=auJJrHgG9Mc

IEEE

Conclusions

What's next...

IEEE

Takeaways

➢ Data is complex and has high intrinsic and monetary value driving next level analysis and applications

➢ Secure and robust tools, software and hardware, infrastructures must be readily available or quickly developed

➢ "Old" technology is the "new" and emerging technologies

➢ Every technology is intermeshed and dependent upon each other

➢ Physical vs Digital worlds become blurred

Driving "Immersive" Digital Reality with Data, Cloud, Edge, Fog, IoT…

IEEE

ieee.org/futuredirections

Kathy Grise
k.l.grise@ieee.org

@klgrise
kathygrise