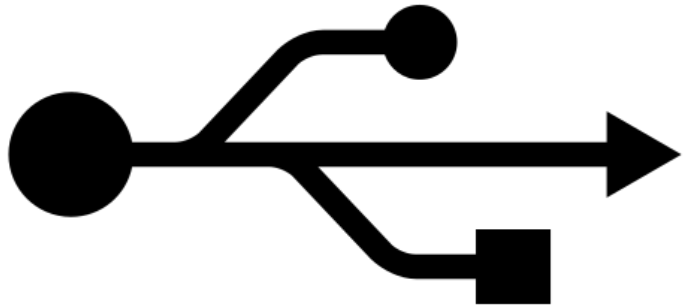


IEEE Milestone Dedication

Universal Serial Bus (USB)

IEEE

30 July 2025

Welcome from Intel

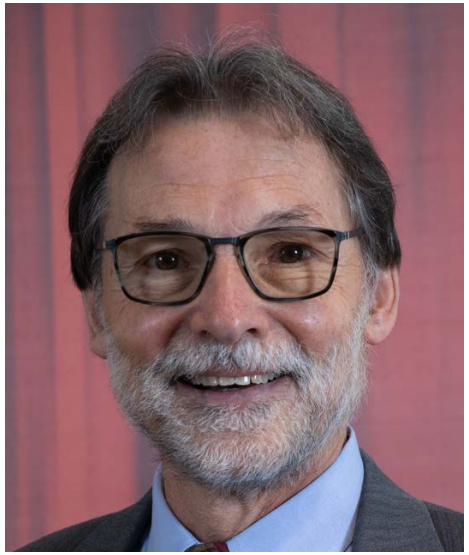
Dr. Richard "Rich" A. Uhlig

Intel Senior Fellow & Corporate Vice President

Director, Intel Labs

IEEE Milestone Dedication: **Universal Serial Bus (USB)**

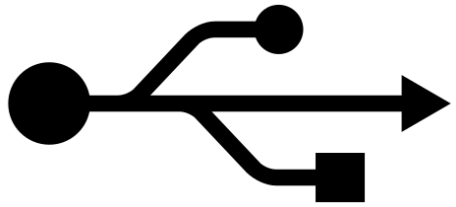
Introductory Remarks



Brian Berg
Berg Software Design
IEEE Region 6 History and Milestones Chair

IEEE Milestone Dedication: **Universal Serial Bus (USB)**

Overview of Our Program



USB is the most successful I/O interface in the history of computing

It is estimated that in excess of 6 billion devices in use in the world today use USB

We're going to hear about how this happened

IEEE Milestone Dedication: **Universal Serial Bus (USB)**

Welcome from the IEEE Oregon Section

IEEE Oregon Section
serving Oregon & SW Washington

David Silver
IEEE Oregon Section Chair

IEEE Milestone Dedication: **Universal Serial Bus (USB)**

Overview of IEEE

Alon Newton
IEEE Region 6
Northwest Area Chair

IEEE Milestone Dedication: **Universal Serial Bus (USB)**

An Overview of IEEE

Alon Newton

IEEE Region 6 Northwest Area Chair

30 July 2025 – Intel's Jones Farm Campus

IEEE
Advancing Technology for Humanity

- IEEE is the world's largest technical professional organization dedicated to advancing technology for the benefit of humanity.
- Congratulations to Intel and the USB-IF team for their amazing achievement as honored by this IEEE Milestone!

The Fuel of IEEE: Mission & Vision

IEEE is where forward-thinking technology professionals come together—in the spirit of collaboration—to discover the next technological innovation, develop international standards, and form communities to share research, education, and humanitarian goals.

- **Our Mission**
  To foster technological innovation and excellence for the benefit of humanity.
- **Our Vision**
  IEEE will be essential to the global technical community and to technical professionals everywhere; and be universally recognized for the contributions of technology and of technical professionals in improving global conditions.

IEEE

The Founding of IEEE

1884 ..... 1912 ..... 1963 ..... TODAY

AIEE
American Institute
of Electrical Engineers

IRE
Institute of Radio
Engineers

IEEE

Advancing Technology for Humanity

IEEE embodies the visions of its founders—applying them to the challenges of today and tomorrow.

 Learn more: ieee.org/about/ieee-history.html

IEEE at a Glance

Global Reach

486,000+
Members
67% of whom are from outside the US

39
Technical Societies
and eight Technical Councils

190
Countries
across **10** geographic Regions

Technical Breadth

2,000+
Annual Conferences

in 109 countries while contributing over 4.5 million total conference papers to IEEE *Xplore*® since 1936

6,000,000+
Technical Documents

via IEEE *Xplore*® Digital Library, with more than **24 million** downloads each month

200+
Top-cited Periodicals

IEEE journals, conference proceedings, and select content dating back to 1884

1,079
Active Standards

and **1,093** more in development

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Technical Expertise that is Broad and Deep

IEEE provides thought leadership and resources for the global tech community

- Aerospace & Defense
- Biomedical Engineering
- Broadcasting
- Circuits
- Communications
- Computer Science
- Control and Automation
- Cyber Security
- Electronics
- Environment
- Industrial systems
- Information Technology
- Internet of Things
- Life Sciences
- Nanotechnology
- Optics
- Power and Energy
- Robotics and AI
- Semiconductors
- Smart Cities
- Smart Grid
- Sustainable Energy
- Transportation and Vehicles
- And more…

Top Organizations Innovate with IEEE

Whenever technology happens, IEEE is there

9 of Top 10
IT Software and Services Companies

8 of Top 10
Telecommunication Companies Worldwide

8 of Top 10
Technology Hardware & Equipment Companies Worldwide

24 of Top 30
Semiconductor Companies Worldwide

Top 10
Aerospace and Defense Companies Worldwide

3 of Top 5
Consumer Durables (Automotive & Electronics) Companies Worldwide

98 of Top 100
Engineering and Technology Universities Worldwide

Top 100
Engineering Universities in the United States

IEEE

The World Benefits from IEEE Information

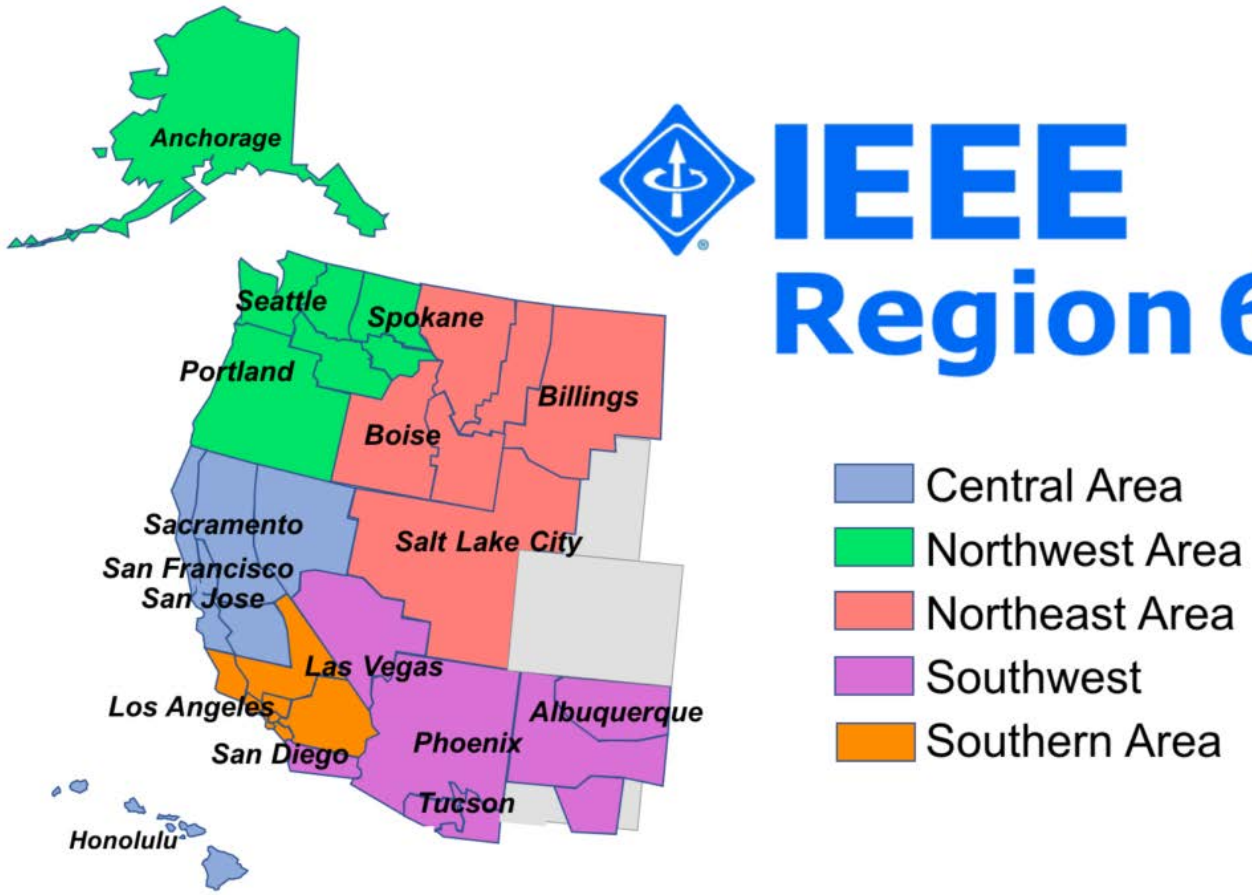
Technology leaders rely on IEEE publications and tutorials

EIGHT NEW IN 2023 and 2024		**IEEE Journals, Transactions, and Magazines**—Top-cited in the fields of electrical engineering and computing, more than 200 publications.
4.5 MILLION CONFERENCE PAPERS		**IEEE Conference Proceedings**—Cutting-edge papers presented at IEEE conferences globally.
SMART GRID, NESC®, 802		**IEEE Standards**—Quality product and technology standards used by worldwide industries and companies to ensure safety, drive technology, and develop markets.
MORE COURSES, NEW SERIES		**IEEE Educational Courses**—Hundreds of course hours in core and emerging technologies.
7,000 EBOOKS		**eBooks Collections**—Nine eBooks collections now available, more than 7,000 eBooks covering technology, engineering, computing, and more.

IEEE

IEEE Regions

Region 6 Areas



Basic Region 6 Info:

- >40,000 members (Jan 2025)
- 35 Sections (major groups)
- 88% Professional, 12% Student members
- Region 6 website https://ieee-region6.org/

IEEE Oregon Section
serving Oregon & SW Washington

https://ieee-oregon.org/live/

IEEE

IEEE Corporate Awards Programs

Accomplishments in IEEE's fields of interest are recognized with annual presentations for extraordinary contributions to technology, society, and the engineering profession

Each award has a unique mission and criteria—and offers the opportunity to honor distinguished colleagues.

IEEE Medals, Recognitions, and Technical Field Awards are sponsored by donors, corporate partners, and IEEE Societies & Organizational Units.

Learn more: corporate-awards.ieee.org

IEEE Medals

IEEE Medals are the highest awards presented within IEEE. The highest honor is the IEEE Medal of Honor, which recognizes an individual for an exceptional contribution or extraordinary career in the IEEE fields of interest

IEEE Medals embrace significant and broad IEEE interests and purposes. They are presented to individuals or teams for outstanding technological innovations and career achievements that have advanced technology for the benefit of humanity.

Past recipients of the IEEE Medal of Honor, have included such visionaries as:

Guglielmo Marconi

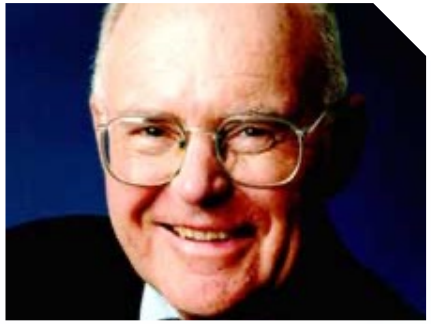
(1920, for radio telegraphy)

William Shockley

(1980, for junction, analog, and junction field-effect transistors)

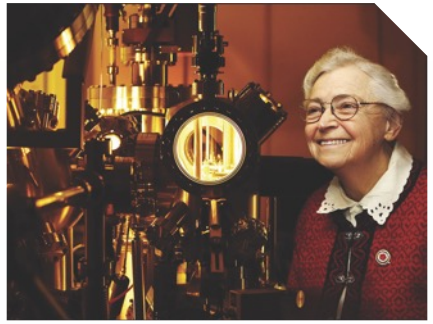
Andrew S. Grove

(2000, for pioneering research in metal oxide semiconductor devices and technology)



Gordon E. Moore

(2008, for pioneering technical roles in integrated-circuit processing, and leadership in the development of MOS memory, the microprocessor computer, and the semiconductor industry)



Mildred Dresselhaus

(2015, for leadership and contributions across many fields of science and engineering)

IEEE – Your Professional Home

Inspiration, passion, creativity, collaboration.

Whether you are starting out or at the very height of your career, these are the stepping stones of your professional path.

No matter where you are in your journey, IEEE can help you find your path. This is why IEEE is your professional home.

- Students/Young Professionals: Launching careers
- Industry: Advancing your career, advancing technology
- Academic: Supporting research and teaching
- Public Service: Humanitarian Activities

Advancing Technology for Humanity

https://www.ieee.org/your-professional-home

IEEE

Learn more:
ieee.org

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Advancing Technology for Humanity

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IEEE's Milestone Program

Brian Berg

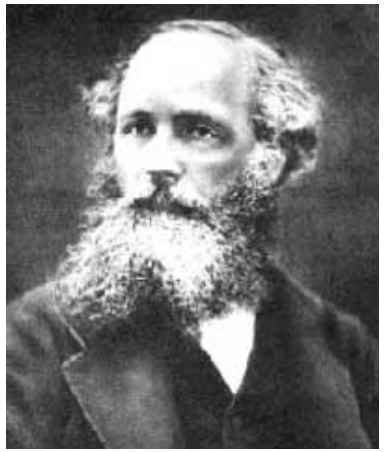
IEEE
Advancing Technology for Humanity

The IEEE Milestone Program

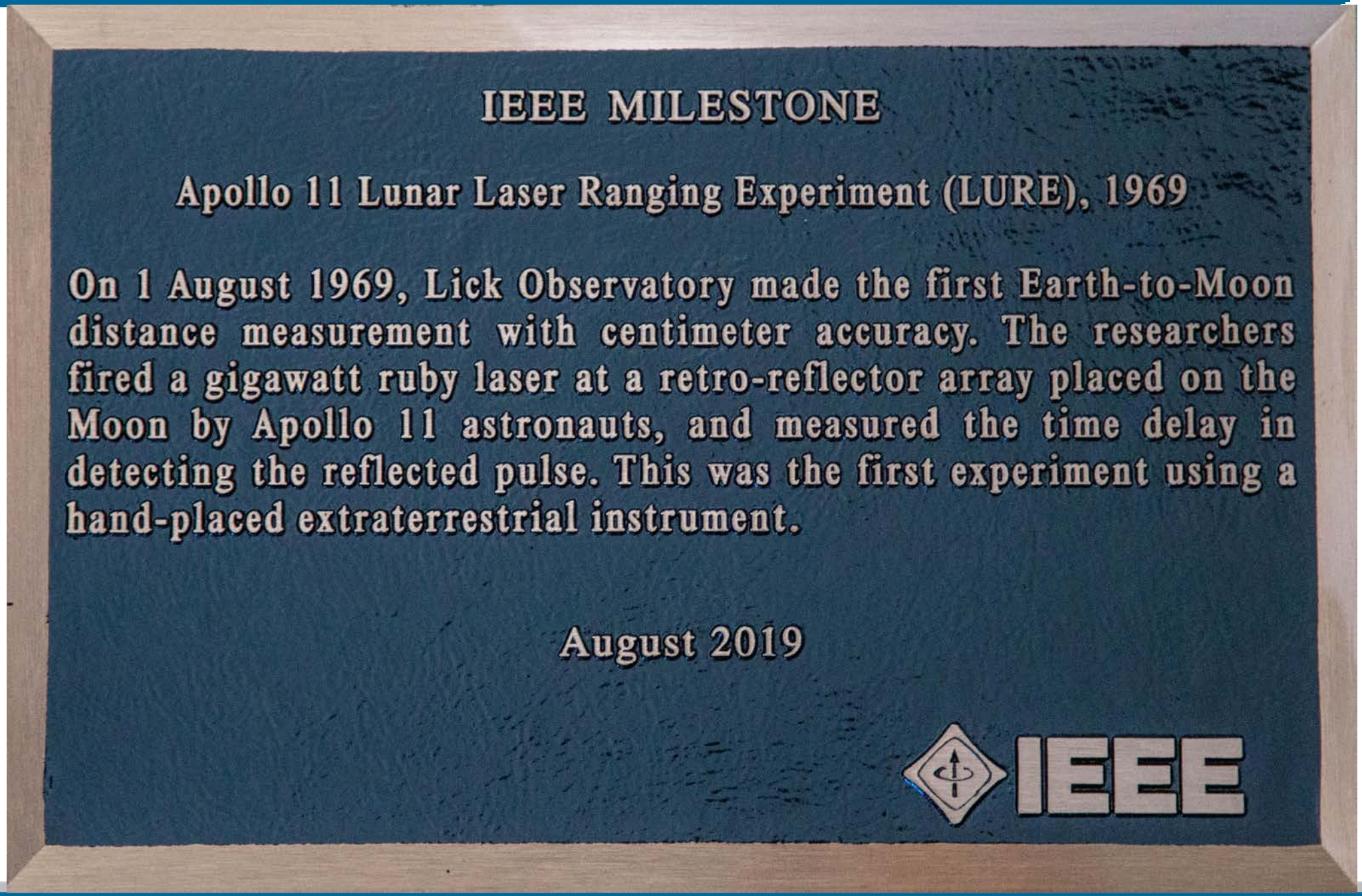
- Milestones honor an achievement, not a person or place
- Achievement must be at least 25 years old
- Milestones are IEEE's Most public visibility
- Here are 2 Milestone plaques at the entry to Pixar's campus near San Francisco

- **Pixar is particularly proud of this recognition by IEEE since it is "an echelon above" their 23 Academy Awards**

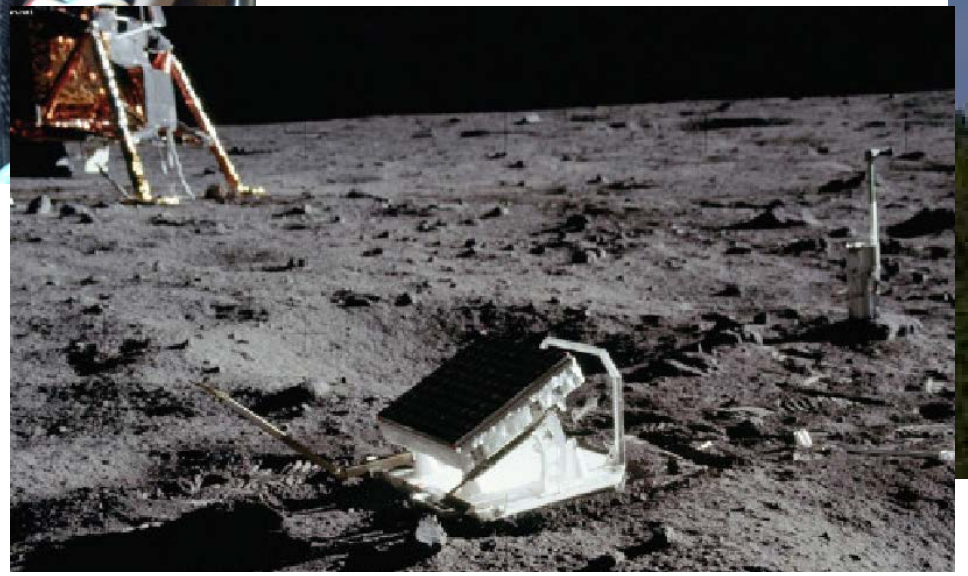
IEEE Milestones Around the World



- 275 Milestones dedicated since 1984, incl.:
  - Maxwell's Equations, 1860-1871
  - Stereo Sound Recording, 1931 (EMI Studios, later renamed Abbey Road Studios)
  - Bletchley Park Code Breaking, 1939-1945
  - CD Audio Player (The Netherlands), 1979
  - Bullet Train (Japan), 1964
  - Project Echo, Telstar, and Discovery of Cosmic Background Radiation, 1959-1965
  - Toyota Prius, the World's First Mass-Produced Hybrid Vehicle, 1997


IEEE MILESTONE
Apollo 11 Lunar Laser Ranging Experiment (LURE), 1969
On 1 August 1969, Lick Observatory made the first Earth-to-Moon distance measurement with centimeter accuracy. The researchers fired a gigawatt ruby laser at a retro-reflector array placed on the Moon by Apollo 11 astronauts, and measured the time delay in detecting the reflected pulse. This was the first experiment using a hand-placed extraterrestrial instrument.
August 2019
IEEE

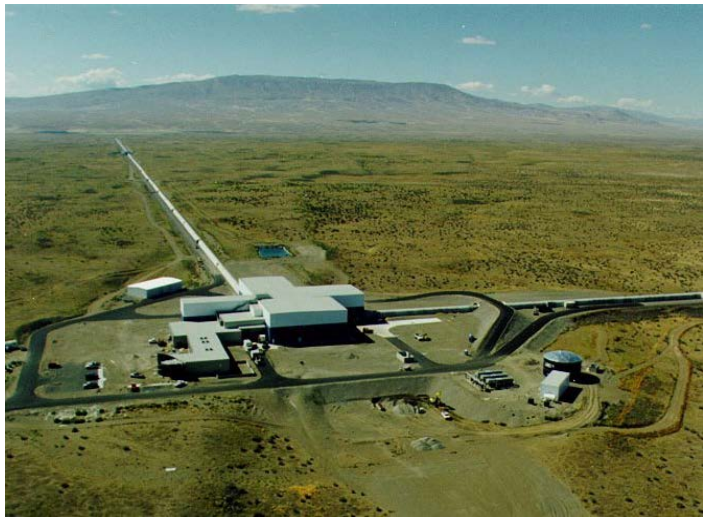
Milestone: Lunar Laser Ranging Experiment (LURE), 1969 (using the retroreflector left by Apollo 11 astronauts)



- LURE was successful at Lick Observatory (overlooking San Jose, California)
- LURE used a weapons-grade 1.2 Gigawatt laser
- You may have seen this on a *Big Bang Theory* episode

Dedicated at Lick Observatory on 1 Aug. 2019
(the 50th anniversary of first successful measurement to the moon)

3 Milestones: Gravitational-Wave Antenna, 1972-1989



LIGO: Hanford, Washington
with 4km long arms

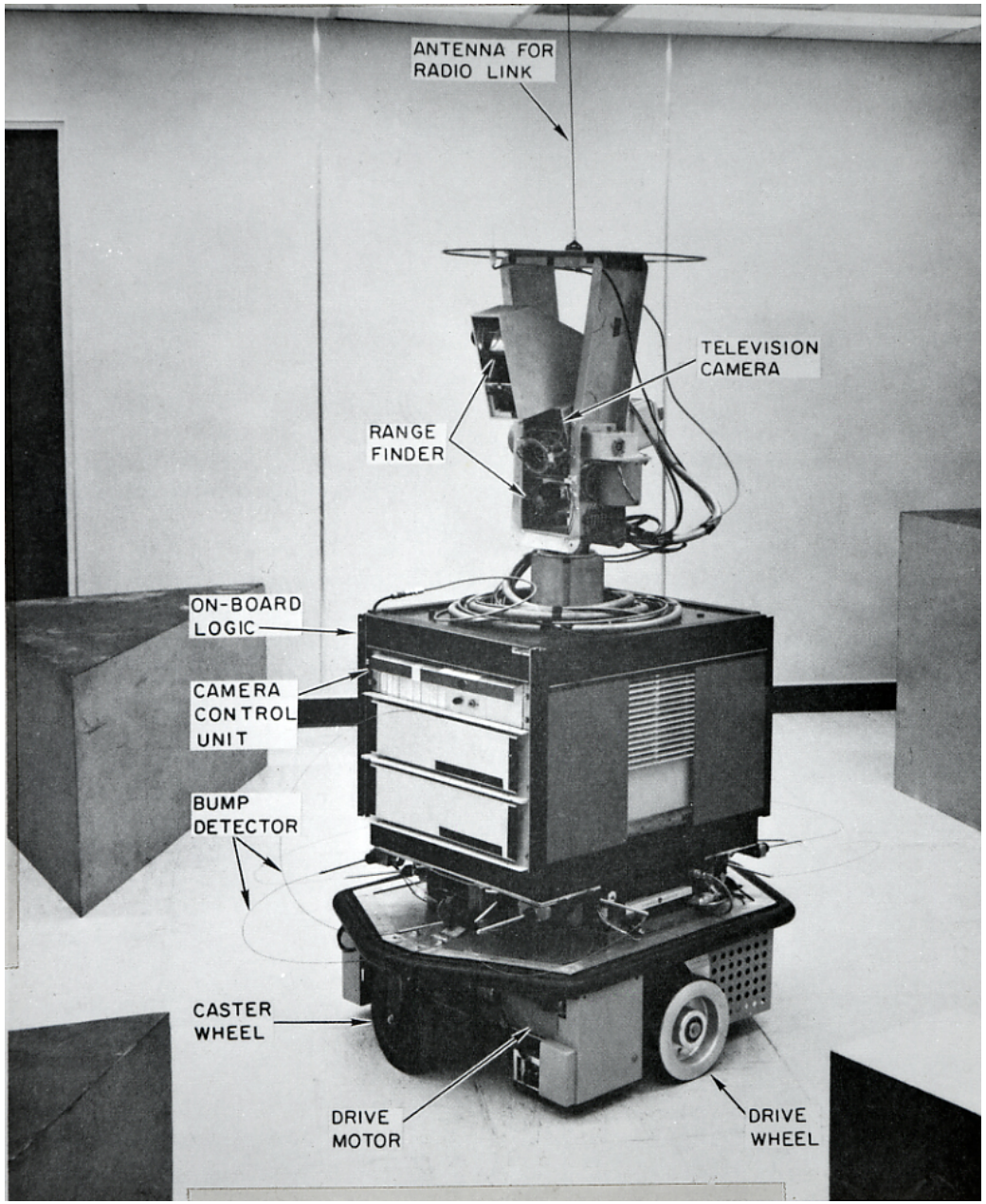
LIGO: Livingston, Louisiana
with 4km long arms

Virgo Observatory: near Pisa, Italy
with 3km long arms

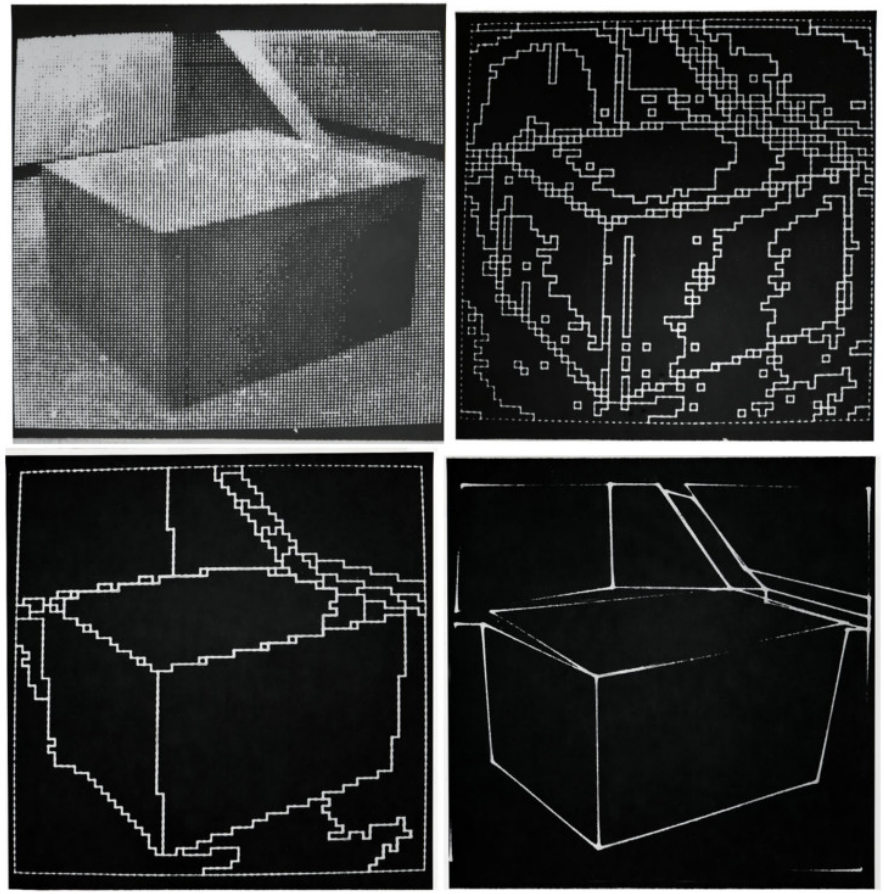
- Einstein's 1916 General Theory of Relativity:
  - He predicted the existence of cosmic ripples that traveled at the speed of light
  - These "gravitational waves" (GWs) carried information about their origin, and clues about the nature of gravity
- In 2015, GWs were detected at 2 LIGOs, as predicted by Einstein

Milestone: Deep Space Station 43, 1972-1987 (Australia)

- First operational in 1972
- 70-meter steerable parabolic radio wave antenna
- Critical in NASA's Deep Space Network
- Supported the Apollo 17, Viking Mars landers, Pioneer and Mariner planetary probes, and Voyager's encounters with Jupiter, Saturn, Uranus, and Neptune.
- Only means to communicate with Voyager 1 and 2
- Milestone dedicated in March 2024



Milestone - SHAKEY: The World's First Mobile, Intelligent Robot, 1966-1972



Developed at SRI, Menlo Park, CA

Funded by ARPA

Milestone: AMPEX Videotape Recorder, 1956

1946: Bing Crosby was the first investor in Ampex's audio tape recording system.

Crosby pre-recorded his radio shows and mastered his audio recordings

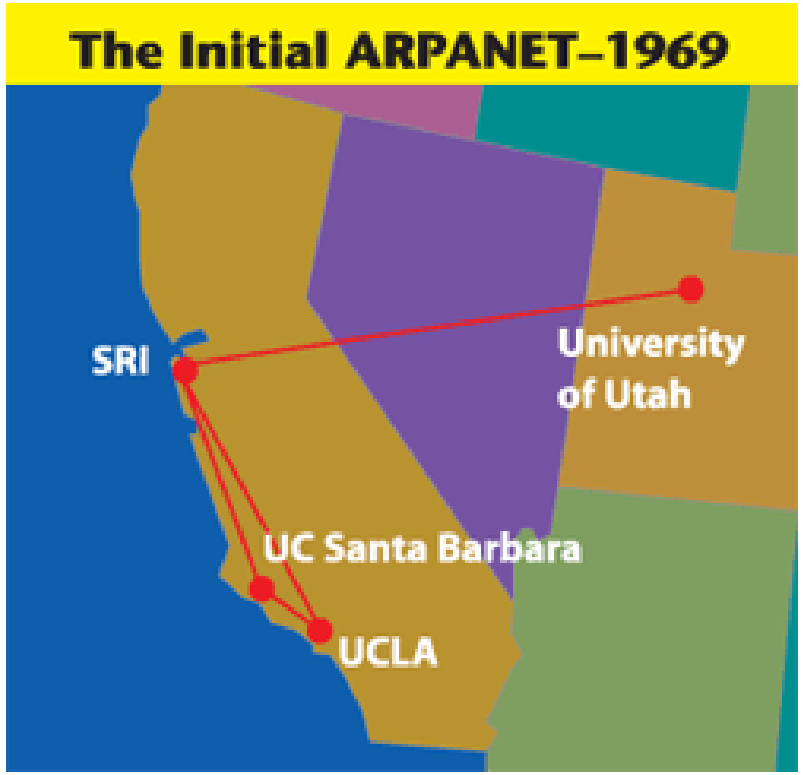
VR1000 1956

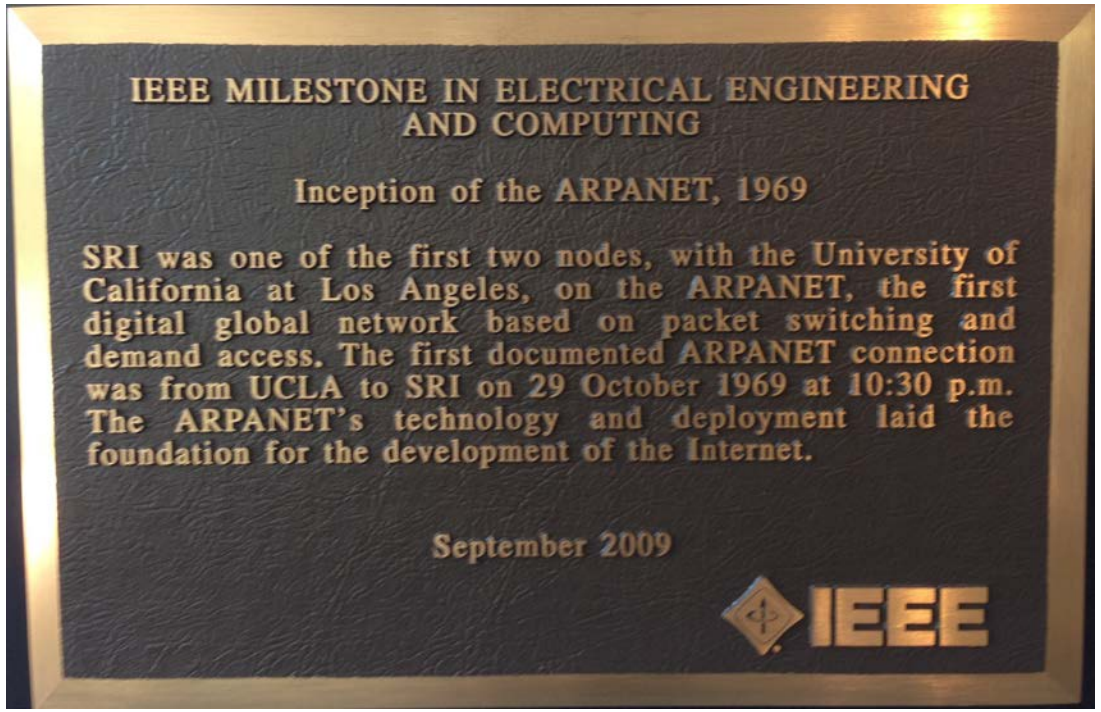
1957: Project Team with early version of the video recorder, and its Emmy Award (Ray Dolby is 2nd from left)

Ampex was in Redwood City, CA

Milestone plaque is on the Stanford Univ. campus

Milestone: First ARPANET Transmission, 1969 (from UCLA to Stanford Research Institute)





3 plaques in SRI's Visitors Lobby (including SHAKEY)

Dedicated in 2009 for ARPANET's 40th anniversary, in conjunction with IEEE's 125th anniversary

Milestone: University of Hawaii's 88-inch Mauna Kea Telescope, 1970

- 1970: World's highest telescope
  - 13,796' elevation
- **First computer-controlled telescope**
- Best place on earth for a telescope:
  - Above 40% of Earth's atmosphere
  - Above 90% of its water vapor
- Now one of 13 telescopes at site
- World's highest Milestone plaque
- Dedicated last month
- Mauna Kea is a dormant volcano

Milestone “Wall of Fame” at Computer History Museum in Mountain View, CA

27 bronze plaques on the exterior wall

Largest collection of IEEE plaques in the world

CHM Computer History Museum

Milestone “Wall of Fame” at Computer History Museum in Mountain View, CA

The left plaque in this photo is the USB duplicate plaque that was just installed on that wall

CHM Computer History Museum

FMS the Future of Memory and Storage

2025 Recipient: Jim Pappas (on August 5)

LIFETIME ACHIEVEMENT AWARD

intel

Jim Pappas led several initiatives that established key industry standards and organizations to the benefit of memory and storage, as well as all of computing.

PCI SIG

PCI EXPRESS

FireWire

AGP ACCELERATED GRAPHICS PORT

CXL Compute Express Link

UALink

INFINIBAND TRADE ASSOCIATION

USB

SNIA

UCIe Universal Chiplet Interconnect Express

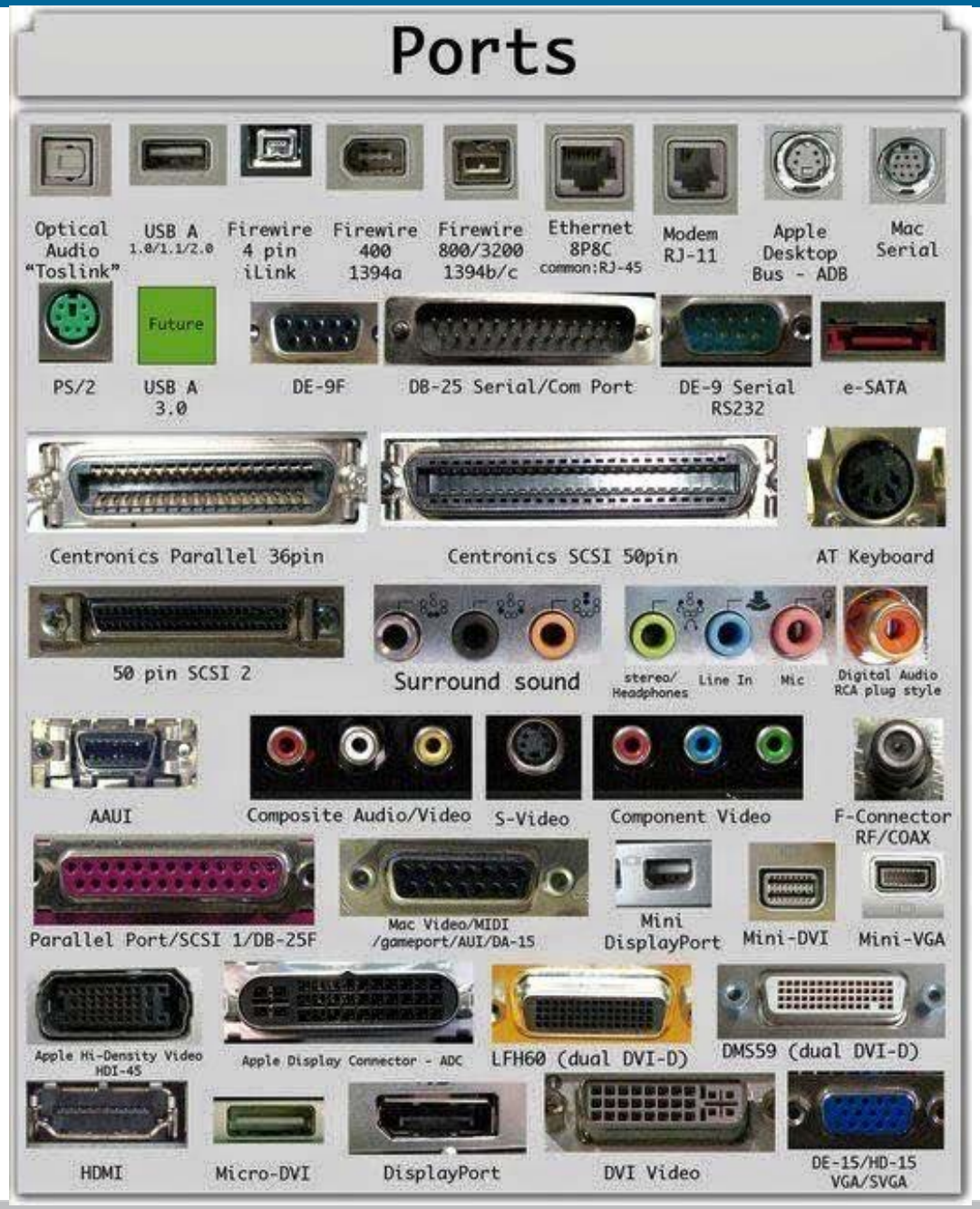
USB: How It Started

Jim Pappas

Director of Technology Initiatives,
Intel (retired)

IEEE Milestone Dedication: **Universal Serial Bus (USB)**

Problem Statement



PC Magazine was Running Stories Like This

USB Leadership Team!

Formation - USB Working Group

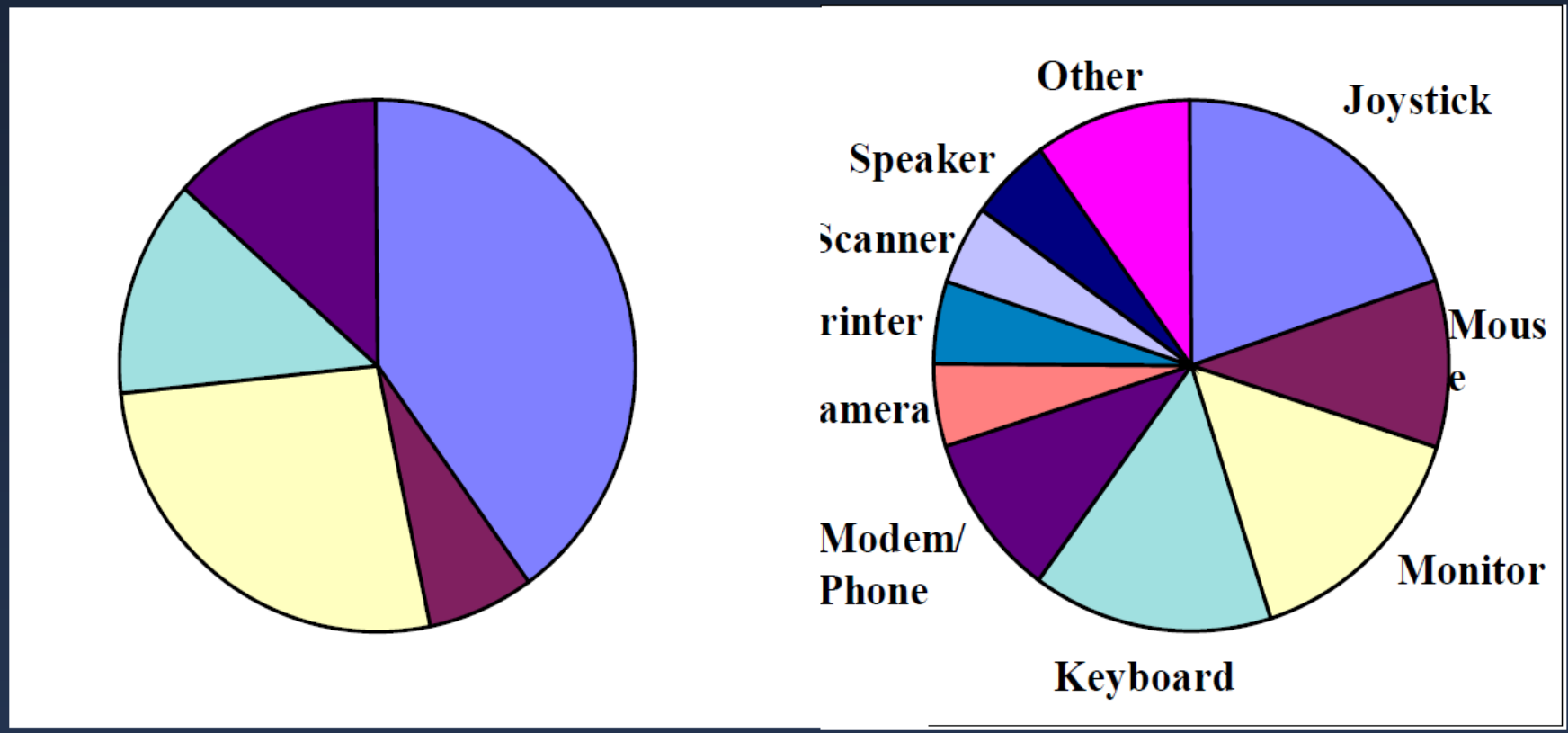
Focus

Low Cost

Microsoft Mouse

Christmas Tree Effect

First 100 million



SOCKETS = 150MU

PERIPHERALS = 100MU

The Tipping Point

Thank You

USB: How We Got to Today

Jeff Ravencraft

USB Implementers Forum (USB-IF) President & COO

IEEE Milestone Dedication: **Universal Serial Bus (USB)**

USB The First Thirty Years!

Jeff Ravencraft, USB-IF President and COO

USB
Enabling Connections™

Agenda

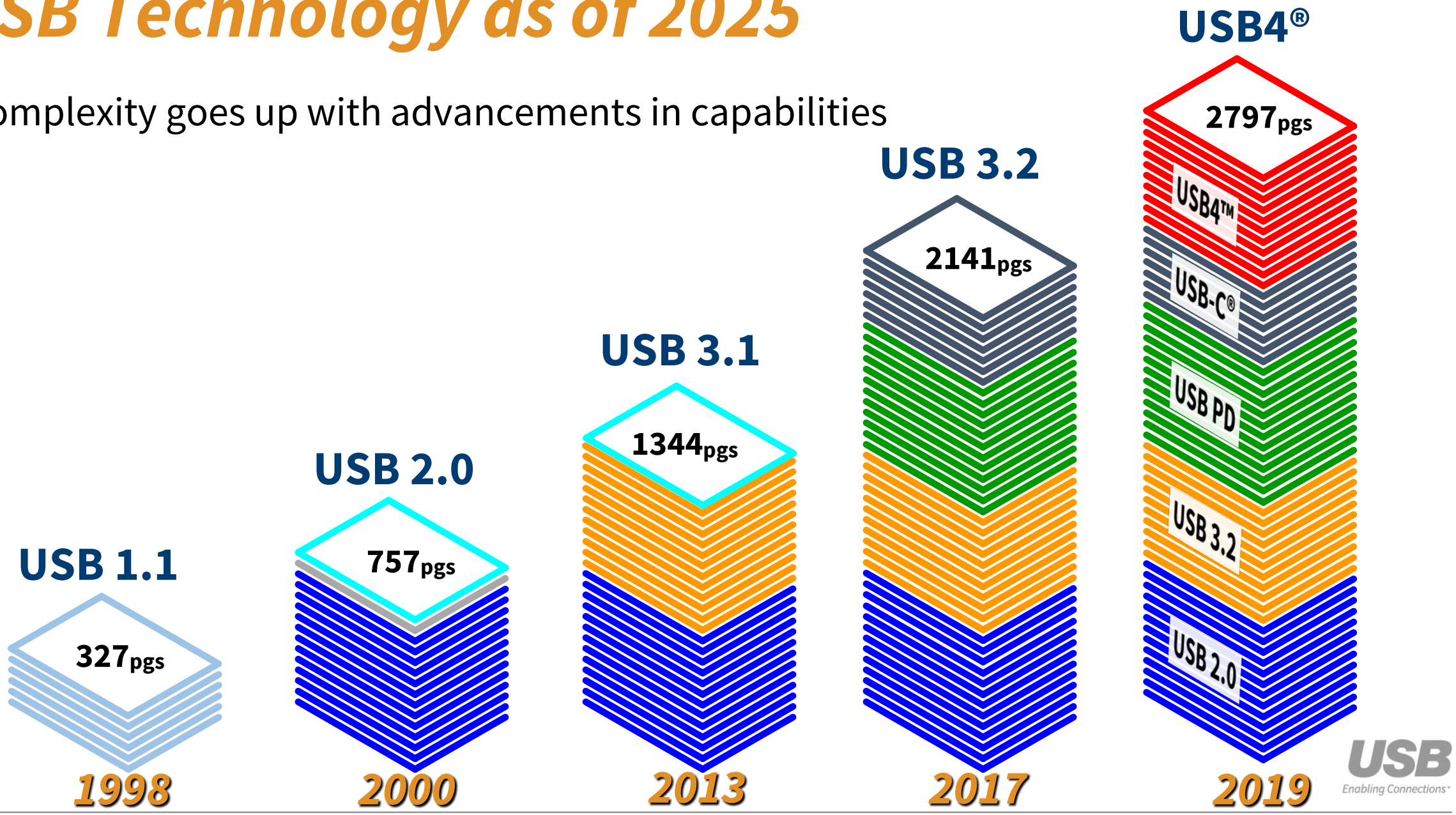
- USB Success
- Where it all began
- Todays USB Data Performance and USB Power Delivery Capabilities
- Transition to USB Type-C®
- EU Mandates USB Type-C and USB PD
- USB-IF Compliance Program
- USB-IF Building Consumer Awareness
- Consumer Education Ad Campaign and Certifiedusb.com
- USB-IF Honor Roll Award Recipients

USB the Most Successful I/O

- USB is the most successful I/O interface in the history of Personal Computing
- USB has migrated into all types of consumer electronics product segments i.e.
  - Airplanes, Automobiles, Cell phones, Desk lamps, Displays, Electric Toothbrushes, Medical electronics, Power Tools, Wall sockets etc.
  - **It's everywhere!**
- USB has been the number one I/O for 30 years
- With the advent of USB4®, USB Type-C® and USB Power Delivery, USB continues to be at the top of the food chain for data performance, charging and Ease-Of-Use for consumers
- There are Billions of USB Devices in the install base today and the industry ships billions of USB products into the market every year, year over year

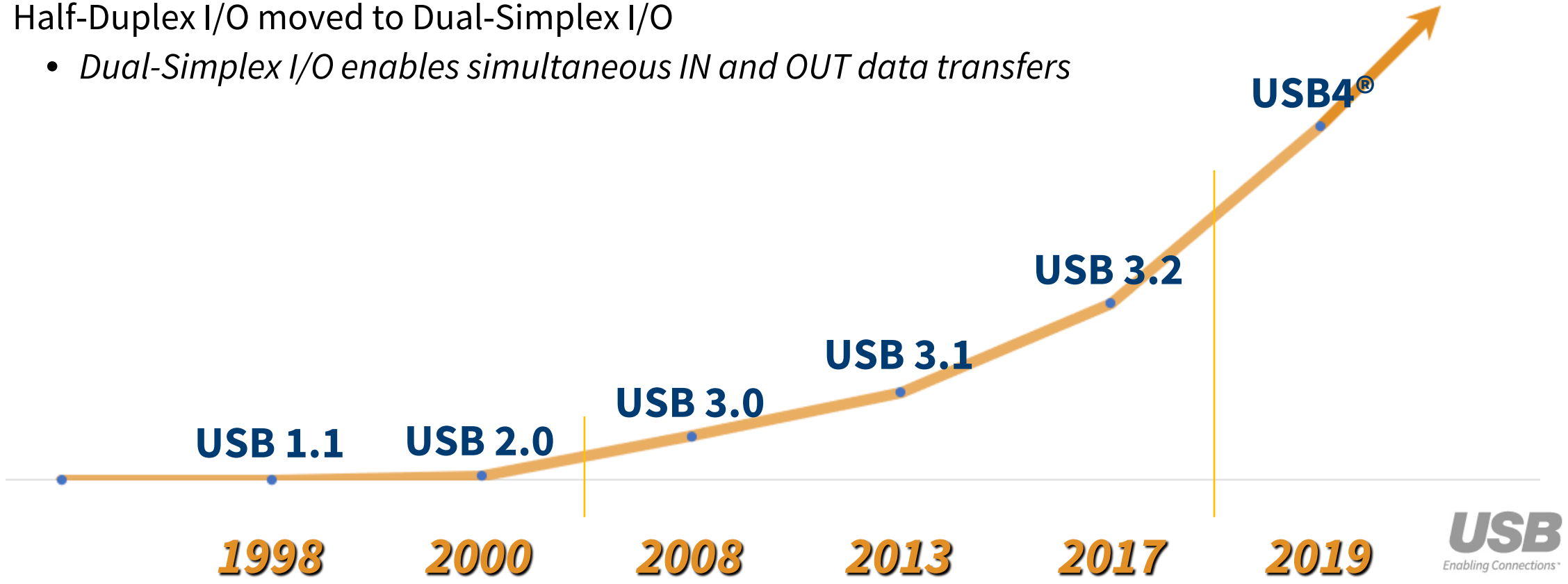
USB Technology as of 2025

- Complexity goes up with advancements in capabilities



USB Technology as of 2025

- As bus speed increased, additional performance benefits improved bandwidth efficiency
  - Transport protocol overhead has reduced from over 20% to less than 5%
  - Half-Duplex I/O moved to Dual-Simplex I/O
    - *Dual-Simplex I/O enables simultaneous IN and OUT data transfers*



USB Data Performance, USB PD, and USB-C®

USB4® Version 2.0 Specification

Enabling Up to 120Gbps of data over USB Type-C®

- A major update enabling a bandwidth boost up to 120Gbps of data performance over the USB Type-C®
- Increased data performance to benefit data-intensive applications, including:
  - High-performance 8K displays, storage, and USB-based hubs and docks.
- Key characteristics:
  - Certain applications, will take advantage of bandwidth boost to 120Gbps/40Gbps configuration that is available through reconfiguring the lanes over the USB-C® interface.
  - Directly tunnels DisplayPort™ and PCI Express®.
    - Aligns with DisplayPort™ Revision 2.1 and PCI Express® Revision 4.
  - **Backward compatibility with all previous versions of USB.**
- USB-C®/USB Power Delivery (USB PD) specifications were updated to enable this higher level of performance.

USB PD 3.2 Specification

Up to 240W of power over USB Type-C®

- Enables up to 240W of power over the USB Type-C® cable and connector.
- Extending USB Power Delivery to a wider-range of applications beyond 100W.
- Key characteristics:
  - Adjustable Voltage Supply (AVS)
    - Enables the device under charge to manage the charger by requesting specific voltages to 100-mV resolutions
  - **Backwards compatible to USB PD 3.1**
- USB Type-C specification was updated to Release 2.1 which defines 240W cable requirements

Transition to USB Type-C®

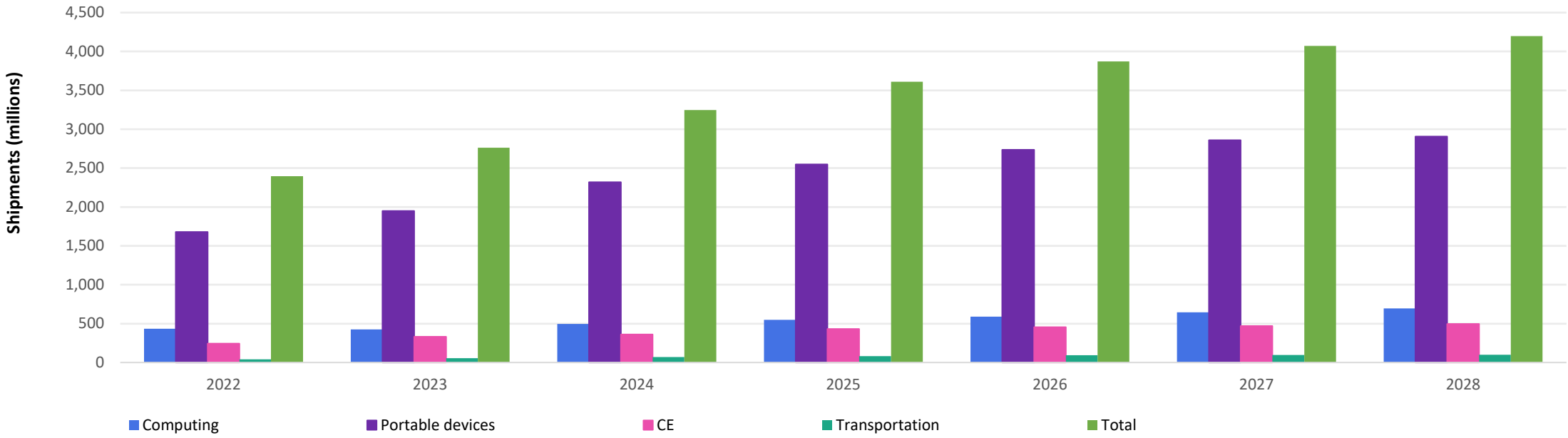
- Products were being designed with smaller form factors/Z-Height (vertical thickness).
- USB Mini/Micro connectors were not designed to support larger devices i.e., laptops, tablets, larger storage devices etc. They were only designed to support cell phones and were not robust enough for larger devices.
- Higher data performance and higher power (wattage) for charging were key drivers.
- As the new smaller connector was being contemplated, it was determined:
  - To make the new connector reversable (doesn't matter how you plug it in)
    - Eliminate the original USB keyed connector designs that came before USB-C®
  - Eliminate the A and B designations on each end for host and device respectively
    - Intelligent devices can also function as a Host vs. a Device
  - Both ends of a USB-C® cable are the same and interchangeable except for transition cables.

USB Type-C was born!

USB Type-C® Global Device Shipments

USB Type-C® 2024 Report – Omdia

USB-C shipments by segment



Source: Omdia

EU Mandates USB-C®/USB PD

Global Positions on USB Common Charging

USB common charging for environmental/e-waste policies.

EU legislation mandates portable electronic devices are required to implement a USB-C® standard charging port and USB PD by Jan 2025 and Q1 2026 for laptops. Draft legislation for EPS/chargers covers USB charging up to 240W.

India has a directive for portable electronic devices to implement USB-C standard charging port effective March 2025. Separate legislation to be considered for wearables.

Brazil drafted legislation for cell phones and chargers to implement USB-C charging port as of July 2024.

The Korean government announced ‘USB-C application guidelines’; recommended applying USB-C in products.

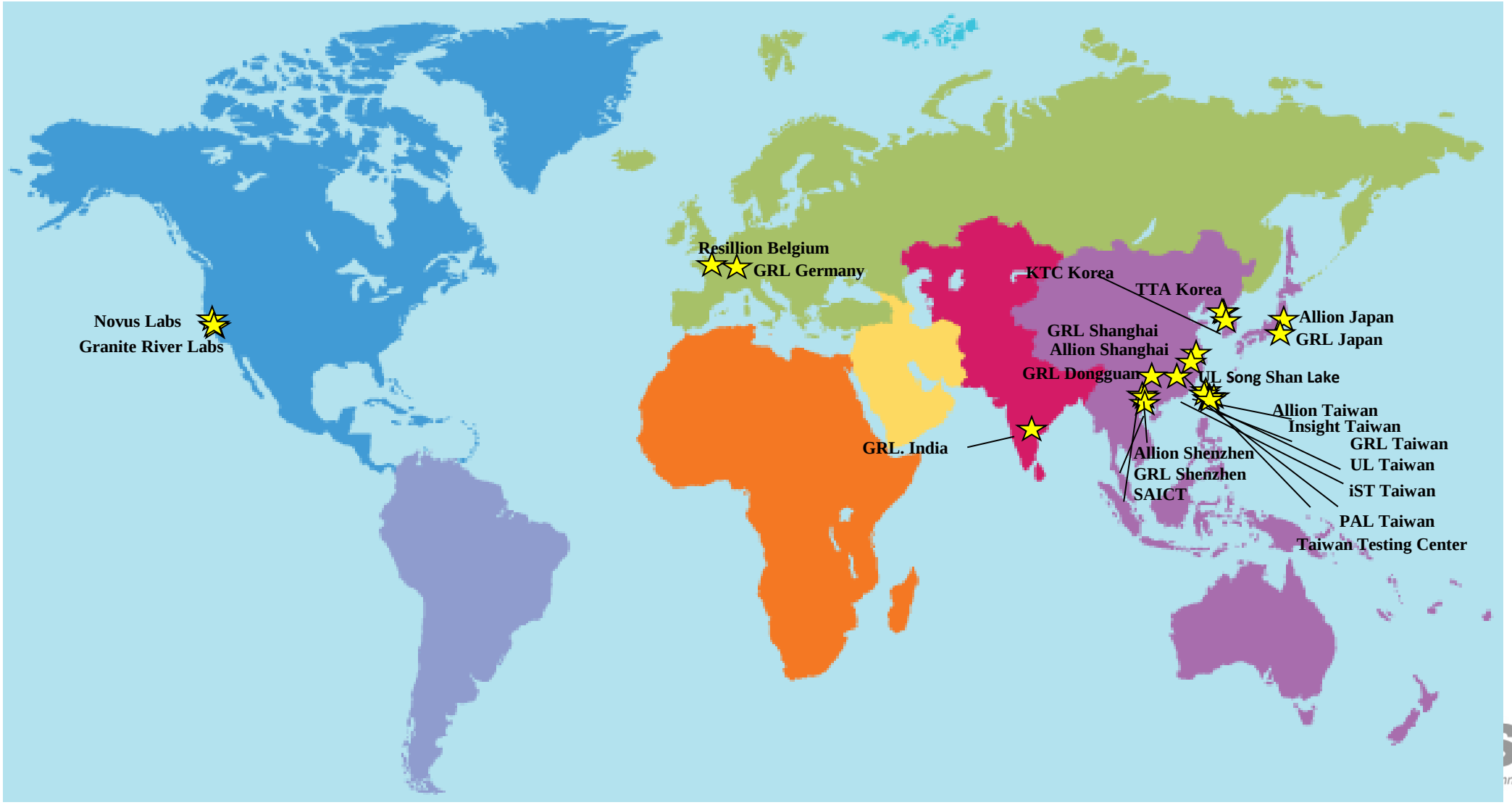
Saudi Arabia requires all new portable electronic devices use USB Type-C® and USB Power Delivery charging ports effective Jan. 1, 2025, and laptops starting April 1, 2026.

Most common charging policies in many countries are based on USB-C and USB PD specifications

USB-IF Compliance/Certification Program

- USB specifications define the product design targets at the level of interfaces and mechanisms.
- To complement the specifications and enable measurement of compliance in real products, the USB-IF instituted a Compliance Program that provides reasonable measures of acceptability.
- The Compliance Program uses multiple test specifications along with a Test ID (TID) to track and define the test criteria used to evaluate a product.
- Products that pass this level of acceptability are considered USB-IF certified and are added to the Integrators List and have the right to license the USB-IF Logos.

USB-IF Authorized Independent Test Labs



USB-IF Branding (Product Logos)

Unified USB-IF Certified Logo & Branding Summary

Host & Device Data Performance Logos

Name	Packaging Logo	Port Logo
USB 80Gbps	CERTIFIED USB 80 Gbps	80 Gbps
USB 40Gbps	CERTIFIED USB 40 Gbps	40 Gbps
USB 20Gbps	CERTIFIED USB 20 Gbps	20 Gbps
USB 10Gbps	CERTIFIED USB 10 Gbps	10 Gbps
USB 5Gbps	CERTIFIED USB 5 Gbps	5 Gbps

Unified USB-IF Certified Logo & Branding Summary

USB Type-C® Cable Logos

Name	Packaging Logo	Cable Logo
USB 80Gbps Cable	CERTIFIED USB 80Gbps 240W; CERTIFIED USB 80Gbps 60W	80Gbps 240W; 80Gbps 60W
USB 40Gbps Cable	CERTIFIED USB 40Gbps 240W; CERTIFIED USB 40Gbps 60W	40Gbps 240W; 40Gbps 60W
USB 20Gbps Cable	CERTIFIED USB 20Gbps 240W; CERTIFIED USB 20Gbps 60W	20Gbps 240W; 20Gbps 60W
USB 5Gbps Cable	CERTIFIED USB 5Gbps 240W; CERTIFIED USB 5Gbps 60W	5Gbps 240W; 5Gbps 60W

Consumer Education Ad Campaign and Certifiedusb.com website

2025 Digital Advertising: Amazon and Google

amazon

Google

Focused Countries:

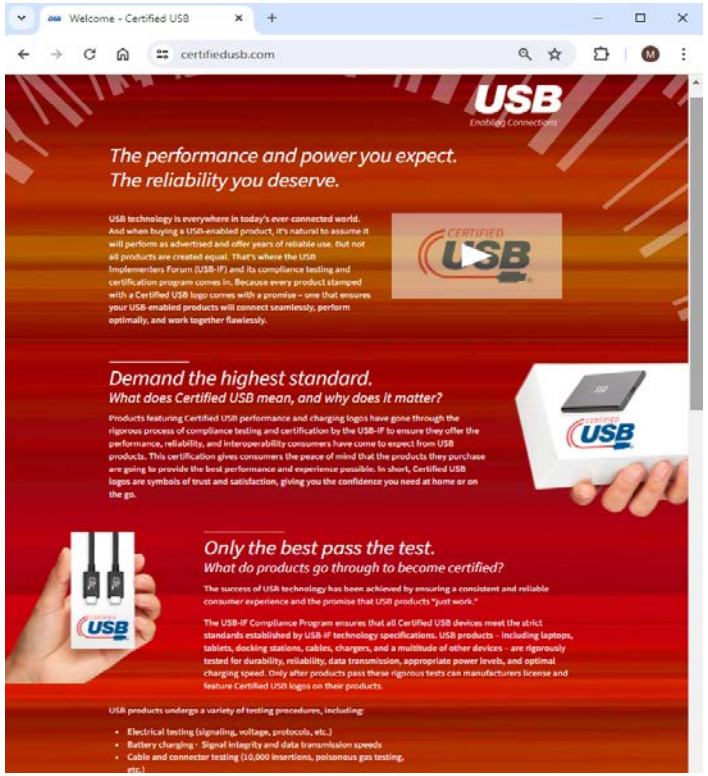
- China
- France
- Germany
- India
- Italy
- Japan
- Netherlands
- Spain
- Sweden
- UK
- US

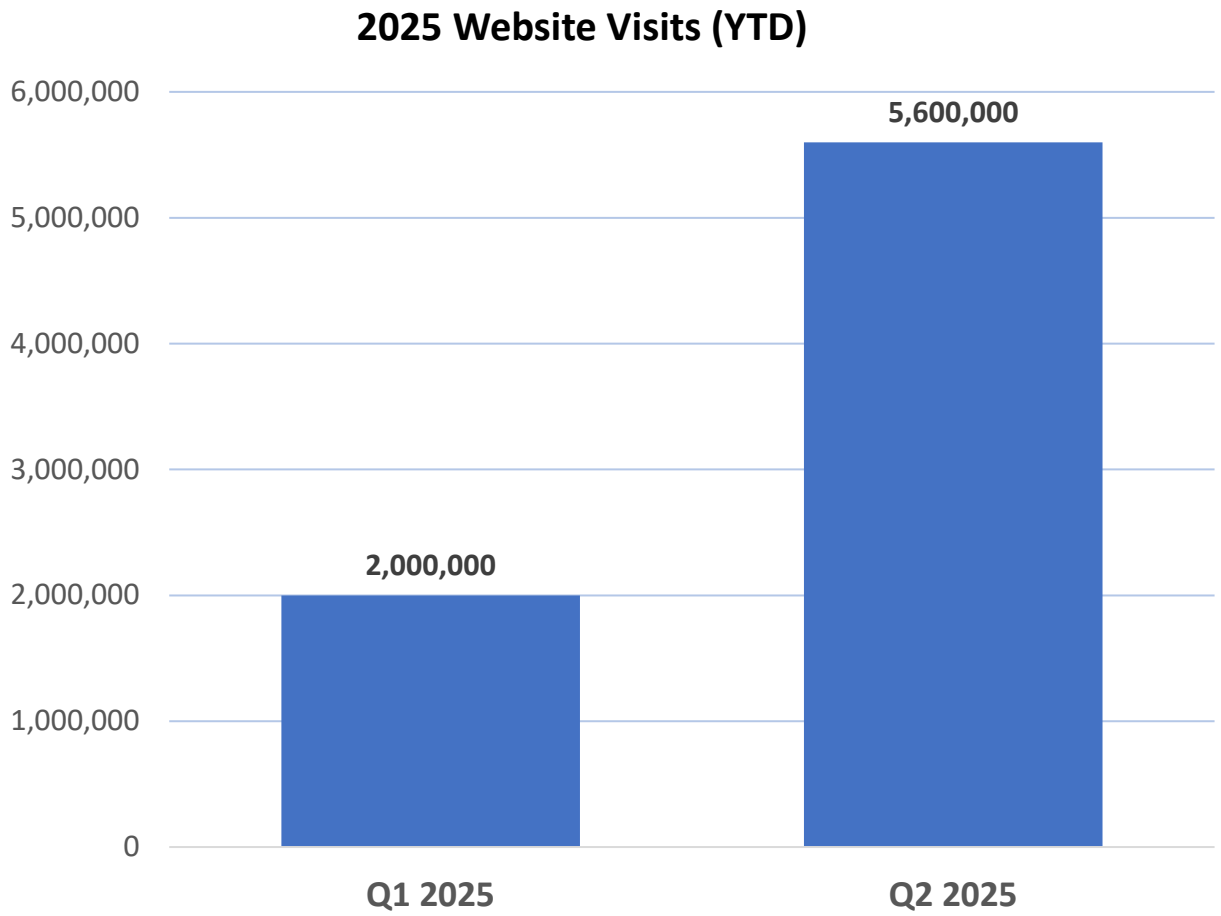
USB Enabling Connections

CertifiedUSB.com

USB-IF Website Metrics

- 7.6 million visits YTD
  - 4.8 million active users globally
- 10.9 million views of Certified USB video YTD
  - Google Ads, Amazon, and YouTube campaigns





USB Enabling Connections™

USB-IF Honor Roll Awards

The First 10 Years

Ajay Bhatt	**Abdul R. Ismail**	**Sue Vining**
John Garney	**Richard Petrie**	**Ed Beeman**
Jim Pappas	**Geert Knapen**	**Ron Schooley**
Stephen Whalley	**Bart Vertenten**	**Terry Remple**
Bala Cadambi	**Paul Berg**	**Shelagh Callahan**
Brad Hosler	**Ralph Smith**	**Steve McGowan**
John Howard	**Kugao Ouchi**	**Nathan Sherman**
Dan Froelich	**Masami (Matt) Katagiri**	**Dave Thompson**
Jim Choate	**Yoshiyuki Tomoda**	**Nobuo Furuya**
John Keys	**Fred Bhesania**	**Jeff Morriss**
Kosar Jaff	**Rene Sommer**	**Mike Glass**

USB-IF Honor Roll Awards

Glen Chandler
Peter Teng
Dan Ellis
Alan Berkema
Yun Ling
Mark Saubert
Mark Bohm
Glen Slick
Terry Lin
Morten Christiansen
Mike Campbell
Jeff Ravencraft

Joseph Scanlon
Marcin Behrendt
Jim Koser
Subramanyam Sankaran
Bob Dunstan
Stone Lin
Martin Borve
Mark Maszak
Hajime Nozaki
Saleem Mohammad
Mark Paxson
Traci Donnell

Will Harris
Mark Fu
Mike Engbretson
Brad Saunders
Karthi Vadivelu
Terrill Moore
Randy Aull
Craig Wiley
Alvin Cox
Sarah Boen
Curtis Stevens

Welcome to the Next Thirty Years

USB
Enabling Connections™

Panel Discussion
USB – The Ubiquitous Connector:
Digging Deeper

Jim Pappas
Jeff Ravencraft

Abdul (Rahman) Ismail
- ***USB-IF Chairman & CTO***
- ***Intel Senior Principal Engineer***

Ajay Bhatt
Intel Fellow
(retired)

IEEE Milestone Dedication: **Universal Serial Bus (USB)**

Panel Discussion
USB – The Ubiquitous Connector:
Digging Deeper

Ajay Bhatt
Intel Fellow
(retired)

IEEE Milestone Dedication: **Universal Serial Bus (USB)**

USB: Digging Deeper – Panel Discussion

In May, Ajay Bhatt's work on USB was honored with the Padma Shri Award by the President of India

USB: Digging Deeper – Panel Discussion

Ajay Bhatt (left) and Bala Cadambi at the 2013 European Inventor Award ceremony in Amsterdam.

They were amongst 5 recognized for their work on USB technology

3 other co-winners: Jeff Morriss, Shaun Knoll, and Shelagh Callahan

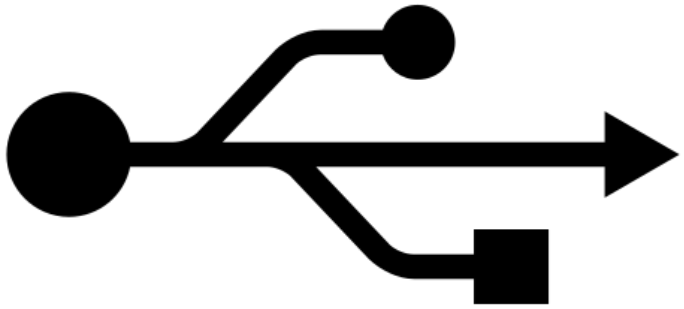
Panel Discussion
USB – The Ubiquitous Connector:
Digging Deeper

Abdul (Rahman) Ismail

- ***USB-IF Chairman & CTO***
- ***Intel Senior Principal Engineer***

IEEE Milestone Dedication: **Universal Serial Bus (USB)**

USB: Digging Deeper – Panel Discussion



30 July 2025

USB: Digging Deeper – Panel Discussion

USB TechZone

USB: Digging Deeper – Panel Discussion

The USB Flash Drive Made the Floppy Obsolete

USB: Digging Deeper – Panel Discussion

USB Flash Drives

USB: Digging Deeper – Panel Discussion

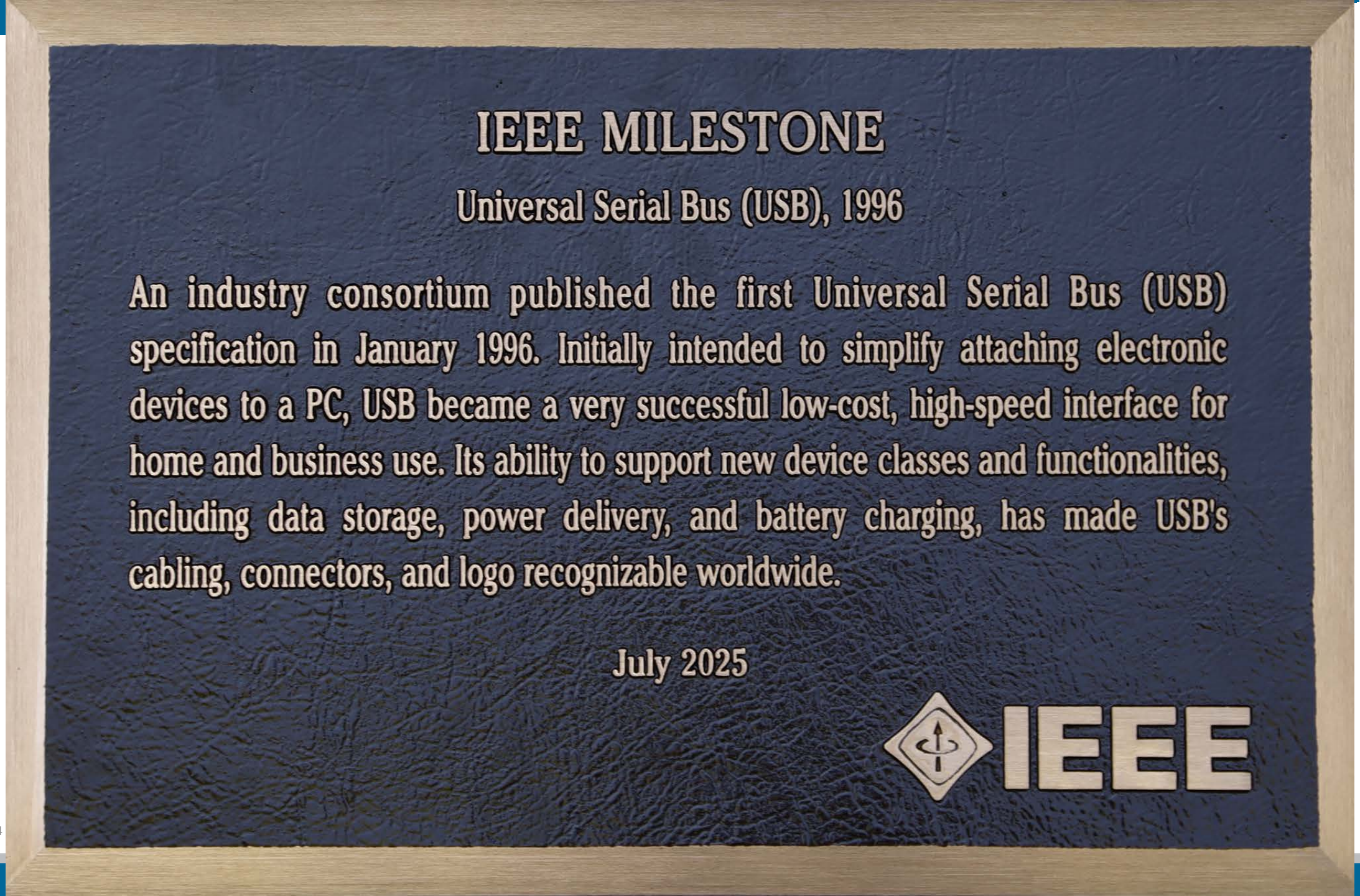
- ***First computer with USB:***
  - ***2 USB connectors***
  - ***USB Keyboard***
  - ***USB Mouse***
  - ***No built-in floppy***
- ***USB Floppy was available***
- ***$1299***
- ***6.5 million units sold***
- ***“i” in name: “internet ready”***
- ***Unique design: a cultural icon***

Released: August 15, 1998

USB: Digging Deeper – Panel Discussion

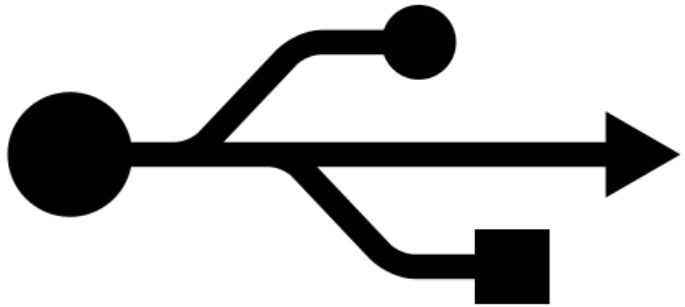
USB License Plates

USB Plaque Citation Reading and Dedication


IEEE MILESTONE
Universal Serial Bus (USB), 1996
An industry consortium published the first Universal Serial Bus (USB) specification in January 1996. Initially intended to simplify attaching electronic devices to a PC, USB became a very successful low-cost, high-speed interface for home and business use. Its ability to support new device classes and functionalities, including data storage, power delivery, and battery charging, has made USB's cabling, connectors, and logo recognizable worldwide.
July 2025
IEEE

Closing Remarks

Thank you to our program participants!
I hope you have had fun, and learned something new!



30 July 2025

Thank you all for coming!

We will now unveil the bronze plaque in the Front Lobby

Refreshments in the Trillium Room

IEEE Milestone Dedication

Universal Serial Bus (USB)