

Introduction to the Internet of Things

Part - 1



Part 1 - Course Learning Objectives

1. Define the term “Internet of Things”
2. State the technological trends which have led to IoT
3. Describe the impact of IoT on society
4. Define what an embedded system is in terms of its interface
5. Enumerate and describe the components of an embedded system
6. Describe the interactions of embedded systems with the physical world
7. Name the core hardware components most commonly used in IoT devices
8. Describe the interaction between software and hardware in an IoT device
9. Describe the role of an operating system to support software in an IoT device
10. Explain the use of networking and basic networking hardware
11. Describe the structure of the Internet
12. Describe the meaning of a “network protocol”
13. Explain MANETs and their relation to IoT

What is Internet of Things

- Starts with a device (a – thing) – any thing besides traditional computer



Add a **network connection** to the device to further enhance its function



Traditional Refrigerator

- Keeps items cold
- Doesn't do much else



“Intelligent” Refrigerator

Tells you:

- When the door is ajar
- When the water filter needs replacing
- When you are low on butter
- When you buy foods with high fat content
- What recipes match its contents



*...enhanced functionality,
but still not networked*

IoT Refrigerator

- Orders food items when stock is low
- Searches for lowest food prices
- Orders water filter when needed
- Anticipates your meals; orders food preemptively
- Searches news sites for worldwide food price trends
- Provides consumption information to businesses for marketing purposes



*Greatly enhanced functionality,
Internet required*



- Define the term “Internet of Things” (IoT)
- State the technological trends that have led to IoT
- Describe the impact of IoT on society

IoT Devices

Computational technology is used to enhance a product – 1950's car with electro-mechanical control



IoT Devices

21st century car – computer-based control systems enable fuel injection, anti-lock braking, etc.



IoT Devices

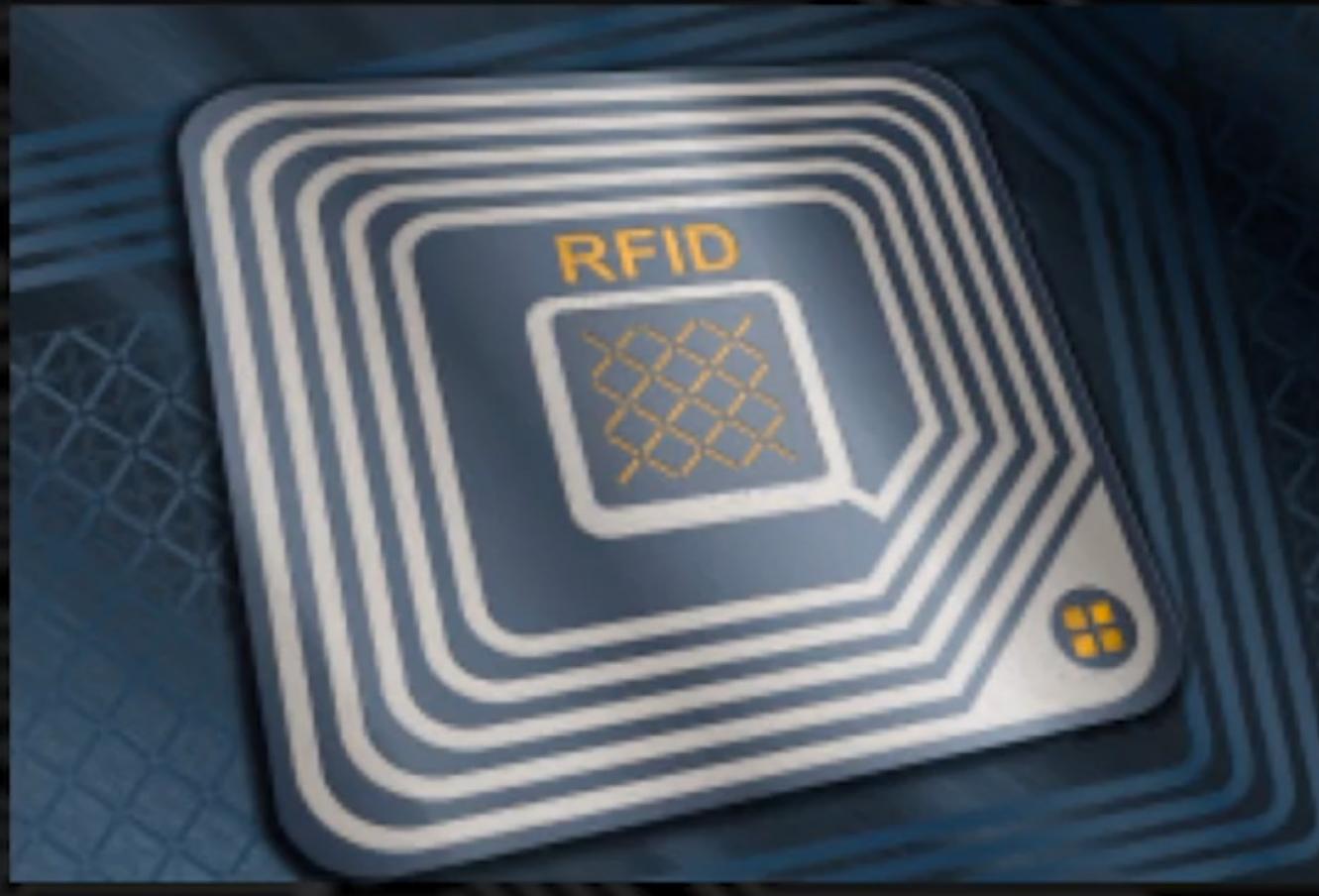
Internet access gives access to external computation and data (“the cloud”)

- 1970's logistical tagging – barcode



IoT Devices

21st century logistical tagging – intelligent RFID tags



Comparsion b/w IoT device and Standard Computer

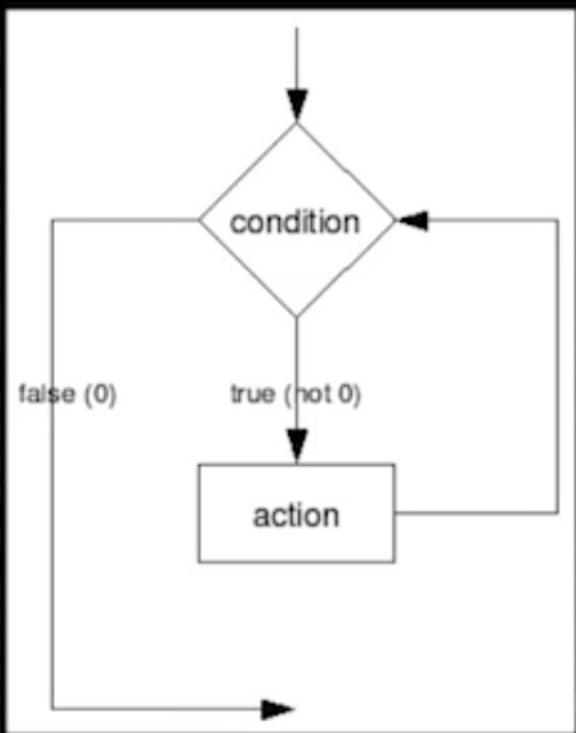
IoT Devices Are Unique

IoT devices have a main function separate from computation

- Cars drive, phones make calls, TVs display shows
- Computation is a means to an end

Computers...*Compute!*

The main function of a computer is to compute – any type of program can be executed



IoT Devices vs. Computers

Computers are **general-purpose**

- OK at executing anything
- Not particularly efficient for type of code



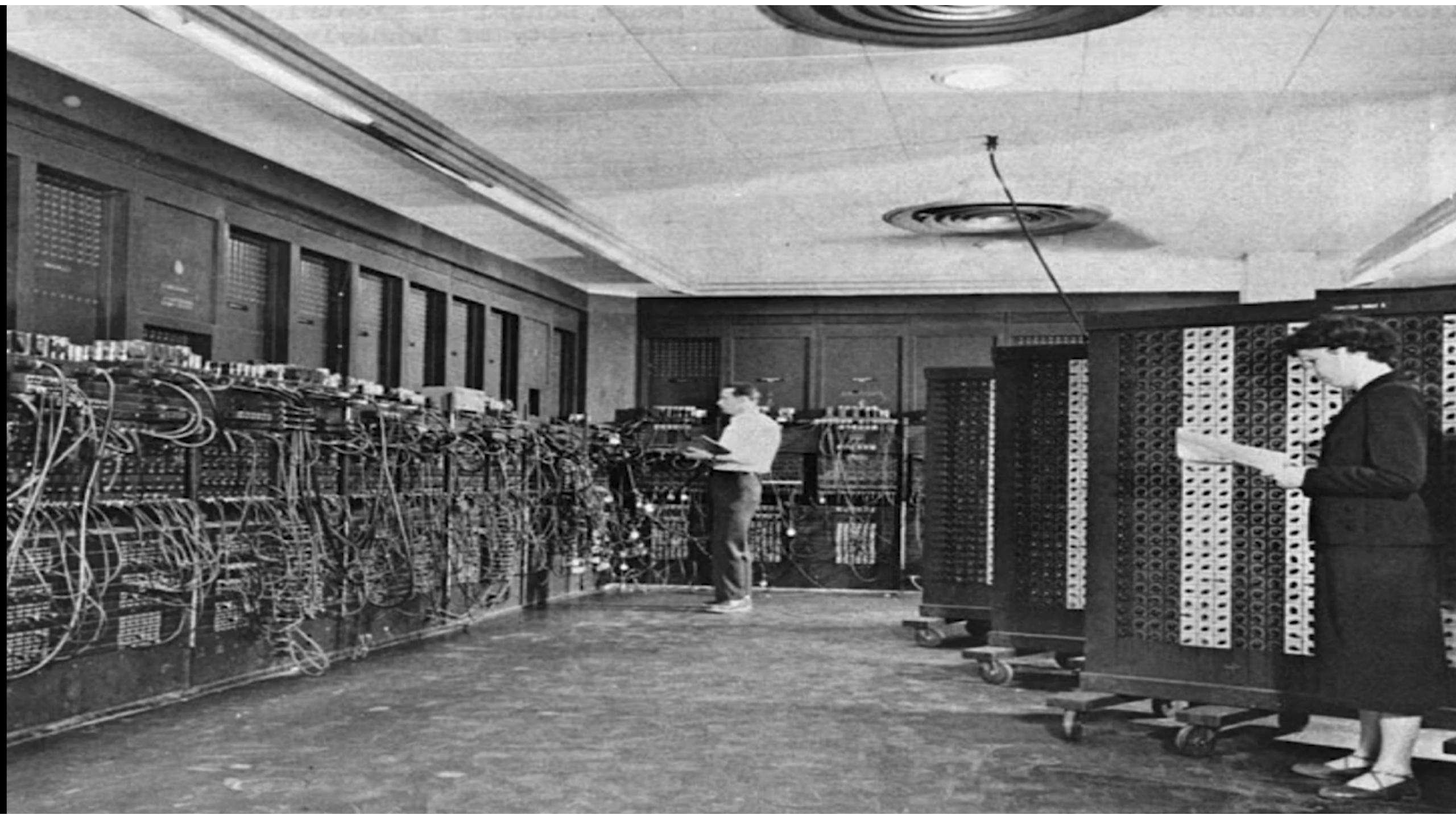
IoT Devices vs. Computers

IoT devices are **special-purpose**

- Software and hardware are efficient for the task – but inefficient for other tasks
- A music player is great for playing – but terrible for playing video
- Laptops can do both – but less efficiently

Trends Supporting IoT

- Convergence of several trends
- Cost of hardware has decreased
 - ENIAC 1945: \$500,000
 - Generic laptop computer today: \$500



IoT Trend: Hardware Size

Smaller size and less weight needed to incorporate computation into devices

- ENIAC 1945: 1,800 square feet; 27 tons
- Laptop computer today: 0.05 square feet, under 3 pounds



IoT Trend: Computational Ability

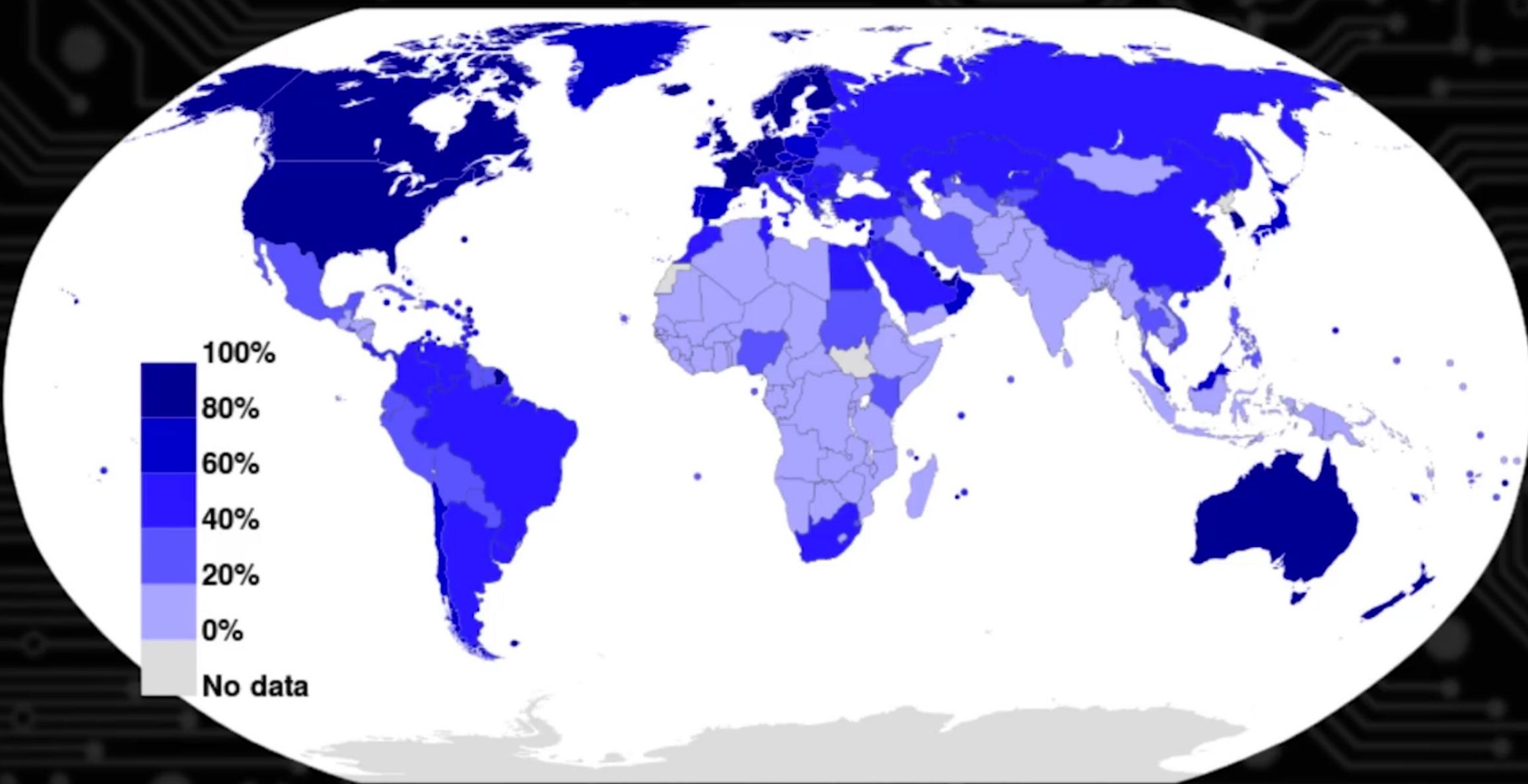
Many IoT devices need significant computation and speed

- Speed-to-text, audio processing, network communication
- ENIAC, 1945: instructions per second → 5,000
- Laptop, today: instructions per second → 18 billion

IoT Trend: Internet Access

Internet available almost everywhere in the developed world

- Some parts of the world still lack easy access, but this is being addressed



Number of Internet users as a percentage of a country's population.

IoT Trend: Internet Access

Wireless access (cell phone, Wi-Fi) enables networking with cheap infrastructure

- Less need to install physical cables



IoT Trend: Internet Access

Data costs are fairly low

- This point is arguable, but many can afford it

IoT Trend: Internet Access

Data bandwidth is high

- Can stream multiple movies in real-time

IoT is Powerful and Pervasive

Interface to the Cloud

- Siri enables search with verbal questions
- View any movie, listen to any song, read any book

Networking is Powerful

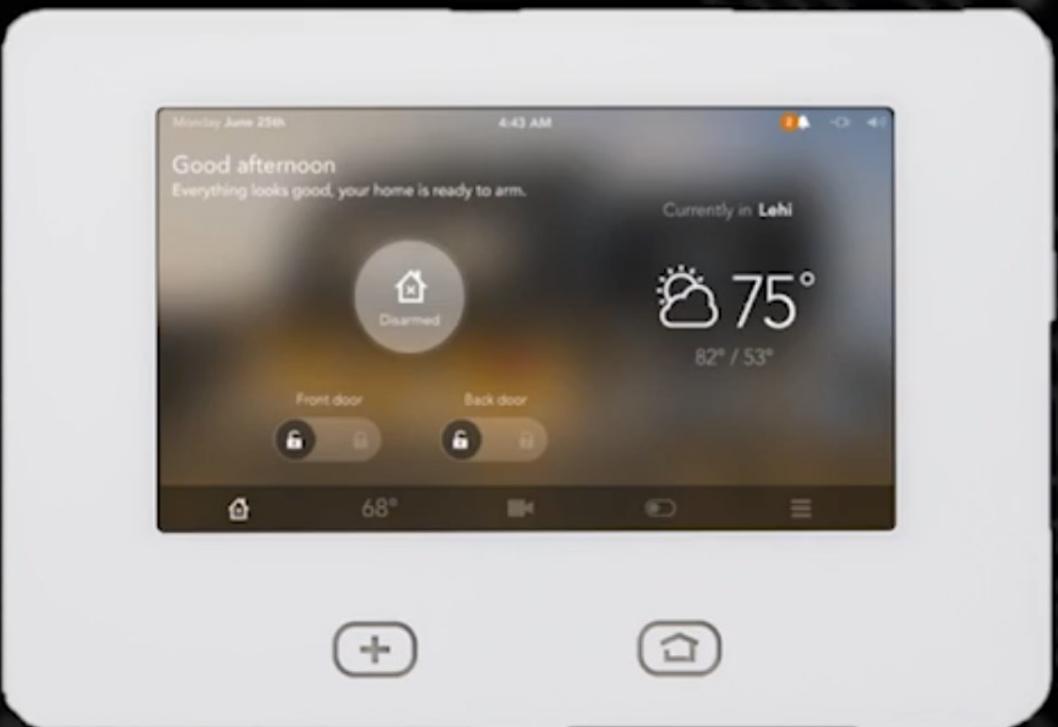
IoT device interfaces can leverage powerful servers and large databases



IoT is Pervasive

At home

- TV/game machine can listen to your commands
- Home automation system can control your appliances



IoT is Pervasive

At work

- Motion sensors detect your presence
- RFID readers detect entry/exit

IoT is Pervasive

On your person

- Cellphones
- Insulin pumps
- Pacemaker, health monitoring devices



IoT is Pervasive

Everywhere else

- Your car
- Traffic lights (red light cameras)





MODULE 1, LESSON 3

Lecture 3.1: Societal Benefits of IoT

**Professor Ian G. Harris, Ph.D.
The University of California, Irvine**

Societal Benefits of IoT

IoT makes life easier

- What food do I need?
- Are my accounts balanced?



Societal Benefits of IoT

Independence from people

- IoT devices handle things you needed humans for
- Fewer doctor visits; no trips to the supermarket



Pacemaker



Link to the world!

- Information access
- Global interactions between people are possible



INTERNET OF THINGS

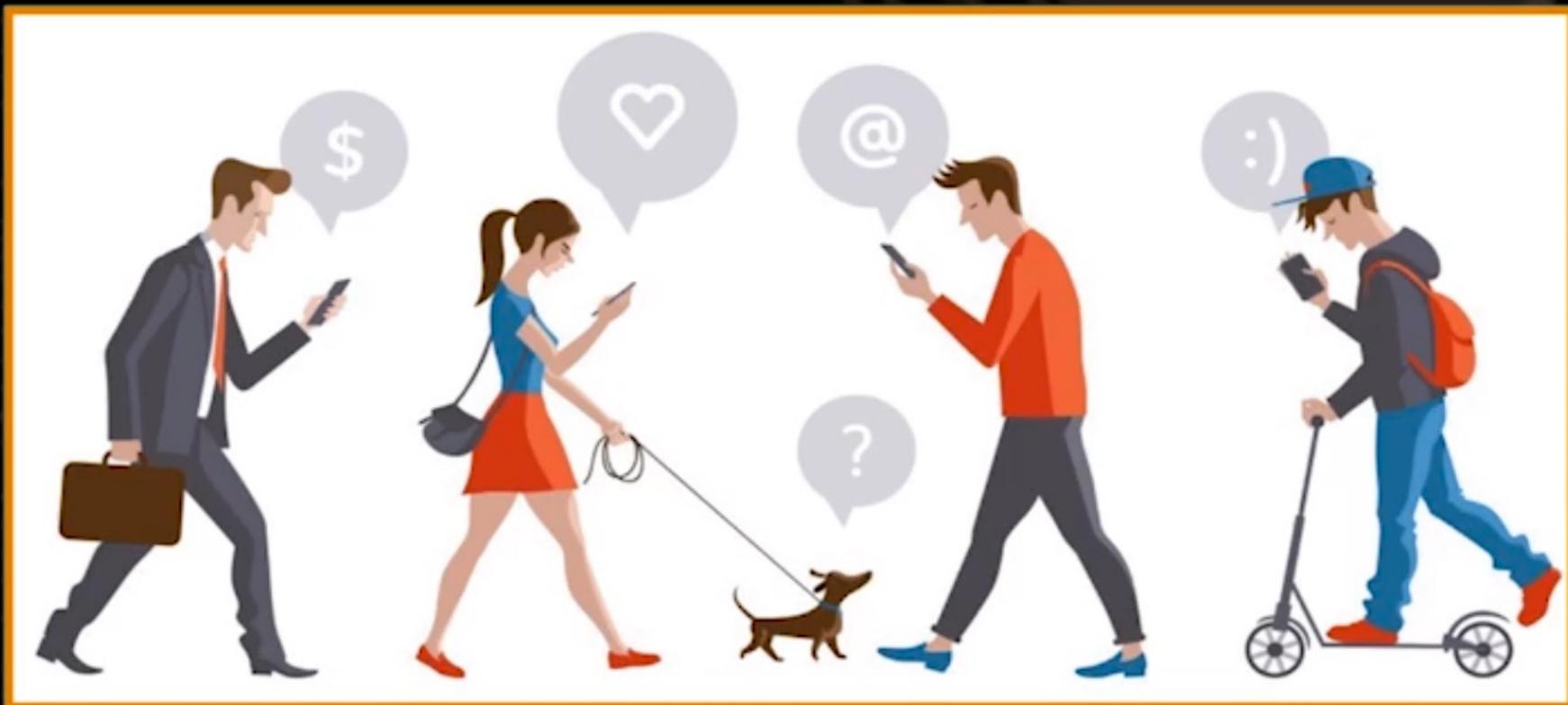
MODULE 1, LESSON 3

Lecture 3.2: Risks, Privacy, and Security

Professor Ian G. Harris, Ph.D.
The University of California, Irvine

IoT Risks

Social isolation



IoT Risks

Dependence on technology and infrastructure

- IoT requires power and network
- Network outages and blackouts are more critical

Privacy and Security

Observation by IoT devices is pervasive

- Location: cell phone
- Health: health monitor
- Media watching habits: TV/media system
- Purchasing habits: credit card, cellphone
- Driving habits: car incident recording

Privacy and Security

Data may be used to market to you

- Health problem? Drugs may be marketed to you

Privacy and Security

Purchasing an IoT device may give the manufacturer permission to use or sell your data

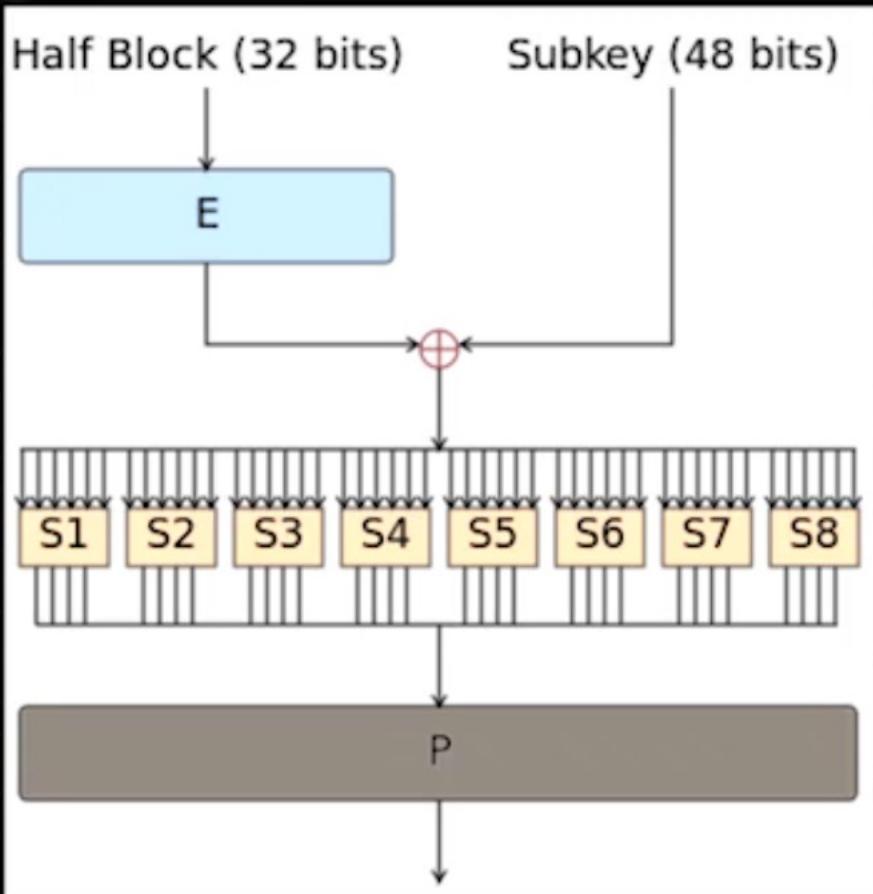
- Consumer agreement contracts can be cryptic

Privacy and Security

Data may be used by insurance agencies

- Were you speeding at the time of the accident?
- Do you have any undiagnosed health problems?

Privacy and Security



Data may not be held in a secure way

- Cloud is attacked with your data inside
- Even encrypted data is decrypted in use

Assignment

Identify and analyze a device that is an IoT device now, but in the past was a non-IoT device. Compare the functions of the device in the past to the functions of the device now. Enumerate any improvements or any diminishments if they exist.