TCSL-70130 Lecture 10: IoT in Education
大數據之教育應用

Shiow-yang Wu 吳秀陽

CSIE 資訊工程學系
NDHU 國立東華大學

2

Lecture Topics

- What is IoT?
- Overview of IoT technologies
- Elements of IoT
- Applications of IoT
- IoT in education
- IoT educational use cases

3

What is Internet of Things?

- The term Internet of Things(IoT) was first suggested by Kevin Ashton in 2009.
- It is used to refer to uniquely identifiable objects and their virtual representations in an internet-like structure.
- If all the objects and people have identifiers, they could be managed and inventoried by computers.
- The world where all objects and people have identifiers and are connected by an internet-like structure is called the Internet of Things.

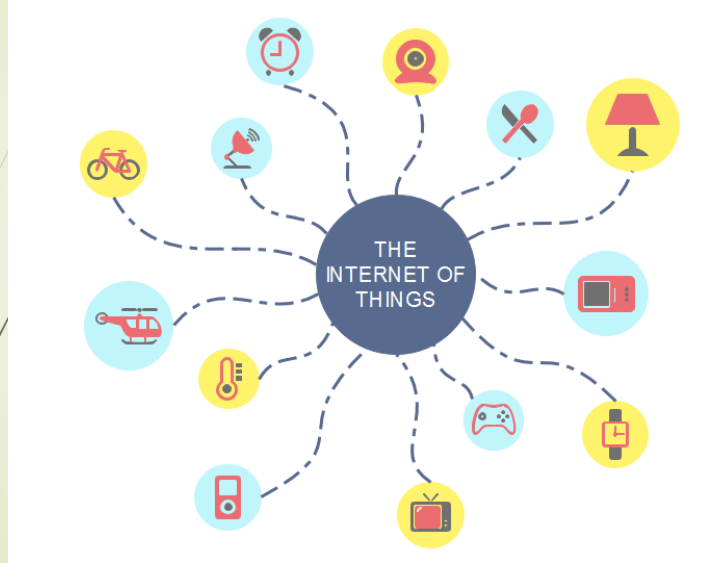
4

Major Subject of 5G (2020-2030)

Connection of
7 Billion of People and
7 Trillion Things

5

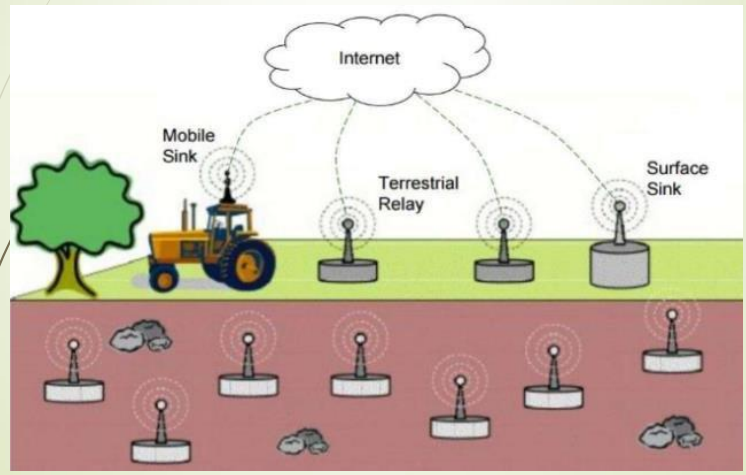
Will have Internet of Things



6

and Internet of Underground Things

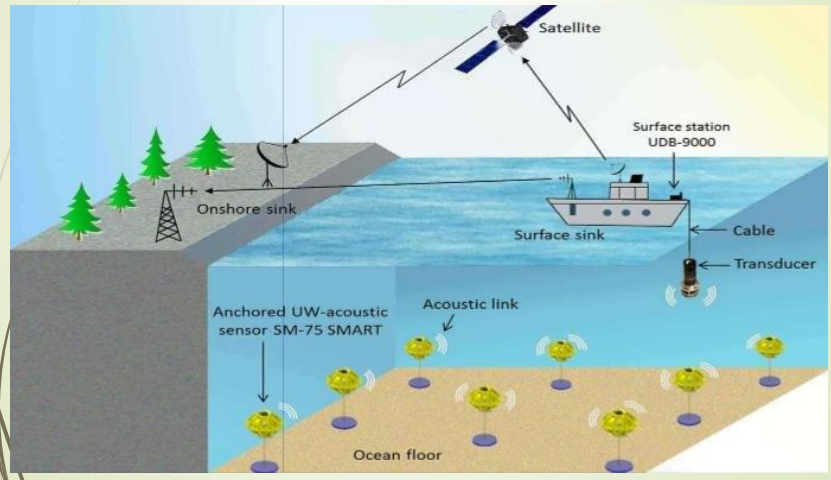
- Yes! IoT is underground now!



7

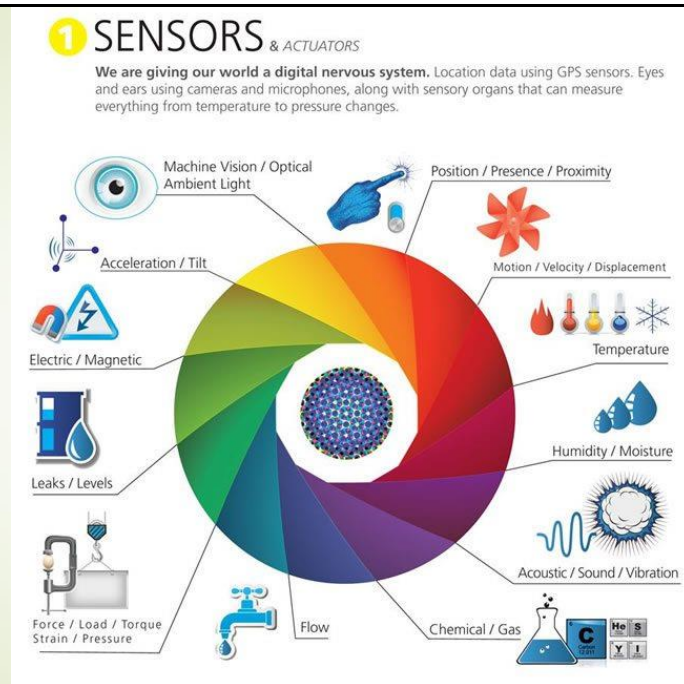
even Internet of Underwater Things

- Even underwater IoT!



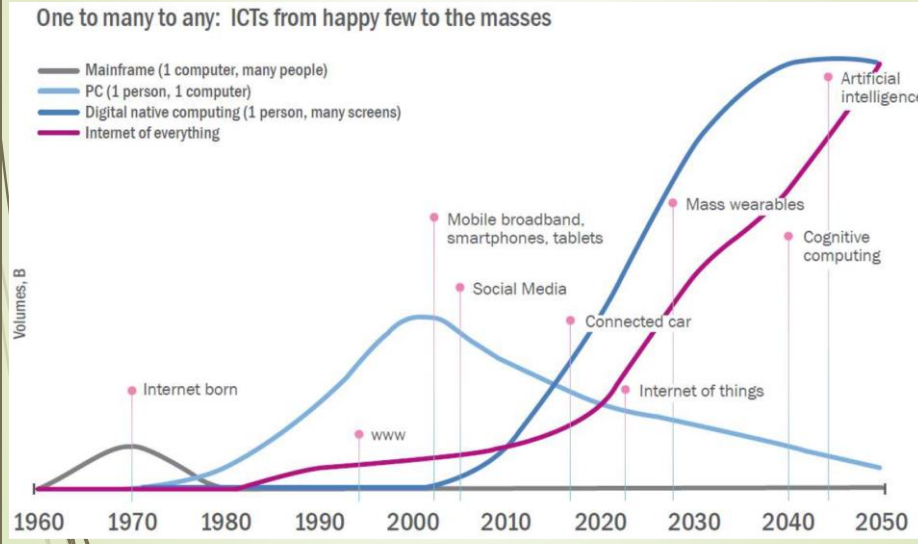
8

IoT Devices



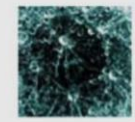
9

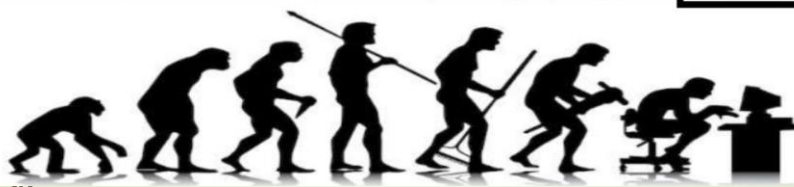
One to Many to Any



10

Evolution of Internet

Internet of boffins	Internet of geeks	Internet of masses	Mobile Internet	Internet of things
				
1969 - 1995	1995 - 2000	2000 - 2007	2007 - 2011	2012 & beyond



11

Internet of Boffins

- 1969: ARPANET carried its first data packet. It was the first network to use TCP/IP.
- 1970: Mark I Network by Davis (a packet switched network)
- 1973: Mark II Network
- 1974: Telenet (an American commercial packet-switched network)
- 1980: Ethernet
- 1990: GOSIP(Government Open Systems Interconnection Profile)
- 1994: first full text Web search engine
- A stage of early evolution and research.

12

Internet of Geeks

- 1995: IPv6 proposed (makes IoT possible)
- 1995: Amazon started its 1st online retail service
- 1995: eBay provided online auction and shopping services
- 1996: Hotmail offered free Web based email service
- 1998: Google Search engine officially launched
- 1998: PayPal started 1st Internet payment service
- Internet penetration was low until 2000.

13

Internet of Masses

- 2000: Dot-com bubble burst, high growth in stock markets, people across the globe started using the Internet, social networking sites emerged
- 2001: Wikipedia started
- 2004: Facebook started
- 2005: YouTube started
- 2006: Twitter started, WikiLeaks started
- The era with high growth, mass services, and social network/media

14

Mobile Internet

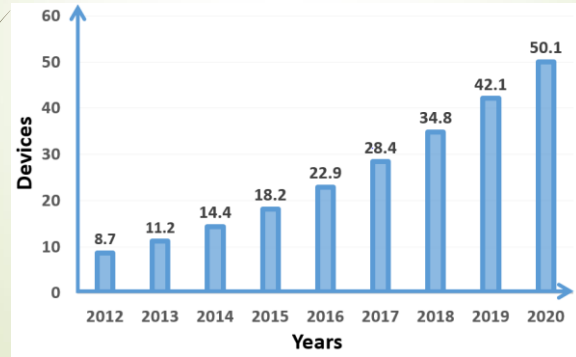
- The first mobile phone call was made on April 3, 1973 with a phone weighed 1.1kg (2.5 pounds) and sized 228.6x127x44.4mm.
- 1996: Nokia 900 Communicator was the 1st commercial mobile phone with internet connection
- Mobile internet was available in 2007 when Apple released the 1st gen iPhone.
- 2007~2011 was the era of mobile internet.

Nokia 9000 Communicator

15

Internet of Things

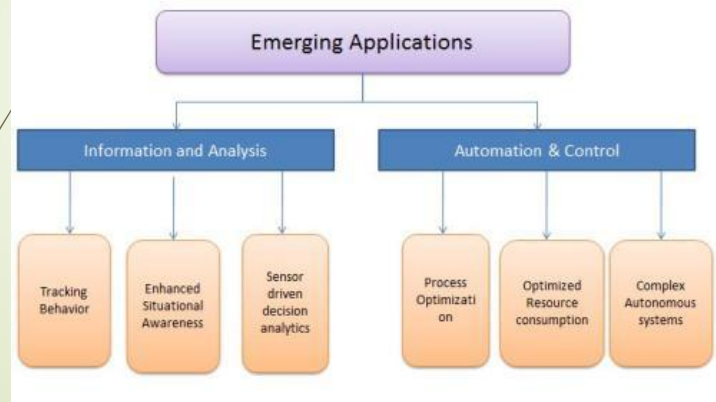
- Since 2012, the number of IoT devices has been increasing each and every day.
- From 2012 to 2020, the number grows from 8.7 billions to 50.1 billions.



16

Emerging Applications

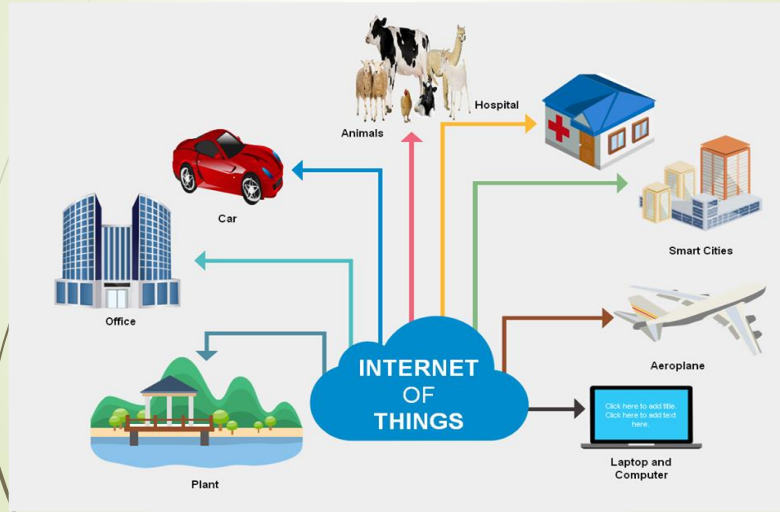
- The emerging applications of IoT:
  - Informaton & Analytics
  - Automation & Control



17

Applications Domains

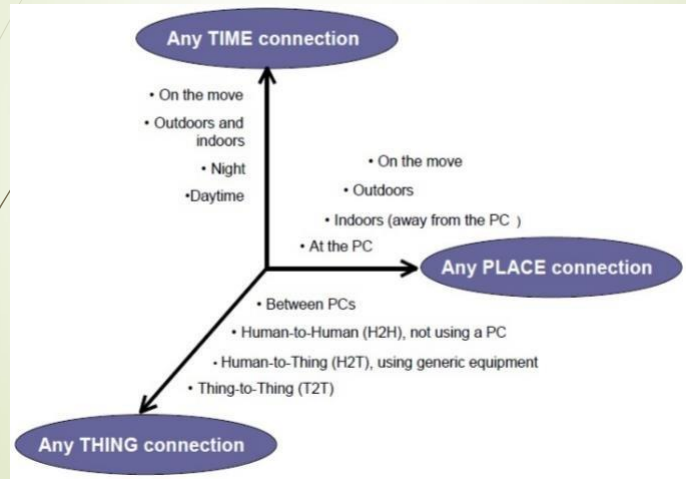
- IoT has deployed in many application domains.



18

3 Dimensions of IoT

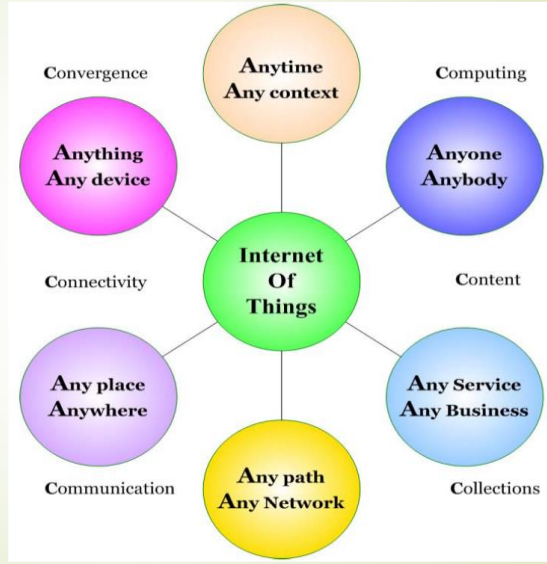
- IoT is to provide Any TIME, Any PLACE, and Any THING connections.



19

More Dimensions and 6Cs

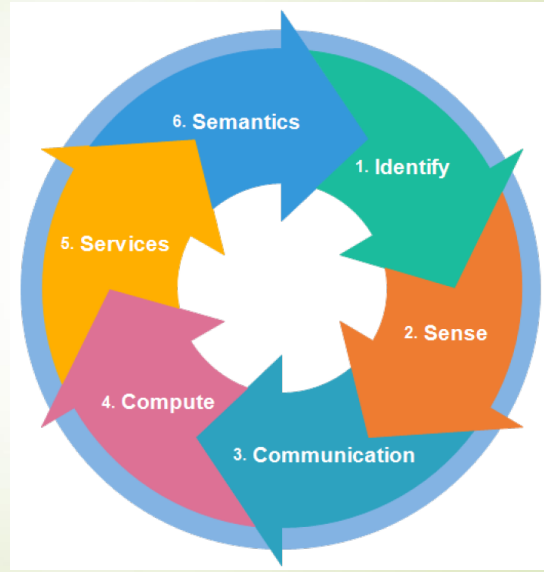
- More dimensions and the 6Cs



20

IoT Elements

- Several elements are required to deliver the functionality of IoT.



21

IoT Elements - Identification

- Need to offer explicit identity for each object.
- Two processes in identification: naming and addressing.
- Naming provides names of objects for referencing
- Addressing offers unique address of specific obj
- Two ore more objects may have same name but always different and unique address.
- Naming methods: Electron Products Codes(EPC), Bar codes, QR codes, Digital watermarking, …
- Unique addressing is assigned by IPv6.

22

IoT Elements - Sensing

- Sensing is the process of collecting information from objects.
- The collected info is sent to the storage media.
- There are many sensing devices:
  - RFID tags
  - Smart sensors
  - Wearable sensing devices
  - Actuators
  - …

23

IoT Elements - Communication

- Communication is essential for different objects to be connected to each other and communicate.
- In communication, objects may send and receive messages, files, and other information.
- Many technologies to facilitate communication:
  - RFID (Radio Frequency Identification)
  - NFC (Near Field Communication)
  - Bluetooth
  - Wi-Fi
  - LTE (Long Term Evolution)

24

IoT Elements - Computation

- Computation is performed on the collected info
- Provide processing power for IoT applications.
- Many HW/SW platforms are available.
- Hardware platforms: Audrino, Rasperry Pi, Intel Galileo, Nvidia Jetson Nano, …
- Software platforms: Android, Tiny OS, Lite OS, ROS (Robot Operating System), …
- Stream processing platforms: Kafka, Flume, Spark, Storm, S4, Google Cloud IoT, AWS IoT, Azure IoT, IBM Watson IoT, Salesforce IoT, …

25

IoT Elements - Services

- Identity-related services: get identity of objects
- Information aggregation: collect info from objects
- Collaborative services: integrate info sources, make decisions, send appropriate responses, …
- Ubiquitous services: offer immediate responses without rigidity of time and place.
- IoT platforms: platforms for hosting, connecting, and integrating IoT services. (next slide)

26

IoT Platforms

- IoT platforms play the role of middleware between hardware/devices and applications.

27

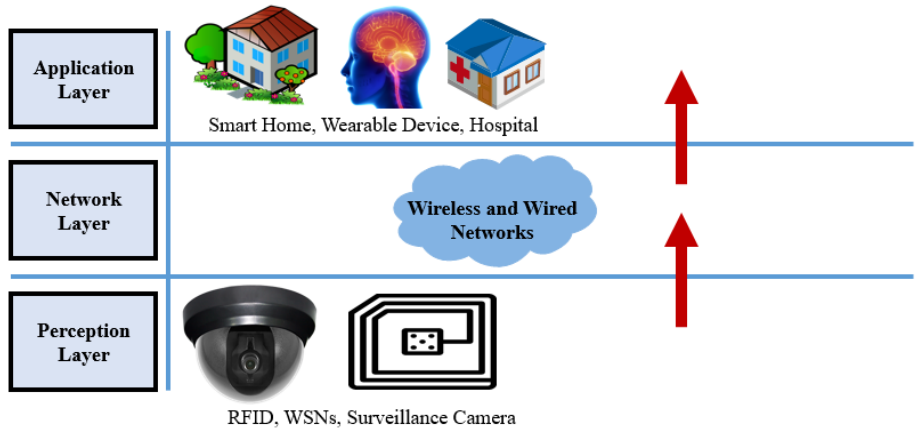
IoT Elements - Semantics

- The brain of IoT
- Coordinating all other elements to facilitate users
- Collect and integrate all information
- Determine the meaning of the data
- Make appropriate decisions
- Send responses to the devices
- Record and evaluation
- Improve effectiveness by machine learning
- Adjust/personalize to individual user

28

Layered Architecture of IoT

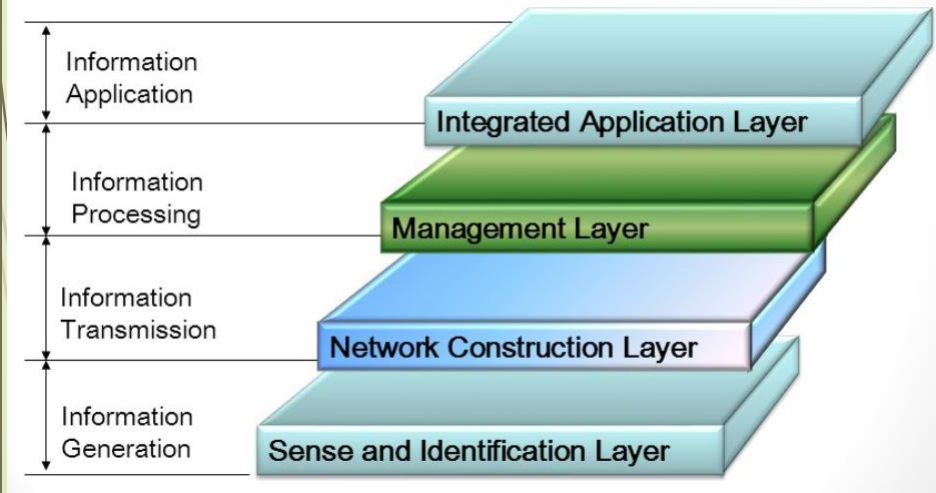
- The most fundamental architecture of IoT consists of three layers.



29

4 Layers Model of IoT

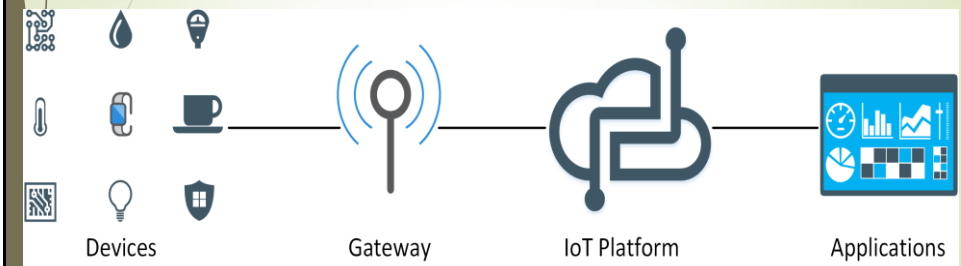
- Also have 4 layers model.



30

IoT Technology Stack

- The IoT technology stack covers all required technologies from connecting an IoT device, to producing data, to an actual purpose.



Sensors & Actuators	Connecting devices to platform	End-to-end IoT services	Smart IoT applications

31

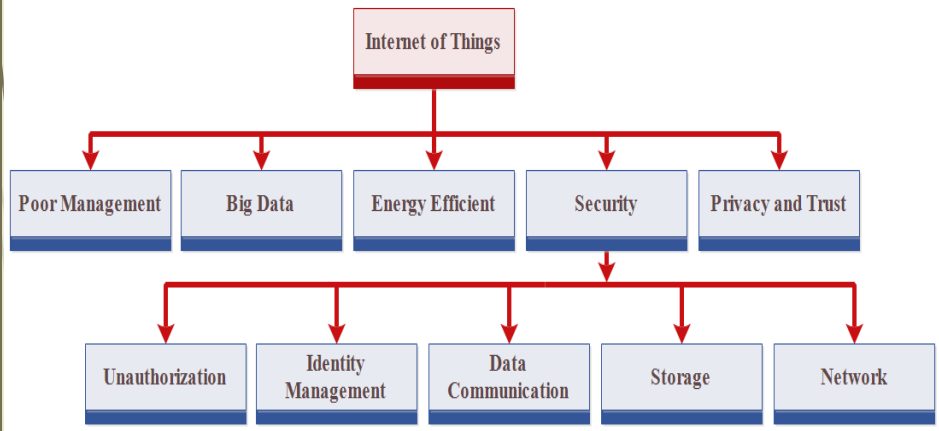
Security in IoT

- IoT devices are much closer to people's every day life than any other devices.
- Security/privacy issues are much more important in IoT since it may affect personal health or even life.
- No benefits of IoT can be provided without proper management of security and privacy.
- Different mechanisms are proposed for different layers of the IoT architecture.

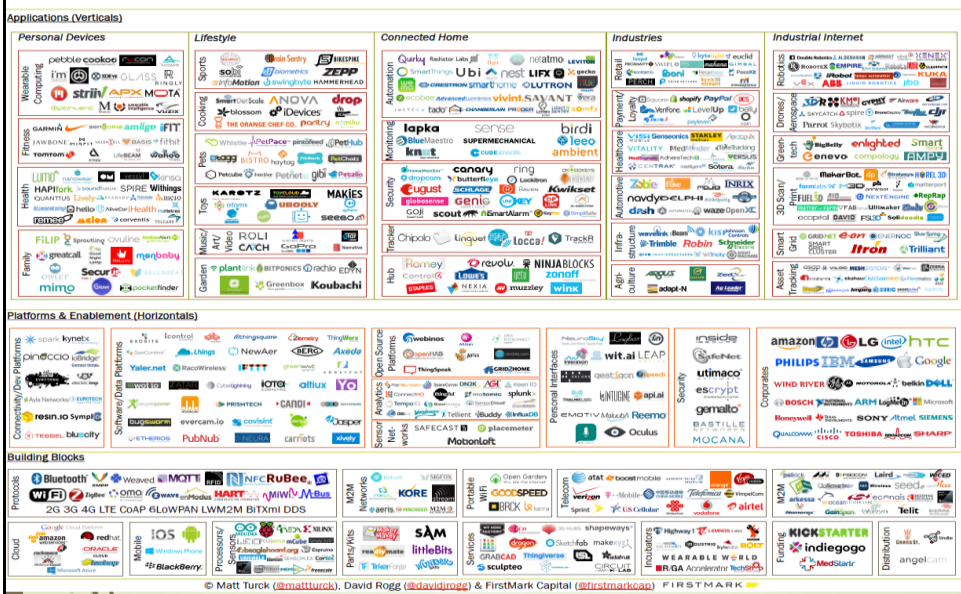
32

Challenges of IoT

- There are many research challenges ahead.



IoT Landscape 2019



IoT in Education

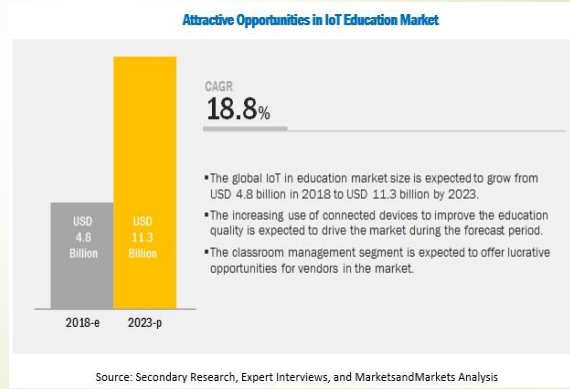
34

- IoT has the potential to transform education by profoundly altering how schools, colleges and universities gather data, interface with users and automate processes.
- IoT enables institutions to:
  - Create new ways for students to learn
  - Change how teachers deliver lessons and test achievement
  - Simplify operations for school administrators
  - Provide a safer environment for students and teachers

IoT in Education Market

35

- According to MarketsandMarkets, the global IoT educational market size is expected to grow from $4.8 billion in 2018 to $11.3 billion by 2023.



IoT Scenarios in School

36

- Smart white boards and other interactive digital media
- Solutions such as smart temperature sensors and smart heating, ventilation and air condition equipment
- Smart student ID cards, attendance-tracking devices, school bus tracking systems and parking sensors
- Wireless door locks, connected surveillance cameras and facial recognition systems
- Research programs

Challenges of IoT Deployment

37

- Provide a simple, automated process for IoT device onboarding.
- Supply the correct network resources for the IoT system to run properly and efficiently.
- Provide proper and rich IoT services/applications for teaching and learning
- Provide a secure environment against cyberattack and data loss.

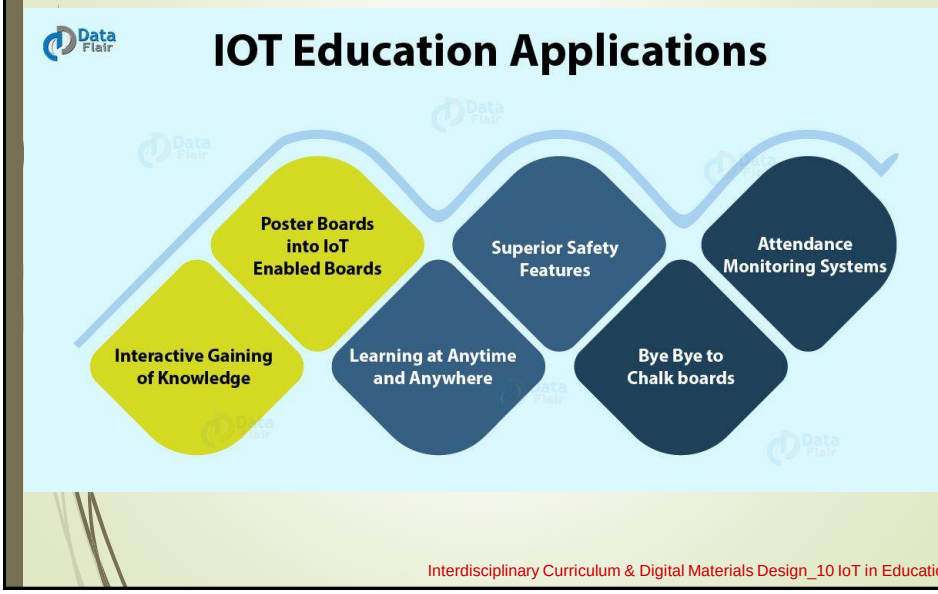
Security/Privacy is Crucial

38

- IoT in education brings an explosion of security and privacy threats.
- The proliferation of sensors and connected devices greatly expands the network attack surface and potential privacy invasion.
- Many IoT devices are manufactured without security/privacy in mind.
- IoT systems are increasingly the weak link for network security and privacy protection in educational institutions.

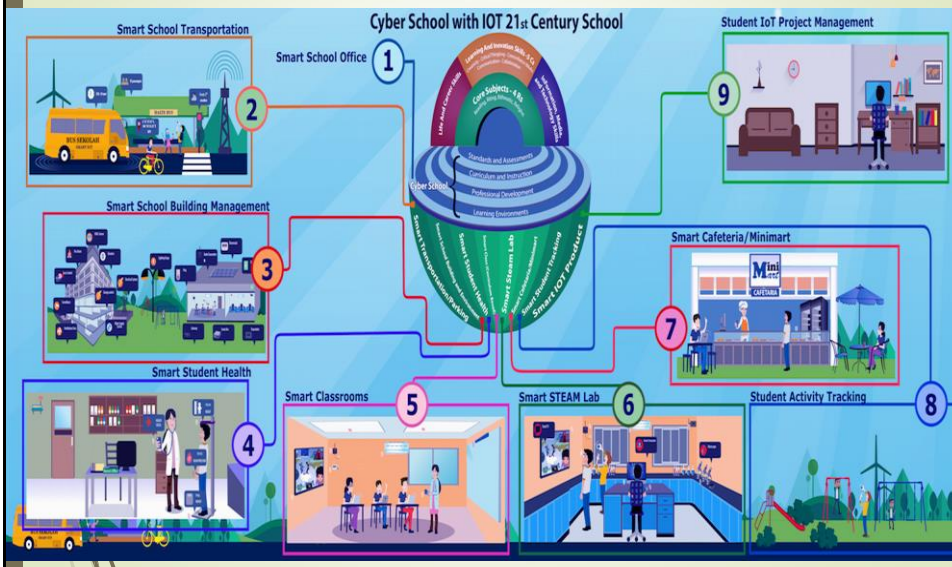
39

IoT Education Applications



40

IoT 21st Century School



41

IoT Use Case – Foreign Language Instruction

- One of the most powerful mechanisms for learning foreign languages is immersion, whose secret weapon is real-time feedback.
- Using connected devices to determine whether students have made the correct statements or selections in foreign language simulation environments, teachers are able to provide real-time feedback to students and automatically monitor student progress.

42

IoT Use Case – Connected/Smart Classrooms

- IoT applications will be the foundation on smart classrooms.
- Students will be automatically counted when the bell rings.
- Wearable devices will determine when the class is too tired or disengaged and may need a break.
- Smart whiteboards will record all notes taken in a class.
- Smart-microphones may even recognize when a teacher mentions there is a homework assignment due and update students' planners accordingly.

IoT Use Case – Smart IDs

43

- A school in Richmond, California, embeds RFID chips in ID cards to track the presence of students.
- Even if students are not present for check-in, the system will track and log their presence on campus.

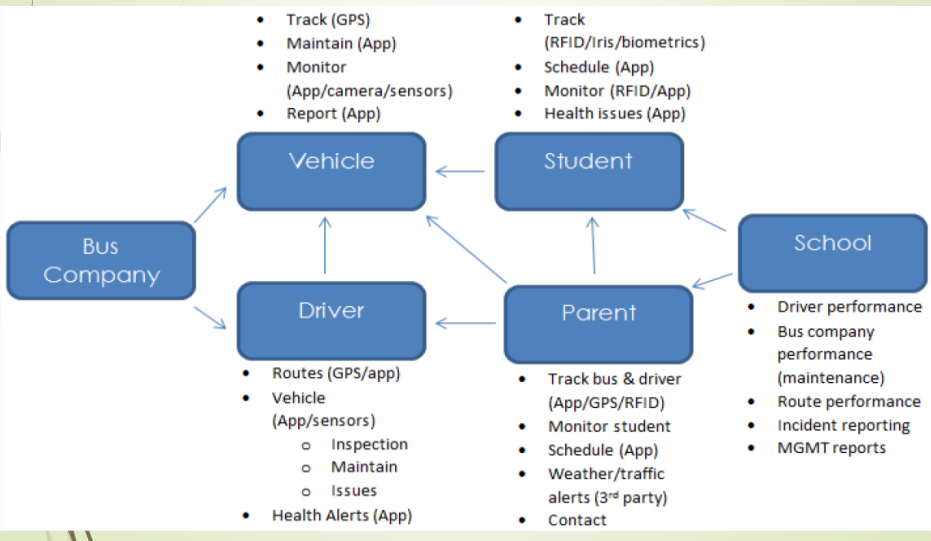
IoT Use Case – Task-Based Learning

44

- IoT facilitates the move from a knowledge transfer model to a collaborative, information-sharing model.
- In task-based instruction, students learn-by-doing and teachers assist when needed.
- IoT systems provide feedback, assistance, and classroom-level monitoring automatically.
- By signaling teachers for help and by increasing difficulty when necessary, no student falls too far behind nor gets too far ahead.

45

IoT Use Case – Smart Vehiclel Management



46

IoT Use Case – Disability Accommodation

- IoT devices and systems is a constructive way to provide educational assistance to disabled learners.
- Hearing-impaired students may utilize a connected gloves and a tablet to translate from sign language to verbal speech, converting sound into written language.

47

Other IoT Applications in Education

- Special education
- Physical education
- School security
- Classroom monitoring using Video-as-a-Sensor technology
- Attendance monitoring automation
- Student physical and mental health
- Learning from home
- Personalized learning
- . . .