CLOUD COMPUTING & INTERNET OF THINGS

EGCO103 INFORMATION TECHNOLOGY IN THE DAILY LIFE

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TOPIC COVERED

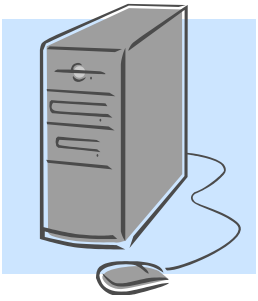
- Cloud Computing
- Mobile Devices
- Internet of Things (IoT)

CLOUD COMPUTING

DO YOU USE THE CLOUD ?

THE BACK STORY (1)

- Computers have internal or hard drive storage (C: Drive)
- CPU has a drive for storing programs, documents, pictures, videos, presentations, etc.
- Content is stored on THAT computer
- To use content must return to THAT computer
- Cannot access this content from another device or computer



Standard Computer Tower or Central Processing Unit (CPU)

Inside the Computer

THE BACK STORY (2)

- Programs
  - Purchase programs
  - Load to the computer
  - Each computer would need the program loaded and stored on the internal drive

THE BACK STORY (3)

- External Storage
  - Allows your content to become mobile
  - Save to the storage device
  - Take device to any compatible computer
  - Open and use content

CD/DVD

Thumb Drive

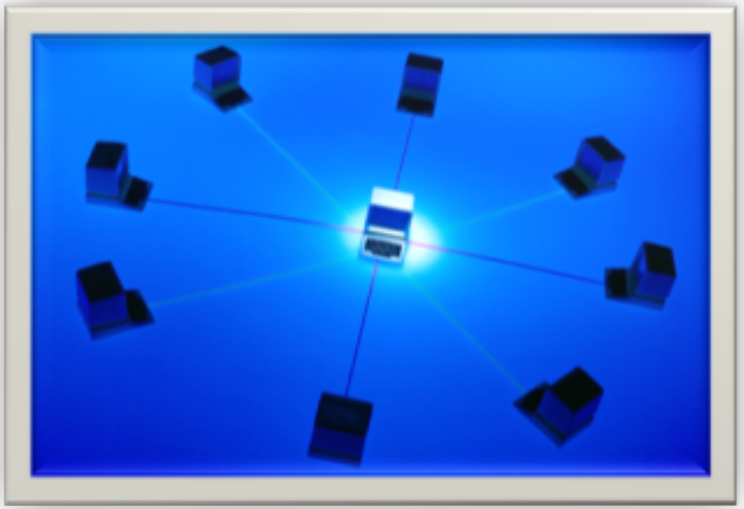
External Hard Drive

SD Card

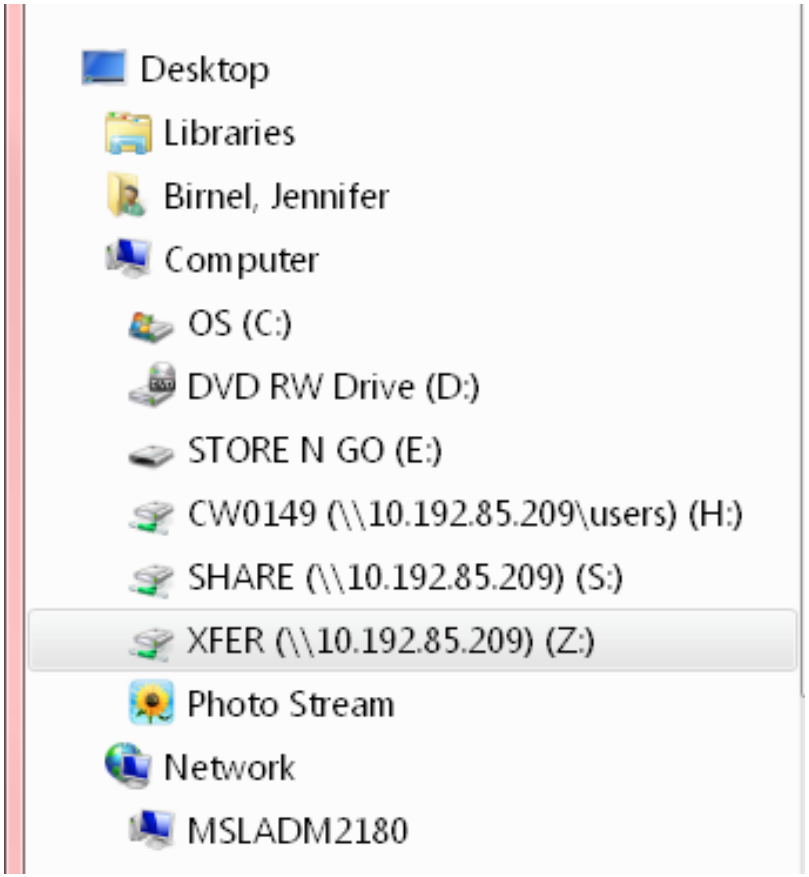
Micro SD Card

THE BACK STORY (4)

- Networked Storage
  - Multiple work stations talk to one unit that stores information and data.
  - Data is not saved to the C: drive, but to a network drive
  - Can retrieve the data stored to the network from any of the connected workstations.



THE BACK STORY (5)



- Saving documents
  - When you do a "save as" on your computer, you choose where to save the material.

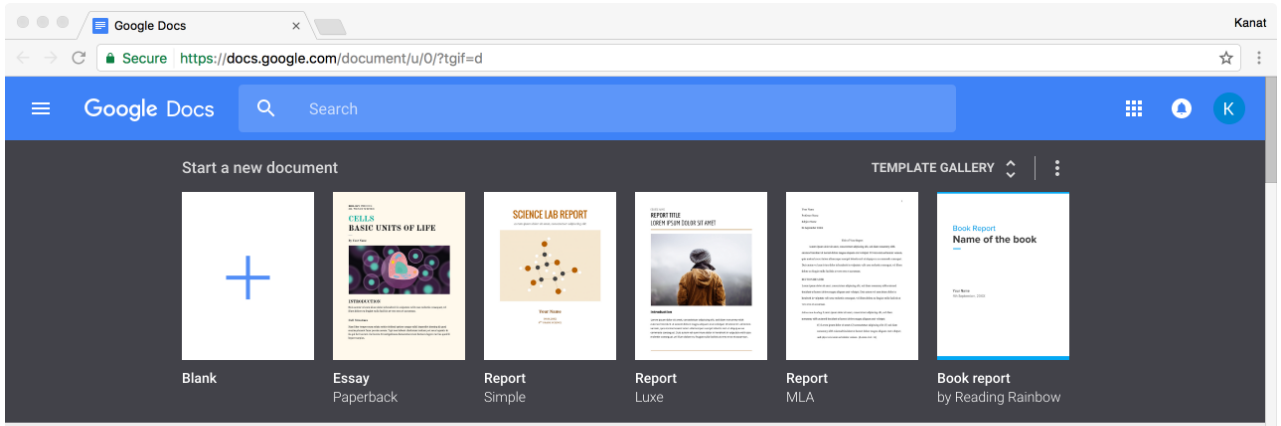
CLOUD STORAGE

- Create an Account – User name and password
- Content lives with the account in the cloud
- Log onto any computer with Wi-Fi to find your content

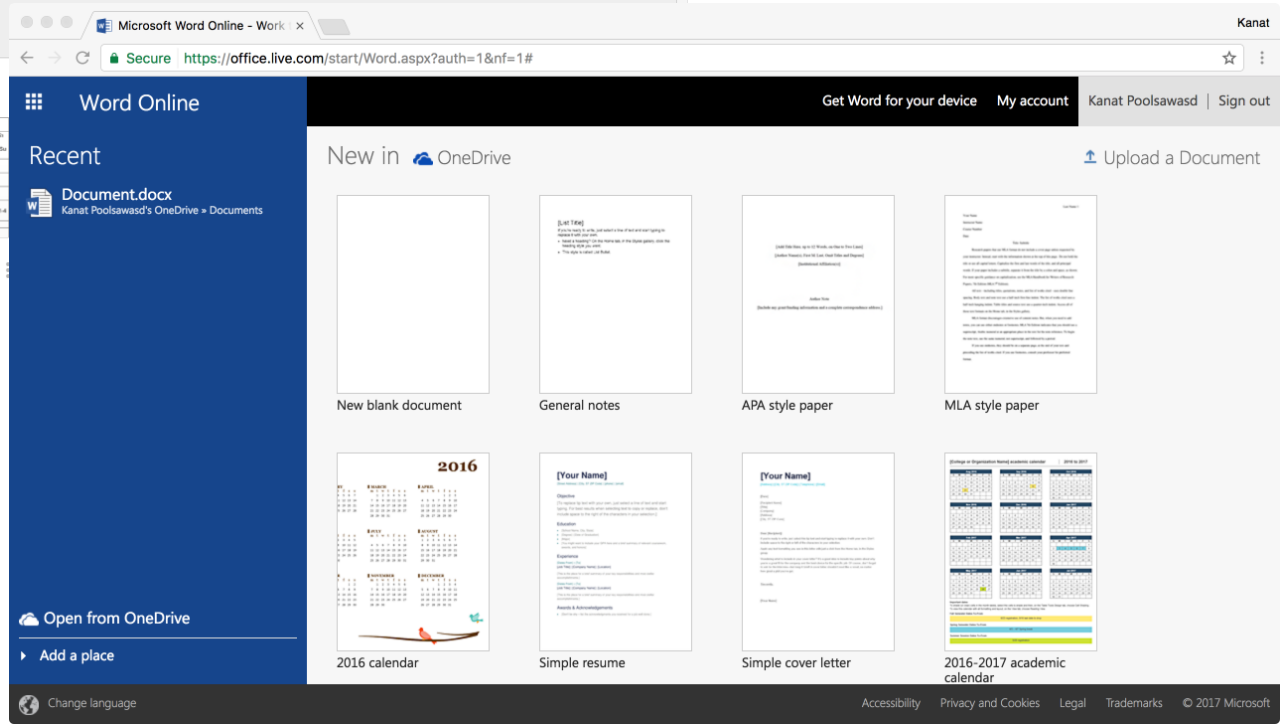
DOWNLOADS FOR STORAGE

- Download a cloud based app to a computer you own
- The app lives on your Computer
- Save files to the app
- When connected to the Internet it will sync with the cloud
- The Cloud can be accessed from any Internet connection

MORE THAN STORAGE (1)

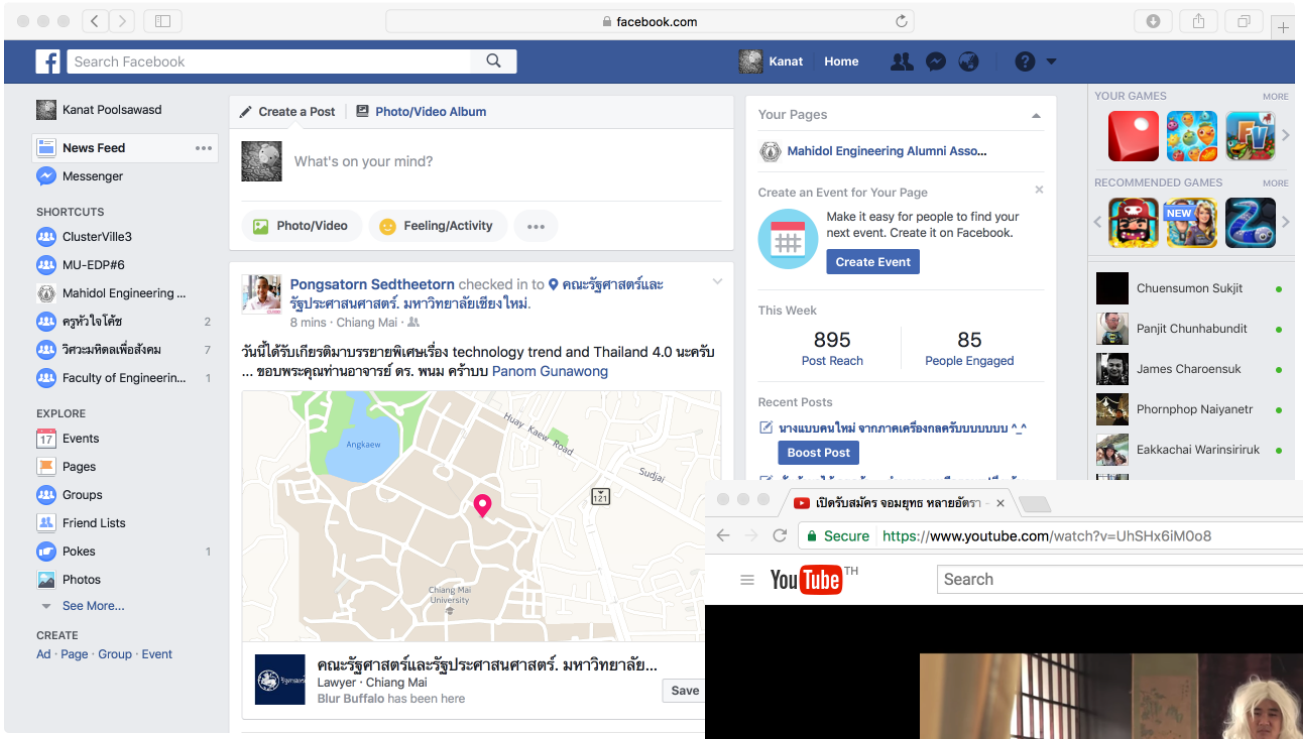


Google Docs

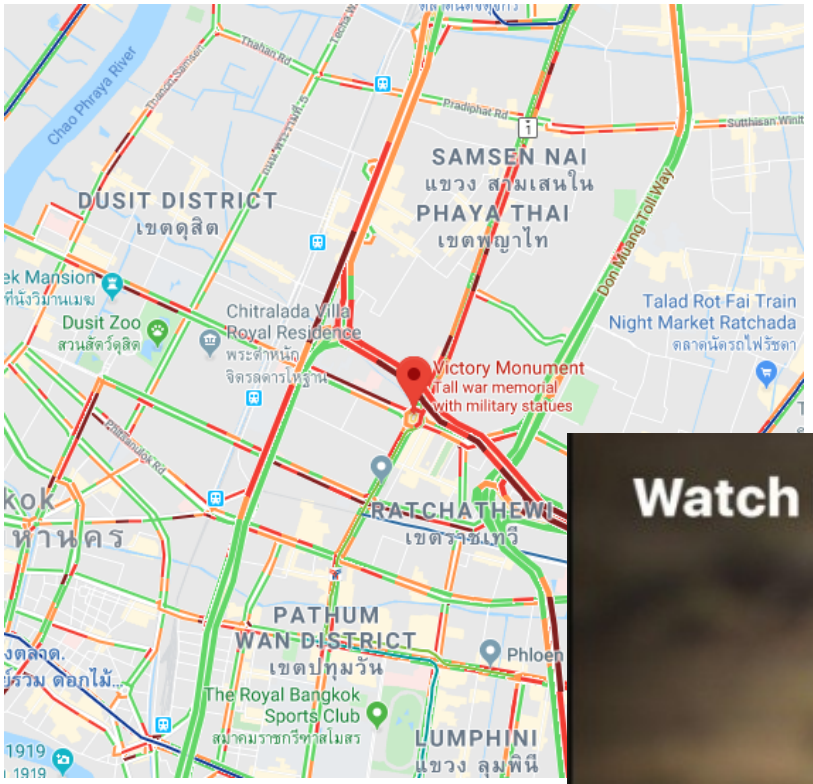


Word Online

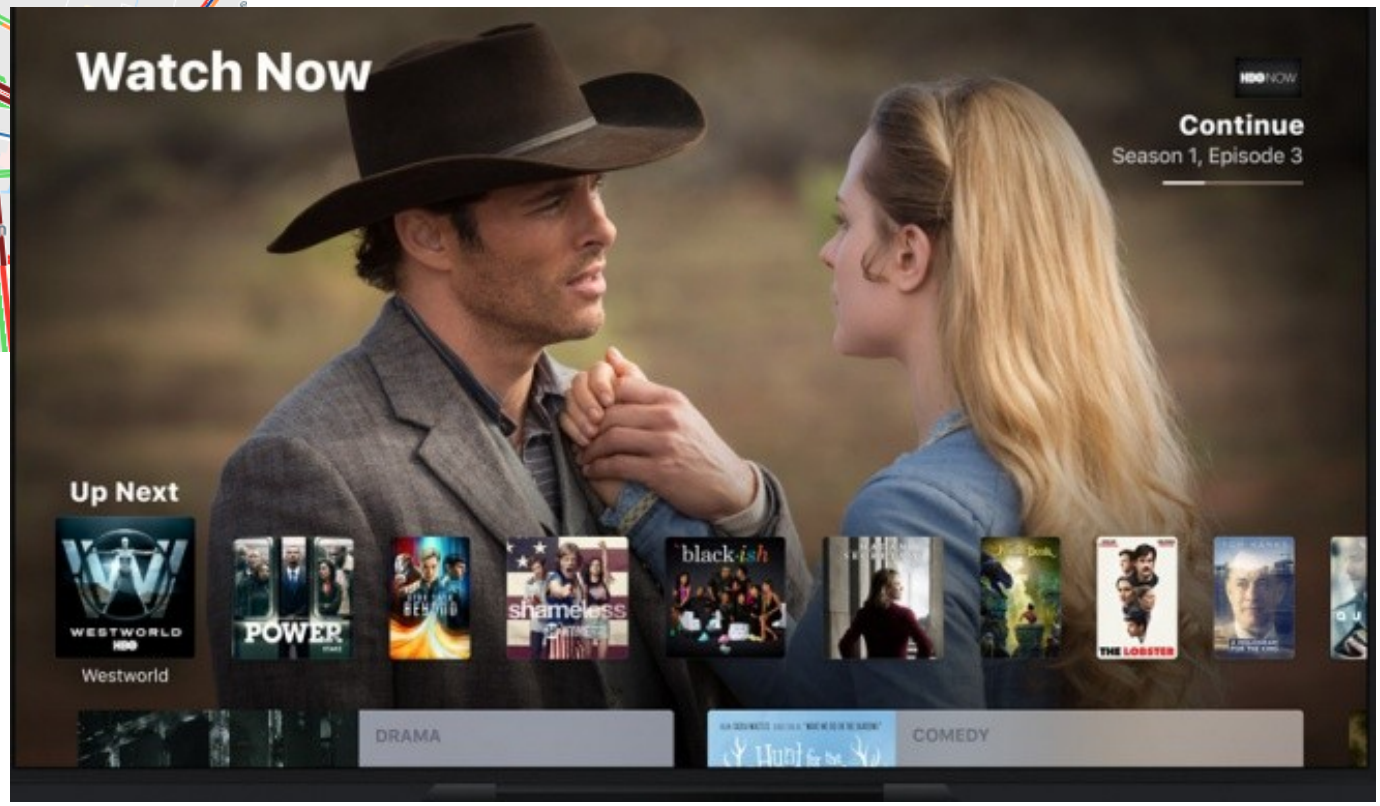
MORE THAN STORAGE (2)



MORE THAN STORAGE (3)

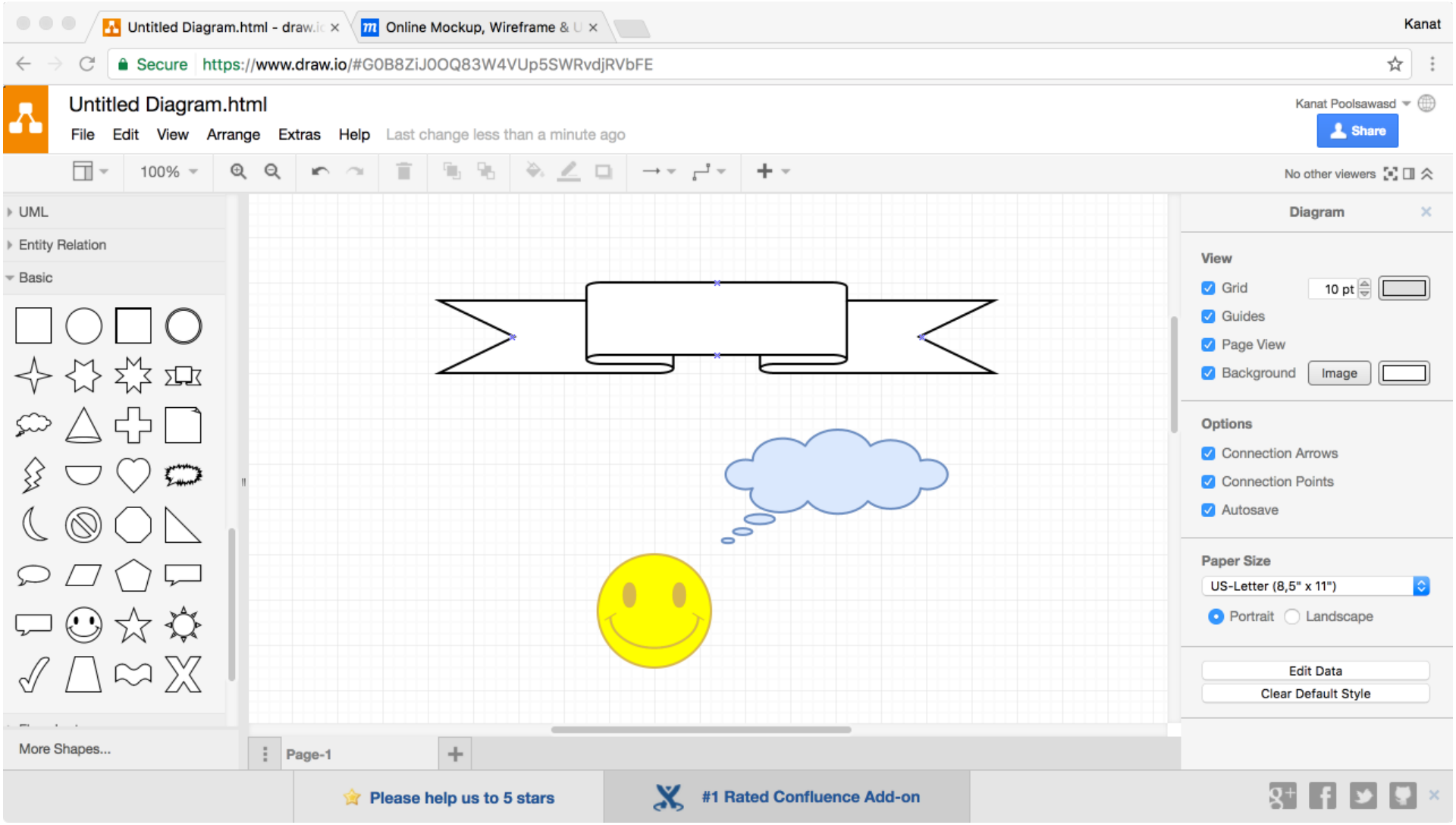


Google Maps

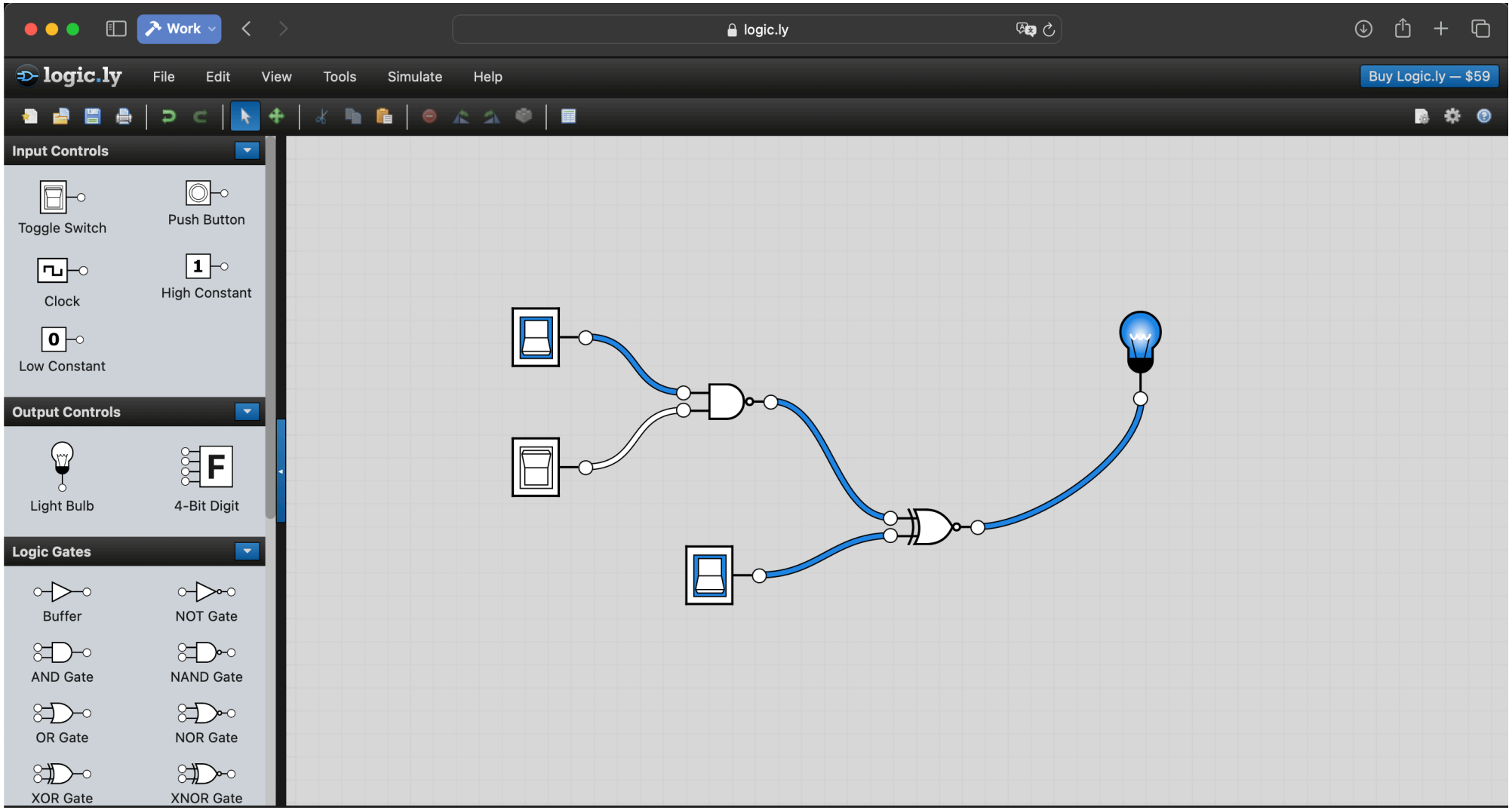


Apple TV

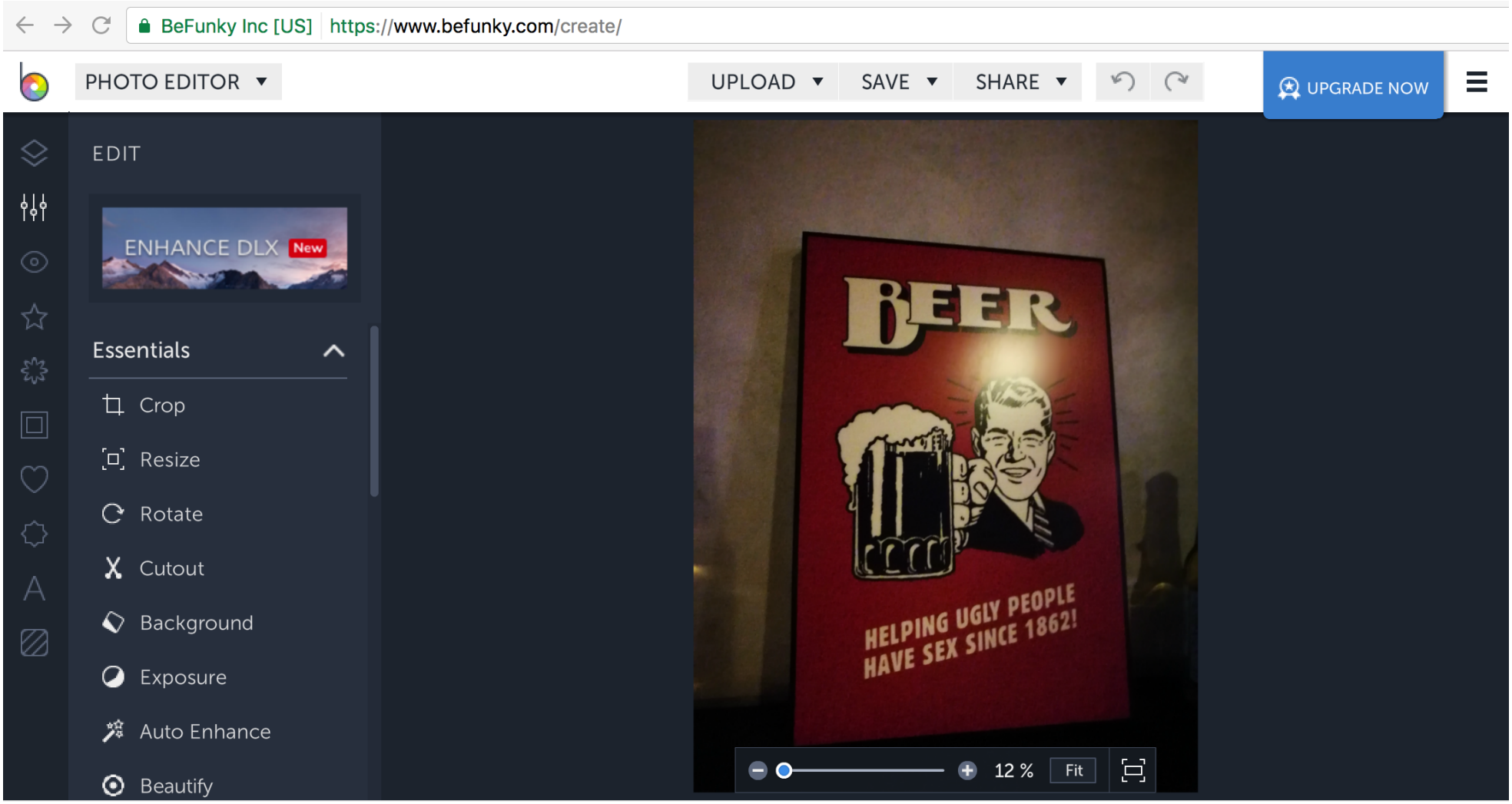
MORE EXAMPLE: DRAW.IO



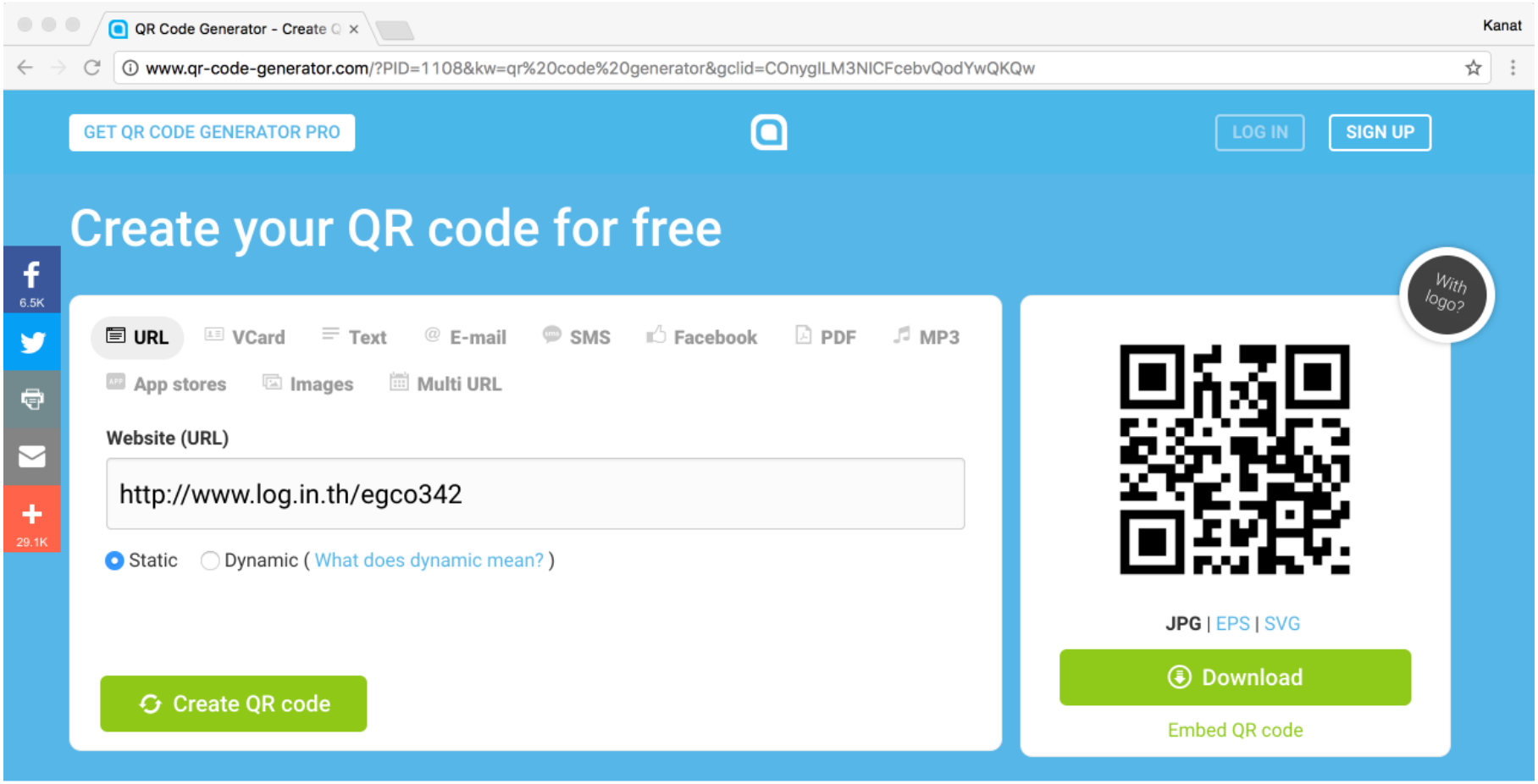
MORE EXAMPLE: LOGIC.LY



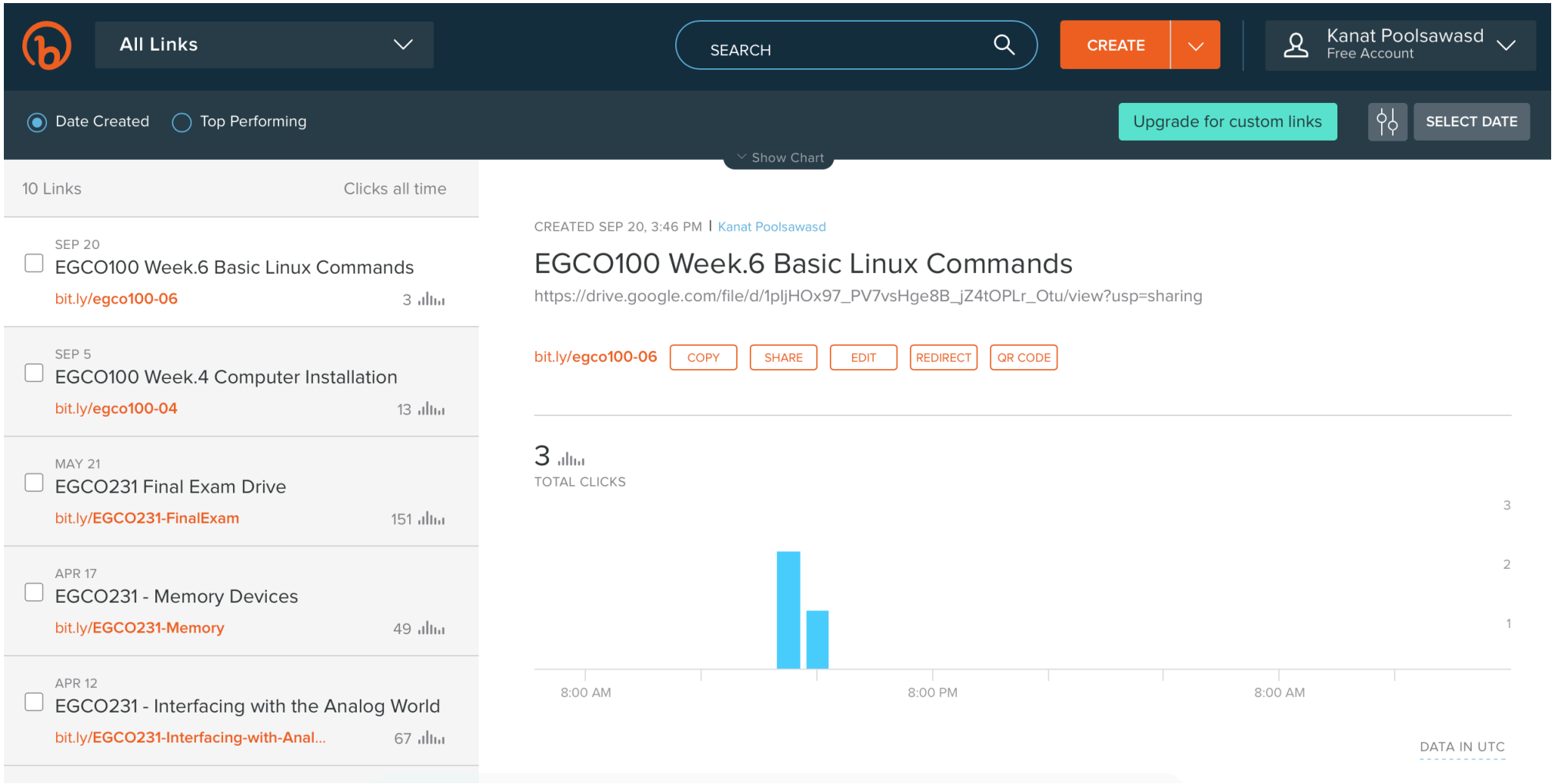
MORE EXAMPLE: BEFUNKY.COM



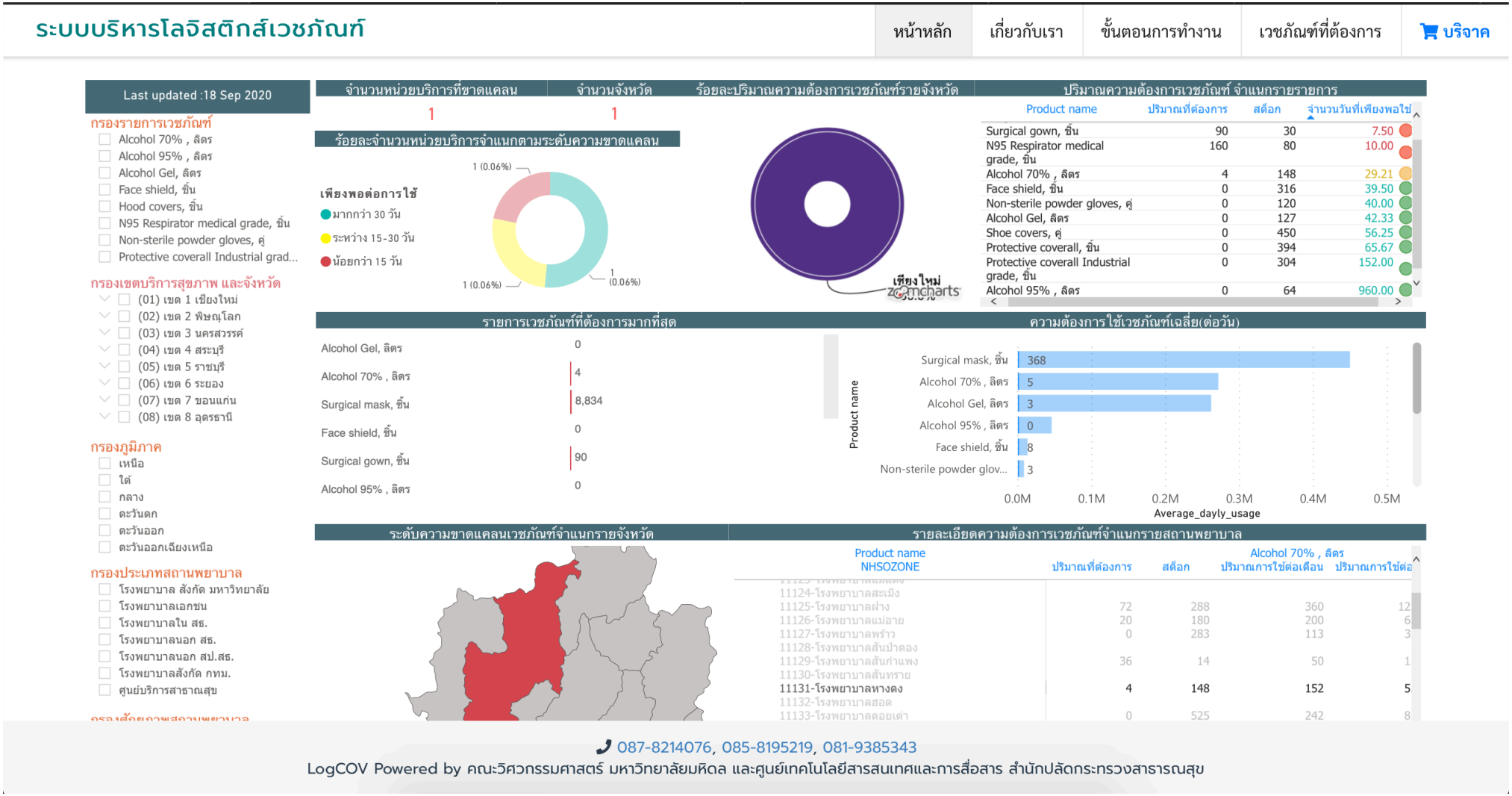
MORE EXAMPLE: QR-CODE-GENERATOR.COM



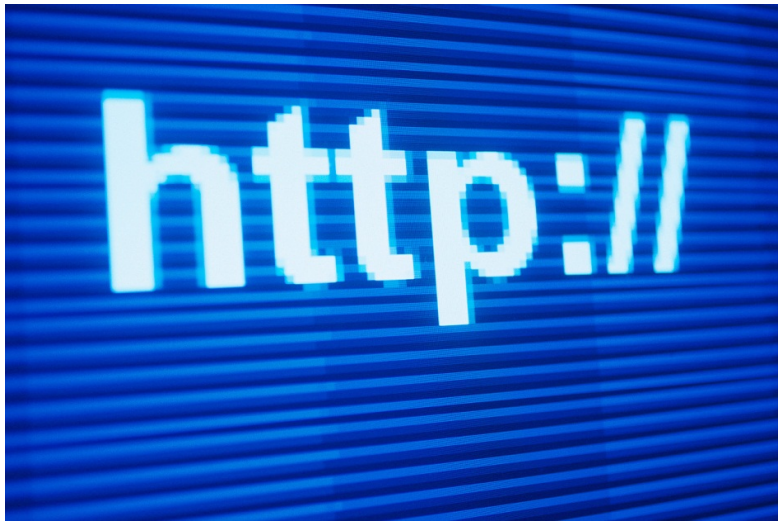
MORE EXAMPLE: BITLY.COM



MORE EXAMPLE: MICROSOFT POWER BI



INTERNET IS REQUIRED

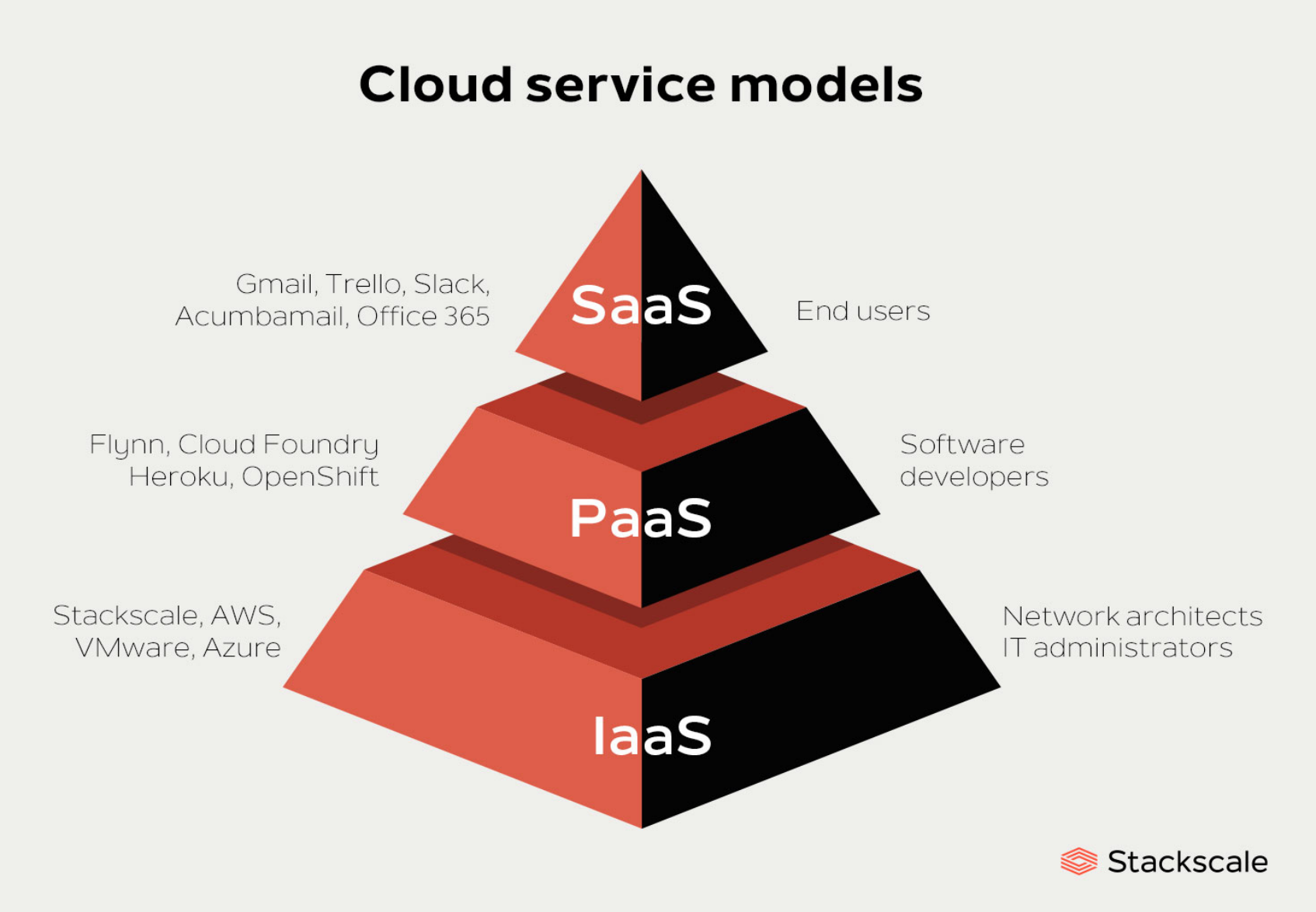


- Creation is happening in the cloud
- Saving is going to the cloud
- To retrieve files, must return to the cloud

BENEFITS

- Saving Large Files
- Multiple file types – Photos, videos, presentations, docs
- Back-up of stored files
- File Sharing
- Access from devices
- Nothing to forget (thumb drive, cd)
- Project collaboration

THE CLOUD COMPUTING STACK



SOFTWARE AS A SERVICE (SAAS)

- Software as a Service (SaaS) is software that is deployed over the internet.
- A provider licenses an application to customers either as a service on demand, through a subscription, in a "pay-as-you-go" model, or (increasingly) at no charge when there is opportunity to generate revenue from streams other than the user, such as from advertisement or user list sales
- Examples: Google Apps, Salesforce, Nivio, Learn.com.

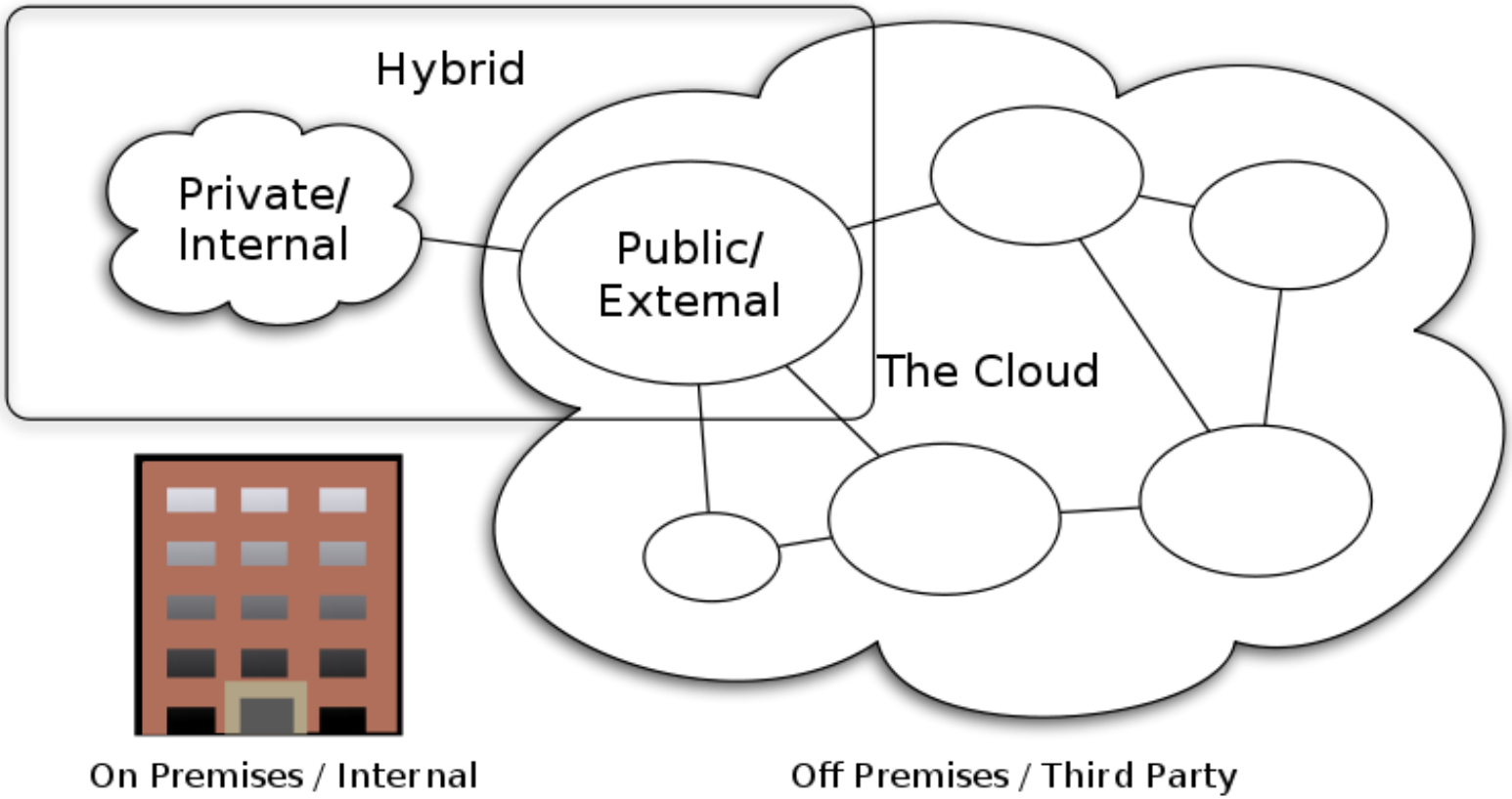
PLATFORM AS A SERVICE (PAAS)

- Platform as a Service (PaaS) brings the benefits that SaaS bought for applications, but over to the software development world. PaaS can be defined as a computing platform that allows the creation of web applications quickly and easily and without the complexity of buying and maintaining the software and infrastructure underneath it.
- PaaS is analogous to SaaS except that, rather than being software delivered over the web, it is a platform for the creation of software, delivered over the web.
- Examples: Windows Azure, Google App.

INFRASTRUCTURE AS A SERVICE (IAAS)

- Infrastructure as a Service (IaaS) is a way of delivering Cloud Computing infrastructure – servers, storage, network and operating systems – as an on-demand service. Rather than purchasing servers, software, datacenter space or network equipment, clients instead buy those resources as a fully outsourced service on demand
- Examples: Amazon EC2, GoGrid, iland, Rackspace Cloud Servers, ReliaCloud.

DEPLOYMENT MODEL



Cloud Computing Types

INFRASTRUCTURE AS CODE (IAC)

- Infrastructure as Code (IaC) is the practice of managing and provisioning computing infrastructure through code instead of manual processes.
- It enables automated, consistent, and repeatable deployment of infrastructure resources like servers, databases, networks, and load balancers using scripts or configuration files.
- This approach is central to DevOps and modern cloud environments, where infrastructure needs to be easily scalable, version-controlled, and maintainable.

KEY FEATURES OF IAC

- Automation: IaC scripts can automatically set up, configure, and tear down infrastructure, reducing human error and manual work.
- Version Control: Since IaC is written as code, it can be stored and tracked in version control systems like Git.
- Consistency: IaC ensures identical environments across development, testing, and production by using the same codebase.
- Scalability: IaC allows rapid scaling of infrastructure to meet demands without manual intervention.
- Documentation: IaC serves as documentation for the infrastructure setup, as the code specifies all configurations and dependencies.

ADVANTAGES OF CLOUD COMPUTING

DISADVANTAGES OF CLOUD COMPUTING

BUILD A SCHOOL IN THE CLOUD
BY SUGATA MITRA

MOBILE DEVICES

MOBILE DEVICES

- Personal Digital Assistant (PDA)
  - A handheld computer principally used for personal information management
- Smart Phone
  - Internet-enabled cell phone that can support mobile applications

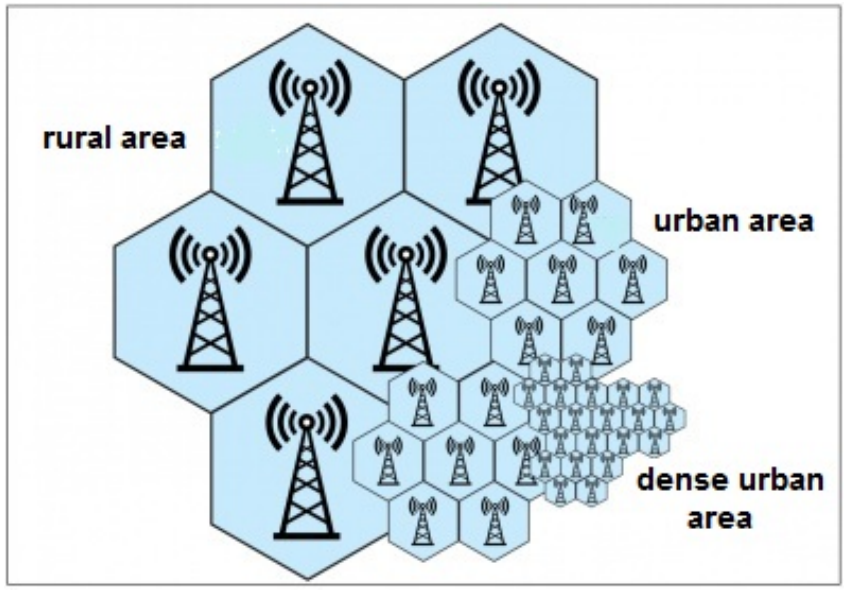
WIRELESS MOBILE OR MOBILE WIRELESS

- Wireless communication systems is type of communication system.
- Dimensions of mobility:
  - The set of properties that distinguishes the mobile computing system from stationary computing system

WIRELESS MOBILE ENVIRONMENT

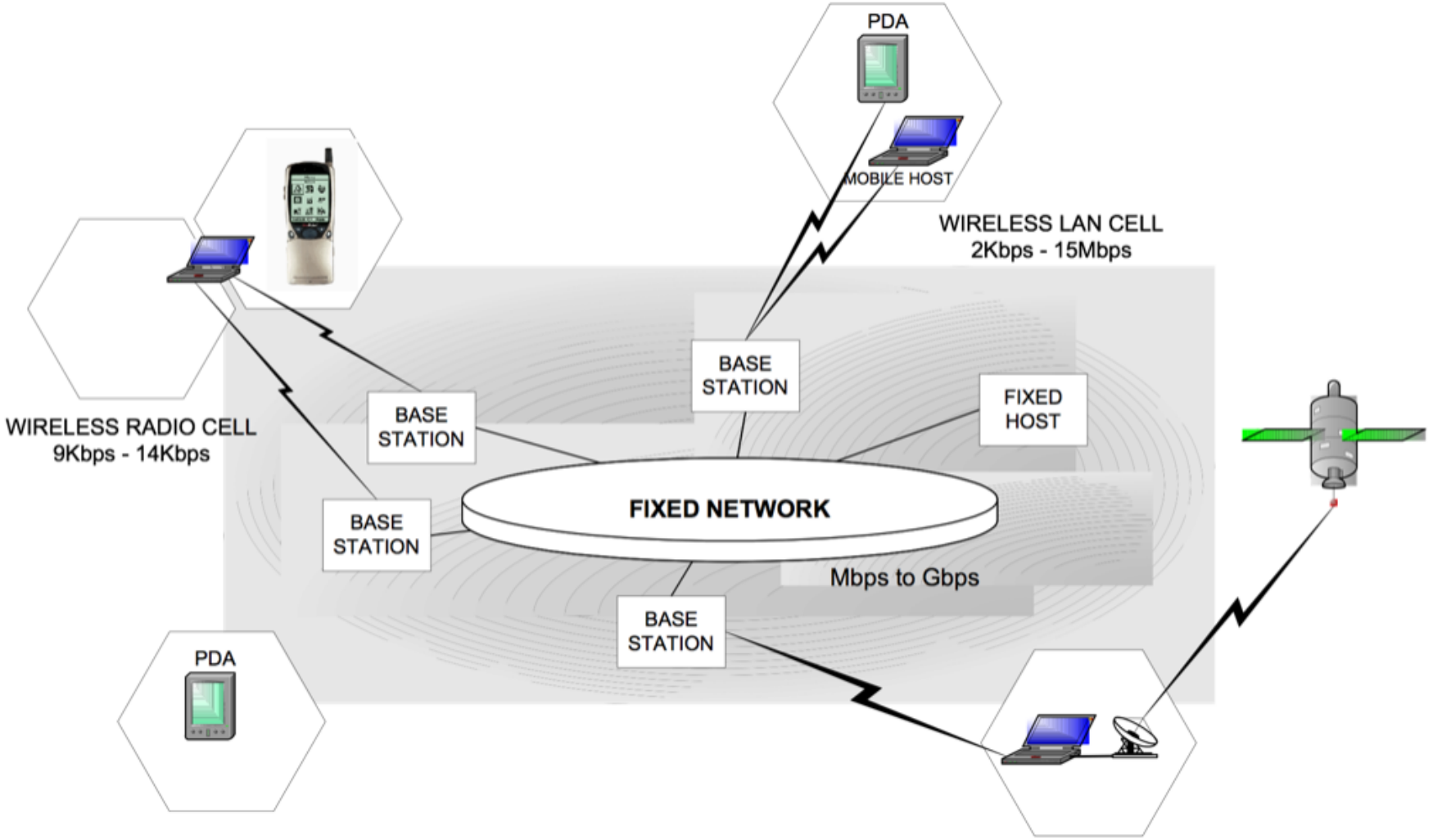
	WIRED	WIRELESS
MOBILE	LAPTOP COMPUTER	FEATURE PHONE TABLET SMART PHONE
FIXED	DESKTOP COMPUTER LANDLINE PHONE CABLE TELEVISION	RADIO (CLASSIC) PC WITH WIRELESS LAN

WIRELESS & CELLULAR COMMUNICATION



- Transmitting voice, data, video and other services data using electromagnetic waves in open space (atmosphere).
- Cellular communication:
  - Wireless communication using unguided media, that is, radio and microwave frequencies or satellites, has found widespread use in mobile phones.

MOBILE NETWORK ARCHITECTURE



WIRELESS CHARACTERISTICS

- Variant Connectivity
  - Low bandwidth and reliability
- Frequent disconnections
  - Sudden
- Asymmetric Communication
  - Broadcast medium
- Monetarily expensive
  - Charges per connection or per message/packet
- Connectivity is weak, Intermittent and Expensive

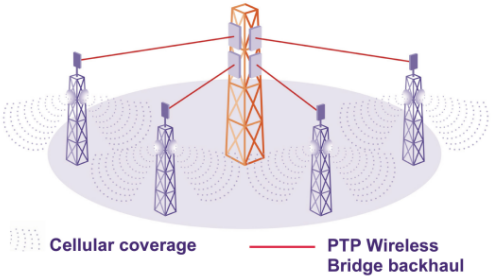
MOBILITY CHARACTERISTICS

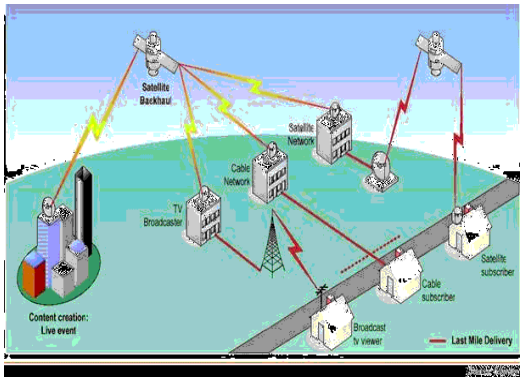
- Location changes
  - Location management - cost to locate is added to communication
- Heterogeneity in services
  - Bandwidth restrictions and variability
- Dynamic replication of data
  - Data and services follow users
- Querying data - location-based responses
- Security and authentication
- System configuration is no longer static

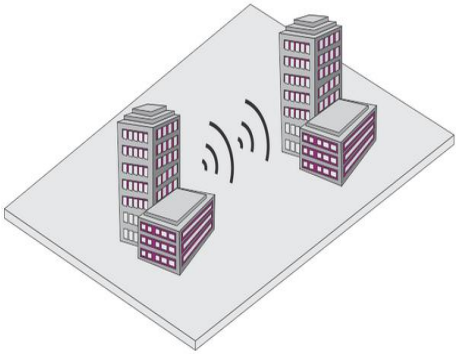
PORTABILITY CHARACTERISTICS

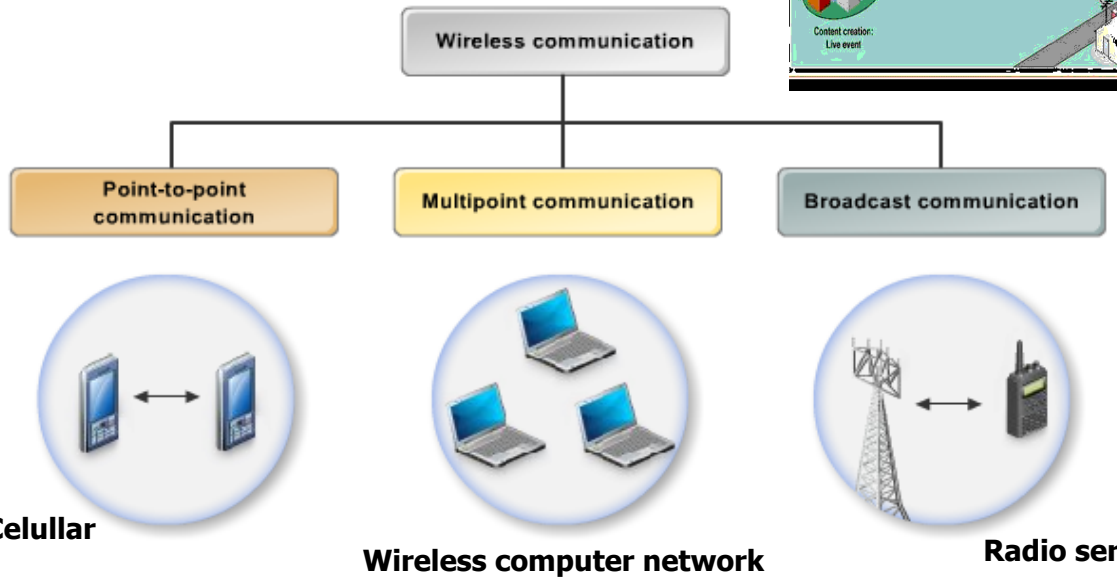
- Battery power restrictions
  - Transmit/Receive, disk spinning, display, CPUs, memory consume power
- Battery lifetime will see very small increase
  - Need energy efficient hardware (CPUs, memory) and system software
- Resource constraints
  - Mobile computers are resource poor
  - Reduce program size – interpret script languages (Mobile Java Script?)
- Small screen sizes
  - Power Consumption vs. Resource Utilization

TYPES OF WIRELESS COMMUNICATION









HOW A MOBILE NETWORK WORKS

WIRELESS TELECOMMUNICATIONS NETWORKS (1)

- 1G
  - The first generation of wireless technology, which was analog based
- 2G
  - The second generation of digital wireless technology; accommodates voice and text
- 2.5G
  - An interim wireless technology that can accommodate voice, text, and limited graphics

WIRELESS TELECOMMUNICATIONS NETWORKS (2)

- 3G
  - The third generation of digital wireless technology; supports rich media such as video
- 3.5G
  - This generation was inserted into the ranks of cell phone generations; it refers to the packet-switched technologies used to achieve higher transmission speeds
- 4G
  - The expected next generation of wireless technology that will provide faster display of multimedia

5G VS 4G: WHAT IS THE DIFFERENCE?

- The fifth generation (and the latest generation) of cellular network technology. 5G cellular networks are expected to provide higher data rates, lower latency, and many more connections than previous generations of cellular network technologies.
- One critical difference is that 5G networks use unique radio frequencies to accomplish what 4G networks cannot. While some 5G networks use higher frequencies, such as those at 30 GHz or more, 4G uses frequencies below 6 GHz.

RADIO WAVES CONNECT DEVICES

5G AND FRAMING

WHAT IS 6G ?

- 6G or the sixth generation of cellular network technology, is a successor of 5G technology. This technology is currently under development.
- However, many wireless communication companies have already started testing 6G networks in some areas. It is anticipated that the 6G network will be accessible completely by the year 2030.

WIMAX

- WiMax stands for Worldwide Inter-operability for Microwave Access.
- This technology is based on IEEE 802.16. It is used to provide higher data rates with increased coverage. It is based on MAN (Metropolitan Area Network) technology.
- Its range is upto 50 Km. It may provide speed upto 70 Mbps and it can operate in Non-Line-of-Sight. This technology is fast, convenient and cost effective.

MOBILE COMPUTING DEVICES

- Smartphone
- Tablet Computer
- Ultra-Mobile PC
- Wearable Computer
- Etc.

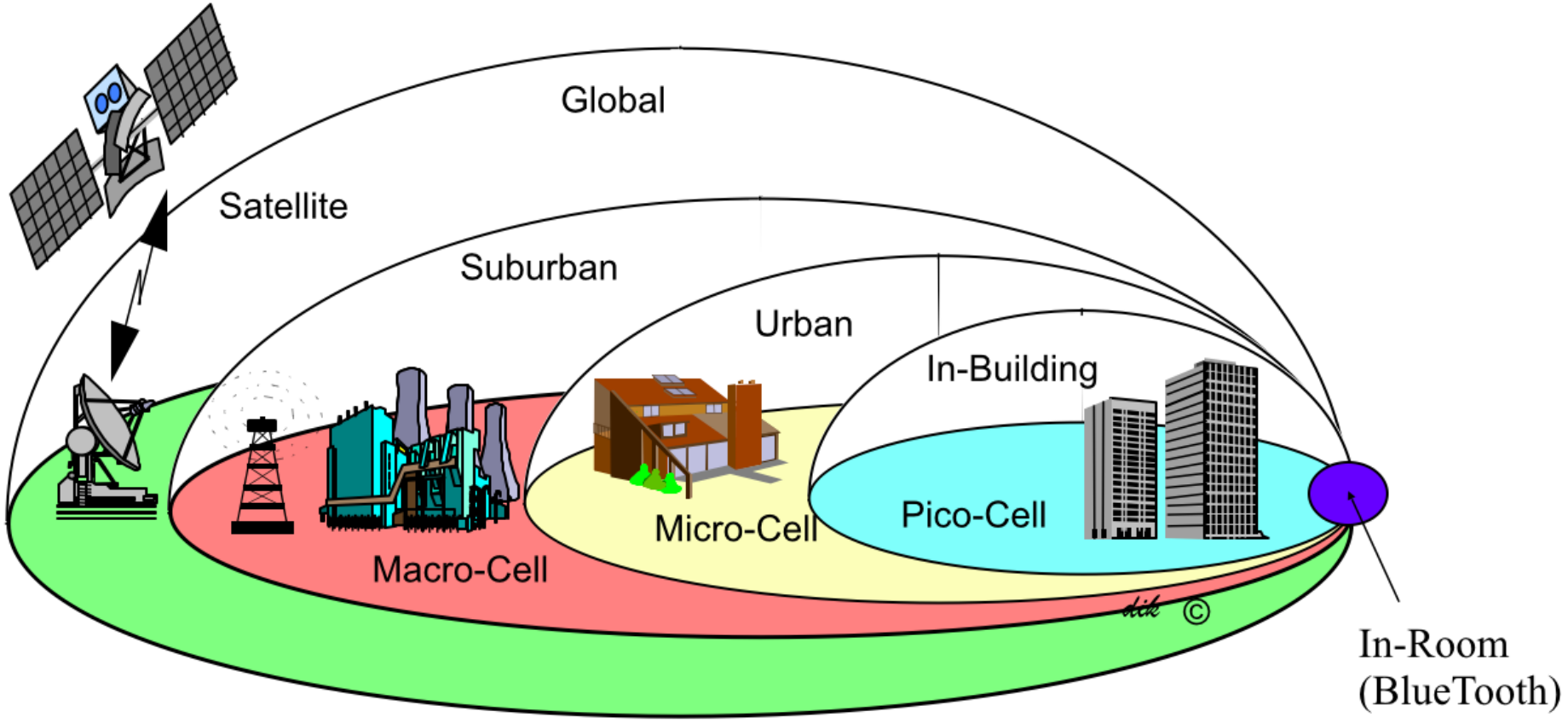
MOBILE COMPUTING LIMITATIONS (1)

- **Range & Bandwidth:** Mobile Internet access is generally slower than direct cable connections.
- **Security Standards:** When working mobile, one is dependent on public networks.
- **Power Consumption:** rely entirely on battery power
- **Transmission Interferences:** Weather, terrain, and the range from the nearest signal point can all interfere with signal reception.

MOBILE COMPUTING LIMITATIONS (2)

- **Potential Health Hazards:** more likely to be involved in traffic accidents.
- **Human Interface with Device:** Screens and keyboards tend to be small, which may make them hard to use.

IMPRESSIVE WIRELESS INFRASTRUCTURE



MOBILE APPLICATIONS

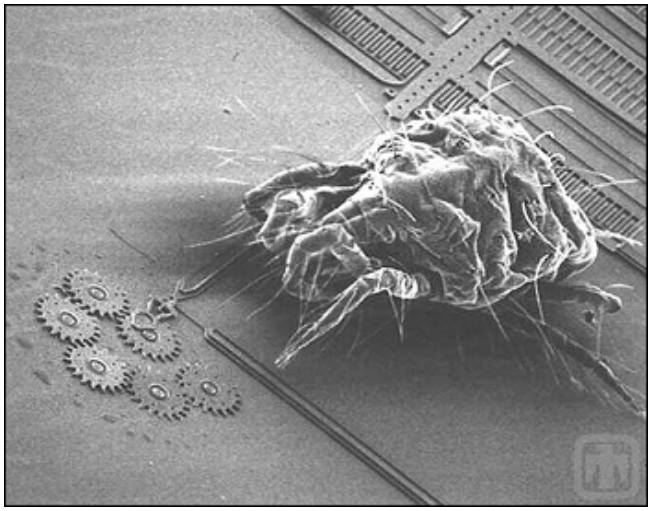
- Expected to create an entire new class of Applications
  - New massive markets in conjunction with the Web
  - Mobile Information Appliances - combining personal computing and consumer electronics
- Applications:
  - Vertical: vehicle dispatching, tracking, point of sale
  - Horizontal: mail enabled applications, filtered information provision, collaborative computing…

GENERAL EXAMPLES OF MOBILE COMPUTING APPLICATIONS

- Vehicles
- Emergencies
- Traveling Salesman
- Entertainment
- Education
- Location Dependent Services etc.

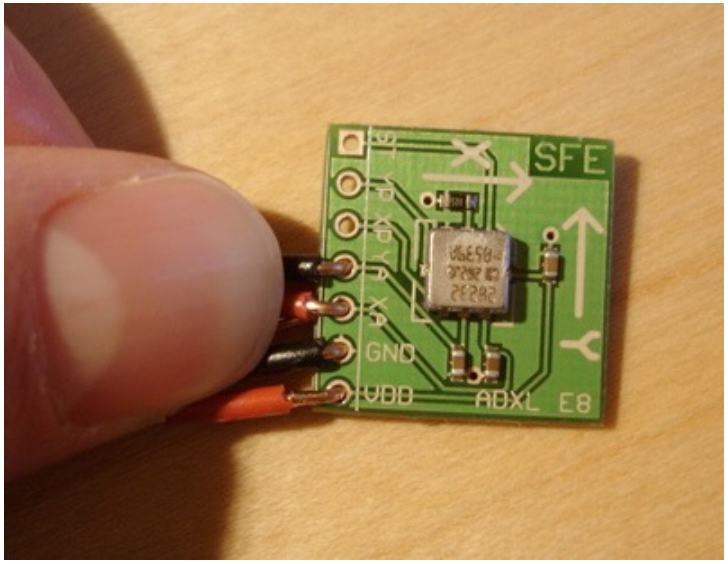
MICRO-ELECTRO-MECHANICAL SYSTEM (MEMS)

- Micro-Electro-Mechanical Systems, or MEMS, is a technology that in its most general form can be defined as miniaturized mechanical and electro-mechanical elements (i.e., devices and structures) that are made using the techniques of micro fabrication.
- The critical physical dimensions of MEMS devices can vary from well below one micron on the lower end of the dimensional spectrum, all the way to several millimeters.



ACCELEROMETER (1)

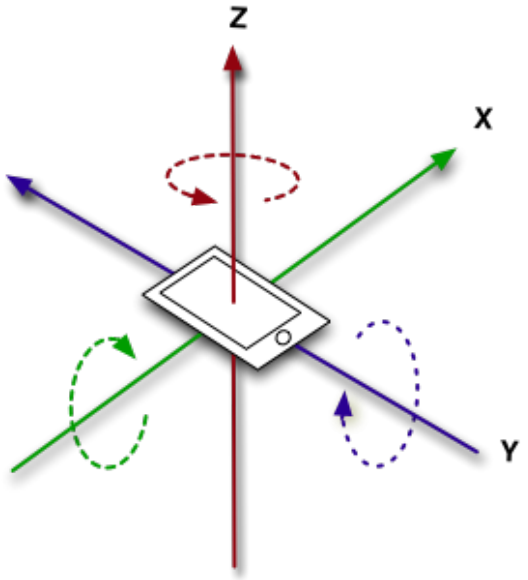
- An accelerometer is an electromechanical device that will measure acceleration forces. These forces may be static, like the constant force of gravity pulling at your feet, or they could be dynamic - caused by moving or vibrating the accelerometer.



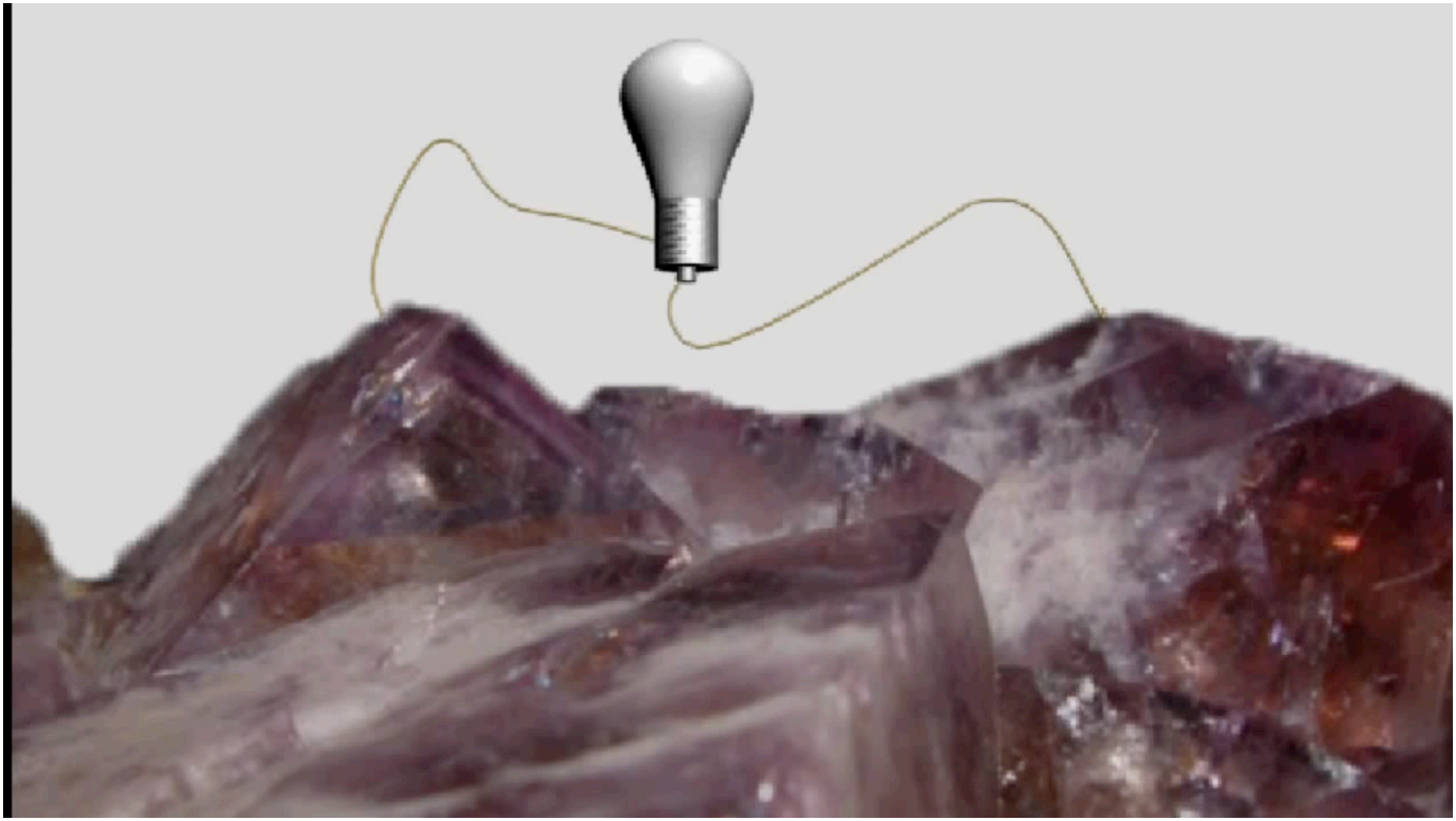
ACCELEROMETER (2)

GYROSCOPE (1)

- A gyroscope is a device that uses Earth's gravity to help determine orientation. Its design consists of a freely-rotating disk called a rotor, mounted onto a spinning axis in the center of a larger and more stable wheel. As the axis turns, the rotor remains stationary to indicate the central gravitational pull, and thus which way is "down."



GYROSCOPE (2)



USES OF A GYROSCOPE OR ACCELEROMETER

- The main difference between the two devices is simple: one can sense rotation, whereas the other cannot.
- The accelerometer can gauge the orientation of a stationary item with relation to Earth's surface.
- The gyroscope maintains its level of effectiveness by being able to measure the rate of rotation around a particular axis.

BLUETOOTH (1)

- Bluetooth wireless technology is a short-range communications system, intended to replace the cable(s) connecting portable and/or fixed electronic devices.
- Created by telecom vendor Ericsson in 1994, from the first Bluetooth enabled device in 1999, to 2008 more than 2 billion devices were using the Bluetooth technology
- In 2010 have been sold 906 million mobile phones Bluetooth enabled, in 2011 more than 40 million Bluetooth enabled health and medical devices were already in the market, as well as one third of all new vehicles produced worldwide in 2011 include Bluetooth technology.

BLUETOOTH (2)

- Bluetooth sends and receives radio waves in a band of 79 different frequencies (channels) centered on 2.45 GHz, set apart from radio, television, and cellphones, and reserved for use by industrial, scientific, and medical gadgets.

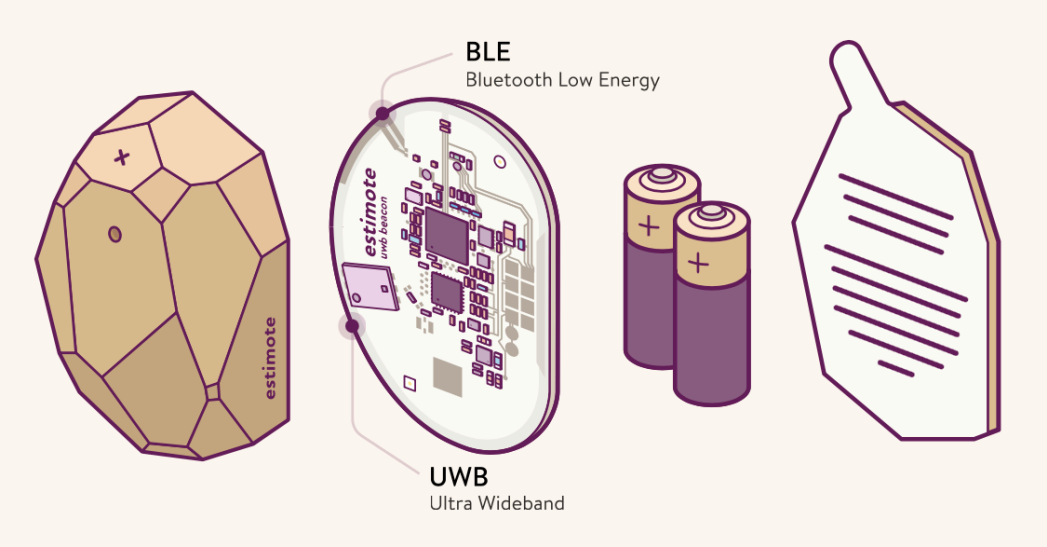
BLUETOOTH LOW ENERGY (BLE)

- Bluetooth Low Energy is famous under many names: BLE, its registered trademark. Originally, it has been designed by Nokia under the name of Wibree before being finally implemented by the GIS
- The BLE technology provides an easy and a reliable interface, which is highly appreciated by consumer electronics manufacturers, mobile application developers and engineers. It has become increasingly suitable for all matters related to the Internet of Things (IoT), which is a fast growing industry nowadays.

BEACON TECHNOLOGY

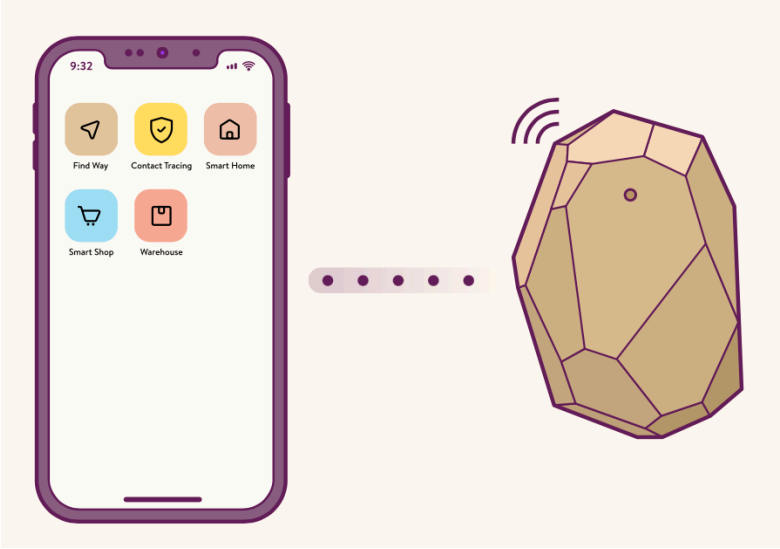
- Beacons are small, wireless transmitters that use low-energy Bluetooth technology to send signals to other smart devices nearby.
- They are one of the latest developments in location technology and proximity marketing. Put simply, they connect and transmit information to smart devices making location-based searching and interaction easier and more accurate.

HOW BEACON WORKS ?



Beacon is a tiny, battery-powered computer. It has several radio modules such as BLE.
It runs intelligent firmware that periodically transmits low-power BLE signals. It can run on small batteries for years.

The iOS SDK allows you to create applications that react to the proximity of many beacons and tags at once.
The API lets you access both distance and angle of the nearby beacons.
Telemetry data including battery status or motion is also available.

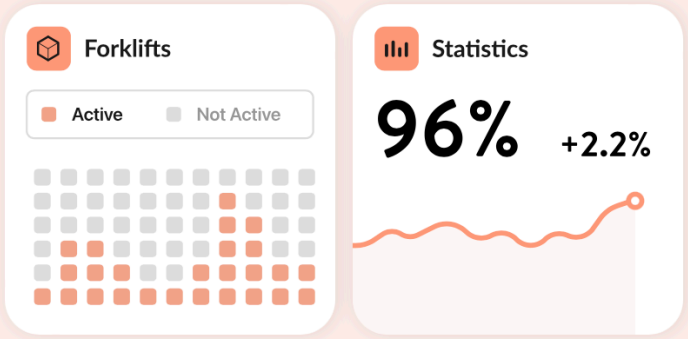


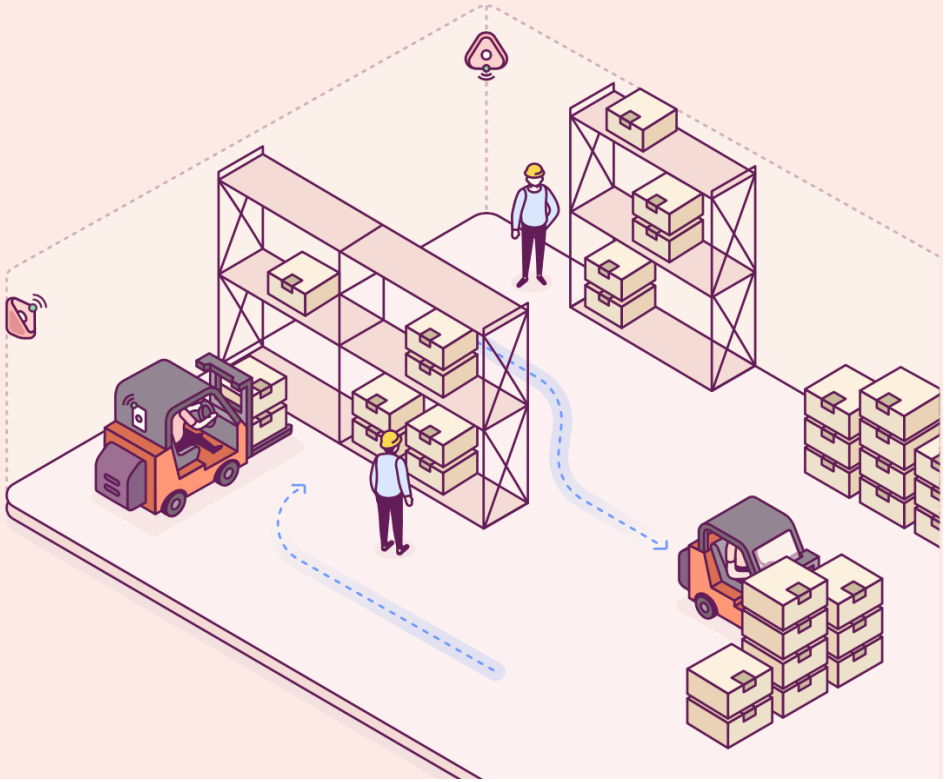
BEACON CASE STUDIES (1)

Asset tracking

See inch-precise position of your key assets real-time. Program in JavaScript notifications or automations crafted for your business.

Example widgets:





* https://estimote.com/

BEACON CASE STUDIES (2)

Airport Safety

Track location of minors, wheelchairs or other equipment to provide safer travel experience.

Example widgets:

Airport Zones

10:01 AM EST

Passport Control
JFK Airport

● Completed

Journey

LOCATION	STATUS
JFK Airport New York	● Checked In
BOS Airport Boston	● Pending
SFO Airport San Francisco	● Pending

* https://estimote.com/

RFID

- RFID is an acronym for “radio-frequency identification” and refers to a technology whereby digital data encoded in RFID tags or smart labels (defined below) are captured by a reader via radio waves.
- RFID is similar to barcoding in that data from a tag or label are captured by a device that stores the data in a database.
- RFID, however, has several advantages over systems that use barcode asset tracking software. The most notable is that RFID tag data can be read outside the line-of-sight, whereas barcodes must be aligned with an optical scanner.

RFID VS. BLE

Features	Radio Frequency Identification (RFID)	Bluetooth Low Energy (BLE)
Response	Identification	Identification + Positioning + Sensor
Frequency Range	3 - 5 m per reader	5 – 50 m per reader
Reader Range	1 - 5 ft.	20 ft.
Reader Cost	$1500 - $2000	$10 - $70
Tag Cost	$0.10	$20
Enabled Sensor	No	Yes
Memory Storage	No	Yes
Integration	Difficult	Easy
Smartphone Compatibility	No	Yes
Battery Life	Really Long	2 - 5 Years

NEAR FIELD COMMUNICATION

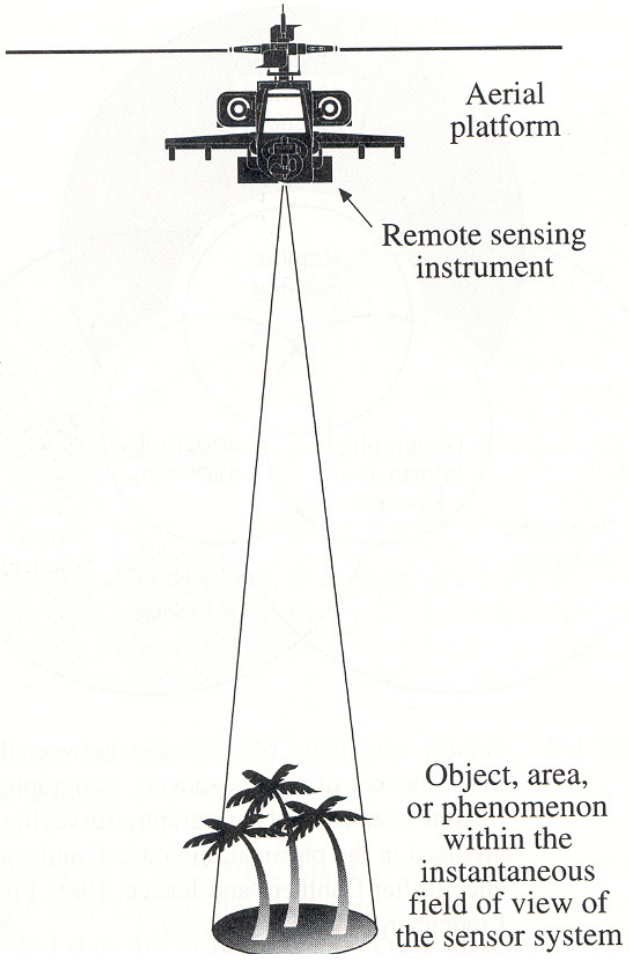
- Near Field Communication (NFC) is a wireless technology that pairs distichs for communication and data sharing.
- Data can be transferred between two devices that are kept within 10 m of distance.
- One device can connect to only one device at a time. The transfer of data takes place at a speed of 424 kbps.
- An NFC device with power can pair or communicate with non-powered NFC chips. This technology suits best for payments and money transfer between two devices, collecting and transferring information etc.

NFC VS. BLUETOOTH

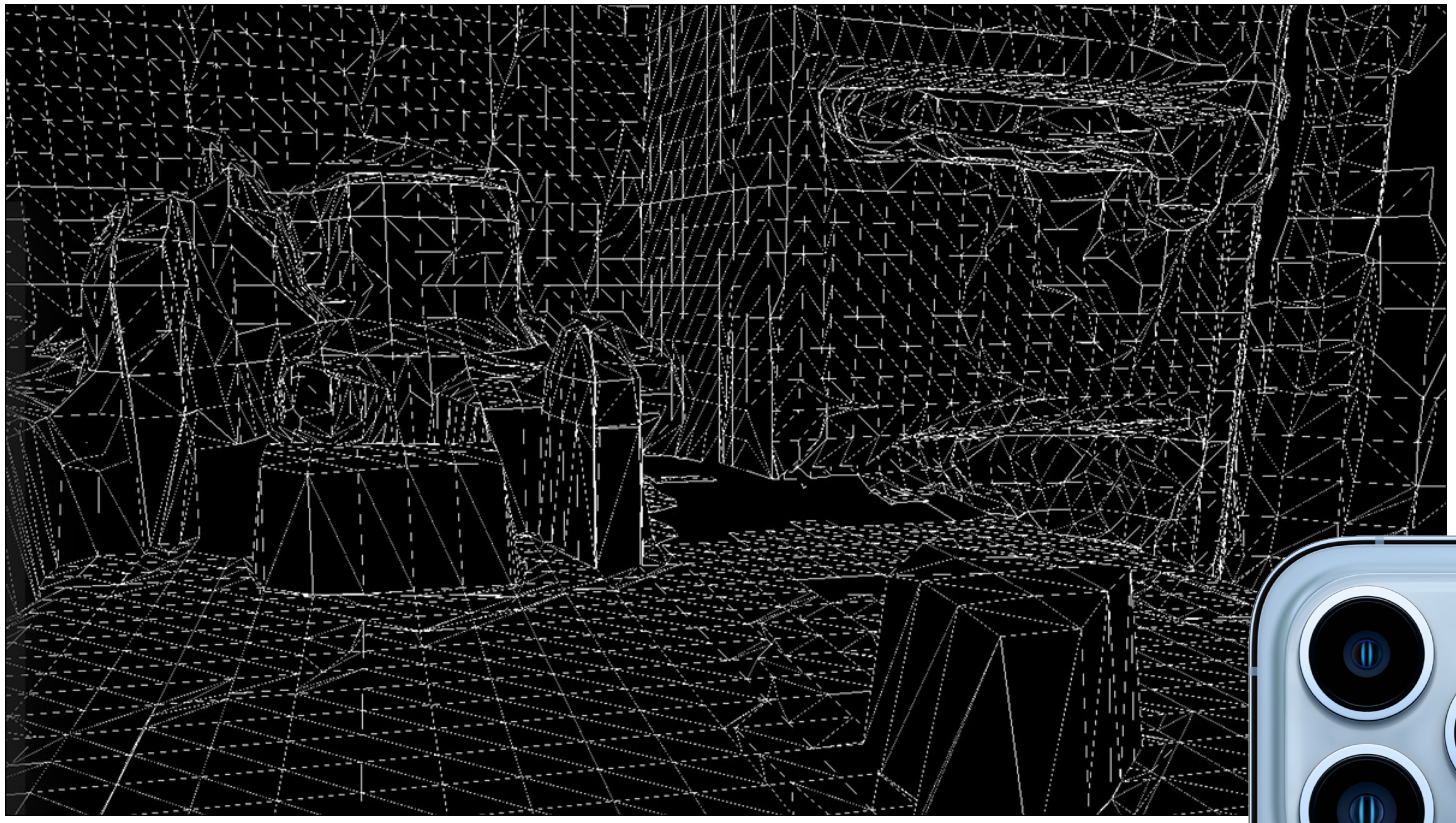
Point of Comparison	NFC	Bluetooth
Technology	Interacting electromagnetic radio fields	Direct radio transmissions
Communication Frequency	13.56 MHz	2.04 GHz
Standards	ISO, ETSI, ECMA	IEEE
Maximum Data Transfer Rate	424 kbits/s	1 to 3 Mbit/s
Simultaneous Connectivity	Only 2 devices at a time	Up to 8 devices at a time
Transmission Range	Up to 4 cm	Up to 10 m

LIDAR

- LIDAR (Light Detection and Ranging)
- LASER (Light Amplification by the Stimulated Emission of Radiation)
- Amplified electromagnetic radiation of a specific frequency and wavelength generated by stimulated emission.
- The radiation emitted by a laser consists of a coherent beam of photons, all in phase and having the same polarization
- Commonly generated in the UV-Visible-IR spectral range



LIDAR IN IPHONE PRO



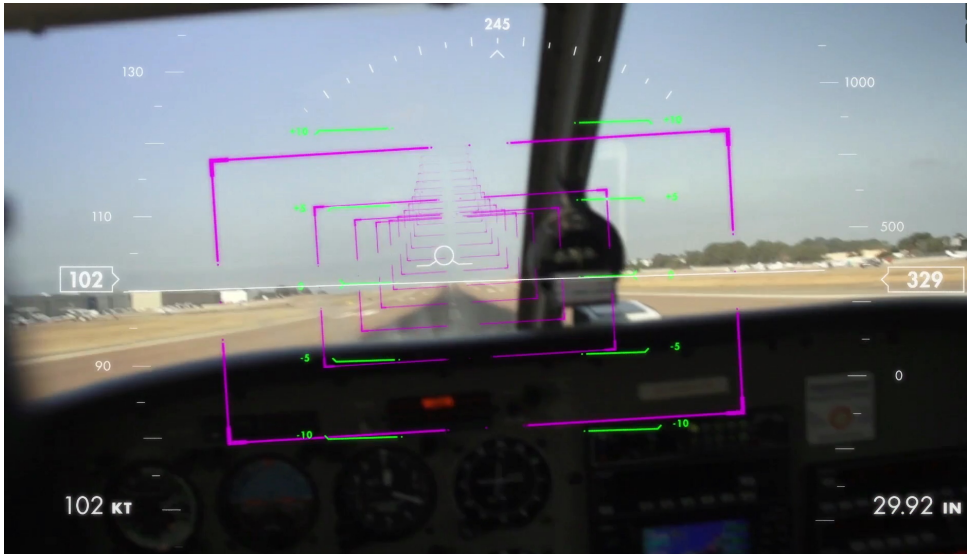
AUGMENTED REALITY (1)

- Augmented Reality (AR) let us see the real-life environment right in front of us with a digital augmentation overlaid on it.

AUGMENTED REALITY (2)

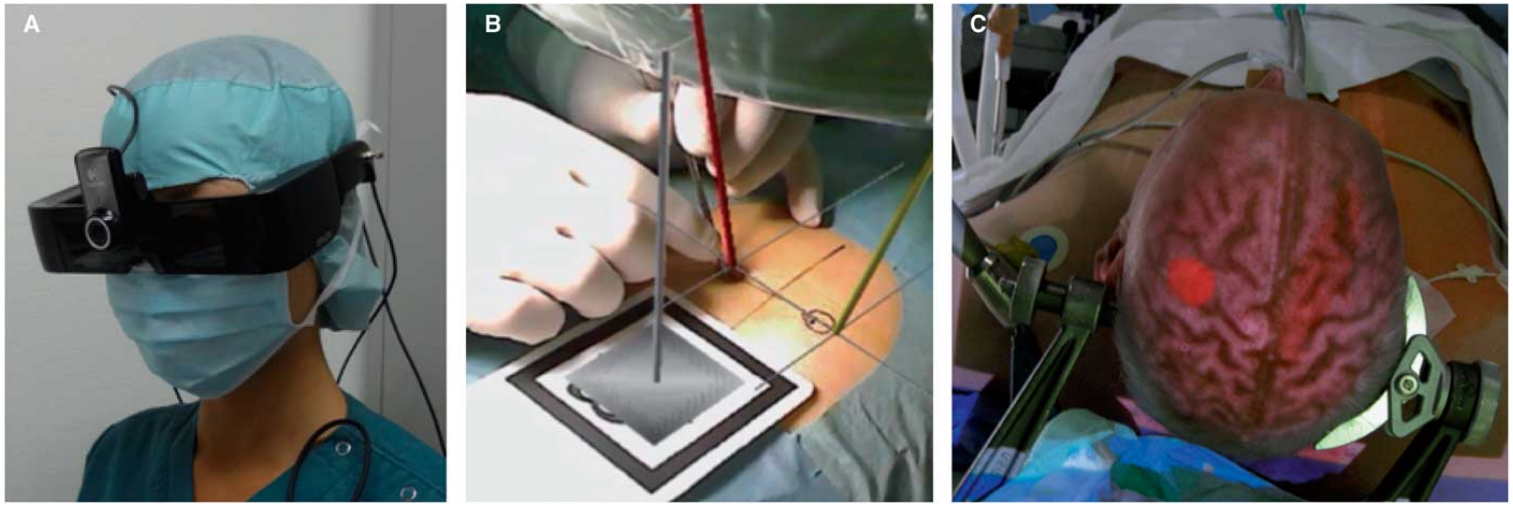
- There are as many uses for AR in our everyday lives as there are Pikachu on the loose in Pokemon GO. Here are just a few examples:
  - Enhanced navigation systems use augmented reality to superimpose a route over the live view of the road.
  - During football games, broadcasters use AR to draw lines on the field to illustrate and analyze plays.
  - Furniture and housewares giant IKEA offers an AR app (called IKEA Place) that lets you see how a piece of furniture will look and fit in your space.

AUGMENTED REALITY (3)



(a)

(b)



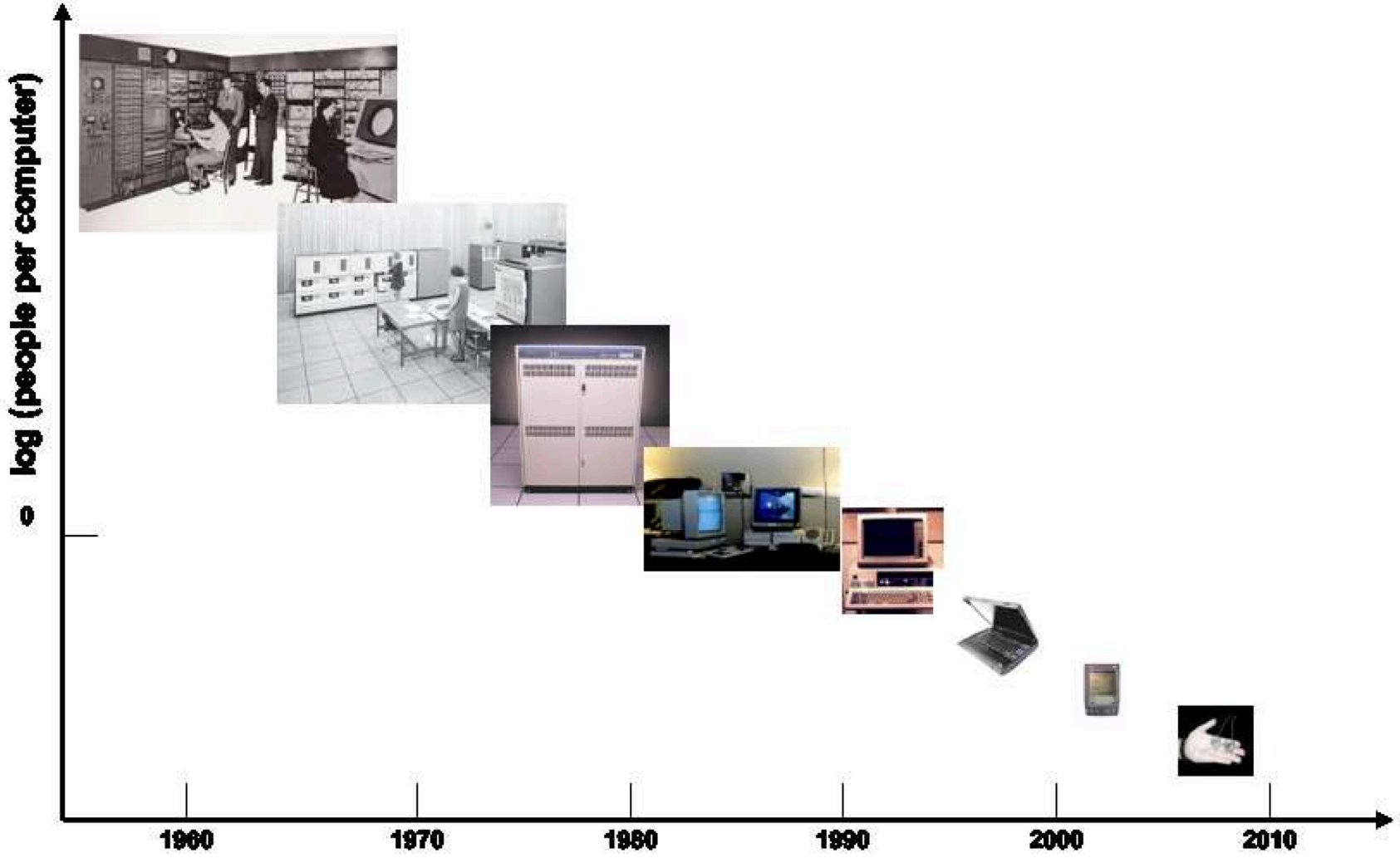
(a) Military fighter pilots see an AR projection of their altitude, speed, and other data on their helmet visor

(b) Neurosurgeons sometimes use an AR projection of a 3-D brain to aid them in surgeries.

MEET THE SIXTHSENSE INTERACTION

INTERNET OF THINGS

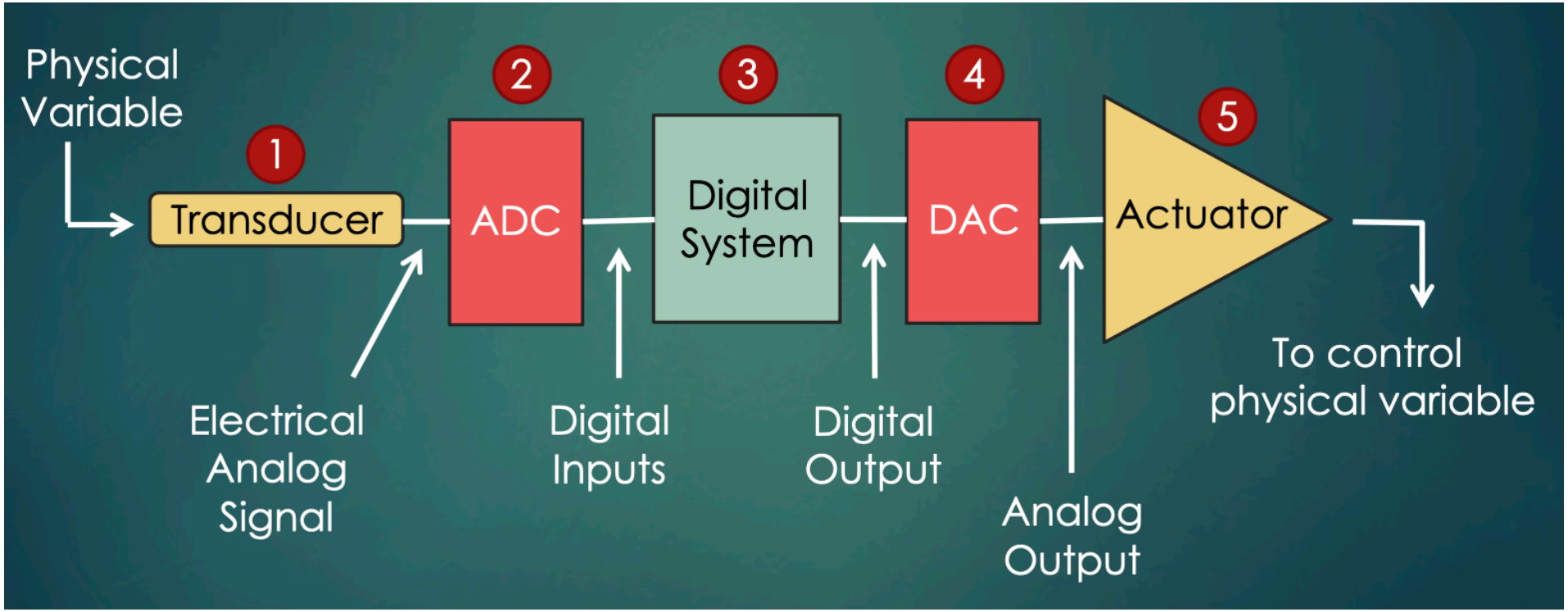
VISION



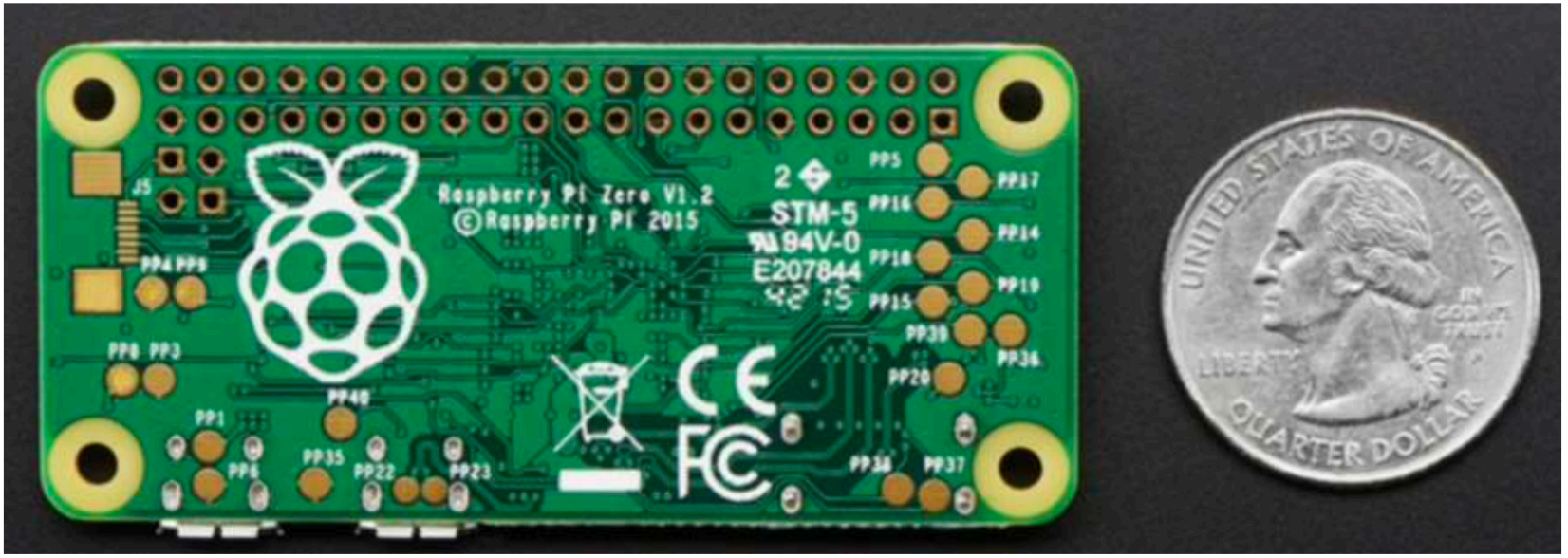
EMBEDDED SYSTEM

- An embedded system is a **microprocessor-based** computer hardware system with software that is designed to perform a dedicated function, either as an independent system or as a part of a large system.
- At the core is an integrated circuit designed to carry out computation for real-time operations.

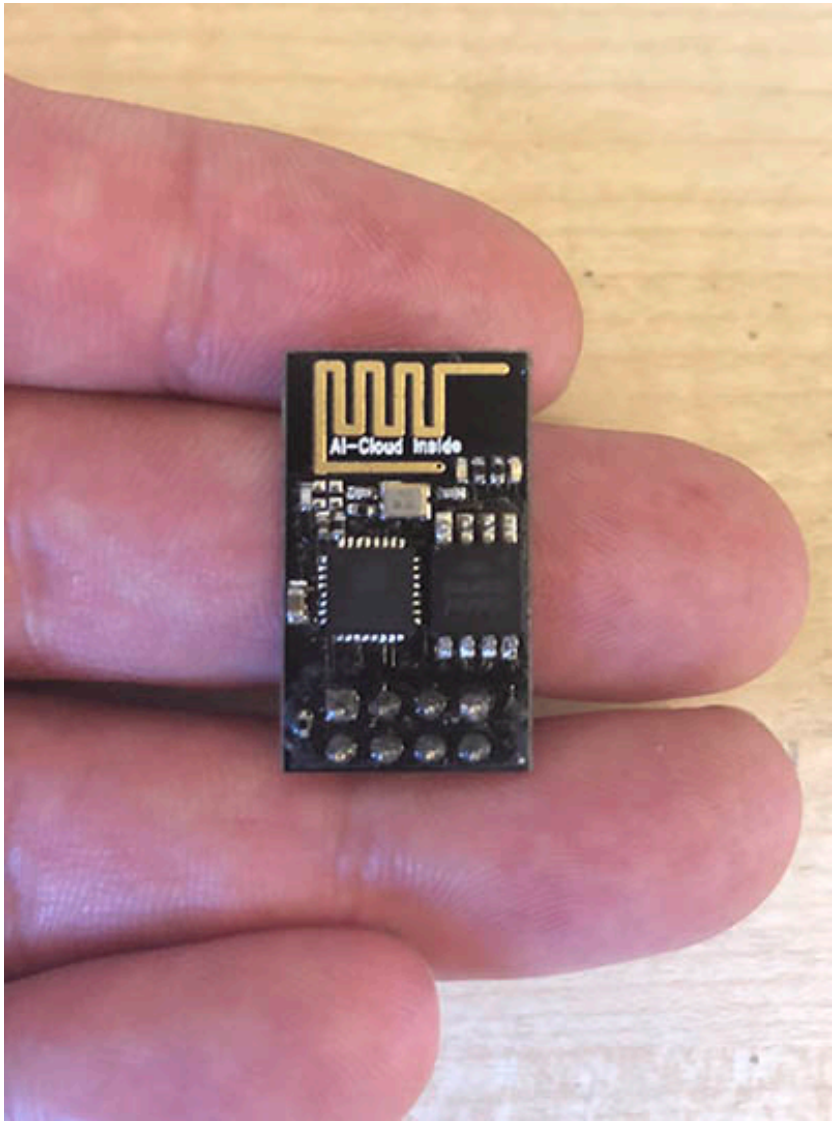
BASIC STRUCTURE



RASPBERRY PI ZERO (฿500)



ESP-8266 (฿50)



ESP-01 (ESP-12F)

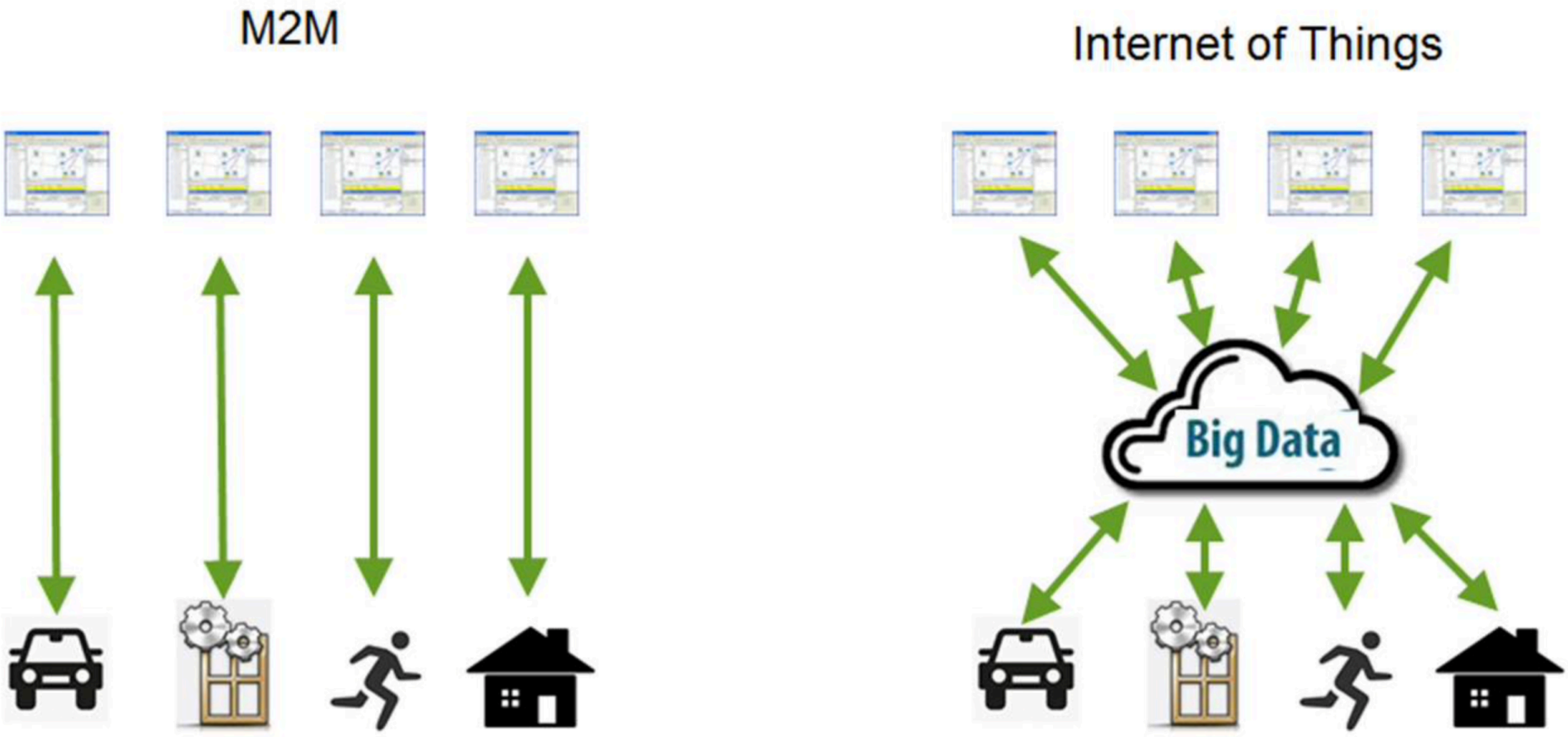
HISTORY OF IOT (1)

- The first telemetry system was rolled out in Chicago way back in 1912. It is said to have used telephone lines to monitor data from power plants.
- Telemetry expanded to weather monitoring in the 1930s, when a device known as a radiosonde became widely used to monitor weather conditions from balloons.
- In 1957 the Soviet Union launched Sputnik, and with it the Space Race. This has been the entry of aerospace telemetry that created the basis of our global satellite communications today.

HISTORY OF IOT (2)

- Broad adoption of M2M technology began in the 1980s with wired connections for SCADA (supervisory control and data acquisition) on the factory floor and in home and business security systems.
- In the 1990s, M2M began moving toward wireless technologies. ADEMCO built their own private radio network to address intrusion and smoke detection because budding cellular connectivity was too expensive.
- In 1995, Siemens introduced the first cellular module built for M2M.

History of IoT (3)



WHY IS IOT IMPORTANT ?

- Ubiquitous Connectivity
- Widespread Adoption of IP
- Computing Economics
- Miniaturization
- Advances in Data Analytics
- Rise of Cloud Computing

IOT DEFINITION

"The IoT can be viewed as a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies (ICT)."

ITU (International Telecommunication Union)

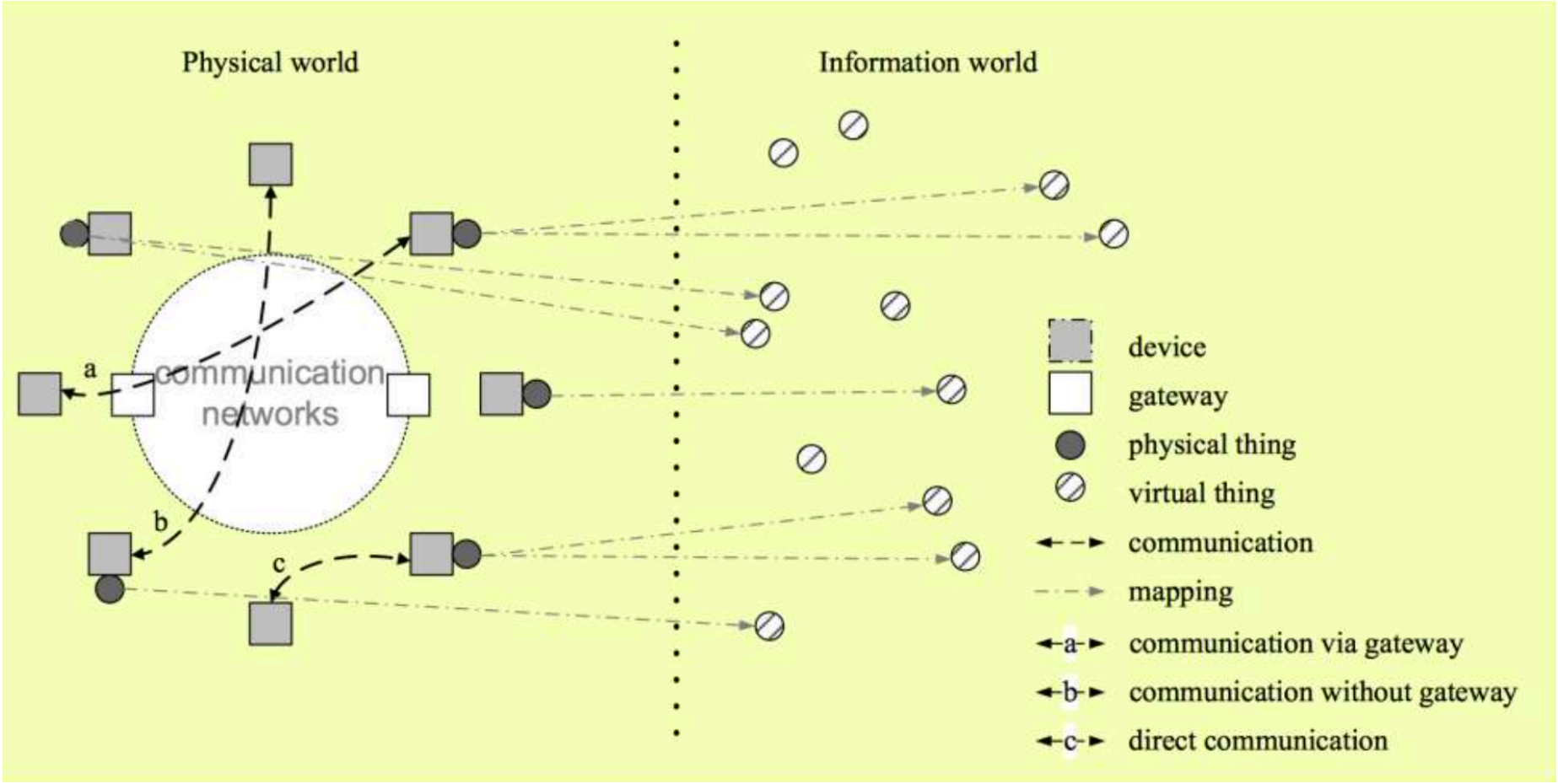
THINGS (1)

- Things are objects of the physical world (physical things) or of the information world (virtual world) which are capable of being identified and integrated into communication networks. Things have associated information, which can be static and dynamic.

THINGS (2)

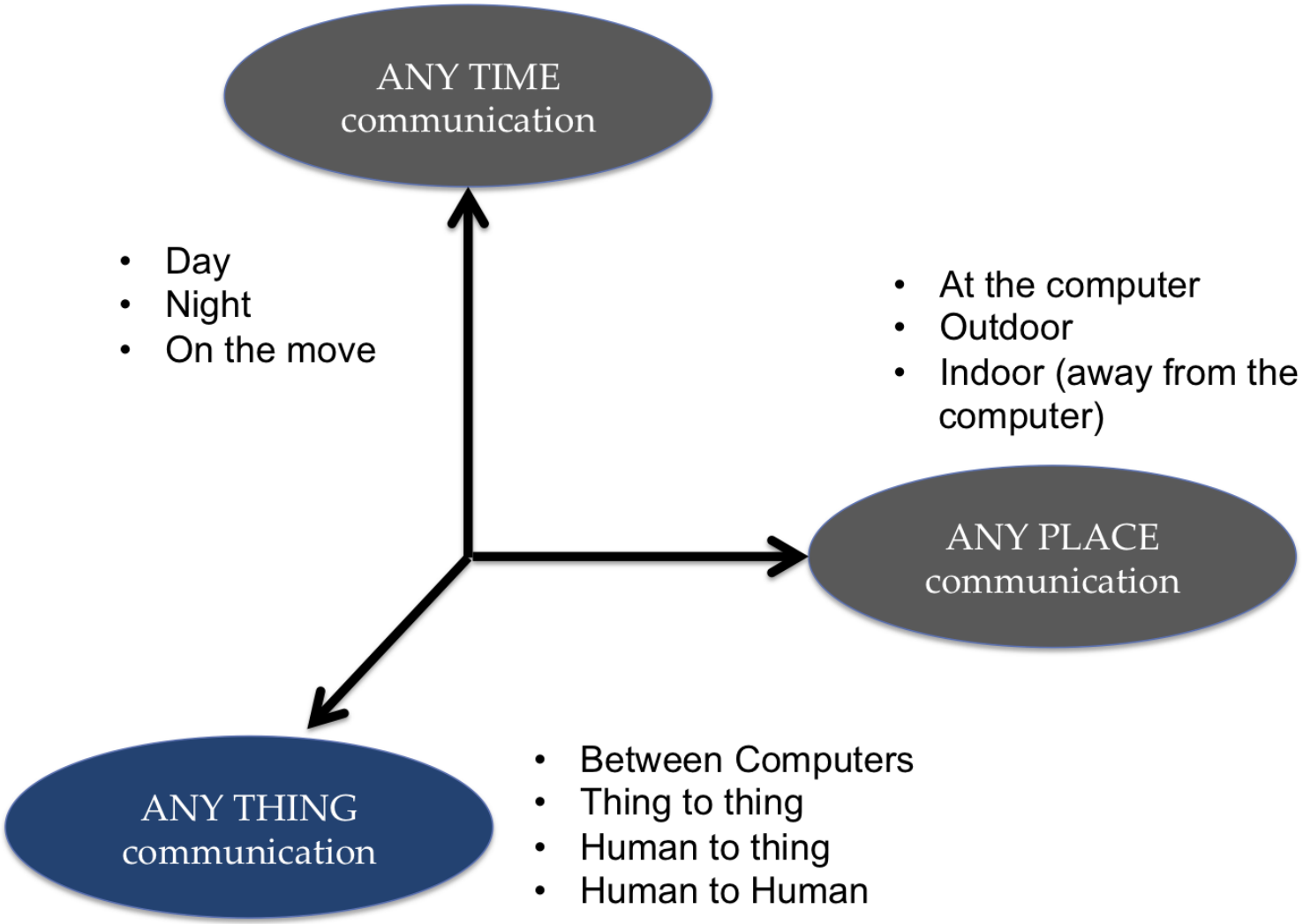
- **Physical things** exist in the physical world and are capable of being sensed, actuated and connected. Examples of physical things include the surrounding environment, industrial robots, goods and electrical equipment.
- **Virtual things** exist in the information world and are capable of being stored, processed and accessed. Examples of virtual things include multimedia content and application software.

ANY-TIME/PLACE/THING (1)



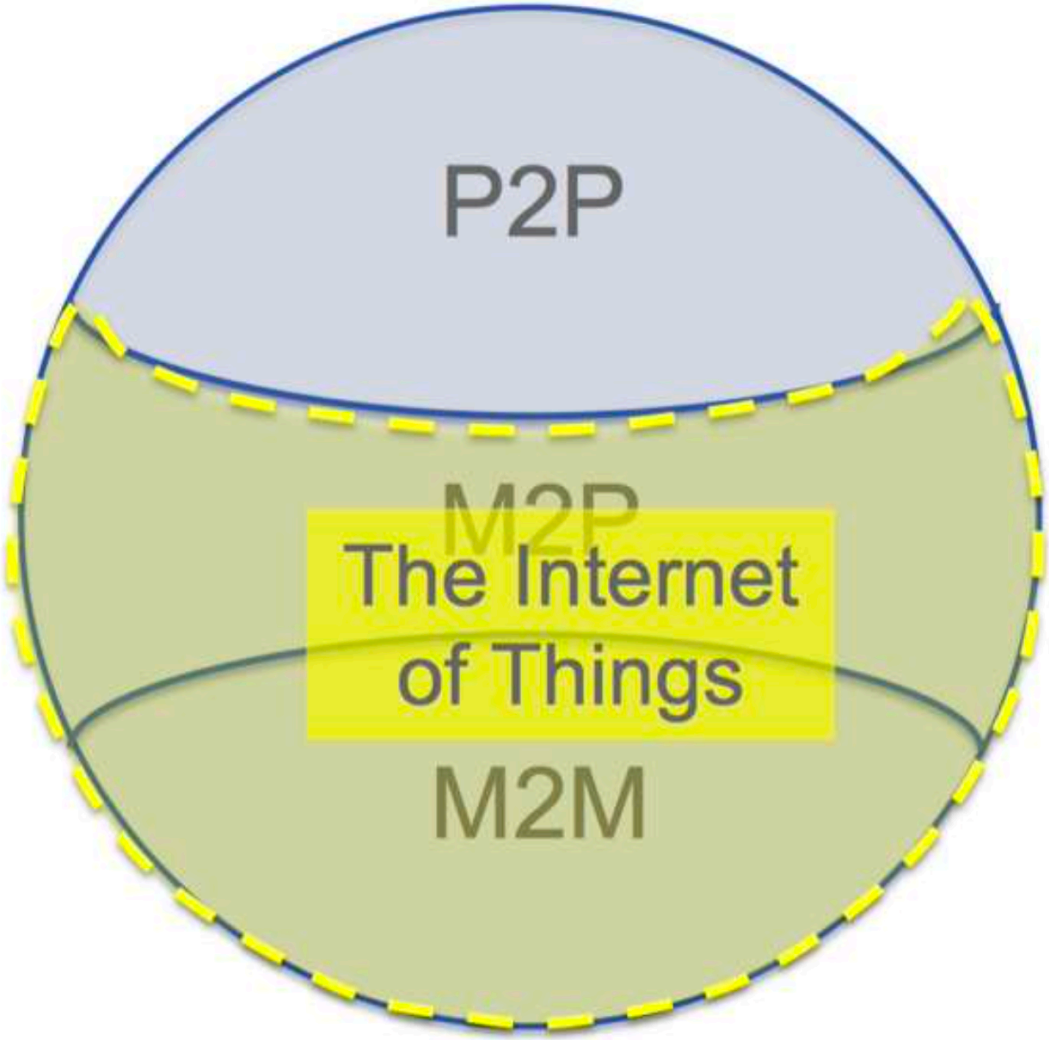
Source: ITU-T Y.2060

ANY-TIME/PLACE/THING (2)



Source: ITU-T Y.2060

ANY-TIME/PLACE/THING (3)



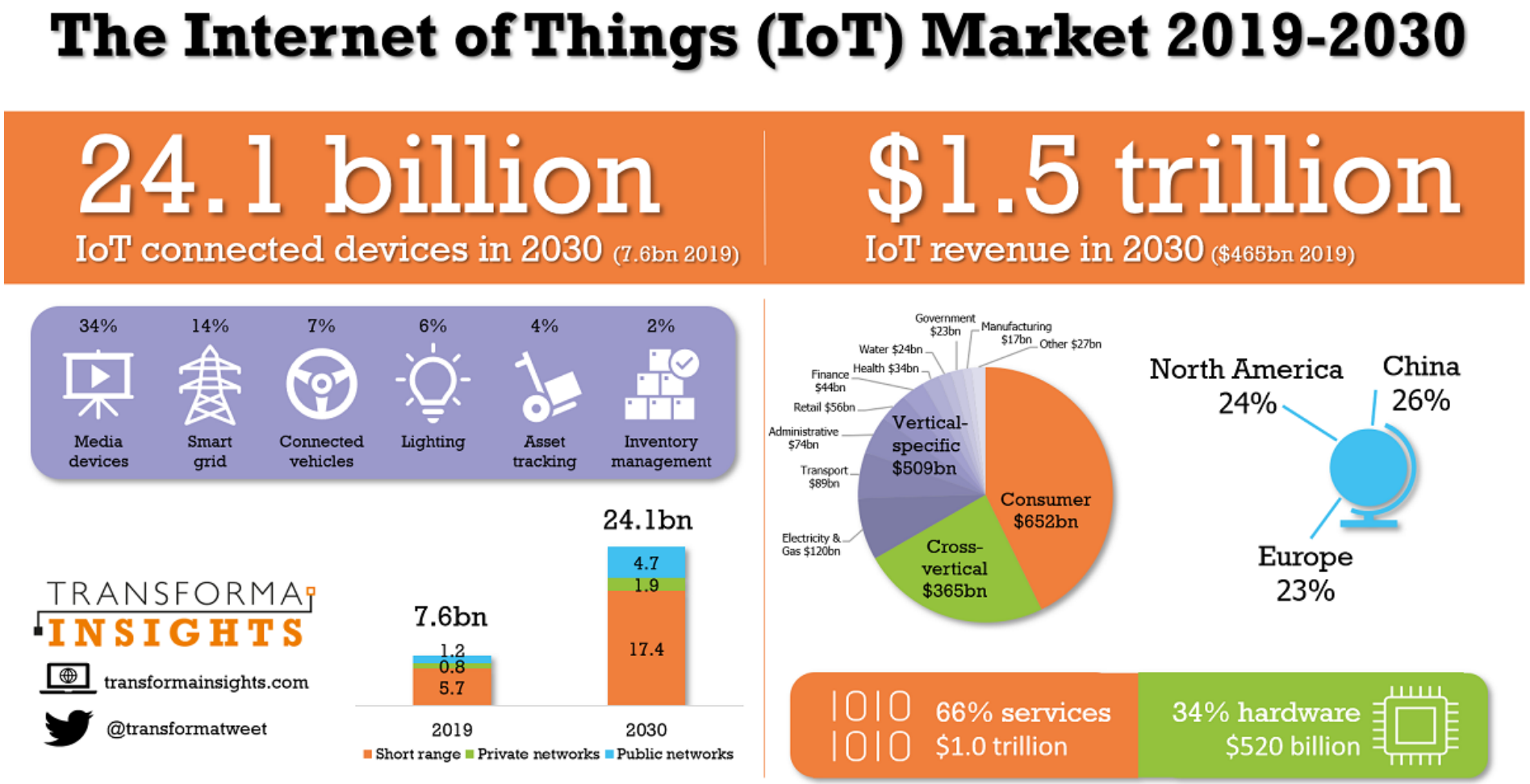
Fundamental characteristics (1)

- **Interconnectivity:** With regard to the IoT, anything can be interconnected with the global information and communication infrastructure.
- **Heterogeneity:** The devices in the IoT are heterogeneous as based on different hardware platforms and networks. They can interact with other devices or service platforms through different networks.
- **Dynamic changes:** The state of devices change dynamically, e.g., sleeping and waking up, connected and/or disconnected as well as the context of devices including location and speed. Moreover, the number of devices can change dynamically.

Fundamental characteristics (2)

- **Enormous scale:** The number of devices that need to be managed and that communicate with each other will be at least an order of magnitude larger than the devices connected to the current Internet. The ratio of communication triggered by devices as compared to communication triggered by humans will noticeably shift towards device- triggered communication.

PREDICTIONS (1)



Source: Transforma Insight, May 2020

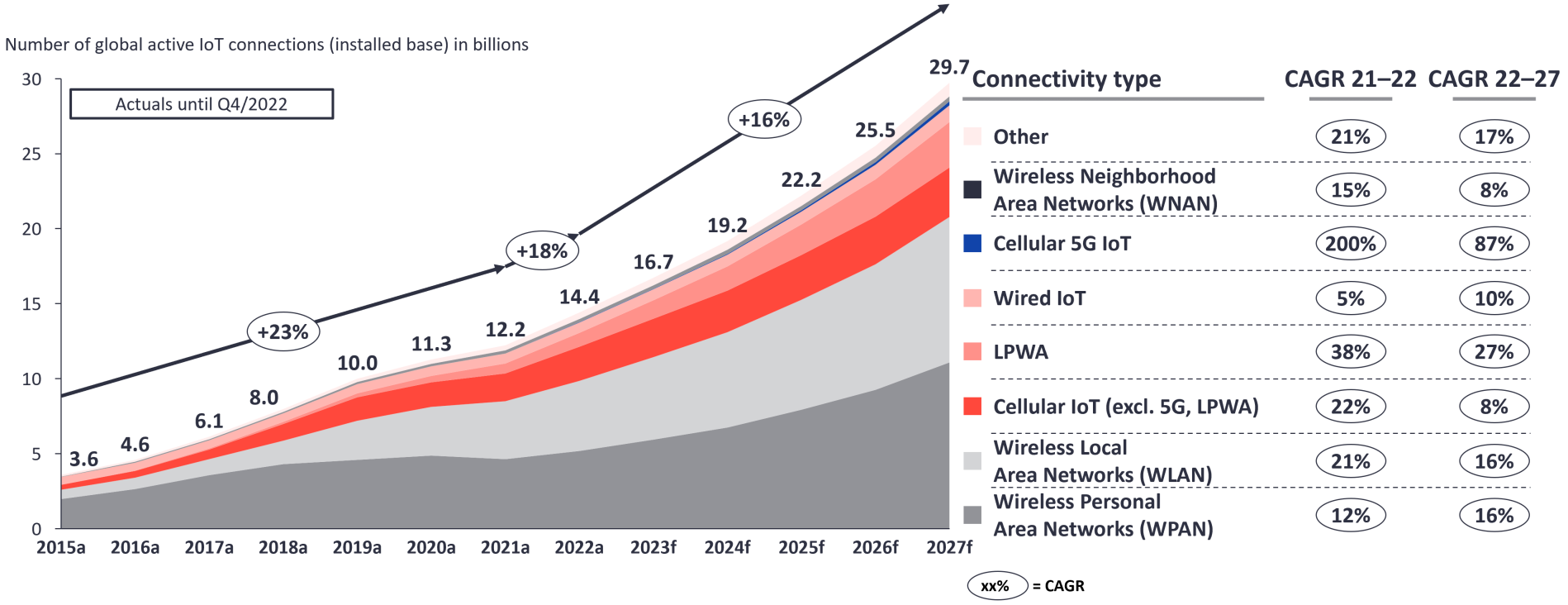
PREDICTIONS (2)

IOT ANALYTICS

May 2023

Your Global IoT Market Research Partner

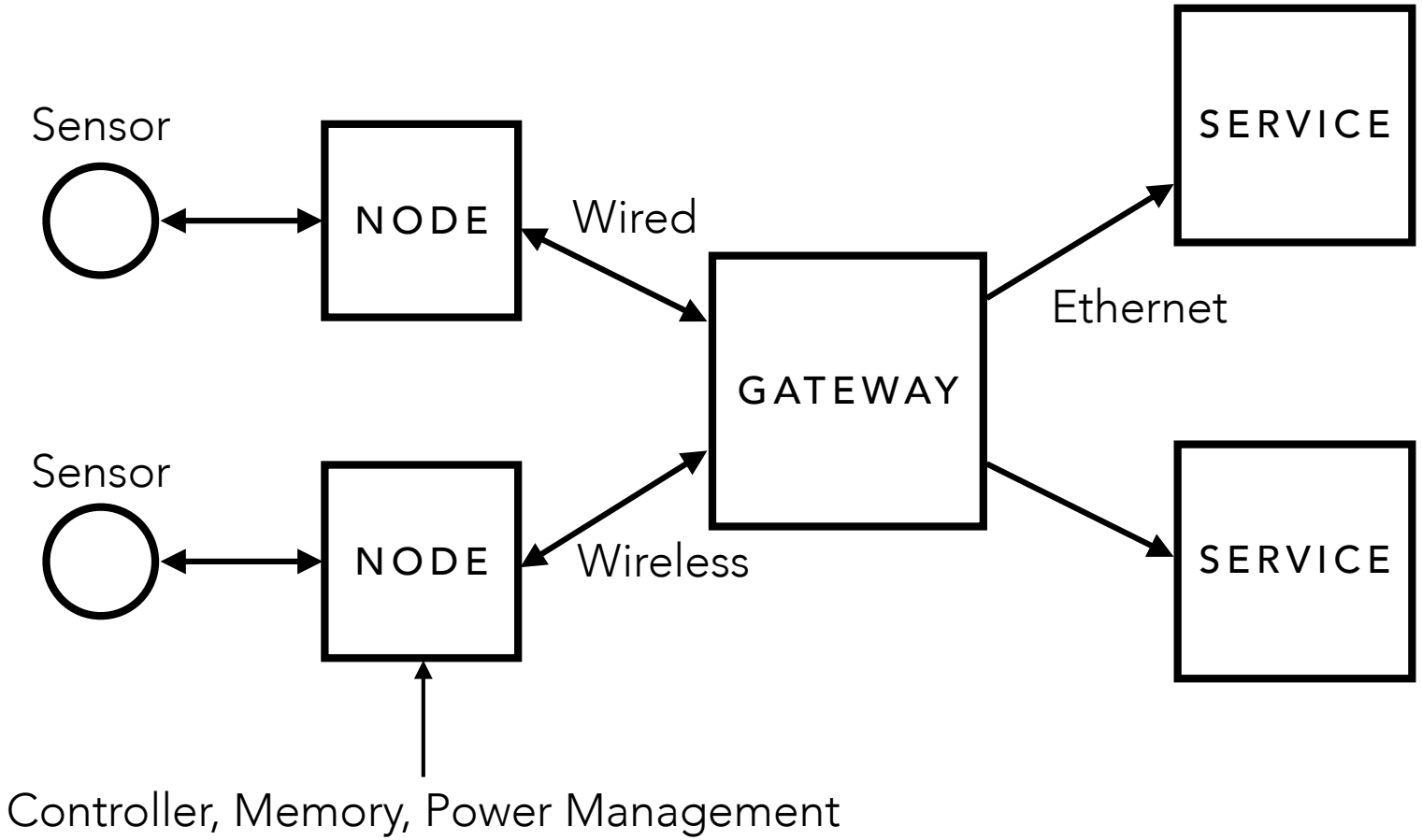
Global IoT market forecast (in billions of connected IoT devices)



Note: IoT connections do not include any computers, laptops, fixed phones, cellphones, or consumers tablets. Counted are active nodes/devices or gateways that concentrate the end-sensors, not every sensor/actuator. Simple one-directional communications technology not considered (e.g., RFID, NFC). Wired includes ethernet and fieldbuses (e.g., connected industrial PLCs or I/O modules); Cellular includes 2G, 3G, 4G, 5G; LPWA includes unlicensed and licensed low-power networks; WPAN includes Bluetooth, Zigbee, Z-Wave or similar; WLAN includes Wi-Fi and related protocols; WNAN includes non-short-range mesh, such as Wi-SUN; Other includes satellite and unclassified proprietary networks with any range.
Source: IoT Analytics Research 2023. We welcome republishing of images but ask for source citation with a link to the original post and company website.

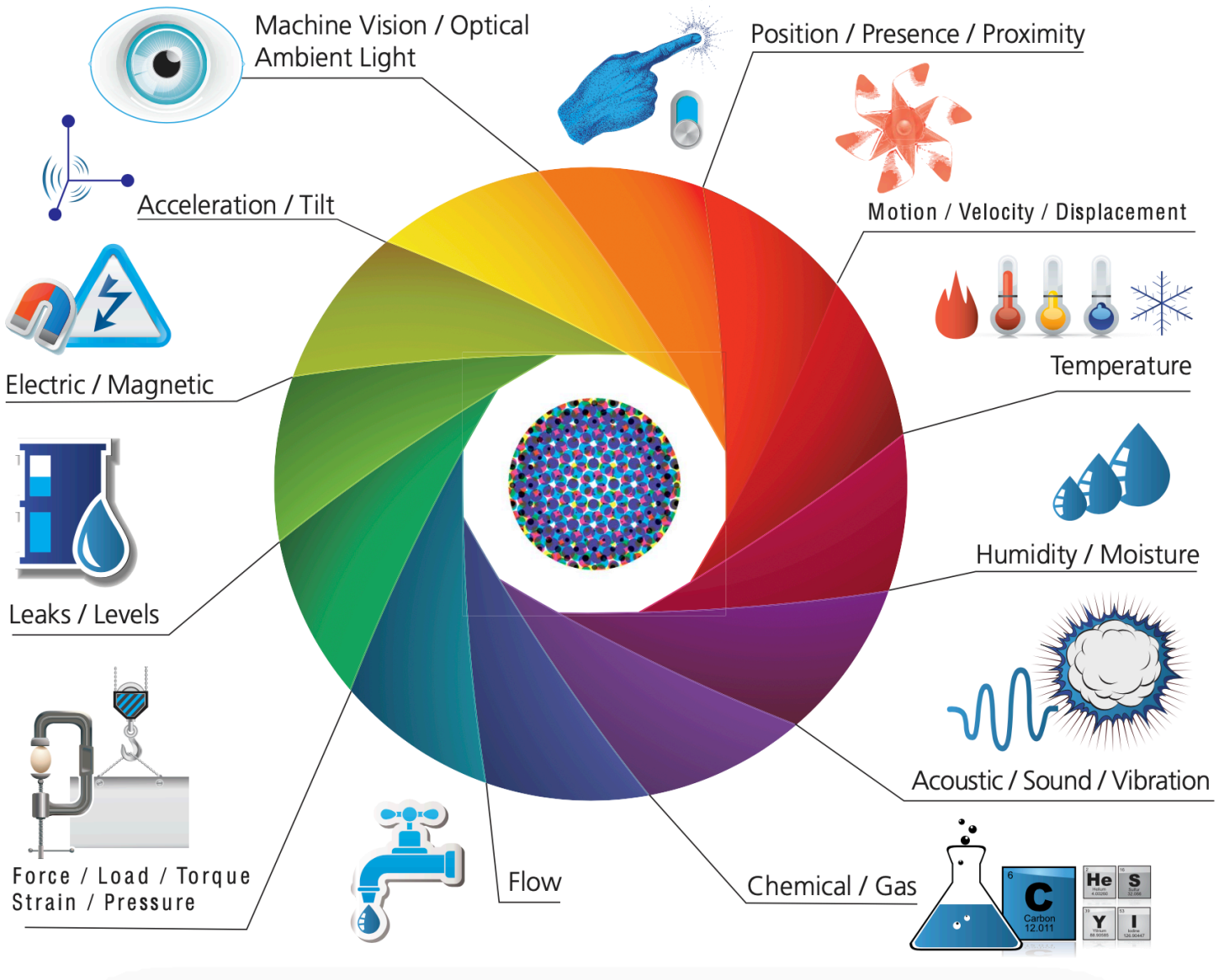
Source: IoT Analytics, May 2023

IOT ARCHITECTURE



Wireless: WiFi, Bluetooth, etc.

SENSORS


Machine Vision / Optical
Ambient Light
Position / Presence / Proximity
Acceleration / Tilt
Motion / Velocity / Displacement
Electric / Magnetic
Temperature
Leaks / Levels
Humidity / Moisture
Acoustic / Sound / Vibration
Force / Load / Torque
Strain / Pressure
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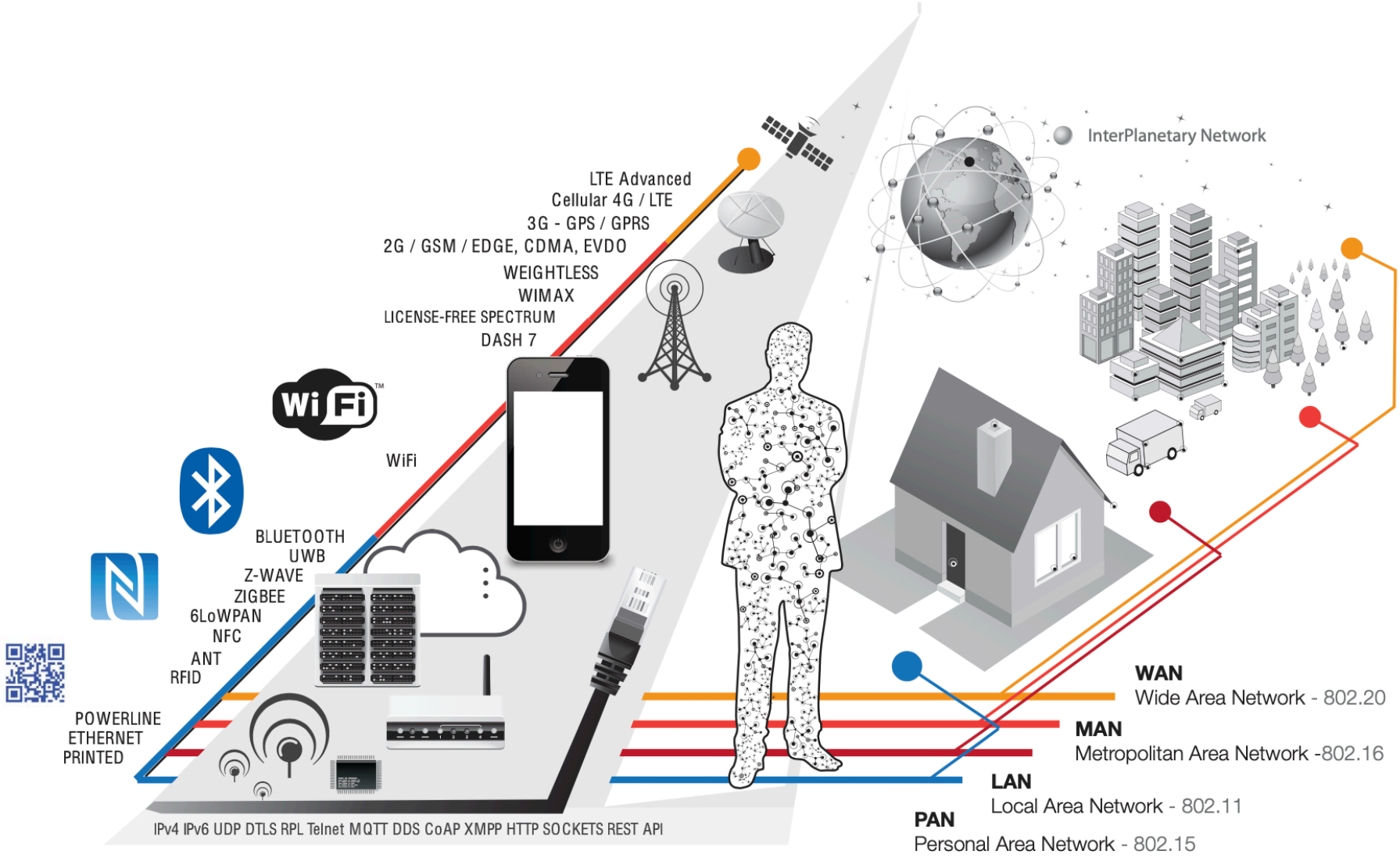
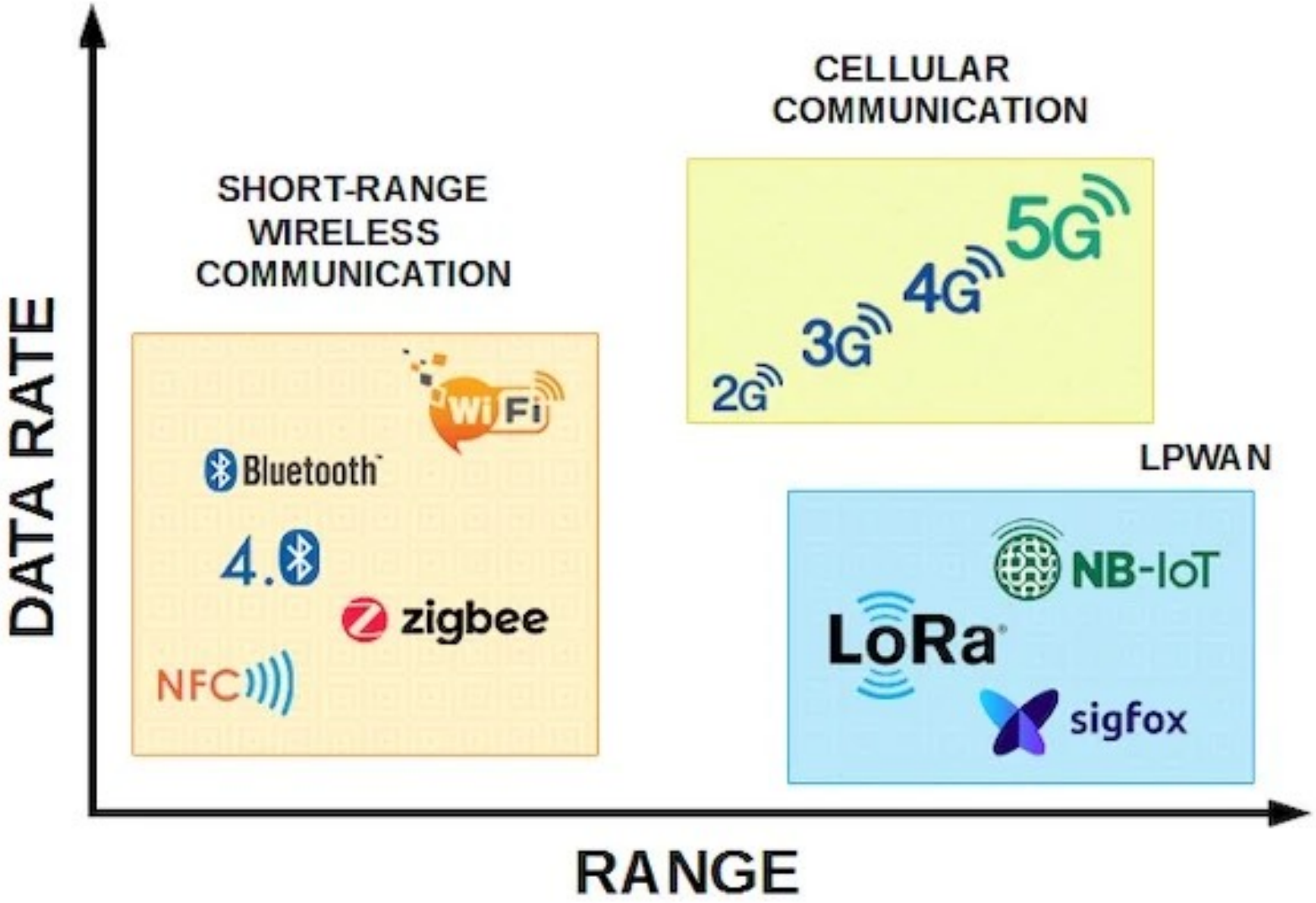
CONNECTIVITY (1)



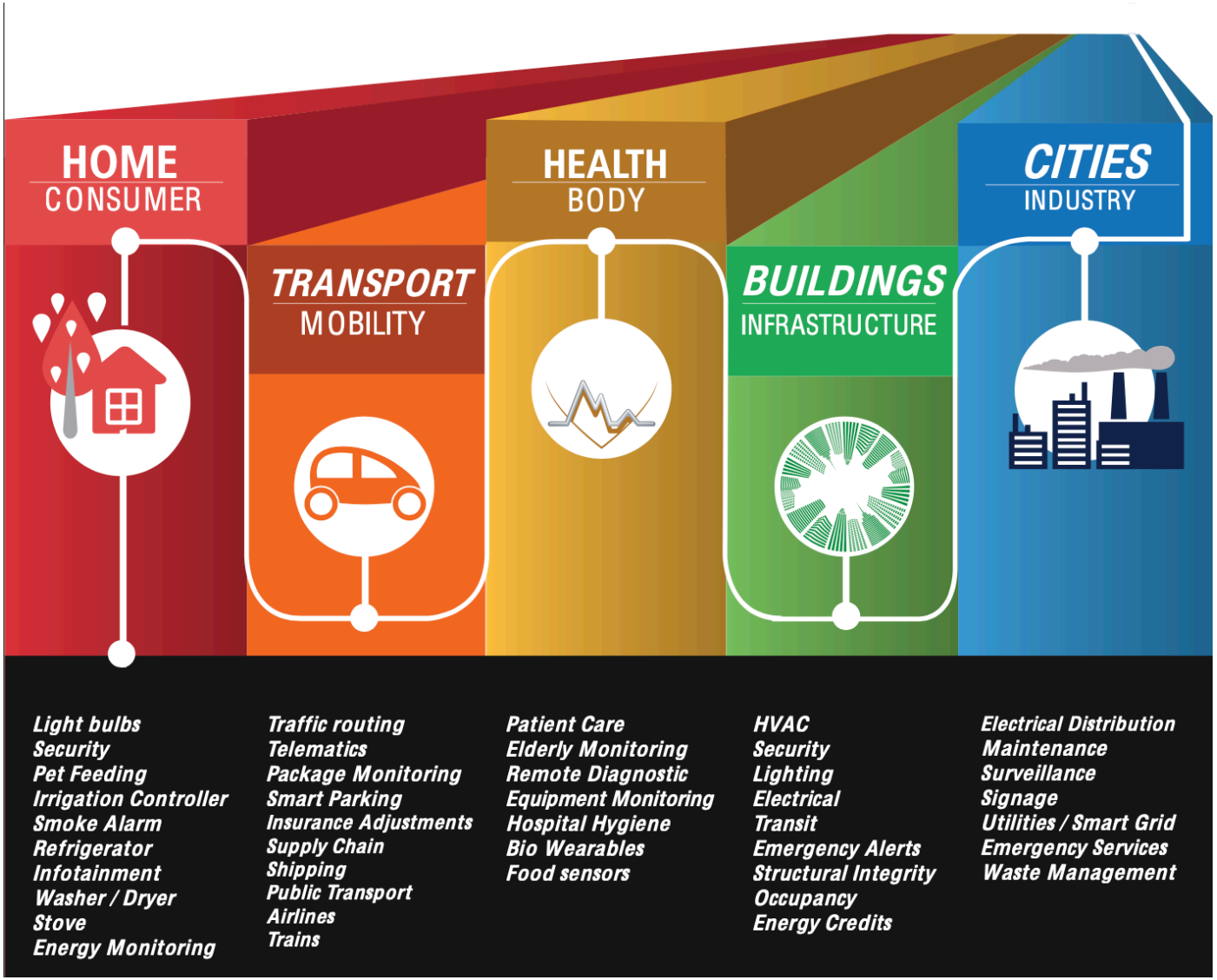
CONNECTIVITY (2)



IPv6

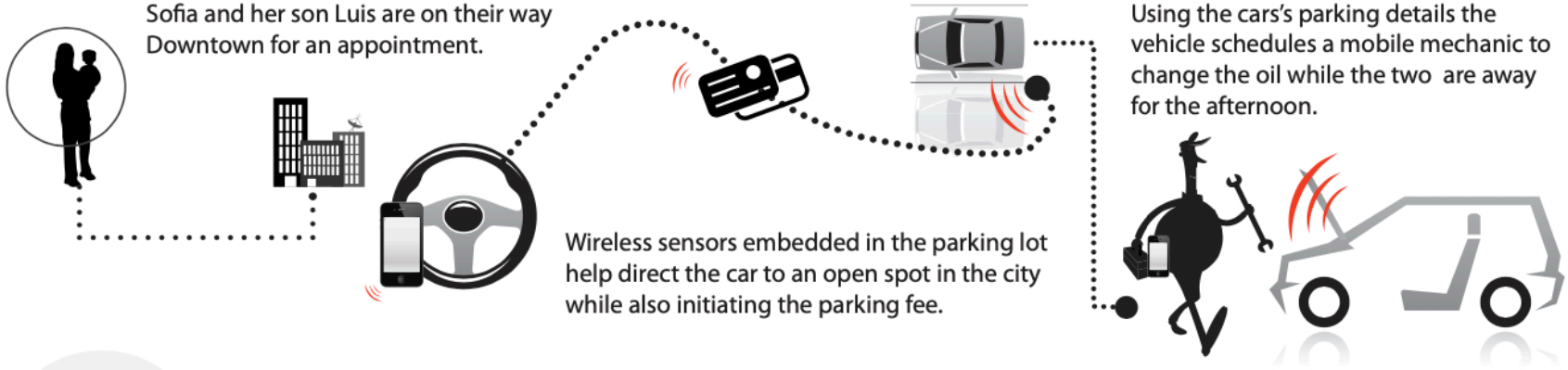
- Smart Objects will add tens of billions of additional devices
- There is no scope for IPv4 to support Smart Object Networks
- IPv6 is the only viable way forward
  - Solution to address exhaustion
  - Stateless Auto-configuration thanks to Neighbor Discovery Protocol
  - Each embedded node can be individually addressed/ accessed

IOT APPLICATIONS



EXAMPLES (1)

TRANSPORTATION + SMART CITIES



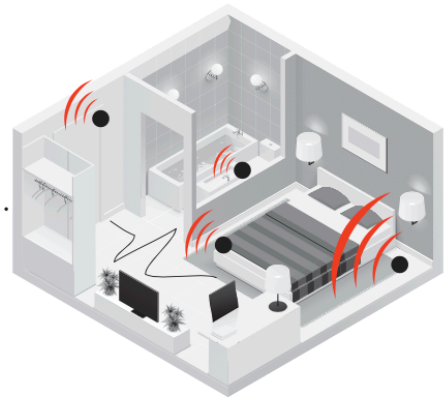
In Downtown San Francisco 20-30% of all traffic congestion is caused by people hunting for a parking spot.

- San Francisco Municipal Transportation Agency (SFMTA)

EXAMPLES (2)

HEALTHCARE + SMART HOME

Aging uncle Earl is still living isolated at his home and you are concerned about his safety.



Wireless sensors throughout his house help measure healthy activity levels, sleeping patterns and medication schedules.

Alerts are automatically sent to health care services and authorized family members if any abnormal activity is detected.

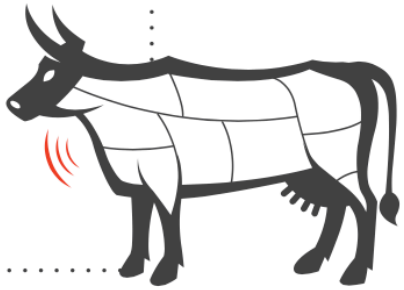
40 million adults age 65 and over will be living alone in the U.S, Canada and Europe.

- U.S. Department of Health and Human Services: Administration for Community Living (ACL)

EXAMPLES (3)

DIGITAL FARM TO TABLE

- Farm & Livestock ID & Sensors
- Food packaging sensors
- Retail Supply Chain Monitoring
- Health Services



Cattle
AIN: 840 003 123 456 789

Location: ID: Braymeadow Farm *FR #00285453543*
Slaughterhouse ID: *#45205343*
Sensor: *Temperature, Accelerometer*
Connectivity: *RFID, NFC, WAN*

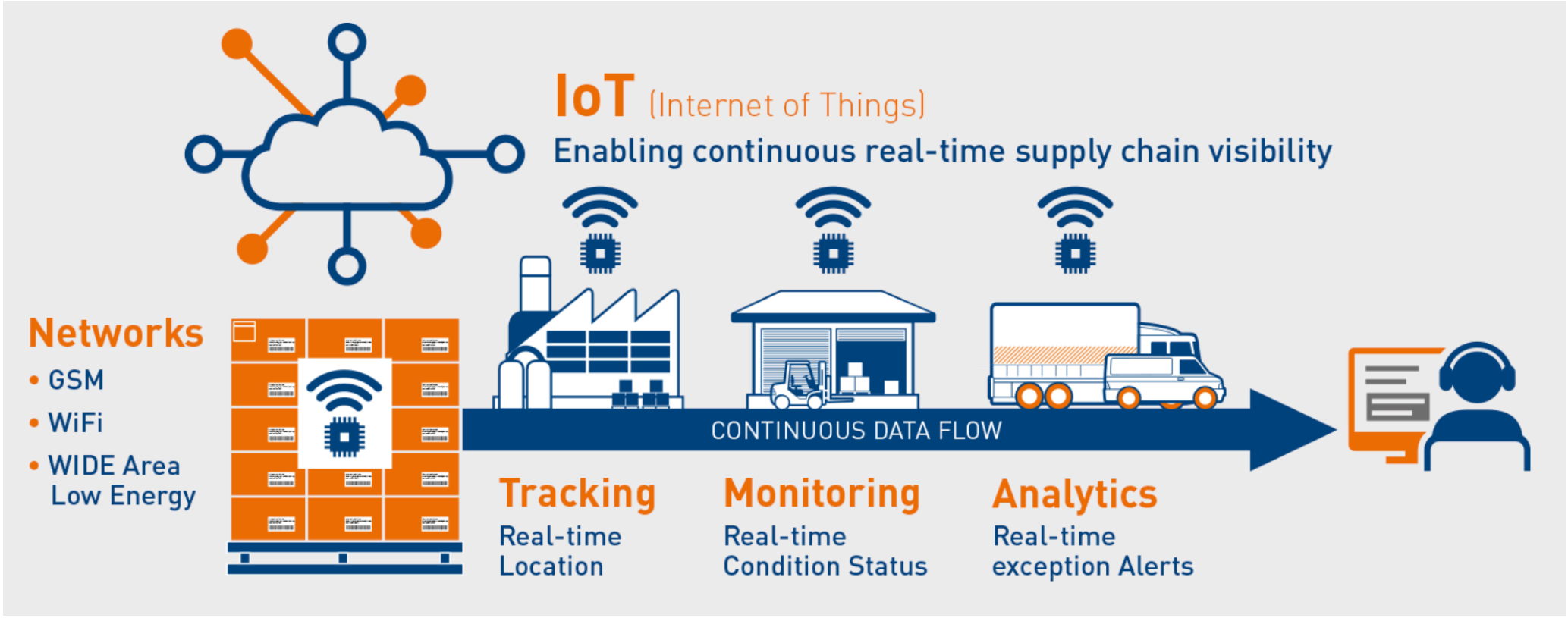
Maria and her daughter are picking up groceries for the week. Using packaging with printed sensors, the two can make sure the ground beef they are purchasing has never reached unsafe temperature levels while on the shelf or being transported.

The packaging also contains a QR code which they can use to query the cow's RFID tag and bring up its history:

- *Where it was raised*
- *What it was fed*
- *Where it was slaughtered*
- *How it was transported*
- *Where it was packaged*
- *The last time it was inspected.*

A week later the U.S. Department of Agriculture's Food Safety Service determines ground beef from originating from a regional packing company and sold at a neighboring store is contaminated with E. coli O157:H7. All packages from this distributer change their alert color and notification messages are sent to those shoppers that may have been impacted.

EXAMPLES (4)


IoT (Internet of Things)
Enabling continuous real-time supply chain visibility
Networks
• GSM
• WiFi
• WIDE Area Low Energy
CONTINUOUS DATA FLOW
Tracking
Real-time Location
Monitoring
Real-time Condition Status
Analytics
Real-time exception Alerts

SERVING CITIZENS AND BUSINESSES BETTER THROUGH TECHNOLOGY

Smart Nation SINGAPORE

- Initiatives that make Citizens' lives better
- Initiatives that create opportunities for Businesses
- Initiatives that build a better home and community

MyInfo Business
- **220,000** SMEs benefiting from **ease of pre-filling** business data at UOB, OCBC and DBS

Networked Trade Platform
- **Under 1 hour** to **process trade permits**, down from several days
- **Single platform** for managing trade permits than across multiple Declaring Agents
- **1,400+** businesses having **one-stop access** to trade financing and supply chain management services

Business Grants Portal
- **19,000** business **grants** applied through this one-stop portal
- **15%** savings in businesses' **time and opportunity costs**

MyTransport.SG
- **140,000** commuters enjoy **one-stop**, personalised journey planning daily

PayNow
- **2.3 million** registered mobile and NRIC registrations for **instant** funds transfers

MyInfo
- **5 minutes** to apply for bank accounts and credit cards with pre-filled information and **instant approvals**, down from 3 days

SingPass Mobile
- **190,000** users seamlessly logging in **without need for passwords**

Healthy 365
- **1.7 million sign-ups** walking to **a healthier lifestyle** through tech-enabled National Steps Challenge™

Moments of Life
- **2,000+** births electronically registered **without queuing and manual form-filling** since 2018
- Child immunisation records accessible on-the-go

Parking.sg
- **15 million coupon-free** parking sessions and **$3.3 million** in **refunds** since 2017

myResponder
- **39,000+** citizen **life-savers** around you
- **13** heart attack victims **saved**

Dementia Friends
- **More than 40** missing seniors with dementia assisted through app community

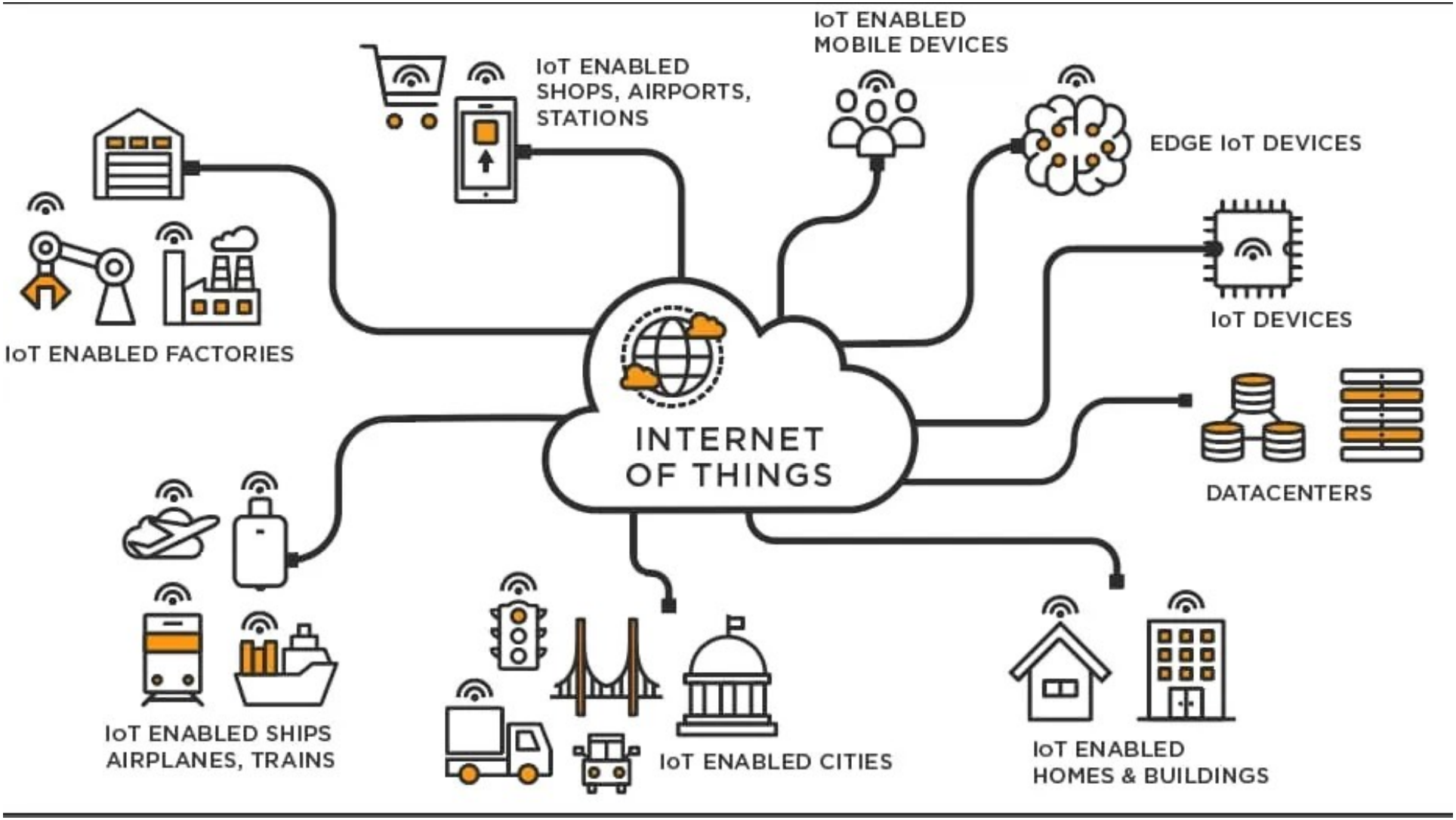
OneService
- **90% of 290,000 municipal cases resolved** within 11 days, down from 16 days

Smart Gravitraps
- **About 50,000** traps deployed in HDB estates to monitor Aedes mosquito population

*Thank you to our citizen volunteers, innovative companies and all who have contributed to our Smart Nation!

Stats correct as of February 2019

MAP OF INTERNET OF THINGS



ASSIGNMENT 8

- ให้แต่ละกลุ่มสรุปเนื้อหาของ **Smart Factory** ว่าคืออะไร และทำไม Smart Factory จะเปลี่ยนการทำงานของโรงงานต่าง ๆ ในประเทศไทยไปอย่างไร
- สรุปเนื้อหา และตอบลงในเว็บของรายวิชา