CS-353-
Internet of things

"Anything that can be connected, will be connected"

Content

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Genesis of IoT

- **IoT Genesis:**

- The Internet of Things (IoT) has not been around that long.

- **It was only in 1999 that the term 'internet of things' was coined by Kevin Ashton.**

- Ashton used the phrase as the title of his presentation for a new sensor project he was working on and it stuck from there.

- While the phrase came about in 1999, the concept of connected devices dates back to 1832.

- When the first electromagnetic telegraph was designed, allowing direct communication between two machines through the transfer of electrical signals.

- However, **the true Internet of Things history began with the invention of the Internet in the late 1960s.**

The world's first IoT device

- The world's first IoT device was invented in the early 1980s at the Carnegie Melon University.

- A group of **students from the university created a way to get their campus Coca-Cola vending machine to report on its contents through a network in order to save them the trek if the machine was out of Coke.**

- They **installed micro-switches into the machine to report on how many Coke cans were available and if they were cold**.

The 1990s

- In 1990, John Romkey connected a toaster to the internet for the first time.

- A year later, a group of students at the University of Cambridge used a web camera to report on coffee.

- They came up with the idea to use the first web camera prototype to monitor the amount of coffee available in their computer labs coffee pot.

- They did this by programming the web camera to take photos three times a minute of the coffee pot.

- The photos were then sent to local computers so everyone could see if there was coffee available.

Paving the way for the future of IoT

- The Internet of Things was a common topic used by the media at the beginning of the 21st Century with several major developments paving the way for the future of IoT.

- LG Electronics introduced the world's first refrigerator connected to the internet in 2000.

- Allowing consumers to do their food shopping online and make video calls.

- This invention was followed by a small rabbit-shaped robot in 2005 that could report the latest news, weather forecasts and stock market changes.

- While the first International Conference on Internet of Things was held in 2008 in Switzerland.

- Today there are more than 27 billion devices connected to the Internet of Things, with experts expecting this number to rise to over 100 billion devices by 2030.

Summary

- The Internet of Things definition: "**Sensors and actuators embedded in physical objects are linked through wired and wireless networks**"
- There are a number of similar concepts but Internet of Things is **by far the most popular term** to describe this phenomenon
- The term **Internet of Things was invented in 1999**, initially to promote RFID technology
- The popularity of the term **IoT did not accelerate until 2010/2011** and reached **mass market in early 2014**
- **M2M or the Industrial internet are not opposing concepts** to the Internet of Things. Rather, they are sub-segments.

Internet of Things definition

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• Internet of Things = "*Sensors and actuators embedded in physical objects are linked through wired and wireless networks, often using the same Internet Protocol (IP) that connects the Internet.*"

Introduction – what is IoT?

- The Internet of things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction - *IoTAgenda*

- A *thing* in the IoT can be a person with a heart monitor implant, a farm animal with a biochip transponder, an automobile that has built-in sensors to alert the driver when tire pressure is low or any other natural or man-made object that can be assigned an IP address and is able to transfer data over a network.

- IoT is a sensor network of billions of *smart devices* that connect people, systems and other applications to collect and share data.
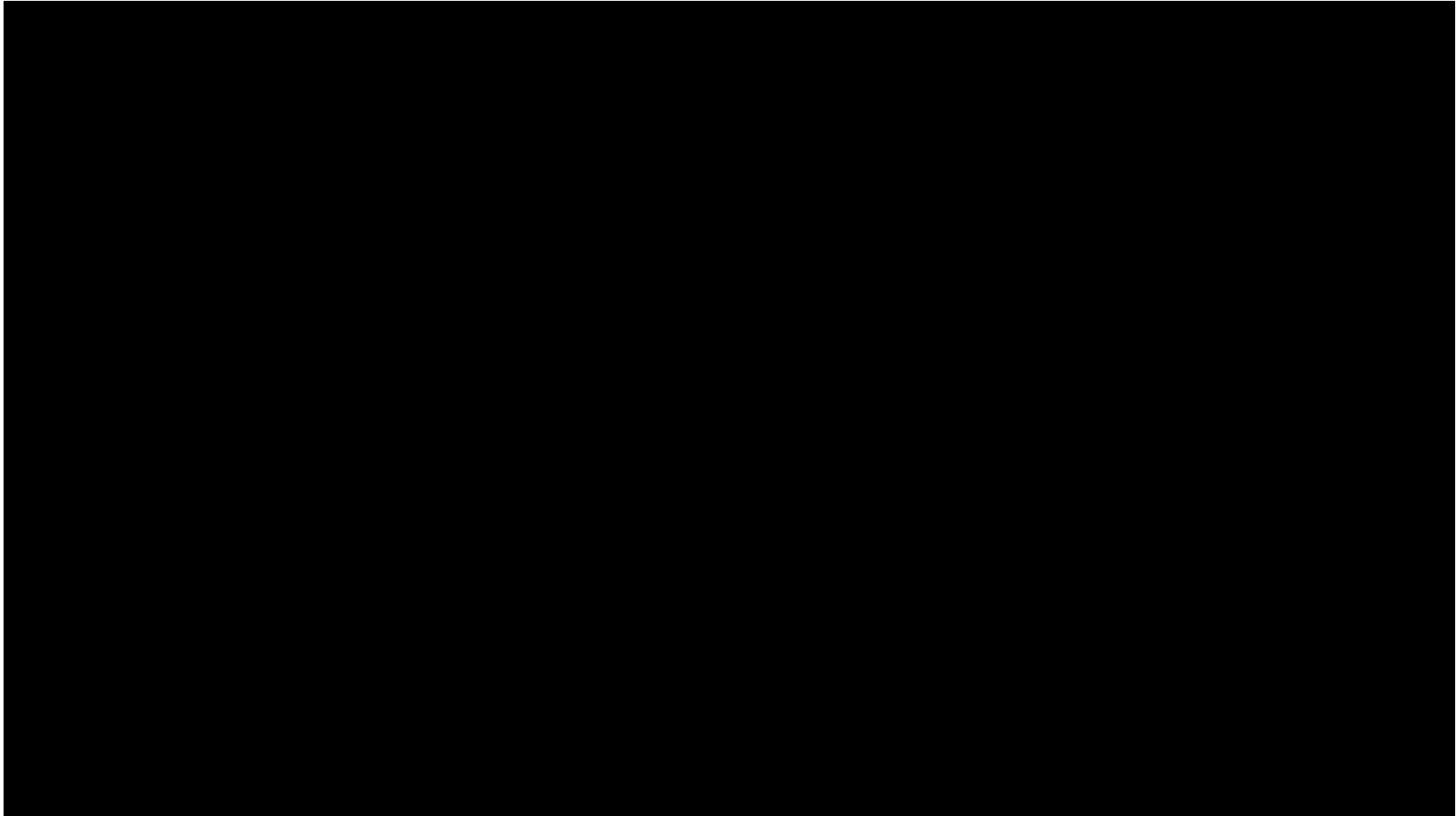
Introduction – cont'd

- IoT is a concept of connecting any device with an on and off switch to the Internet (and/or to each other). This includes everything from cell phones, coffee makers, washing machines, headphones, lamps, wearable devices and almost anything else you can think of.

- This also applies to components of machines, for example a jet engine of an airplane or the drill of an oil rig – **Forbes**.

- The IoT is a giant network of connected "things" (which also includes people). The relationship will be between people-people, people-things, and things-things.

- The dominant *consumer IoT device*, worldwide, is the smart TV.

- Between 25-35% cent of consumers worldwide own a television that can connect to the Internet, according to a Deloitte research. However, other areas of the IoT market are growing rapidly.
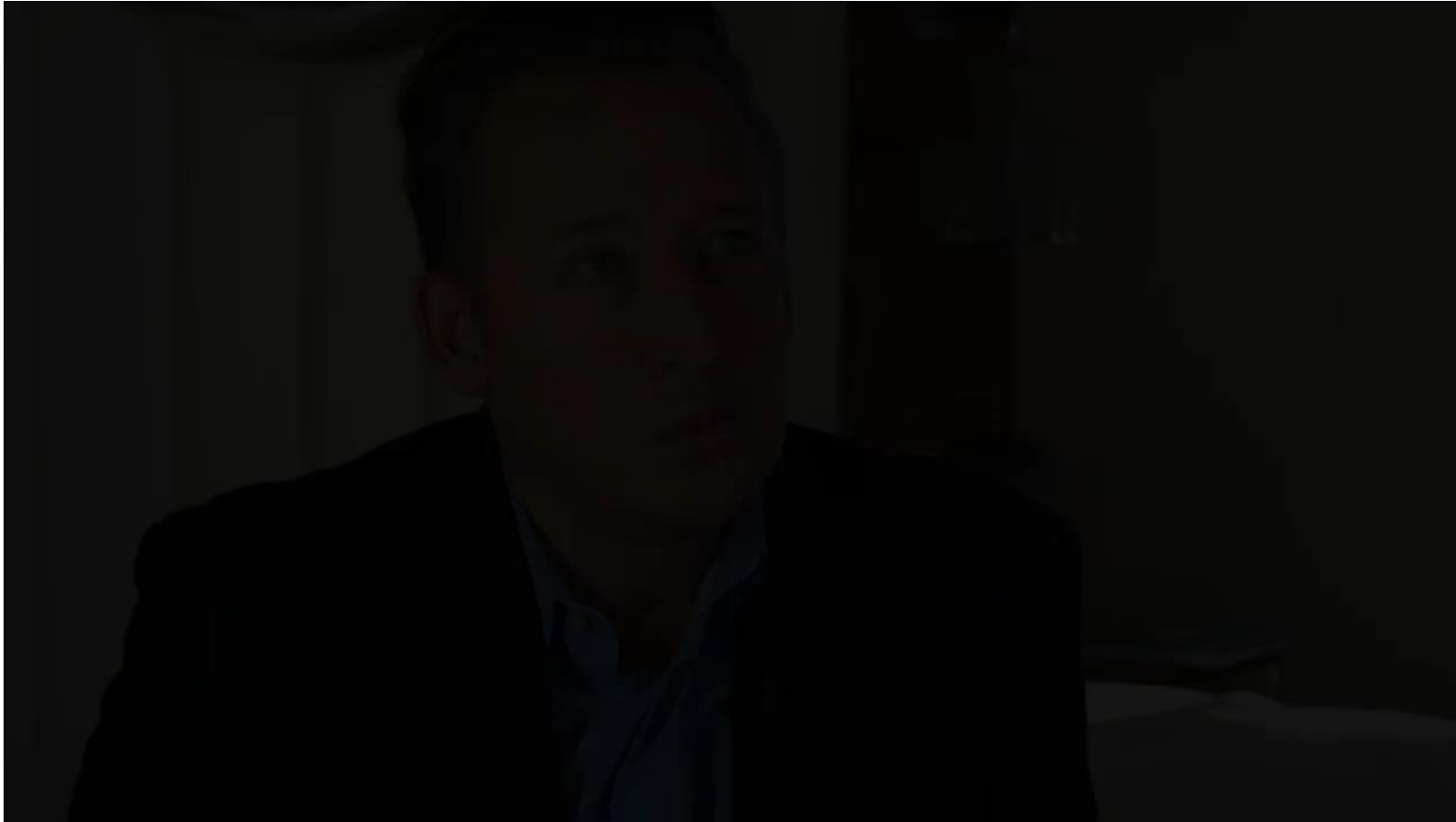
Why IOT?

- Organizations in a *variety of industries* are using IoT to operate more efficiently, better understand customers to deliver enhanced customer service, improve decision-making and increase the value of the business.
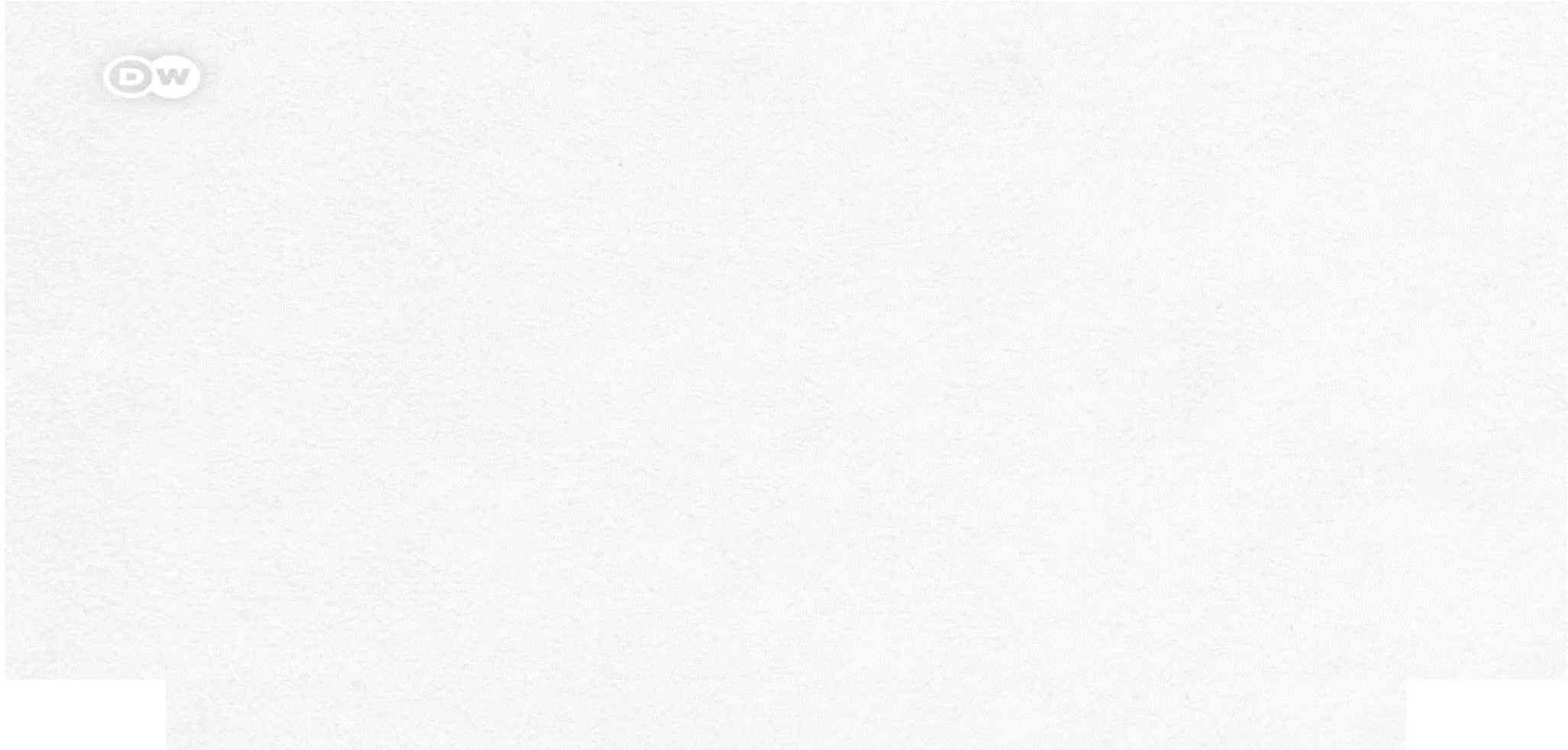
IoT ecoystem

- An IoT ecosystem consists of web-enabled smart devices that use embedded processors, sensors and communication hardware to collect, send and act on data they acquire from their environments.

- IoT devices share the sensor data they collect by connecting to an IoT gateway or other edge device where data is either sent to the cloud to be analyzed or analyzed locally.

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Internet of Everything-Fundamental

Top 10 Strategic IoT Technologies and Trends - GARTNER

1) **Trend No. 1: Artificial Intelligence (AI):** "Data is the fuel that powers the IoT and the organization's ability to derive meaning from it will define their long term success."

2) **Trend No. 2: Social, Legal and Ethical IoT:** These include ownership of data and the deductions made from it, algorithmic bias, privacy and compliance with regulations such as the General Data Protection Regulation. "Successful deployment of an IoT solution demands that it's not just technically effective but also socially acceptable."

3) **Trend No. 3: Infonomics and Data Broking:** The theory of infonomics takes monetization of data further by seeing it as a strategic business asset to be recorded in the company accounts. By 2023, the buying and selling of IoT data will become an essential part of many IoT systems.

Top 10 Strategic IoT Technologies and Trends – GARTNER (cont'd)

4) **Trend No. 4: The Shift from Intelligent Edge to Intelligent Mesh:** The shift from centralized and cloud to edge architectures is well under way in the IoT space. These mesh architectures will enable more flexible, intelligent and responsive IoT systems — although often at the cost of additional complexities.

5) **Trend No. 5: IoT Governance:** As the IoT continues to expand, the need for a governance framework that ensures appropriate behaviour in the creation, storage, use and deletion of information related to IoT projects will become increasingly important.

6) **Trend No. 6: Sensor Innovation:** The sensor market will evolve continuously through 2023. New sensors will enable a wider range of situations and events to be detected.

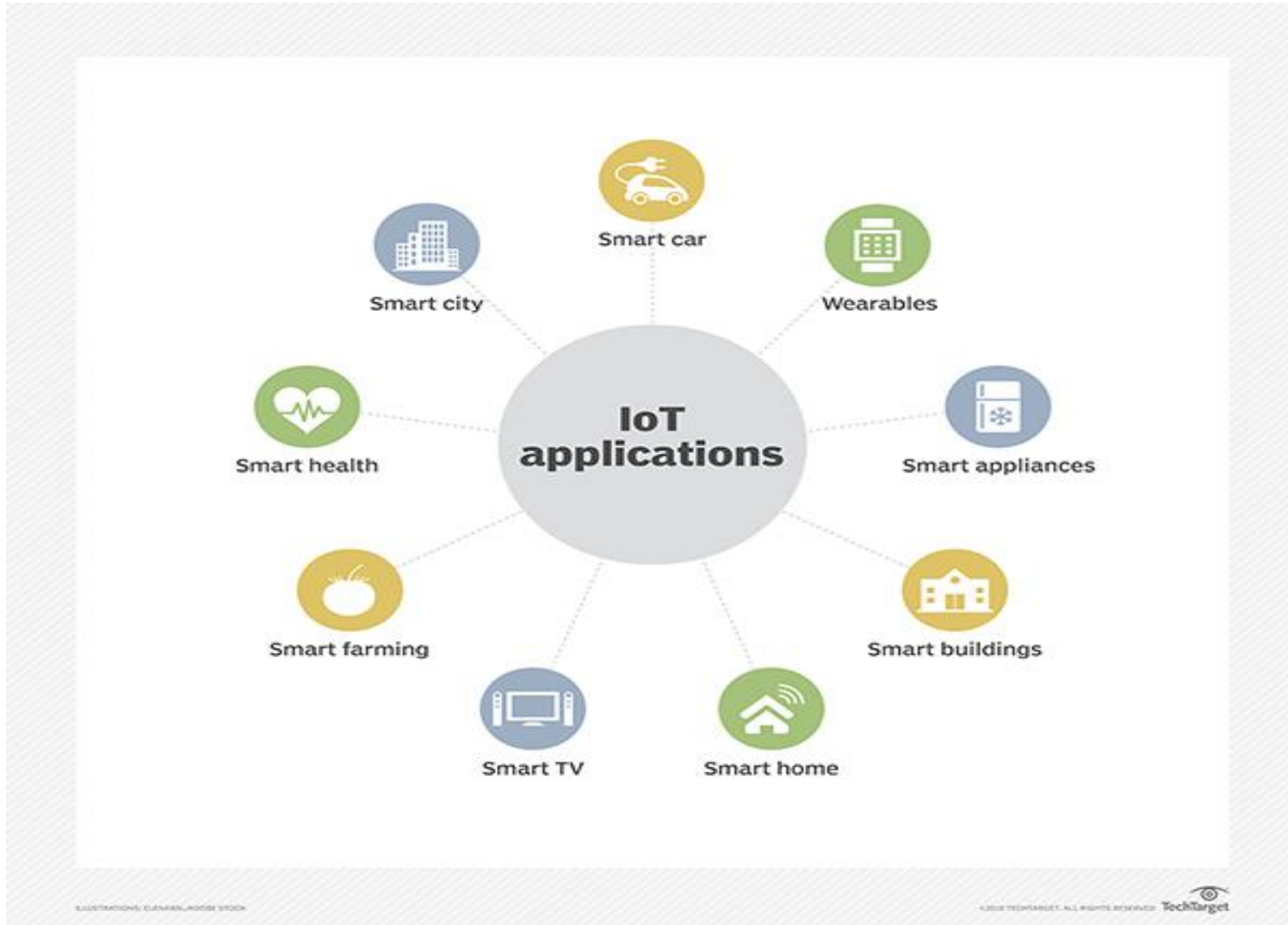# Top 10 Strategic IoT Technologies and Trends – GARTNER (cont'd)

7) **Trend No. 7: Trusted Hardware and Operating System:** '.. by 2023, we expect to see the deployment of hardware and software combinations that together create more trustworthy and secure IoT systems…'.

8) **Trend 8: Novel IoT User Experiences:** User experience driven by 4 factors: new sensors, new algorithms, new experience architectures and context, and socially aware experiences.

9) **Trend No. 9: Silicon Chip Innovation:** By 2023, it's expected that new special-purpose chips will reduce the power consumption required to run IoT devices.

10) **Trend No. 10: New Wireless Networking Technologies for IoT:** IoT networking involves balancing a set of competing requirements. In particular they should explore 5G, the forthcoming generation of low earth orbit satellites, and backscatter networks.

Benefits of IoT

IoT offers a number of benefits to organizations, enabling them to:

1. Monitor their overall business processes;

2. Improve the customer experience;

3. Save time and money;

4. Enhance employee productivity;

5. Integrate and adapt business models;

6. Make better business decisions; and

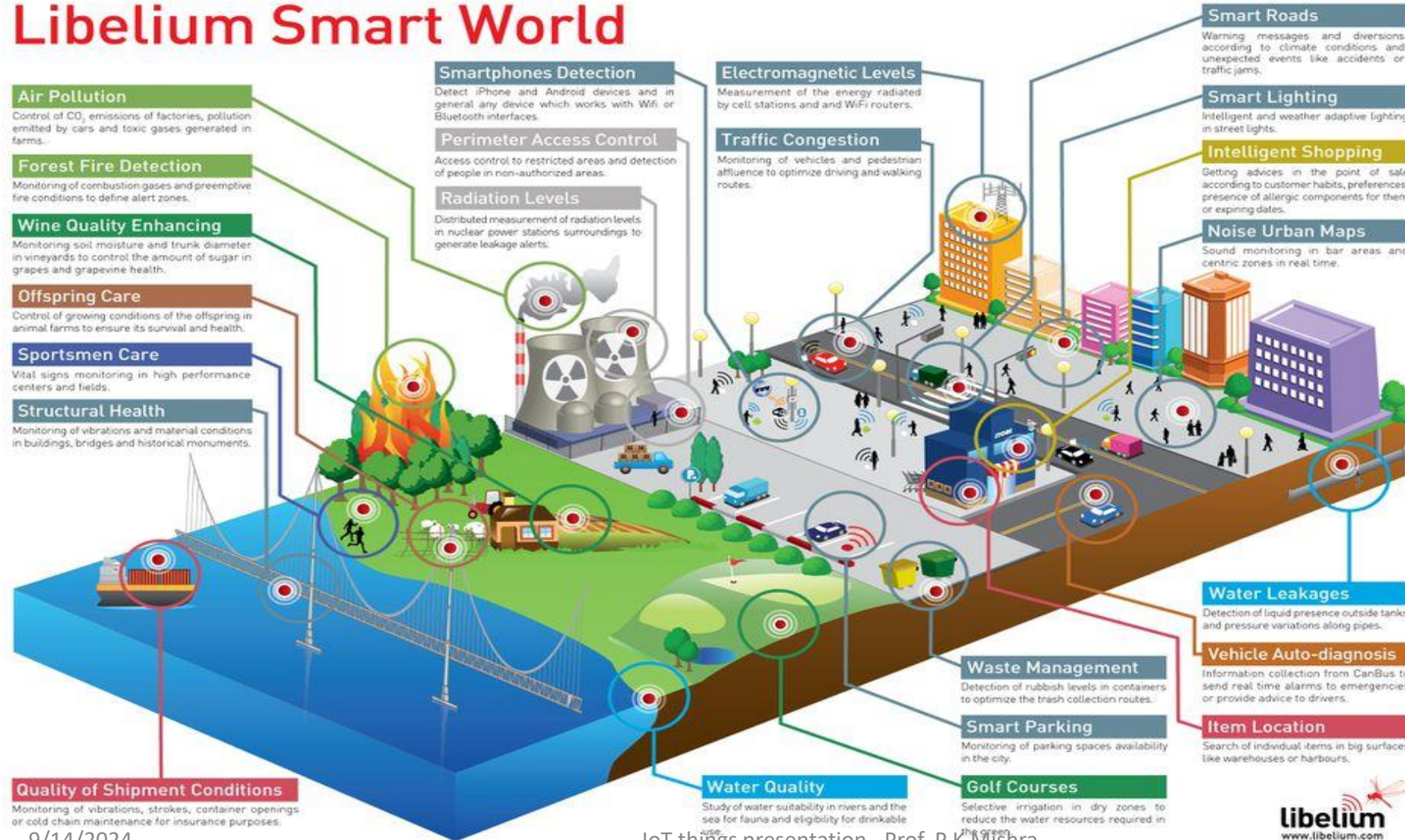7. Generate more revenue.

Consumer and enterprise IoT applications

Source: [https://internetof thingsagenda.tec htarget.com/defi nition/Internet- of-Things-IoT](https://internetofthingsagenda.techtarget.com/definition/Internet-of-Things-IoT)

The smart world of the future – using Iot

IoT things presentation - Prof. P K Mishra

Source:
https://www.forbes.com/sites/jacobmorgan/2014/05/13/simple-explanation-internet-things-that-anyone-can-understand/#ef2433f1d091

Sample: Consumer IoT Products & Services

1. Helmet Concussion Sensor
2. Medical Alert Watch
3. Smart Fitness Clothing and Smart Running Shoes
4. **One-Button Product Purchases:** "Order at the click of a button!" Amazon has taken that phrase literally and produced physical branded buttons called *Amazon Dash* that link to products in your home.

- Say you run out of laundry powder.
- You can press your Dash button for Surf Excel Matic liquid and Amazon will reorder your Surf Excel Matic liquid product for you.
- No need to sign onto the Web, fumble with payment methods, or retype credit card numbers.

1. Garden Sensors
2. Smart Televisions

Helmet concussion sensor

Shockbox MultiSport Helmet Sensor
by Shockbox

★★★☆☆ 7 customer reviews

Currently unavailable.
We don't know when or if this item will be back in stock.

- Wireless head impact sensors sends alerts direct to your smartphone when a hit is too hard
- Long range Bluetooth connects to smartphone over 100m away inside arenas
- 100 hour rechargeable battery life with supplied micro USB cable
- Fits on all sizes of hockey helmet with high bonding adhesive tape
- Free downloaded Shockbox smartphone App displays history of impacts over set threshold

https://www.amazon.com/Shockbox-LM2004-EXT-MultiSport-Helmet-Sensor/dp/B00DVHA1LM?imprToken=NXcTrCppNfgrAo2MA1K7ig&slotNum=2&SubscriptionId=AKIAIO22DD3AFUSKXUKQ&tag=makeusw-20&linkCode=xm2&camp=2025&creative=165953&creativeASIN=B00DVHA1LM

Amazon DASH

amazondash

Instantly reorder your favorite products

Dash Buttons are available for millions of products that ship with Prime.

Getting Started

Always Accessible

Find Dash Buttons on the Amazon home page, or at Your Dash Buttons, where you can sort, label, or delete your buttons.

If you've purchased a product on Amazon that is typically reordered, we will automatically create a Dash Button for you. You can add new Dash Buttons from the product details page of any product available

Dash with Your Echo Show

"Alexa, show my Dash Buttons"

You can also say, "Alexa, show my Dash Buttons" on the Echo Show to see all of your Dash Buttons.

Learn more about Dash Buttons on Echo Show.

Samsung Family Hub

Access your Dash Buttons on the Samsung Family Hub smart refrigerator. Together, Amazon and Samsung make it easy to reorder the everyday essentials that keep your household running.

To get started, find Amazon Dash in your Family Hubs Apps.

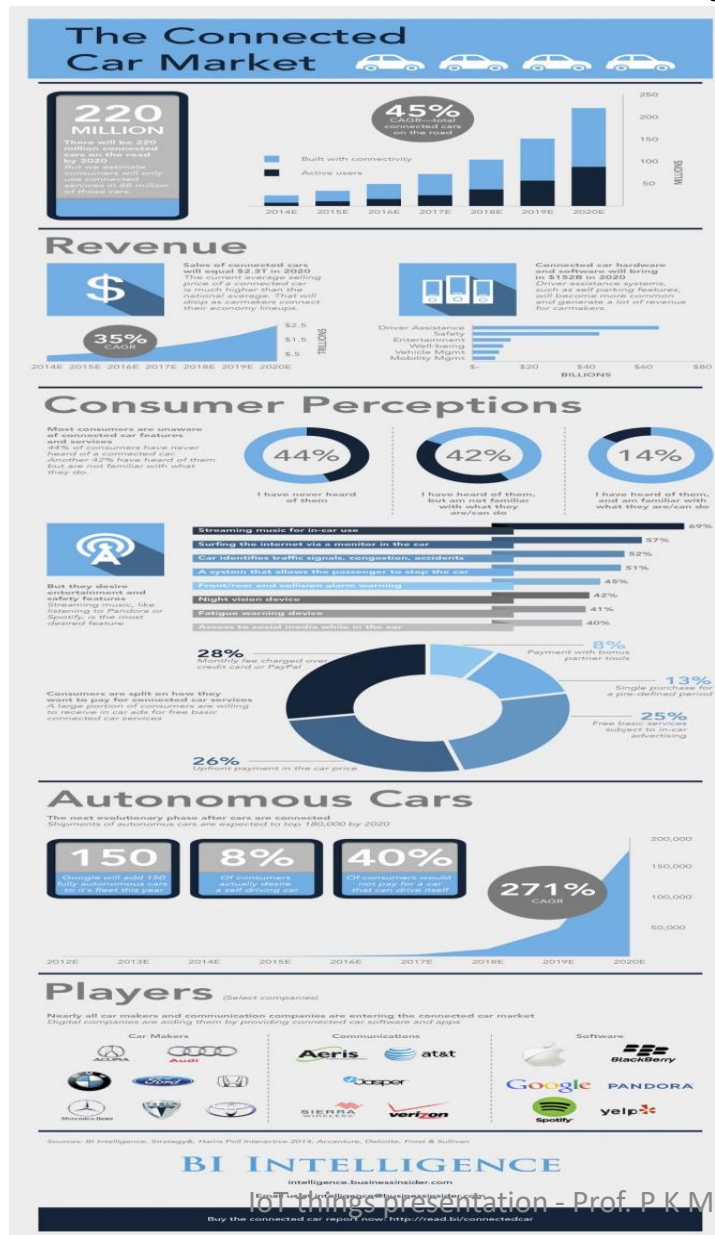https://www.amazon.com/b?ie=UTF8&node=17729534011

Kinsa thermometer

Well Informed

Kinsa uses your age, fever and symptoms to help you understand when and how to soothe symptoms, take meds or call the doctor.

Monitoring your temperature and can call your doctor as necessary

Connected car story

The connected car is equipped with internet connections and software that allow people to stream music, look up movie times, be alerted of traffic and weather conditions, and even power driving-assistance services such as self-parking.

Source: https://www.businessinsider.com/connected-car-statistics-manufacturers-2015-2?IR=T

Smart farming: Use of IoT to improve agriculture

- In IoT-based smart farming, a system is built for monitoring the crop field with the help of sensors (light, humidity, temperature, soil moisture, etc.) and automating the irrigation system.

- The farmers can monitor the field conditions from anywhere.

- This is highly efficient compared to the traditional/conventional approach.

- In terms of environmental issues, IoT-based smart farming provides great benefits including: better and efficient water usage, and optimization of inputs and treatments.

- Therefore, smart farming based on IoT technologies enables growers and farmers to reduce waste and enhance productivity.

- Some of the IoT applications in this area are:
  i.   Precision farming
  ii. Agricultural drones
  iii. Livestock monitoring
  iv. Smart greenhouses

Industrial IoT (IIoT)

- Industrial IoT (IIoT) focusses on the use of cyber-physical systems to monitor the physical factory processes and make data-based automated decisions.

- While the physical systems are made the intelligent using IoT, the real-time communication, and cooperation both with each other and with humans is established via the wireless web

- IIoT brings in the concept of 'a *connected factory leads to a smart factory*'.

IIoT in Manufacturing

1. **Digital/connected factory**: IoT enabled machinery can transmit operational information to the partners like original equipment manufacturers and to field engineers.

2. **Facility management:** The use of IoT sensors in manufacturing equipment enables condition-based maintenance alerts.

3. **Production flow monitoring:** IoT in manufacturing can enable the monitoring of production lines starting from the refining process down to the packaging of final products.

4. **Inventory management:** IoT applications permit the monitoring of events across a supply chain.

IIoT in manufacturing (cont'd)

5. **Plant Safety and Security:** IoT combined big data analysis can improve the overall workers' safety and security in the plant. .

6. **Quality Control:** IoT sensors collect aggregate product data and other third-party syndicated data from various stages of a product cycle.

7. **Packaging Optimization**: By using IoT sensors in products and/or packaging, manufacturers can gain insights into the usage patterns and handling of product from multiple customers.

8. **Logistics and Supply Chain Optimization**: The Industrial IoT (IIoT) can provide access to real-time supply chain information by tracking materials, equipment, and products as they move through the supply chain.

IOT CHALLENGES

Security, privacy and data sharing issues

- Because IoT devices are closely connected, all a hacker has to do is exploit one vulnerability to manipulate all the data, rendering it unusable.

- And manufacturers that don't update their devices regularly -- or at all -- leave them vulnerable to cybercriminals.

- However, hackers aren't the only threat to the internet of things; privacy is another major concern for IoT users.

- For instance, companies that make and distribute consumer IoT devices could use those devices to obtain and sell users' personal data.

- Challenges with IIoT:
    - i.   Security of data – same as above
    - ii.   Reliability and stability – of IIoT sensors
    - iii. Connectivity of all the systems in IIoT setup – no maintenance envisioned?
    - iv.   Blending legacy systems – IIoT is new in the market

What NEEDS TO be done?

1. Consumer education
2. Product reviews and comparisons
3. Vulnerability disclosure and vulnerability markets
4. Self-certification and voluntary codes of practice
5. Trust marks and labels like Internet Society's Online Trust Alliance (OTA) IoT Trust Framework
6. Government initiatives
7. Mandated security requirements
8. Mandated certification
9. Liability reform
10. Etc.
11. **No intervention!?**

The future of IoT

- Bain & Company expects annual IoT revenue of hardware and software to exceed $550 billion by 2023.

- McKinsey & Company estimates IoT will have an $11.1 trillion impact by 2025.

- IHS Markit believes the number of connected IoT devices will increase 12% annually to reach 125 billion in 2030.

- Gartner assesses that 20.8 billion connected things will be in use by 2020, with total spend on IoT devices and services to reach $3.7 trillion in 2021.

- By 2023, the average CIO will be responsible for more than three times as many endpoints as this year – Gartner

- Garter forecasts that worldwide IoT Security Spending will be 3.11 billion by 2021 largely driven by regulatory compliance.

- Great improvements in the security of IoT devices driven by manufacturers' own initiatives as well users' demand for better secure devices.

- Global manufacturers will use analytics data recorded from connected devices to analyze processes and identify optimization possibilities, according to IDC and SAP.

- Business Insider forecasts that by 2020, 75 percent of new cars will come with built-in IoT connectivity.
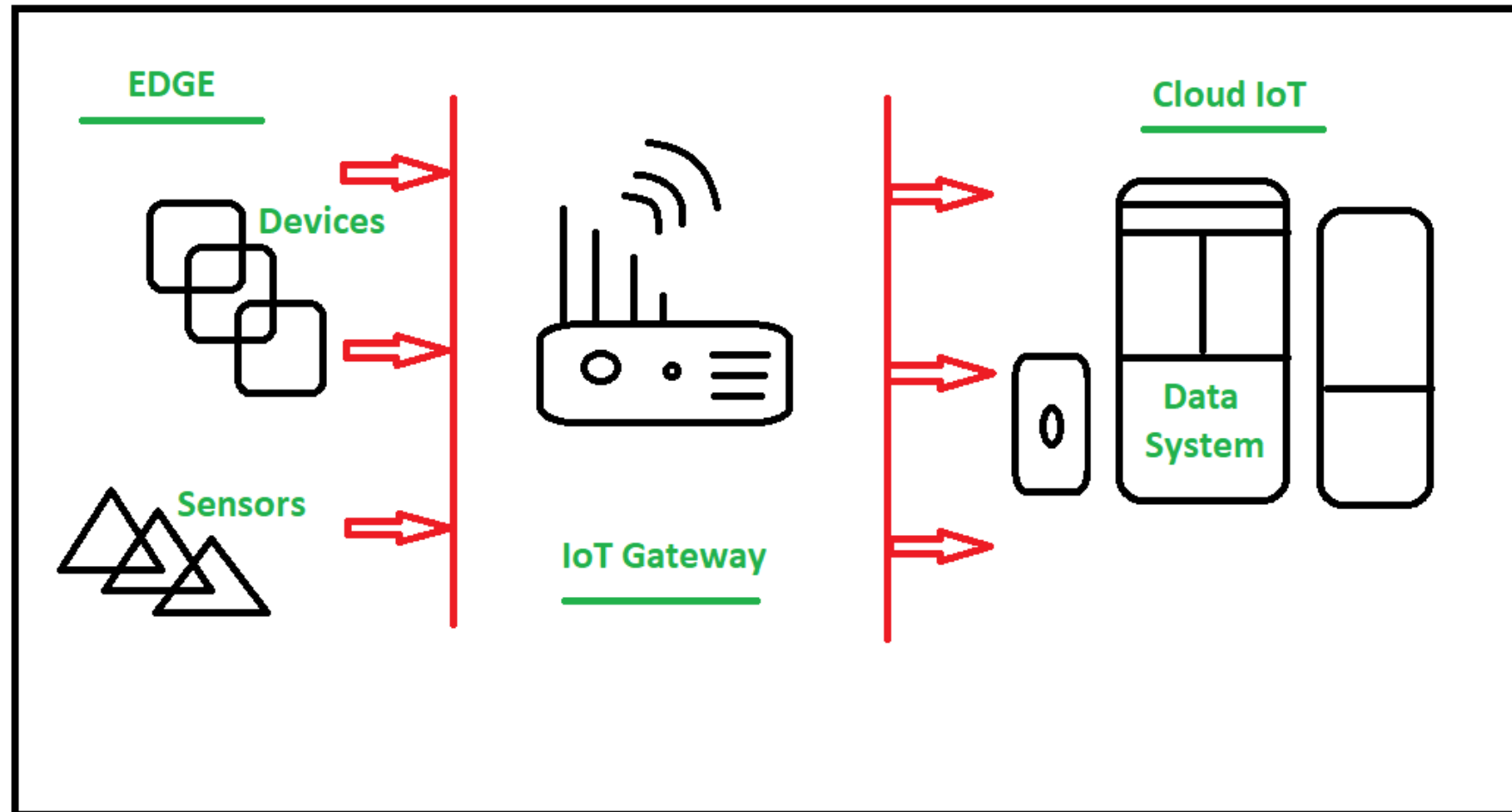
Internet of Things (IoT) Gateways

• **Gateway** provides bridge between different communication technologies which means we can say that a Gateway acts as a medium to open up connection between cloud and controller(sensors / devices) in Internet of Things (IoT).

• By the help of gateways, it is possible to establish device to device or device to cloud communication.

• A gateway can be a typical hardware device or software program.

• It enables a connection between sensor network and Internet along with enabling IoT communication,

- it also performs many other tasks such as this IoT gateway performs protocol translation, aggregating all data, local processing and filtering of data before sending it to cloud, locally storing data and autonomously controlling devices based on some inputted data, providing additional device security.

- The below figure shows how IoT Gateways establish communication between sensors and cloud (Data System) :

IoT Gateway

- As IoT devices work with low power consumption Battery power) in other words they are energy constrained so if they will directly communicate to cloud/internet it won't be effective in terms of power.

- So, they communicate with Gateway first using short range wireless transmission modes/network like ZigBee, Bluetooth, etc as they consume less power or they can also be connected using long range like Cellular and WiFi etc.

- Then Gateway links them to Internet/ cloud by converting data into a standard protocol like MQTT.

- Using ethernet, WiFi/cellular or satellite connection.

- And in mostly Gateway is Mains powered unlike sensor nodes which are battery powered.

- In practice there are multiple Gateway devices.

- Let's think about a simple IoT gateway, then our smartphone comes into picture as it can also work as a basic IoT gateway when we use multiple radio technologies like WiFi, Bluetooth, Cellular network of smart phone to work on any IoT project in sending and receiving data at that time this also acts as a basic IoT Gateway.
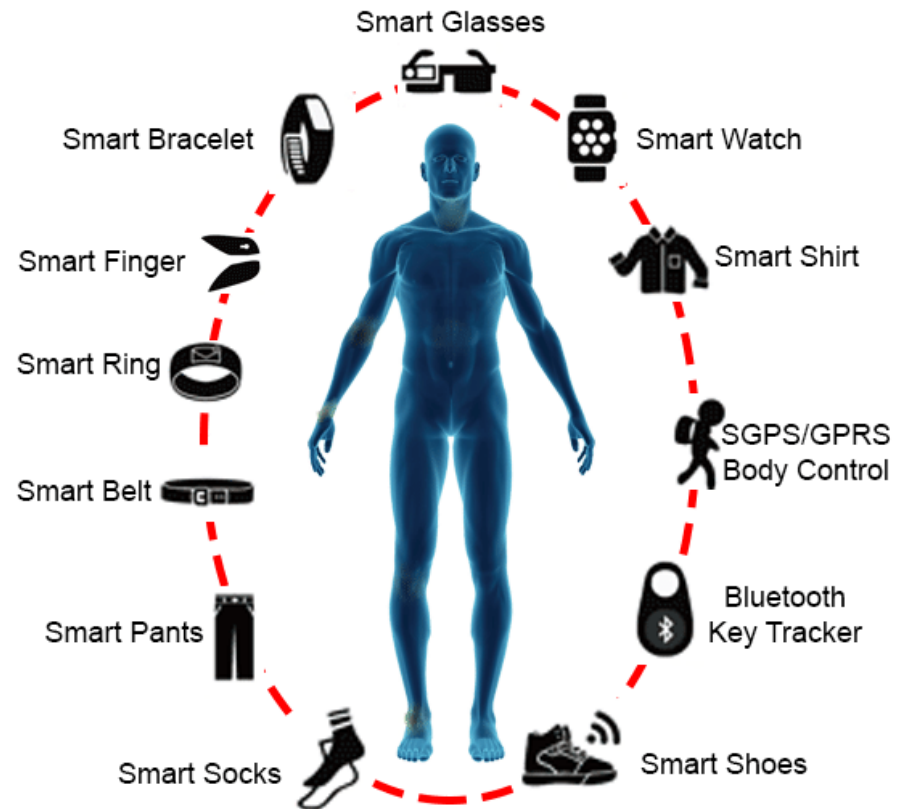
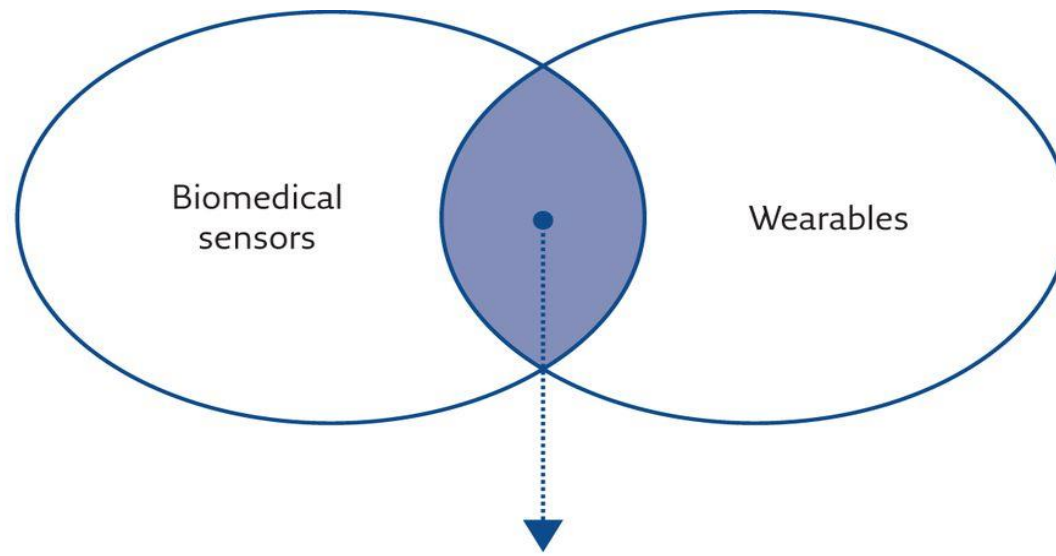# Key functionalities of IoT Gateway :

- Establishing communication bridge
- Provides additional security.
- Performs data aggregation.
- Pre processing and filtering of data.
- Provides local storage as a cache/ buffer.
- Data computing at edge level.
- Ability to manage entire device.
- Device diagnostics.
- Adding more functional capability.
- Verifying protocols.

Working of IoT Gateway :

- Receives data from sensor network.
- Performs Pre processing, filtering and cleaning on unfiltered data.
- Transports into standard protocols for communication.
- Sends data to cloud.

• IoT Gateways are key element of IoT infrastructure as Gateways establish connection for communication and also performs other task as described above.

• So, IoT Gateway is one of most essential thing when we start think about an IoT ecosystem.

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IoT Wearable Technology
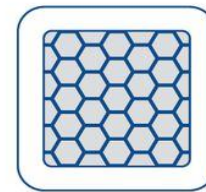
Biomedical sensors

Wearables

Wearable biomedical sensors
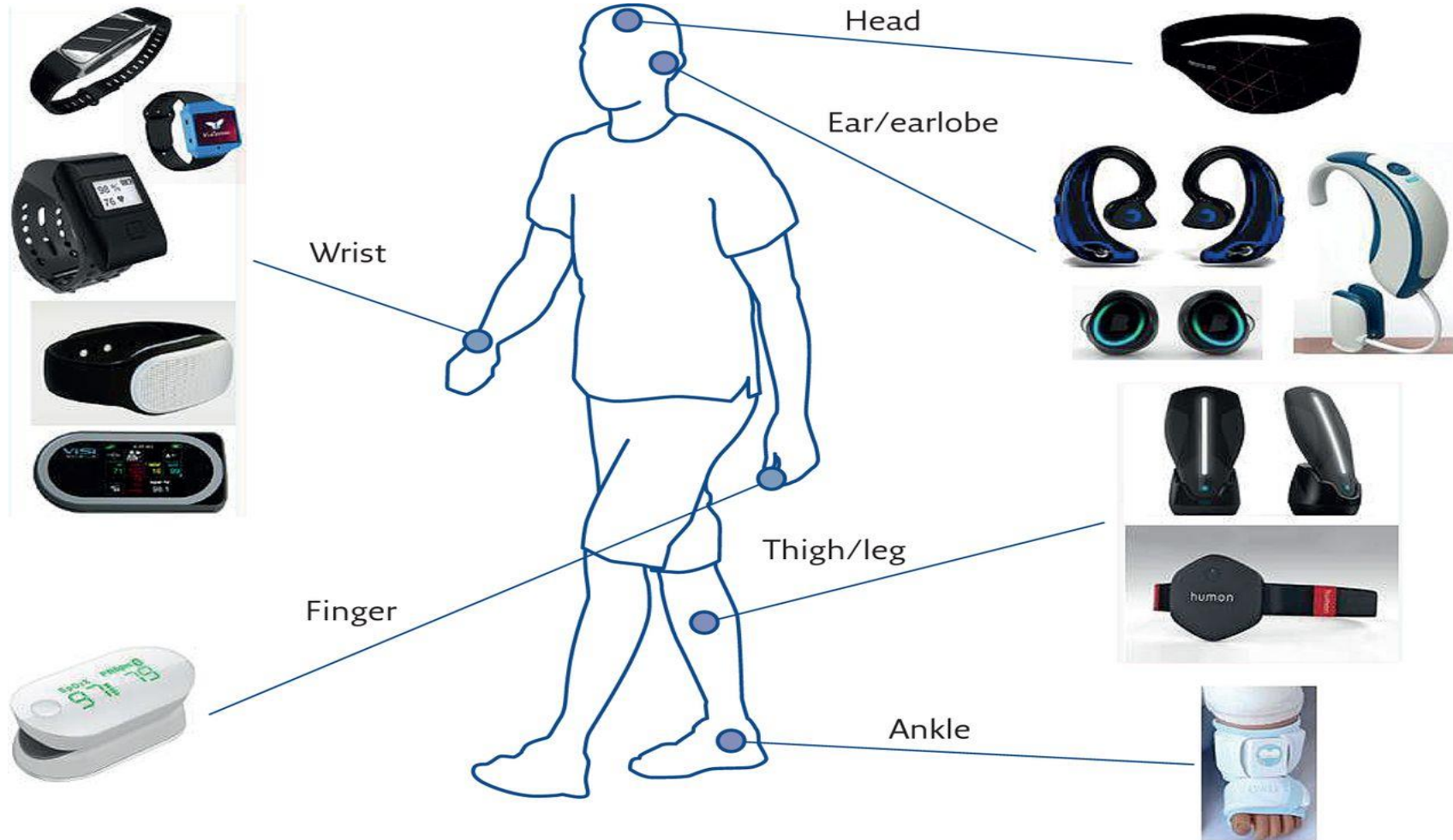
Activity trackers

Smart watches

Smart clothing

Patches/ tattoos

Ingestibles/ smart implants

Strap

Shirt/bra

Motion sensors

Zephyr

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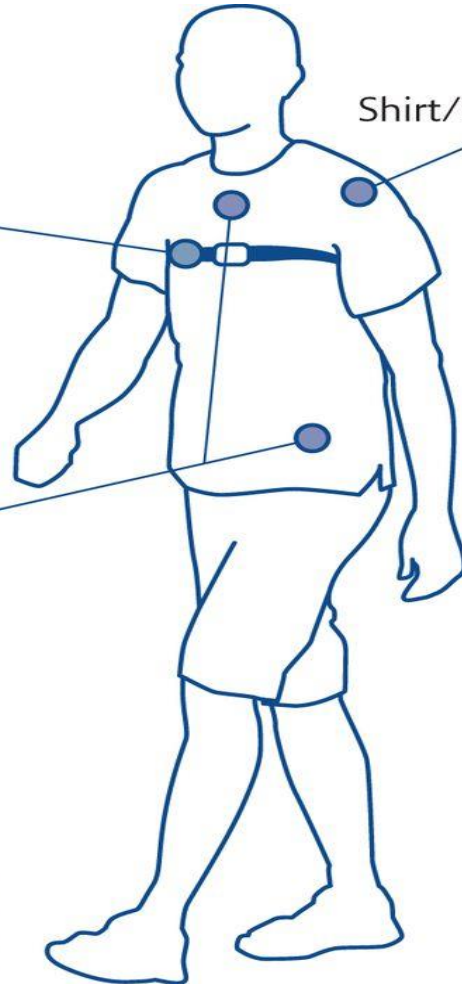
1.43% believe that wearables devices will replace smartphones in future

2.30% commit to wear at least 5 wearables by 2020 for various purpose

3.57% believe wearables will submerge dependency on friends/ family

4.52% people would love to watch TV in wearables screen

Some Challenges which we can face while developing such product?

- Security might cause some problems by manipulating physical hardware.
- Battery life can cause some problem when device is measuring data from many sensors.

.

- **What can be done with data that have been collected from wearable gadgets?**

- Data analytics (e.g can give different set of advices such as change battery of device in 15 days).

- Predictive analysis (e.g Health Care).

- Event Triggers (e.g Turn the Geyser On when returning from workout).

- Given the way that a little gadget might be worn on a piece of the body not ordinarily in see or effortlessly open, the conceivable outcomes for a human-machine interface (HMI) are somewhat restricted — and unquestionably do exclude a huge show or console

- In numerous cases, physical catches in favor of a watch can be set to various alternatives with catch blends and the present capacity showed on the screen. This still doesn't add up to a very rich user interface. The technology uses Phone as a gateway to transmit the data and the cloud services help to achieve different goals.

Edge Computing

- **Edge computing** is a <u>distributed computing</u> paradigm that brings <u>computation</u> and <u>data storage</u> closer to the sources of data. This is expected to improve response times and save <u>bandwidth</u>.[

- "A common misconception is that edge and <u>IoT</u> are synonymous.

- Edge computing is a topology- and location-sensitive form of distributed computing, while IoT is a use case instantiation of edge computing.

- "The term refers to an architecture rather than a specific technology.
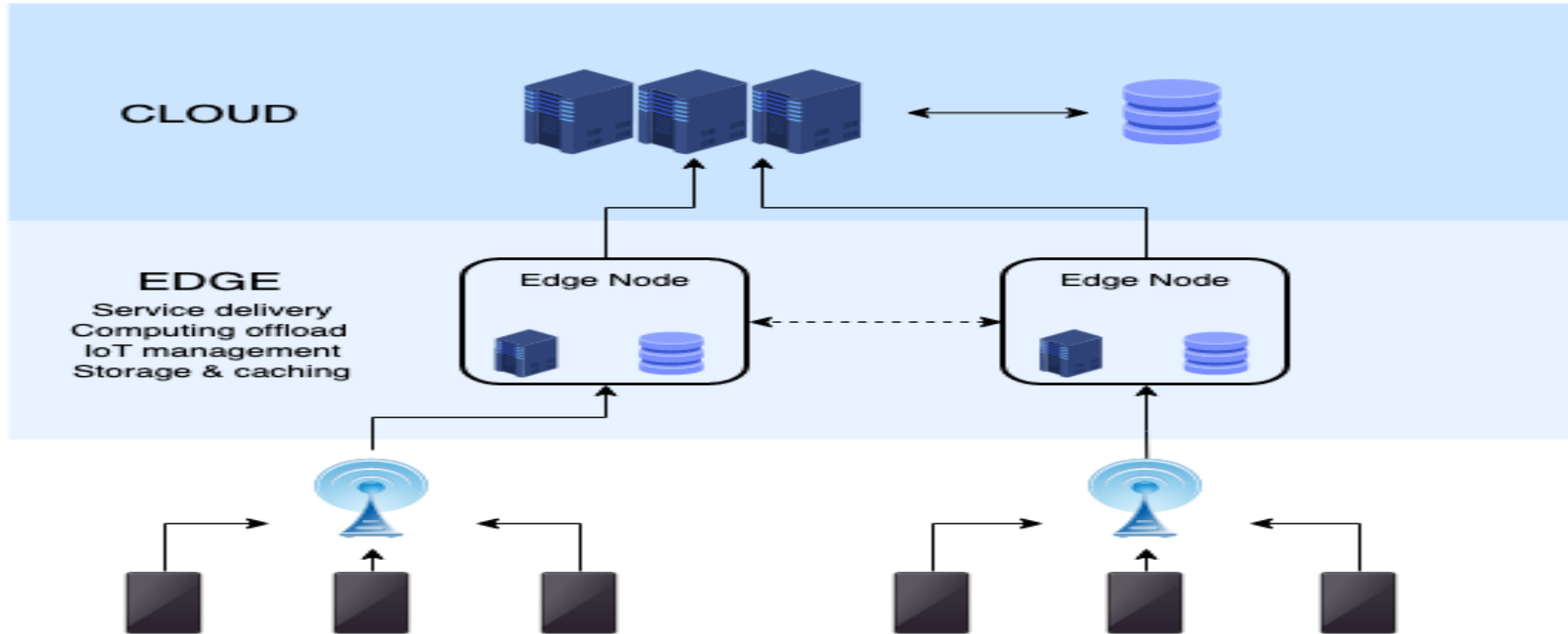
-]

- The origins of edge computing lie in <u>content distributed networks</u> that were created in the late 1990s to serve web and video content from edge <u>servers</u> that were deployed close to users.

- In the early 2000s, these networks evolved to host applications and application components at the edge servers, resulting in the first commercial edge computing services that hosted applications such as dealer locators, shopping carts, real-time data aggregators, and ad insertion engines.

- One definition of edge computing is any type of <u>computer program</u> that delivers low latency <u>nearer to the requests</u>.
- Karim Arabi, in an IEEE DAC 2014 Keynote and subsequently in an invited talk at MIT's MTL Seminar in 2015, defined edge computing broadly as all computing outside the cloud happening at the edge of the network, and more specifically in applications where real-time processing of data is required. In his definition, <u>cloud computing</u> operates on <u>big data</u> while edge computing operates on "instant data" that is real-time data generated by sensors or users.
- The term is often used synonymously with fog computing.
- According to *The State of the Edge* report, edge computing concentrates on servers "in proximity to the last mile network.
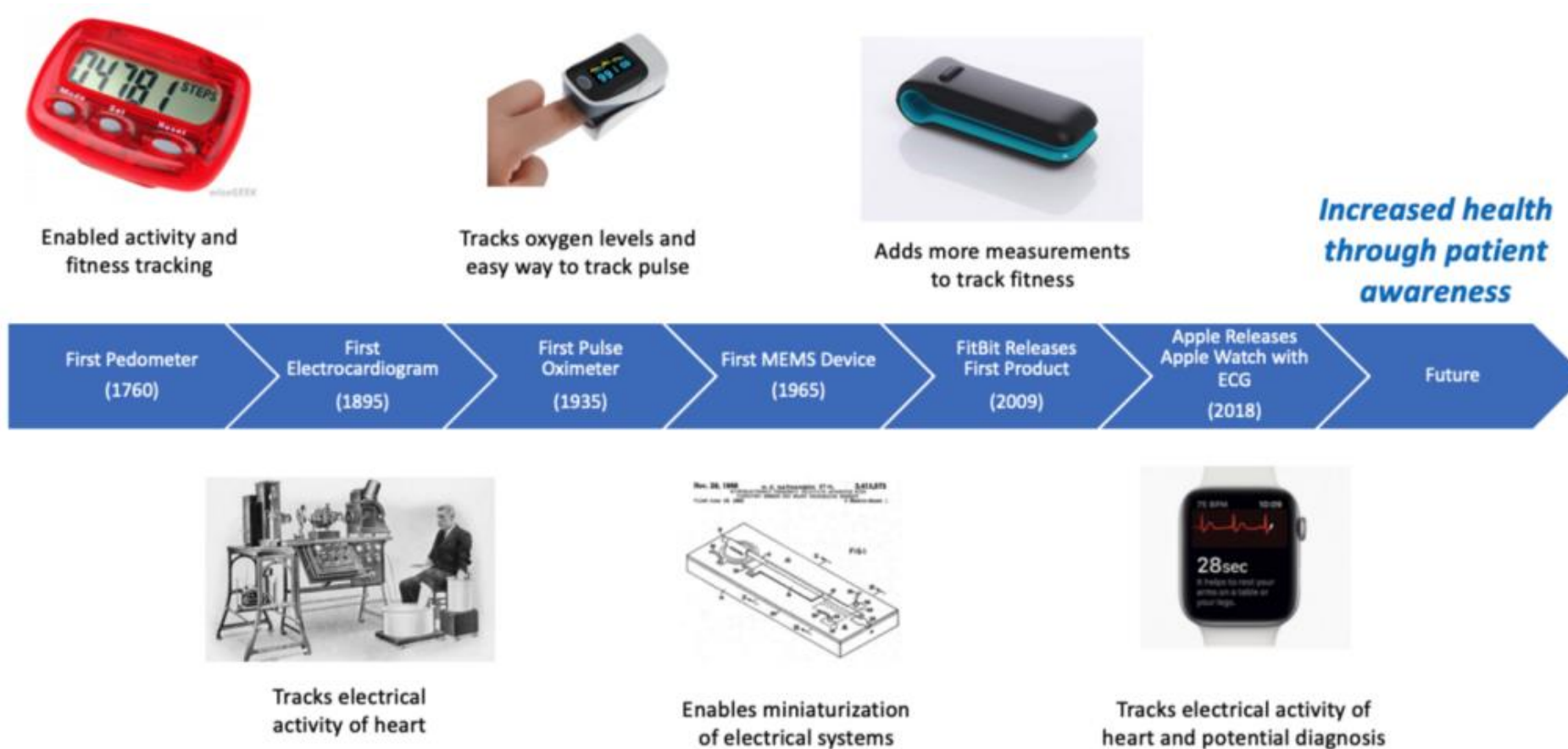
- "Alex Reznik, Chair of the <u>ETSI</u> MEC ISG standards committee loosely defines the term: "anything that's not a traditional data center could be the 'edge' to somebody."

- Edge nodes used for game streaming are known as *gamelets*, which are usually one or two hops away from the client.Per Anand and Edwin say "the edge node is mostly one or two hops away from the mobile client to meet the response time constraints for real-time games' in the <u>cloud gaming</u> context."

- Edge computing may employ <u>virtualization</u> technology to make it easier to deploy and run a wide range of applications on edge servers.

- Privacy
- Security
- Scalability
- Relaiability
- Speed
- Efficiency
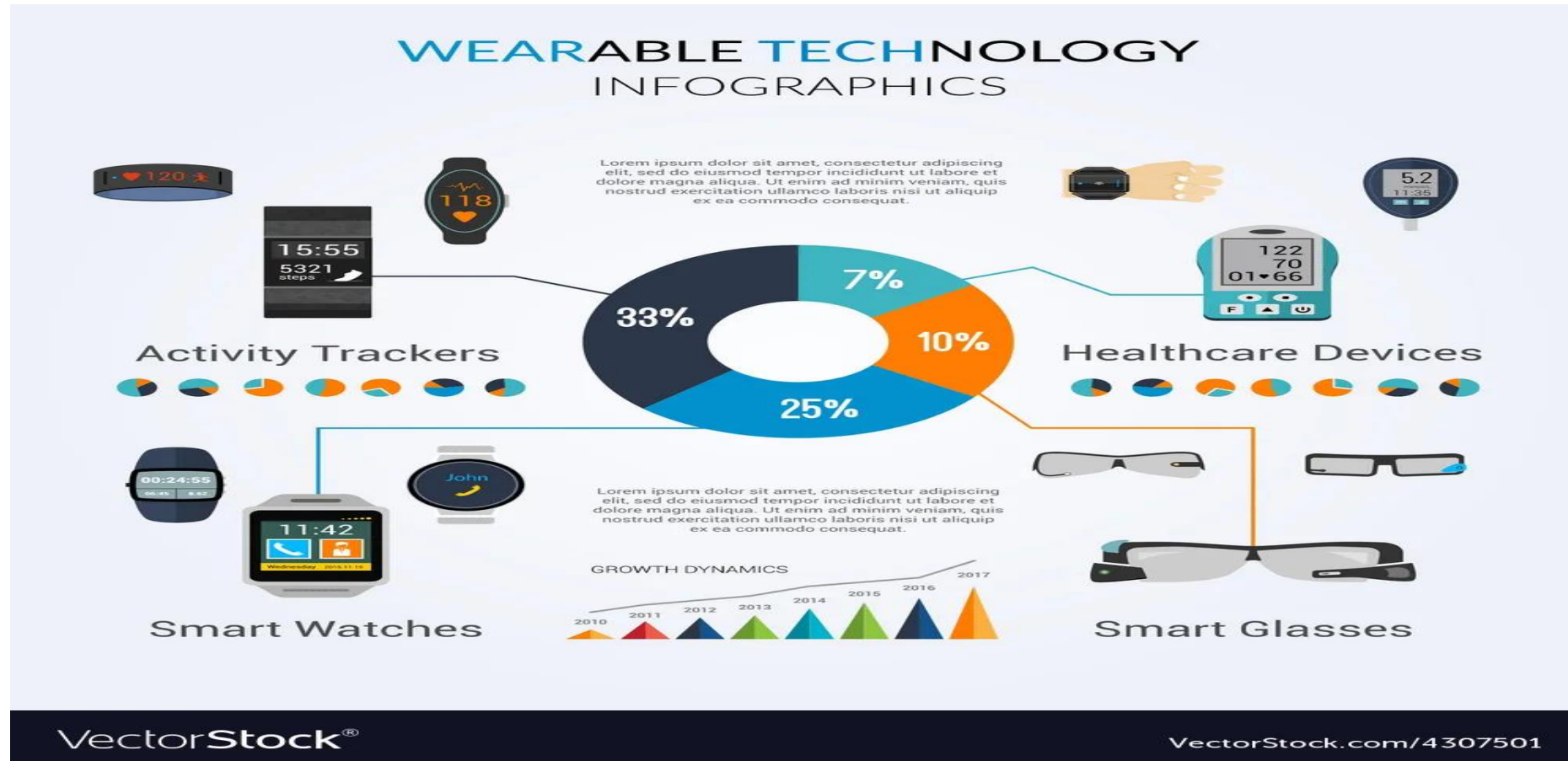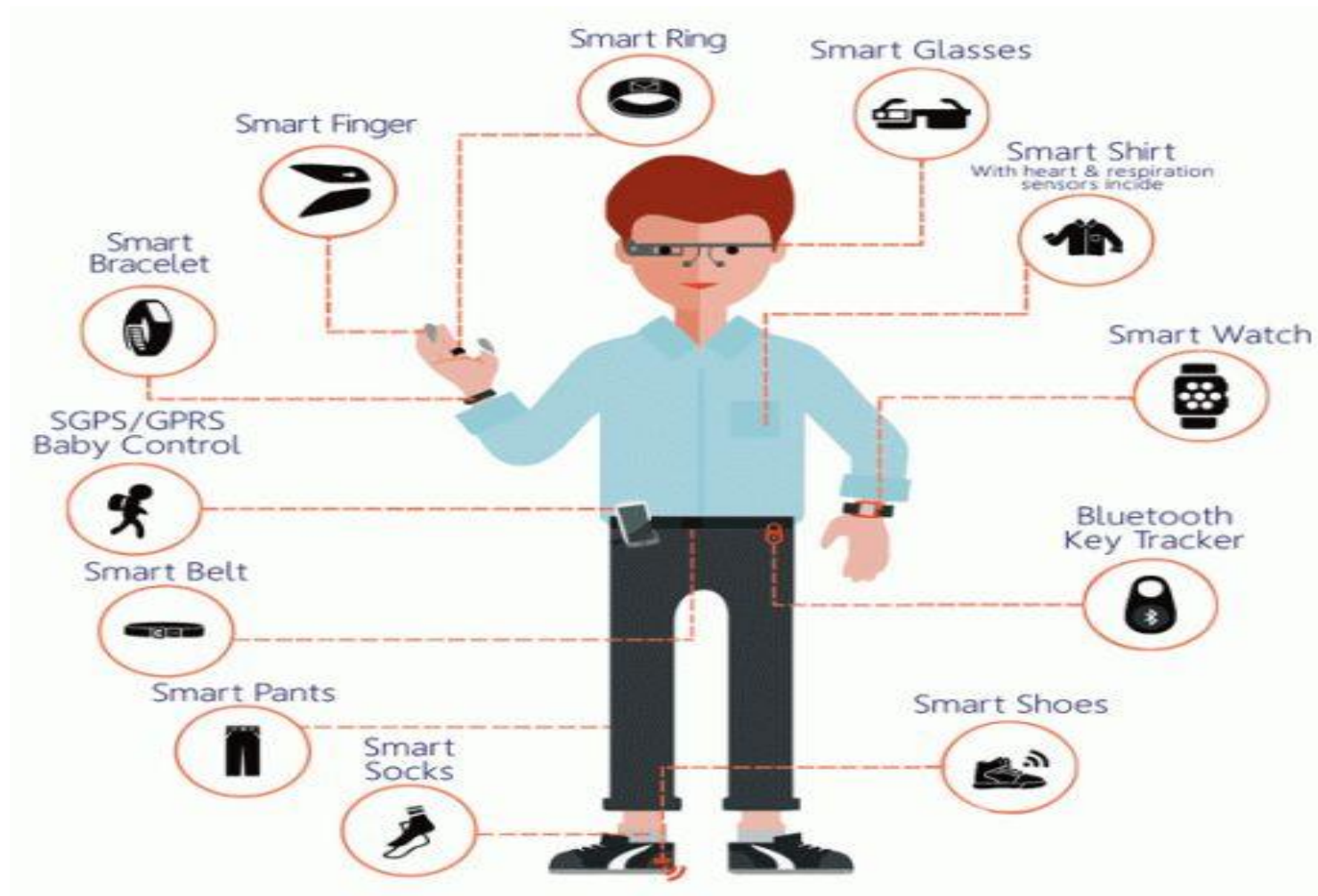
IoT –Ecosystem(edge computing)

: Evolution of health monitoring technologies into smaller and wearable devices (White, 2011), (The History of the Electrocardiogram), (Digital Fingertip Pulse Oximeter), (Harvey C. Nathanson), (Eight years of Fitbit news leading up to its planned IPO), (Hall, 2019) Wearable health devices are already capable of measuring multiple vitals through various

Enabled activity and fitness tracking

Tracks oxygen levels and easy way to track pulse

Adds more measurements to track fitness

Increased health through patient awareness

| First Pedometer (1760) | First Electrocardiogram (1895) | First Pulse Oximeter (1935) | First MEMS Device (1965) | FitBit Releases First Product (2009) | Apple Releases Apple Watch with ECG (2018) | Future |

Tracks electrical activity of heart

Enables miniaturization of electrical systems

Tracks electrical activity of heart and potential diagnosis

- The wearable health technologies field is flourishing due to the emergence of MEMS technology, enabling these devices to shrink to the size of your standard wristwatch. They allow for continuous tracking and immediate feedback of the customer's health. The current trajectory of the industry will result in wearable health technologies able to track more physiological signals, thus improving the health of consumers through patient awareness. Is this the true future of the wearable health technologies industry? As possible risks are rising from these new technologies, the benefits will outweigh these risks.

Infographics- WT

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End

Thanks for listening