

# THE INTERNET OF THINGS

## Chapter 1

### THE INTERNET OF THINGS: AN OVERVIEW

- **THE FLAVOUR OF THE INTERNET OF THINGS:**

- (Examples of IOT)
- 1) The alarm rings. As you open your eyes, you see that it's five minutes later than your usual wake-up time.
- The clock has checked the train times online, and your train must be delayed, so it lets you sleep in a little longer.
- 2) In your kitchen, a blinking light reminds you it's time to take your tablets.
- 3) If you forget, the medicine bottle cap goes online and emails your doctor to let her know.
- 4) On your way out of the house, you catch a glow in the corner of your eye.
- Your umbrella handle is lit up, which means that it has checked the BBC weather reports and predicts rain.
- 5) As you pass the bus stop on the way to the station, you notice the large LCD display flash that the number 23 is due.
- When the bus company first installed those displays, they ran on the expected timetable information only, but now that every bus has GPS tracking its location, they simply connect to the bus company's online service and always give the updated information.
- 6) An ornament with a dial notices the change and starts to turn so that the text on it points to the word "Travelling".
- Your family will also see later that you've arrived at "Work" safely.
- 7) The wrist band's large display also makes it easy to glance down and see how fast you are running and how many calories you've burned.
- All the data is automatically uploaded to your sports tracking site, which also integrates with your online supermarket shopping account to make it easy to compare with how many calories you've eaten.

### THE "INTERNET" OF "THINGS":

- All the cases we saw used the *Internet* to send, receive, or communicate information.
- And in each case, the gadget that was connected to the Internet wasn't a computer, tablet, or mobile phone but an object, a *Thing*.
- **These Things are designed for a purpose:**
- the umbrella has a retractable canopy and a handle to hold it.
- A bus display has to be readable to public transport users, including the elderly and partially sighted and be able to survive poor weather conditions.
- The sports bracelet is easy to wear while running, has a display that is large enough and bright enough to read even when you are moving, and will survive heat, cold, sweat, and rain.
- Unlike a calm light in the umbrella stand, gives piece of information to process subconsciously when you pass it on the way out of your home, an app requires you to perform several actions. (you have to take the phone out of your pocket

or bag, unlock it, navigate to the right website , you have to type the URL and read the data from a small screen.)

- Rather than having greater capabilities, the smart umbrella simply moves the same intelligence into your environment so that you don't have to change your routine.
- So the idea of the Internet of Things suggests that rather than having a small number of very powerful computing devices in your life (laptop, tablet, phone)
- you might have a large number of devices which are perhaps less powerful (umbrella, bracelet, mirror, fridge, shoes).
- The definition of ubicomp, however, would also include the air fresheners which release scent when they detect movement in the room as part of its domain.
- That is to say, such a device is an intelligently programmed computer processor, driven by sensors in the real world, and driving output in the real world, all embedded into an everyday object.
- These factors make this ubicomp, and it is only differentiated from the "Internet of Things" by the fact that these days most of the really interesting things done with computing also involve an Internet connection.
- But what does it mean to "connect an object to the Internet"?
- Clearly, sticking an Ethernet socket into a chair or a 3G modem into a sewing machine doesn't suddenly inspire the object with mysterious properties.
- Rather, there has to be some flow of information which connects the defining characteristics of the Thing with the world of data and processing represented by the Internet.
- The Thing is present, physically in the real world, in your home, your work, your car, or worn around your body.
- This means that it can receive inputs from your world and transform those into data which is sent onto the Internet for collection and processing.
- So your chair might collect information about how often you sit on it and for how long.
- The presence of the Thing also means that it can produce outputs into your world with what we call "actuators".
- Some of these outputs could be triggered by data that has been collected and processed on the Internet.
- So your chair might vibrate to tell you that you have received email.
- We could summarize these components in the following simple equation:
- Note that in all the cases we've looked at, the form of the object follows the function of the Thing:
- your chair is designed to sit on, the sewing machine to sew at, and so on.
- The fact of also being connected to the Internet and having general-purpose computing capabilities doesn't necessarily have an impact on the form of the object at all.

$$\begin{array}{c}
 \textit{Physical Object} \\
 + \\
 \textit{Controller, Sensor, and Actuators} \\
 + \\
 \textit{Internet} \\
 = \\
 \textit{Internet of Things}
 \end{array}$$

*An equation for the Internet of Things.*

### THE TECHNOLOGY OF THE INTERNET OF THINGS:

- It is worth taking a little time to look at the Internet of Things through a lens of the history of technology to more clearly understand how and where it fits.
- Technology's great drivers have initially been fundamental needs, such as food and water, warmth, safety, and health.
- Hunting and foraging, building and medicine grow out of these needs.
- Then, because resources for these things are not always distributed where and when one might like, technological advances progress with enabling and controlling the movement of people.
- Trade develops as a movement of goods from a place where they are plentiful and cheap to one where they are rare and valuable.
- **Storage** is a form of movement in time—for example, from harvest time, when food is plentiful and cheap, to the following winter, when it is highly valued.
- Information becomes key, too—hence, the development of **language to communicate** technology to others.
- Travellers might pass on messages as well as goods and services, and an oral tradition allows this information to pass through time as well as space.
- From writing, via the telegraph, radio, and television, to digital information, more and more technology has been about enabling the movement of information or doing interesting things with that information.
- As technology has progressed, new categories of objects have been created:
- in the electronic age, they have included telephones, radios, televisions, computers, and smartphones.
- As with most new technology, these devices tended to start out very expensive and gradually come down in price.
- Demand drives down prices, and research leads to optimization and miniaturisation.
- Ultimately, it becomes not just possible but also feasible to include functionality that would previously have required its own dedicated device *inside* another one.
- mere computing power isn't a sufficient precondition for the Internet of Things.

- Rather, we are looking at computing power linked on the one hand to electronic sensors and actuators which interact with the real world and on the other to the Internet.
- It turns out that the rapid sharing and processing of *information* with services or other consumers is a huge differentiator.
- Internet connectivity is also cheaper and more convenient than it used to be.
- Whereas in the past, we were tied to expensive and slow dial-up connections, nowadays we have broadband subscriptions, providing always-on connectivity to the Net.
- Wired Ethernet provides a fairly plug-and-play networking experience, but most home routers today also offer WiFi, which removes the need for running cables everywhere.
- For situations in which a fixed network connection isn't readily available, mobile phone connectivity is widespread.
- Another factor at play is the maturity of online platforms.
- Whereas early web apps were designed to be used only from a web browser, programming using an Application Programming Interface (API), which allows other programs, rather than just users, to interact with and use the services on offer.
- As the online services mature, so too do the tools used to build and scale them.
- Web services frameworks such as Python or Ruby on allow easy prototyping of the online component.
- Similarly, cloud services such as Amazon Web Services mean that such solutions can scale easily with use as they become more popular.
- **ENCHANTED OBJECTS:**
- Technologist, David Rose has talked about Enchanted Objects and has categorised various objects drawn from fairy tales and fantasy literature in ways that apply as much to technological objects.
- **For Protection,**
- Ex: In story:
- The **magical swords** and helmets protected the main characters of fairy tales from their enemies,
- In reality:
- the development of science and technology throughout history been driven by the need for **military** superiority, for the purpose of **security**.
- **Health** has been a driver for many quests to find an ingredient for a health potion and for research into various branches of medicine, pharmacology and surgery, physiotherapy, and diet.
- Ex: In story:
- Snow White's wicked stepmother asking "Mirror mirror on the wall, who's the fairest of them all?"
- In reality:
- to the friends settling an argument of fact by looking up articles from Wikipedia on their smartphones.
- **Human Connection**, even when one's loved ones are far away.

- the postal service, telephones, and social networking help keep us in touch with our family and friends.
- Ex: In story:
- for *Effortless Mobility* invented **flying carpets**, and even teleportation.
- In reality:
- Through technology, we have invented cars and railways, bicycles, and **aeroplanes**.
- The need for ***Creative Expression***
- Ex: in stories by the enchanted paintbrushes and magic flutes
- In reality:
- from charcoal to paint to computer graphics, or from drums to violins and electronic synthesisers.
- So, **technology** has always been associated with **magic**, and so this will be true almost by default for the Internet of Things.
- A **key element** of many enchanted objects is that above and beyond their practical enchantment they are given a name and a personality—implying an **intelligence greater than strictly necessary to carry out the task for which they are designed**.
- so our connected devices, or Things, have processing and communicating capabilities well beyond the needs of the average lamp or umbrella.
- **WHO IS MAKING THE INTERNET OF THINGS?**
- There are many crossover points between all the disciplines listed.
- Artists may collaborate with designers on installations or with traditional craftspeople on printmaking.
- Designers and engineers work closely to make industrial products, and hobbyist “hackers” (in the sense of tinkerers (unskilled person)).
- In the Internet of Things:
- A hacker might tinker at the prototype for a Thing;
- A software developer might write the online component;
- A designer might turn the ugly prototype into a thing of beauty, possibly invoking the skills of a craftsperson
- And an engineer might be required to solve difficult technical challenges, especially in scaling up to production.

## Chapter 2

### DESIGN PRINCIPLES FOR CONNECTED DEVICES

- **CALM AND AMBIENT TECHNOLOGY:**
- ubicomp is often also referred to as *ambient computing*.
- the term “**ambient**” is **not** something to which we **actively pay attention** and in some cases as something which we seek to remove (e.g., ambient noise in a sound recording).
- the term ***calm technology***—systems which **don’t compete for attention** yet are ready to provide utility or useful information when we decide to give them some attention.