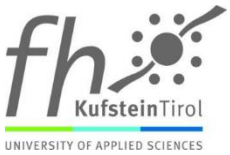

Marshallplan-Jubiläumsstiftung
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UNIVERSITY

ANALYSIS OF THE APPLICATION AREAS, THE INFLUENCE AND THE POSSIBILITIES OF COMPUTATIONAL CAPACITY (OF IOT DEVICES) IN THE INFRASTRUCTURE SECTOR AND COMPARISON OF THE RESULTS BETWEEN AUSTRIA AND THE USA

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LIST OF ABBREVIATIONS

Abb.	Abbreviation
IoT	Internet of things
US	United States
USA	United States of America
RFID	Radio-frequency identification
AI	Artificial intelligence
WEB	World wide web
TLS/SSL	Transport layer security/Secure sockets layer
BOT	Software applications running automated tasks
DDOS	Distributed denial of service
OSI/ISO	Open System Interconnection Model
CHACHA20	Encryption method
API	Application programming interface
LED	Light emitting diode
km/H	Kilometers per hour
GPS	Global positioning system
SITA	Société Internationale de Télécommunications Aéronautiques
GB	Gigabyte
CCTV	Closed circuit television
ACARS	Aircraft communications addressing and reporting system
ÖBB	Österreichische Bundesbahnen
IBM	International business machines corporation
AT&T	American telephone and telegraph
GE	General electric
IT	Internet
SAP	German software company know for ERP systems

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1 INTRODUCTION

1.1 Description of the thesis and motivation

My thesis mainly focuses on the application areas of IoT devices in the infrastructure sector. As we are constantly surrounded and influenced by digital devices, this topic is of high importance. We can find computational capacity in many situations of our day to day life, without even noticing it. The influence, the importance and the dependence we have on these devices is immense. It is a real challenge to cope with the fast-changing technology. For example, digital supermarkets need some time to get accepted by the public and the consumer. But this is just the beginning. As technology develops and computational capacity gets cheaper[1] and more efficient, much more parts will be supported by digital devices. Sooner or later, technology will take most of our tasks and we are even more correlated to them. Therefore, the relevancy of this topic is very high.

With this thesis, I try to analyze the current situation and application areas of IoT devices and I will especially focus on the transportation infrastructure sector. I also want to point out the influence such devices and rapidly enhancing technology have. It is a constant learning process, to understand the digitalized world. Nowadays, everything is about efficiency. Maximal output at minimal input is what the modern world wants. IoT devices provide exactly that – efficiency. The possibilities are limitless and every day, new helping devices are provided. The interaction with the consumer, is one of the essential parts, but this is not always as easy as it sounds. This thesis should provide information and knowledge about the things that run the modern world. It should help us to cope with the technology and to live in our digitalized world.

1.2 Relevancy and benefit

As mentioned before, the influence and the relevance of computational capacity is ubiquitous in our society[2]. We often forget to question and analyze things we take for granted and this is the reason, I want to give sensitization and enlightenment to the community and pass on the results I gain from my analysis. Often, we do not think about things or do not see the

[1] https://www.statista.com/statistics/203759/average-selling-price-of-desktop-pcs-worldwide/

[2] https://www.statista.com/statistics/471264/iot-number-of-connected-devices-worldwide/

possibilities, advantages or disadvantages, technology offers us. That is the reason, why we have to analyze, question and observer such things, to actually understand what is going on. We do not know how our world will look like in the future, but one thing is for sure: Computers and computational capacity will grow and takeover a lot of things[3]. This will surely increase our efficiency, but what is the price to pay for?

To cope with the fast-changing technology and the digitalization, we need to inform people about these trends, the possibilities and also the hazards. My goal is to contribute the knowledge I gain throughout this research, to the people that use these devices every day and provide the information, that may help to understand our digitalized world a little bit better. At the end we as consumers are in charge of what happens with the technology. The industry produces what we demand and I am looking forward finding out what we actually want.

1.3 Methodical consideration

The implementation of these thesis includes following methodical considerations:

- In which application areas can computational capacity be found?
- Which influence does it have on our everyday life?
- Which possibilities, advantages and disadvantages do these devices provide us?
- What is the today's progress of the technology?
- What can be expected in the near future?
- What significant differences are there between the USA and Austria?
- Is the USA a trendsetter for technology?
- How does the interaction between devices and human work?
- Which overvalue is added through the use of digital devices?
- Is it necessary to use computational capacity?
- What happens if society does not accept digitalization in some areas?

[3] https://www.statista.com/statistics/264084/worldwide-sales-of-industrial-robots/

1.4 General goals and expectations

The main goal is to analyze the application areas, the influence and the possibilities computational capacity has on our everyday life. We consider computational capacity and computers as essential nowadays. Transportation tickets even cannot be bought, without the use of some kind of computer. I want to analyze all these things and provide it to the people, who use the technology every day.

I am especially interested in the differences between the USA and Austria. The USA is a kind of trendsetter for technology and smart tools. But is there really that big of a difference? Is a country like Austria less developed, regarding IoT and smart devices? Of course, the USA is a much bigger country, but does that mean that Austria does not have smart solutions, or does it? Technology is knowledge and knowledge is might. Are the United States pioneers for technology, or is Austria a trendsetter as well?

The goal is to find out more about those research areas and summarize them in a scientific way to create new knowledge, information and overvalue. We have to understand the technology, otherwise technology will understand us at some point. I want consumers to think about that, because in the end we are the ones that decide, which technology we need and which not. The comparison between the USA and Austria, is a very interesting element. During my time in the USA, I tried to gather as much information as possible about the key questions of my thesis. To combine the experiences of two different countries, is a fantastic opportunity. This will certainly give interesting information about our technology lifestyle.

1.5 Specialization in transportation infrastructure

As IoT devices and computational capacity are used in many ways and use cases[4], a specialization for this field of study must be made, in order to deliver concrete results. In this research I therefore concentrate on transportation infrastructures, especially in airports and in public transportation. Airports are the biggest infrastructure hubs in this field and are known for high capacity[5], constant interaction with computer systems, highly efficient systems, on the edge technology and the crucial use of technology. This makes it perfect for my analyzation and observation. Public transportation as well, is one field of study strongly correlated

[4] https://www.statista.com/statistics/485252/iot-endpoint-spending-by-category-worldwide/

[5] https://www.statista.com/chart/4598/the-worlds-top-10-busiest-airports/

with the usage of IoT devices. Efficiency is the keyword for modern transportation. This specialization allows me to provide more detailed information and to do a deeper research in this field. The last few months, I was fortunate to travel to some of the biggest airports in the USA and even the world and to experience high efficient systems, interacting with the real world. It showed me how important and advanced technology is and what impacts IoT devices have and will have at airports. My observation and analyzation showed me interesting results, which I will present in the second part of my research.

2 Introduction to IoT devices and general explanations

This chapter explains the basic concepts of the internet of things and covers important parts, key components and further concepts related to this topic. The goal is to give an overview and introduction to this field of study and provide a knowledge base for the reader.

2.1 [6]The internet of things

Figure 1: Internet of things

The internet of things is a widely used term, which covers and correlates with lots of different topics. The key part is the connection or network of hardware devices and sensors and their communication with each other. Gathering data through different sensors, process the information and unite the data to add value, is the overall description and function of the IoT. In the real world, these networks help us to add value to certain things and make certain tasks easier and more efficient. The central combination of data from different sources, makes it very powerful. Many things in the modern world are dependent on the help of those devices and statistics show that there is a growing demand every year[7]. In order to make networks efficient, several parts and concepts have to work together. Some of those aspects and concepts are explained in detail in the next chapters of this paper.

[6] https://mspalliance.com/wp-content/uploads/2017/03/IoT.png

[7] https://www.statista.com/statistics/471264/iot-number-of-connected-devices-worldwide/

2.2 IoT devices

IoT devices are hardware devices containing computational power and different sensors to measure interaction from their surroundings and environmental influences. There is a wide variety of sensor available and low cost electronic components, enable a large spread of devices in different sectors. RFID tags are only one of many examples for low cost electronical components, which interact in real world use cases. Sensors are responsible for gathering exact and valid data and make information available in networks. Modern fridges, light bulbs, light switches[8] and many more things are equipped with ports, to connect to the network and lay the base for collecting data in every day used things. There are already many devices that are equipped with sensors, but do not share the data in networks. These are potential use cases, in which the IoT can help to make processes more efficient in the future. Low cost, wide spread and the simplistic use are just some of many factors for the growth of IoT and IoT devices. To show the variety of sensors and the power of digital devices, the following enumeration provides different sensors with their description.

Sensor	**Explanation**	**Use case**
Hydrophone	Microphone specialized for the use in water.	underwater acoustics, sonar
Microphone	Converts sound into electrical signals	music, television, broadcasts, blogs
Seismometer	Measures motion on the ground.	earthquakes, volcanic eruptions
Oxygen sensor	Measure the proportion of oxygen.	air quality, automobiles
Radar gun	Measures the speed of moving objects	speed controls
Speedometer	Measures and displays the instantaneous speed of a vehicle.	cars, trucks, busses

[8] https://www.cnet.com/news/smart-bulbs-vs-smart-switches-the-pros-and-cons-of-connected-lighting/

Tilt sensor	Measures the tilting in two axes.	mobile phones, planes, sail boats, satellites
Gyroscope	Measures and maintains orientation and angular velocity	mobile phones, Compass, virtual reality
RFID reader	Radio frequency identification identifies objects with electromagnetic waves.	retail stores, time tracking, package tracking, supply chain management, library systems
Infrared sensor	Measures infrared light radiating from objects.	security, blood flow, heat detection, detection of environmental chemicals

Table 1: Overview IoT sensors and use cases

2.3 Networking and connection between devices

The key concept of the IoT is the connection between several individual devices. The generated data gets transferred over a network and can be combined to gain knowledge about the process. Several small devices with their own logic and processes can lead to improvements in certain cases, however the concept of the IoT is to combine the data from various sources, interpret the data at one central place and enhance the process significantly. The more data there is, the better the process can be analyzed. Combining separated networks can lead to more data and more efficiency. The challenge is to connect those independent networks. Ownership, system interfaces, spreading or accuracy, can lead to problems.

2.4 Internet of things vs self-controlled devices

Self-controlled devices operate on their own, without resources from a central place or other devices and based on this information, they act and enhance certain situations. The problem is that they are limited to their own scope and the only way to make these devices “smarter” or to scale the system, is to extend the network and create a IoT network with more devices. This enables scalability and higher efficiency, compared to one self-controlled device. Of course, certain situations do not need a sophisticated network of devices, but as soon as

complex processes and situations are involved, networks can lead to a much more efficient environment.

2.5 Interaction between technology and user

A crucial part of the IoT is the direct interaction between user and technology. Depending on the use case, users interconnect with devices and digital information in their everyday lives. The challenge is to support the user and provide data without interfering. A solution must be more efficient and convenient for the user to be accepted. The system gathers not only environmental facts, but also user habits and actions and the system must analyze, collect, process and improve the experience afterwards. The acceptance and the influence IoT devices have on users, is covered later in this paper.

2.6 Ubiquitous Computing

The constant influence of computational power in our everyday life is growing constantly. Even simple tasks are supported by smart devices to be faster, more efficient and easier. More and more devices appear in different situations and the consumer has to adopt to the new technology. It usually takes some time, until the consumer uses and accepts the help of those devices. By being surrounded of technology every day, it is expected to work and interact seamlessly with the user. Over time computers evolved from mainframes to personal computers and now to ubiquitous computing, the next big step.

2.7 Data mining, interpretation and action

Saving and collecting data is the first step to create efficient IoT networks. Data mining and interpretation must be operated on the gathered data to improve the processes and to add value. Sensors provide big loads of data over a connected network and the challenge is to find and combine the pieces of information and create value. Algorithms are responsible for processing the data so that improved actions can be taken. Some modern cars for example do have systems for automatic breaking. Connecting those devices in a network, does not improve the automatic breaking system[9]. The data has to be interpreted and processed first, to create value and then improved actions can be taken. Break assistants from similar cars

[9] https://www.consumerreports.org/car-safety/automatic-emergency-braking-availability-expands-with-2017-cars/

then know, that there is heavy traffic in a certain street. The value created does not only depend on the data quality, it also depends on how the data was processed and what the system learned out of the information.

2.8 Artificial Intelligence

Artificial intelligence is the next step of data mining. Processing and analyzing is the key to generate value. With AI, data mining comes to another level, where humans create sophisticated algorithms, so that machines learn out of the data and get smarter by themselves[10]. The huge amount of data processed by the system every day, helps the machine to understand processes, connections and relations. Research in the field of AI shows the enormous capabilities of self-learning machines. With more and more IoT devices, AI is crucial to support this growth and to improve processes.

2.9 Big Data

Data is the new power and knowledge of today's world. The rising data volume and stored amounts of data lead to the phenom called big data. The challenge is to separate and to filter the important data from the rest and interpret them in a valuable way. Every day more and more data is produced from IoT devices, phones and other computational devices. This is the logical consequence of humans using technology. With the rising amount of data[11], the data storage, processing power and the analytics also have to grow and improve. Especially AI and sophisticated data mining are required, to cope with those enormous amounts of digital information. Furthermore, questions about security and anonymity arise. Users are concerned about being monitored and losing their privacy. System hacks, leaks and availability issues have much more catastrophic effects. Imagine airports, which have information about boarding tickets and check in system, breaking down and having availability issues. It is a constant race to keep up with the growing big data and to find solutions to gain knowledge.

[10] https://www.techrepublic.com/article/ibm-watson-the-inside-story-of-how-the-jeopardy-winning-supercomputer-was-born-and-what-it-wants-to-do-next/

[11] https://www.economist.com/news/briefing/21721634-how-it-shaping-up-data-giving-rise-new-economy

2.10 Mobile phones

In the year of 2017, 4.77 billion mobile devices are in use worldwide[12]. This shows how crucial and how widely spread digital devices have become and what role they play in our everyday life. Mobile phones can be compared to IoT devices, they have many sensors, gather data and can be connected over a network. However, a mobile phone is not considered as an IoT device. IoT devices do often have very limited power and their main task is to gather data through sensors, while a mobile phone is much more complex and sophisticated, because it not only gathers data from sensor, it also runs an operating system which provides a universal platform for applications. The internet of things therefore is more correlated to simple sensors and data gathering. The operating power of IoT usually happens at one or several servers, whereas mobile phones are a closed system in itself. IoT devices as well as mobile phones do however interact with humans in different situations and help us in every-day life situations. They do have similar goals and end results, but they do differ in the way they work and operate.

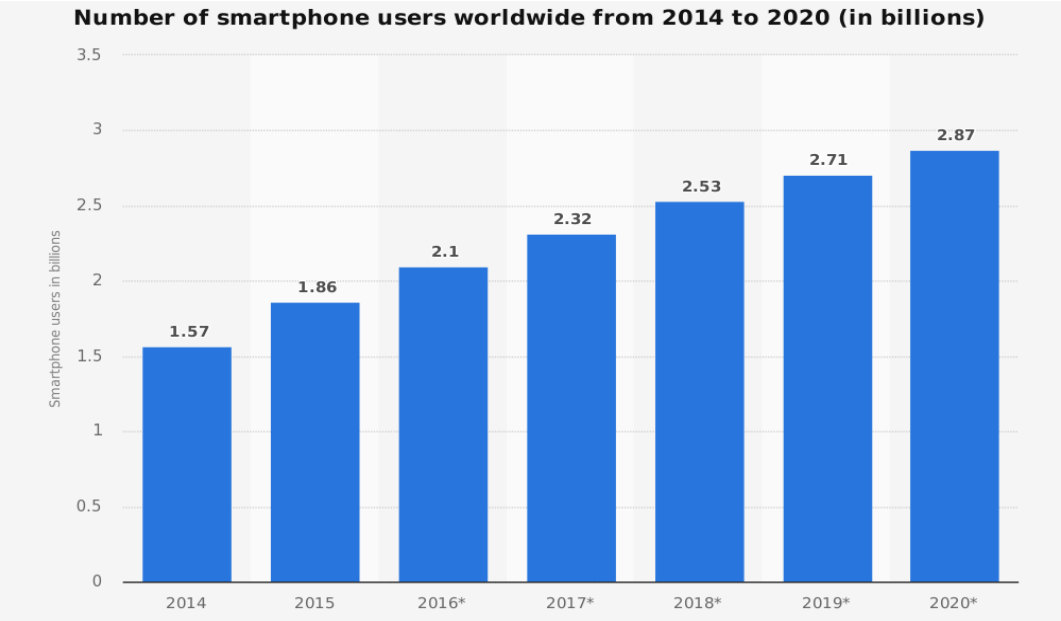


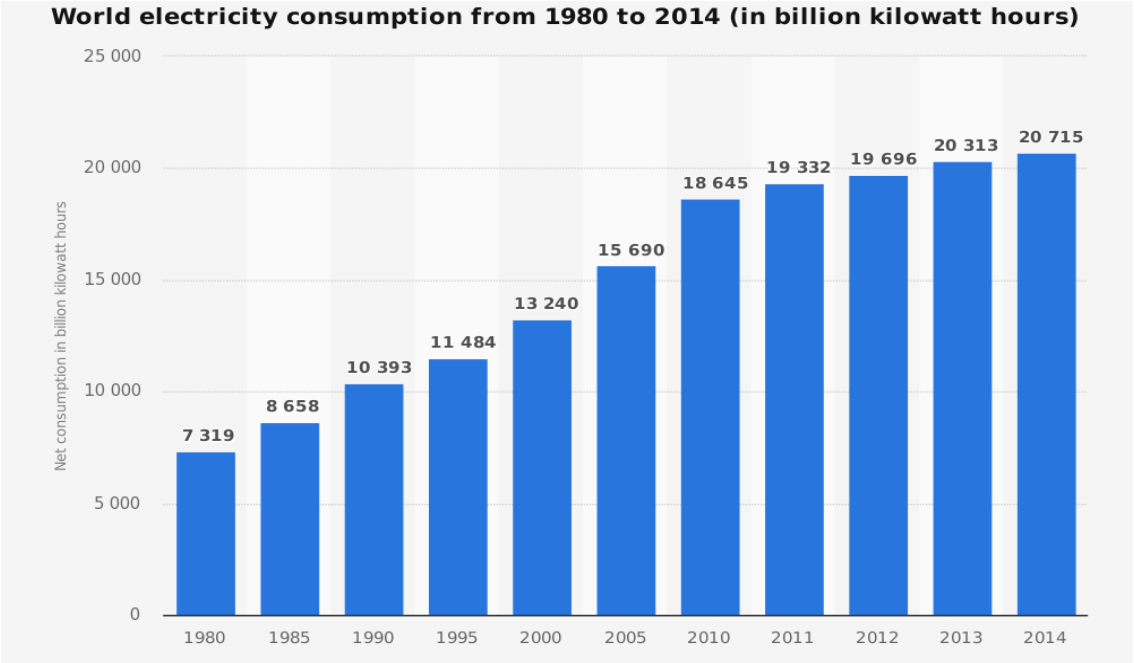
Figure 2: Statistic: Mobile users worldwide

2.11 Energy consumption

Every computational device needs a source of electricity. Whether it is from a power plug, a USV or a battery. However, there could be some problems involved with suppling enough

[12] https://www.statista.com/statistics/330695/number-of-smartphone-users-worldwide/

electrical power to devices in the near future. Some countries already import big percentages of their need of electricity from other countries[13][14]. Technical solutions are required to cope with a rising energy consumption[15]. The hoover dam is just one example for artificial generated electricity. With exponential growth, different solutions must be installed at least at some point in the future. Efficient energy consumption of IoT devices is a research in itself and a very important one. With technical progress, energy consumption can be minimized, while computational power is being increased. The challenge is not only to make an existing device more efficient, the challenge is to make it more efficient and more powerful at the same time. As the IoT sector is rising constantly, energy efficiency also has to be considered for future applications and use cases.



[16]

Figure 3: Statistic: Worldwide rising energy consumption

[13] https://www.eia.gov/todayinenergy/detail.php?id=30192

[14] https://www.forbes.com/sites/judeclemente/2016/04/03/californias-growing-imported-electricity-problem/#558f3d5c4469

[15] https://www.statista.com/statistics/280704/world-power-consumption/

[16] https://www.statista.com/statistics/280704/world-power-consumption/

2.12 Digitalization

The steady growth of IoT devices and networks also contribute to digitalization. Real world use cases use computational power and smart tools to enhance the experience. Ubiquitous computing, digitalization and IoT, are therefore correlating terms for smart and digital solutions and processes.

3 Security and IoT devices

Security is one very important aspect, not only in the sector of IoT devices, but also in the field of digitalization. Crucial and confidential data is transmitted over networks and often stored in remote locations. On the internet, great effort is made to secure data connections of websites and WEB applications. Transmitting data with TLS/SSL[17] protocols and very sophisticated algorithms, help encrypting and securing critical data[18]. There a certain security standards and algorithms that are used in the world wide web to secure data connections. Because of the different use cases and the different functions of IoT networks and the operation by privatized companies, security can lead to issues. The following security issues have to be addressed in IoT networks.

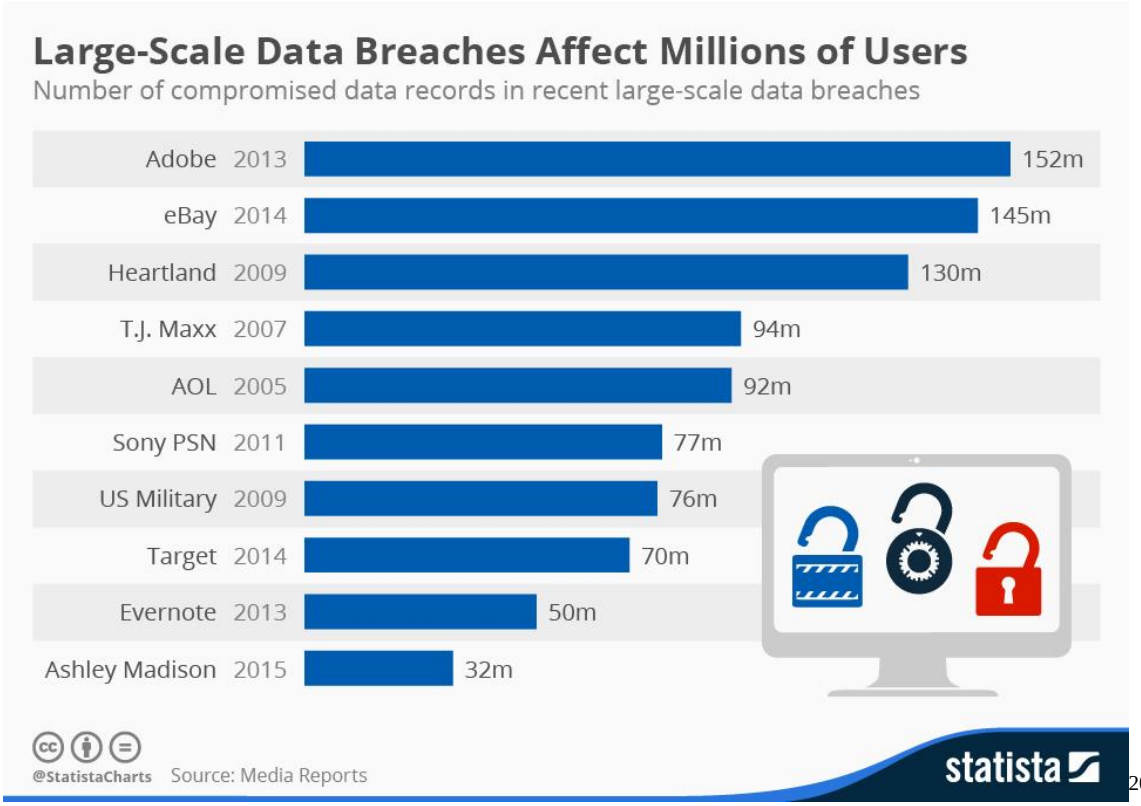
3.1 Data privacy

Every digital device that stores data can be a security concern. IoT devices and networks are no exception. In some use cases, sensible data from the user gets stored and interpreted in the network. Data leaks or hacks could lead to significant security issues[19]. To prevent the leaking of data, the operating company must make certain preparations, which include network configurations, subnets, switched networks, router configuration, server updates, server operating systems and many more aspects. Keeping systems secure costs time and money, but is crucial in many use cases. Isolated networks usually are easier to secure, because they only operate in their own scope, however as soon as there is a connection to another network or a connection with the internet, security precautions have to made.

[17] https://technet.microsoft.com/en-us/library/cc784450(v=ws.10).aspx

[18] http://searchsecurity.techtarget.com/definition/MD5

[19] https://www.statista.com/chart/2540/data-breaches/



[20]

Figure 4: Statistic: Users affected from data breaches

3.2 Vulnerabilities and hacking

The main goals of hackers include gathering data from a system, or using systems in a harmful way, for example in BOT networks[21] or malware. Networks often include many devices, which leads to many entry points in the network. Those networks can be very powerful and can be abused for DDOS attacks[22]. It is much harder to hack or gain access to an isolated system or network. By connecting an IoT network to the internet, the system availability is worldwide and it can be accessed from remote places. In this case, the security policies have to be reconsidered.

3.3 Updates

Updates are provided to close security issues in programs. Not only servers or applications can receive updates, also IoT devices are updated regularly. The important thing is to not

[20] https://www.statista.com/chart/2540/data-breaches/

[21] http://searchsecurity.techtarget.com/definition/botnet

[22] https://securelist.com/ddos-attacks-in-q3-2017/83041/

forget about all the systems running in a network. Update cycles of smart light bulbs or the refrigerators operating system can be overseen. This lack of updates can lead to security issues and provide attackers entry points to the network. Therefore, updates should be addressed seriously and in time to close as much security issues as possible.

3.4 Dependency and failure

In many cases, humans rely on the help of IoT devices. Surgery or airports are only two examples that show the trust we have in those devices. Because of the dependency on digital devices, the effects of a failure can be dramatic[23]. Backup systems, intensive testing and constant improvements are important to eliminate factors of failure.

3.5 Encryption

Data is transmitted in bits and bytes over physical or wireless connections. The connection of different networks and IoT devices requires physical connection and protocols from different layers of the OSI/ISO layer protocol. Specialized protocols like TLS/SSL[24] and encryption algorithms were created to secure the internet and the communication over networks. Without the encryption of data, many today known internet services would not work and we would communicate our data and messages in plain text. In sensitive cases like bank transaction or password logins, a non-encrypted way of communication would be fatal[25]. In IoT devices, sensible transactions have to be elicited and analyzed and up to date encryption methods have to implemented to secure the network. Encryption can get very sophisticated, but is the only way to protect attackers from sniffing data over network connections.

3.6 API security

IoT devices and sensor are very hardware oriented, while servers, applications and data mining, operates on a software oriented level. In order to convert and transmit the data so that the server and applications understand the sensor information, many steps, protocols and

[23] https://www.standard.co.uk/news/world/passengers-face-chaos-after-airport-checkin-systems-crash-across-globe-a3645816.html

[24] https://technet.microsoft.com/en-us/library/cc784450(v=ws.10).aspx

[25] https://nakedsecurity.sophos.com/2015/06/11/49-busted-in-europe-for-man-in-the-middle-bank-attacks/

API´s are involved. Every step and every API has to be secure and the network is only as secure as its weakest point.

3.7 User

The biggest security threat in IT systems still is the user[26]. A system can be as secure as possible, however if the human user makes mistakes, all of the security precautions can be useless. Courses and training should help to teach the right usage of digital devices.

4 Documentation of researching and observing IoT networks

During my period of research, I was able to travel to some big transportation hubs, including San Francisco International Airport, Orlando International Airport, Vancouver International Airport, Seattle International Airport, Berlin International Airport, Düsseldorf International Airport and Vienna International Airport. I also used different means of public transportation throughout the USA and Austria. From my point of view, it obviously was not possible to get access to networks or devices, so I have to rely on my personal experiences, observations and researches of conducted studies. However, observing and experiencing different use cases and analyzing them, is research enough to present and conduct interesting knowledge in this research. We often do take IoT devices for granted and therefore do not pay attention of the use cases. Keeping in mind how powerful those networks are and how they influence our day to day workflow, shows the process and the way they add value to certain situations. My main goal therefore is to describe, summarize and present my observations from different places in the following paragraphs.

4.1 Airports and public transportation infrastructure

I already stated my reason for focusing on airports and public transportation infrastructures. This enables me to research in a much more detailed and concrete way. There are many use cases and fields of study for Internet of things devices so that it would be impossible to summarize and observe all of them in this research. As airports and public transportation are responsible for getting people to places all over the world and are examples for IoT devices and networks in use, these specialization is perfect for my kind of research.

[26] https://securityintelligence.com/the-role-of-human-error-in-successful-security-attacks/

4.2 Application areas of IoT devices

During traveling to various places in the United States as well as in Austria and researching articles on the internet, I experienced different use cases of electronic devices and networks which are described in detail in this paragraph.

4.2.1 Traffic and smart cities

Especially big cities with lots of traffic rely on sophisticated IoT devices to guarantee efficient and optimized processes. As I visited big cities like Los Angeles, Seattle San Francisco and Miami, I had the chance to observe some of the following use cases in real life.

4.2.1.1 Smart parking

Smart parking systems measure how many free parking spots are available. Every parking spot has its own sensor, which generates data about availability and location. Free parking spaces are indicated and information about occupancy is provided. I experienced those parking systems not only at big parking houses and institutions in the USA, but also in Austria at big supermarkets and shopping malls. San Francisco for example provides the free parking spaces in a mobile application and according to surveys, the system has reduced weekday greenhouse gas emissions by 25%[27].

Another smart parking IoT device is a parking meter, which dynamically calculates parking prices and provides tickets directly at the parking spot. I experienced parking meter systems in Miami Beach (Ocean Drive), Los Angeles, Santa Monica and New Orleans and in bigger Austrian cities like Vienna[28].

4.2.1.2 Traffic lights

Every big city has a sophisticated traffic light system, which includes different components and networks. While the American systems do differ in its operation compared to European systems, the main process is the same. At crossings all the individual components have to work together and networks establish the connection between those devices. Interference and interaction with pedestrians also have to be considered in systems like that. Traffic lights in some cities go even further than just regulating the traffic according to prescheduled periods and try to react to the current situations. Cameras, magnetic fields and sensor arrays

[27] https://www.lgc.org/resources/community-design/lpu/apr2016/

[28] http://statescoop.com/la-expands-smart-parking-coverage-area-to-3-new-communities

are installed, to make the traffic as efficient as possible. A system like that might seem easy, but they are and have to be very sophisticated. The many dynamic factors make it hard to develop a general working system for all kind of situations and with highest security and fail-safety in mind. Those systems are therefore a real-life example of sophisticated sensors, working together in a network to enhance processes. This example also shows how dependent modern infrastructure is on computational power and digital processing.

4.2.1.3 Traffic monitoring

The monitoring of traffic can give useful information about the traffic flow and behavior in different places and different streets. Preventing traffic jams still is a big problem, especially in big cities like Los Angeles and Miami[29]. With the power of IoT devices and network connections, those problems can be statistically analyzed and with the power of data mining and AI, improvements and decisions can be made on the generated data.

4.2.1.4 Speeding cameras

Automated speeding cameras are another example for large IoT devices and networks. Several sensors measure the speed of an approaching car and can determine whether it is speeding or not. The picture and the data get send over a network to a central place, where further steps will be taken. The part that is different from all the other traffic related speeding cameras is, that they usually do not get data from each other. They are connected in a network, but the individual devices do not learn from each other. However, there are speed cameras that measure the average speed from one point to another, by measuring the time a car needs for this distance[30]. As different cameras need to know the data from each other and make decisions on the combined data, a more sophisticated network has to be established.

4.2.1.5 Red light crossing

In specific areas, IoT systems are used to prevent red light crossing cars. Especially on the main streets of Miami, systems like these are installed, to prevent such situations. In America the traffic light process does vary from the European one. Traffic lights are not in front of the crossing, they are installed after the crossing. In some places it therefore is allowed to turn right, although the traffic lights are red. However, at some crossings turning on red is

[29] http://www.laweekly.com/news/la-has-the-worst-traffic-congestion-in-the-world-7953381

[30] http://www.carbuyer.co.uk/tips-and-advice/160228/how-do-average-speed-cameras-work

prohibited and smart sensors help to keep control over it. Cameras are installed on traffic lights and make photos of cars crossing at red. Because crossing at red means breaking the law, this system has to work very exactly and precise. Modern traffic lights are very sophisticated and cover many different use cases. Therefore, this system has to be flexible and accurate, in many different situations as well.

4.2.1.6 Toll fee by number plate

In Florida the street toll is payed by plate or prepaid passes, which are controlled at the exit of every fee required street. As soon as the street is entered, a photo is made from the number plate or the pass and the toll automatically is sent over mail. This system works completely autonomous and the physical attendance of personal is made redundant and costs are saved.

4.2.1.7 Lightning management

During the night cities spent enormous power to light up streets, buildings, transport stations LED walls, banner and many more things. To make this process more efficient, sensors are placed in different spots that measure aspects of their environment. With this data, lights can be dimmed or switched off in places that are not required to be lightened. The sensor also tells the lights at which time to switch on or which places are darker and therefore have to be lightened first. Similar systems are commonly used in smart consumer homes. 2014 Barcelona installed high efficient LED lampposts with IoT sensors, which implement a sophisticated lightning management system and Los Angeles is also planning on such a system[31].

4.2.1.8 Traffic cameras

There are different approaches on monitoring traffic. In many cases traffic gets monitored with IoT devices and sensors. The generated data should help to avoid traffic and enhance security. Traffic is a very complex topic and the quality of the action that can be taken, comes up to the data mining quality. Avoiding traffic jams is not the only use case for those cameras, recognizing cars from different viewpoints, face recognition and selecting the best path for travelling are possible use cases for this kind of IoT system.

[31] https://www.greenbiz.com/article/3-ways-iot-already-making-cities-smarter

4.2.1.9 Air quality and pollution

In large cities, air quality and pollution can lead to big environmental problems. Transit traffic and transportation in general are big factors for greenhouse gas emissions[3233] and strongly related to global warming. In order to measure air pollution, IoT devices connected in a network provide useful data on which actions like lowering speed limits or limiting the weekend traffic can be taken. One example is the introduction of the permanent speed limit of 100 km/H in Tirol, because of the air pollution caused from traffic.

4.2.1.10 Waste management

With the help of IoT, waste management can be optimized and enhanced. Sensors indicate when trashcans are full and the waste disposal company only have to pick certain cans. Furthermore, an optimized route can be calculated for picking up the trash, which makes the disposal management process much more efficient. The city of Los Angeles has a similar system called Bigbelly[3435].

4.2.2 Connected transportation

Modern means of transportation implement different IoT networks to make public transport faster and more efficient. More than 900 million people use the public transportation system of the "Wiener Linien" in Vienna every year[36], this shows the potential of data an optimization that can be made in such a system, with the help of computing.

4.2.2.1 Bus and train digital schedules

Many cities have digital bus schedules with live arriving times. This is only possible, because of IoT devices and networks, which update the location and distribute it over a network of

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[32] https://www.transportenvironment.org/what-we-do/cars-and-co2

[33] https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions

[34] http://parks.lacounty.gov/wps/portal/dpr?1dmy&page=dept.lac.dpr.home.detail.hidden&urile=wcm:path:/dpr+content/dpr+site/home/newsroom/news+and+special+events/smart+recycling+and+waste+management+comes+to+la+county+parks+with+big+belly,+inc

[35] http://blog.bigbelly.com/los-angeles-ninth-council-district-expands-installation-of-bigbelly-smart-waste-and-recycling-system

[36] https://www.wien.gv.at/english/administration/statistics/public-transport.html

different screens and sometimes even mobile apps. The next step for public transport would be to connect schedules from trains, busses and other means of transportation and synchronize them.

4.2.2.2 Uber and Lyft real-time location update

Taxi services like Uber and Lyft are very popular in the United States, however also big Austrian cities like Vienna offer this service. Those car services are big networks, including many cars and drivers, which are managed at a central place. Because of the many sensors like live update GPS, the user and the application know exactly where the drivers are and can make decisions, calculate prices and show routes based on this information. In some of the biggest cities of the US, huge potential was created with the help of digital applications.

4.2.2.3 Overhead monitors Interstate

Overhead monitors at busy streets like the main interstates in the United States or the Autobahn in Austria implement similar networks like train and bus schedules. The monitors provide information about speed limits, regulations and accidents. They are controlled at a central place and therefore a big IoT network is established. Sometimes other sensors and devices mentioned before in the study like speed cameras, traffic cameras or air quality and pollution sensors, can be combined with overhead monitor systems to create even more efficient scenarios.

4.2.2.4 Ticket automat

Automated ticket automats can be found at various different means of public transportation and work in similar ways. Often several means of transportation share the same ticketing system and therefore work seamlessly throughout the city[37]. A variety of different sensors like card readers, laser scanners and smart algorithms are connected in one big city network to make this possible. Some systems even allow the customer to buy tickets online or over a mobile app. There are some differences in Austrian and USA public transportation systems, which I will cover later in this paper.

4.2.2.5 Car 2 go carsharing

Car 2 go is an innovative concept of carsharing throughout a certain area. Mobile apps and connectivity create a similar experience to Uber or Lyft, where the car can be located over

[37] https://tfl.gov.uk/fares-and-payments/oyster

GPS and with the mobile app, it is even possible to open the doors. A sensor in the car recognizes the user and the confirmed rental and opens its doors. Another innovative way to improve city live with technology.

4.2.2.6 City bikes

Especially Vienna has a great system of free city bikes, which are not only convenient for tourists, but also for people who want to get around quickly. Once registered at one of the ticket automats, it is possible to login at one of the stations and unlock the bike. I have seen such systems in different European cities, however in cities in the USA, there clearly is a lack of systems like that.

4.2.3 Airports

One of the biggest hubs for getting people to places are airports. Efficiency, time and security is crucial and computers help to retain those qualities. The next paragraph only gives some of the many examples of IoT networks in use. The size and the throughput of those systems make them very interesting.

4.2.3.1 Monitors and flight schedule

Different planes from different countries and airlines arrive and leave constantly and around the clock. Timetables have to be up to date and the consumer has to be informed every time delays or other time issues happen. A complex monitor system therefore is crucial at airports and behind the simple looking LED boards is a combination of systems, which include many sensors to display the latest flight times and information.

4.2.3.2 Parking

Short term and long-term parking possibilities have to be provided for a large amount of people, in order to run an airport. Parking spaces are separated in terminals and park houses for structured and easy parking experiences. Parking sensors, which tell people about free parking spots and the occupancy, are often found at modern airports. As there are many different parking segments, information is shared between different parking houses to redirect people arriving at the airport and looking for parking spots.

4.2.3.3 Automated ticket check-in

After arriving at the airport, ticket check-ins are in place to check the luggage, reserve a seat and print a valid ticket. The problem with check-in desks is that there are times where no people are queuing and then there are peak times where many people have to be checked for

a flight. Distributing the peak times and offering different options for check-in therefore is a good idea. With the help of IoT devices, the check-in can be made at one of the self-check in computers, provided by the airline. Passport validation and customer information is gather through different IoT sensors and sent over a network. This saves time, because there is no need to queue at the desk and it spreads peak times, with continuous availability.

4.2.3.4 Package tracking via GPS

After luggage check-in the computer intelligence takes over the process of getting the luggage to the right plane, in time and on the most efficient route[3839]. Many sensors are involved for measuring weight, scanning the tickets and pushing the luggage to the right conveyor belt. In the future it even should be possible to track the personal baggage over a mobile app. The company SITA reckons that by 2018, half of the airports will use baggage tracking systems[40]. 21.6 million bags are mishandled in the year of 2016, according to a study conducted by SITA[41]. To guarantee transparency and customer information, IoT networks are implemented and installed.

4.2.3.5 Security traffic analyzation and delay times

Airports have to cope with huge amounts of people every day. The risk of delays, because of queuing at security checks or check in gates, therefore is high. Sensors help tracking the airport traffic and display the estimated time delay and keep the customers satisfied. A similar system has been installed at Birmingham Airport in England[42] and the future expects many more use cases of such systems at other big airports.

4.2.3.6 Aircraft maintenance sensors

Airlines preschedule safety and maintenance checks for their airplanes in order to guarantee safety and seamless functionality. Because of fixed scheduling rhythms, sometimes just minor things have to be repaired. To increase efficiency, IoT devices could help to measure certain components in the airplane and automatically send the information if something

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[38] http://readwrite.com/2016/07/15/smart-bag-testbeds-can-take-the-worry-out-of-your-vacation-dt4/

[39] http://www.telegraph.co.uk/travel/travel-truths/What-happens-to-lost-luggage/

[40] https://www.ibm.com/blogs/internet-of-things/smart-air-travel/

[41] http://www.telegraph.co.uk/travel/travel-truths/What-happens-to-lost-luggage/

[42] https://internetofbusiness.com/birmingham-airport-iot/

needs to be repaired[43]. This could elongate maintenance schedules, which safes costs, time and resources. The bombardier C series for example has engines fitted with more than 5000 sensors, which generates 10 GB per second[44]. This immense data flow and gathering requires high capacities connections and big data mining to improve aircraft maintenance.

4.2.3.7 In airplane monitor information systems

Modern airplanes provide information to the passenger about temperature, height, pressure, route and estimated time. This onboard system gets its data from the many installed sensors in the airplane and gets transmitted over a network, which processes the information.

4.2.3.8 Customs fingerprint and photo scan

Customs and immigration processes are supported by different IoT devices like cameras and fingerprints. Based on the gather information of the sensor, decision about the identity and the entry of a country are made. Centralized databases and powerful networks guarantee secure information and valid data. Therefore, this is an important part and supports the customs process to make it more secure, more exact and faster.

4.2.3.9 Real time smartphone updates

Over 2.8 billion people have a smartphone worldwide[45]. The ubiquitous surrounding by this digital device changes our behavior and the way we gather data and information drastically. The user wants centralized, processed and real-time data to control and see what is going on. With the many networks at airports, it is an obvious scenario for combining different aspects and information from the IoT systems and provide it over a mobile app. From schedules to baggage tracking to check-in tickets and codes, data needs a display or medium to show its data to the customer and the mobile phone system is the most convenient way. It is always important to understand who gets the data and what they have to do with it. In the case of consumer oriented IoT networks, the data has to be simple and graphical to be accepted and

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[43] http://www.mro-network.com/maintenance-repair-overhaul/southwest-installing-advanced-airplane-health-monitoring-sensors

[44] http://aviationweek.com/connected-aerospace/internet-aircraft-things-industry-set-be-transformed

[45] https://www.statista.com/statistics/330695/number-of-smartphone-users-worldwide/

understood. The mobile app market is the ideal tool and interface, for combining analyzed data with the end consumer.

4.2.3.10 "Smart homes" – air conditioning control and lightning

Smart homes and buildings have sensors to reduce energy loss, by automatically switching off the light or reducing the air conditioning if nobody is in the room. Solutions like this do reduce energy needs in private households. The same concept is scaled up in bigger environments, like shopping malls, hotels and of course airports. Obviously, the systems at airports do differ from the ones used at home, because they operate in a whole different scenario, however they do have the same goal, saving energy. This functionality and convenience is established over many sensors, connected through a network and an action handling, based on data and information. Another excellent example for smart devices in everyday use, without knowing that they are present and enhance our environment and living.

4.2.3.11 Fire alarm detection

Fire alarm systems contain multiple sensor for detecting smoke and fire in buildings. All the sensors are connected to a central controller over a network. Technically spoken it therefore is an IoT network. Systems like these are around for many years and make our everyday life more secure. Mobile applications even send messages in the case of a fire.

4.2.3.12 Security cameras

Security cameras are a well discussed topic in some countries like Austria, because of the privacy issues connected to filming at public places. There are precise rules to follow for the use of CCTV cameras, published from the Austrian Data Protection Authority[46]. America has different laws regarding CCTV cameras and therefore many public security cameras are installed in public places. With detection and face recognition algorithms, concepts like these are raised to a higher level and are much more powerful than intended in the first place.

4.2.3.13 ACARS

The Aircraft Communications Addressing and Reporting System was developed in the 1970s and was the first communication system between airplanes. Now the industry concentrates on fitting airplanes with broadband connectivity and offer this service as a product to the

[46] http://www.eversheds-sutherland.com/global/en/what/publications/shownews.page?News=en/austria/press-reports-en/20100501_M_en_CCTV_in_Austria

customer and guarantee a seamless internet connection. This example shows how fast technology is emerging and developing. Experts estimate that by 2030, about 90% of all aircrafts will have some sort of connectivity[47]. This connectivity not only has advantages for the consumer, it also has advantages for producers and airlines. It generates whole new possibilities and use cases for digital solutions, because of the existing and seamless connectivity.

4.3 Is there a significant difference between Austria and the USA?

In my opinion there is a significant difference not only between the United States and Austria, but also between Austria and other countries in Europe. Big airports around the world are investing and expanding their IoT networks and application areas to make the airport experience even more efficient. Austria obviously is a small country and therefore it seems to me like the trend takes some time until it reaches Austrian airports as well. Directly compared to the United States, Austria maybe is not a trendsetter for IoT devices at airports, but obviously airports in smaller countries do not have to cope with that many people. Airport traffic however is also rising in Austria and decisions and improvements sooner or later will be required to keep up with the strong demand.

Austria maybe is not a trendsetter for IoT usage at airports, however public transportation is surely one of Austria's figureheads. Public transportation in America often is outdated or do not work seamlessly and efficiently in bigger cites. America is the country of cars and public transportation seems only a second option. Compared to Europe or Austria, public transportation does not have the value it has in European countries. In Austria public transportation does work very well most of the time and all different people use it to get to work or to places. Digital monitors with live tracking, mobile app with live data (ÖBB app), digital ticket automates and seamless transition for different means of transportation. American public transportation seem to lack those digital tools. The Orca in Seattle or the Bart system in San Francisco for example. In "megacities" like that, the systems are out do date and tickets can only be purchased with cash, because the automats do not take credit cards. There

[47] http://interactive.aviationtoday.com/avionicsmagazine/june-july-2016/the-aircrafts-place-in-the-iot-revolution/

is no connection system to bus lines or other means of transportation and the most convenient way to get around is Uber or Lyft.

However, by comparing digitalization and IoT device usage in US cities and Austrian cities in general, the United States clearly have more sophisticated tools than we have in Austria. There are more companies in the field of IoT in the US and clearly the Silicon Valley is the world's hotspot for digitalization. So, to summarize my experiences both in Austria and the United States, both countries use computational power to make processes more efficient and to solve certain problems. The United States clearly is one step further than Austria. Self-driving cars, traffic cameras, face recognition and smart airports are some examples. However, Austria has some fields where they clearly have more sophisticated and modern systems. As mentioned before, public transportation is one of those fields, Car 2 go, and city bikes are more sophisticated as well. It pretty much comes down to the mentality of a certain country and what the consumer wants and needs. Austria is different in many ways and so are the use cases for IoT devices. Of course, there are many use cases in common, but the interesting thing to me was where they differ.

4.4 Is the USA a trendsetter for trendsetter for technology in general?

Yes, in my opinion the USA is a trendsetter for IoT devices and networks and digitalization. One of the many examples are automated check outs at supermarkets. In America this is popular for many years now, but in Austria you can hardly see supermarkets with such systems. Now some supermarket chains in Austria also implement similar systems, but it took some time until the trend caught on in Austria. There are many other examples of IoT trends, not only in the USA, but also in the rest of the world. Statistics show the immense amount of money America spent in this sector every year[48]. Such an enormous scope of research and investment is of course impossible in countries like Austria. However, this does not mean that there should not be any research or any companies in Austria as well. When I tried to find statistics of Austria, I hardly could find anything. This shows the conservative approach

[48] http://www.businessinsider.com/the-us-government-is-pouring-money-into-the-internet-of-things-2016-5

the country has to this big and world changing technologies. Austria is known for their research in quantum computers (university of Innsbruck)[49], so why is there a lack of research and companies focusing in this field of study?

Statistic show that 7 out of the 10 top IoT cities are in the United States[50], similar to the results of the top 20 IoT companies[51]. IBM and Google followed by Intel and Microsoft, are the world leading IoT companies. Therefore, the United States are clearly considered as a trendsetter.

5 How IoT and rapidly enhancing technology influence our everyday life?

5.1 Advantages and disadvantages of IoT

The main goal is to enhance certain processes regarding efficiency and costs. As with most modern technologies, every advantage also has its disadvantage. The following paragraph describes some of the key aspects in detail.

5.1.1 Information

Information is one of the many things networks and systems provide and information is what we want to know. Mobile phones, Smartwatches and other wearables constantly provide data, that is processed and visualized. Alarm clock, shopping list, weather, temperature and many more information can be gather through digital networks. But this collection of "Big Data" not only has its advantages.

Because of measuring nearly everything, systems sometimes know more as they supposed to. Data mining and artificial intelligence is not only used to provide useful data to the end consumer, it is also used to predict behavior. This is a level where it can get dangerous and privacy issues arise. Information is knowledge and knowledge is power. It is crucial that only the right persons have the right information. Considering smartphones, Instagram, Facebook, Snapchat and other mobile applications, this race seems already lost. We should

[49] https://scitechdaily.com/physicists-develop-data-bus-for-quantum-computers/

[50] https://bizztor.com/wp-content/uploads/2015/07/IoT-city-ranking.png

[51] https://iot-analytics.com/top-20-iot-companies-q2-2015/

definitely be more careful about what information we share and what costs it takes to use certain digital service.

5.1.2 Efficient use of resources

Some of the worlds systems are operating on non-renewable recourses like oil, coal and gas[52]. Because of the shortage of resources, efficiency has a very high priority. Many processes are digitalized to make them as efficient as possible and IoT systems together with sophisticated data mining play a key role[53][54]. Of course, at some point the resources will be gone and alternative ways to power electrical devices must be found. Electricity and renewable forms of energy will be necessary in the future. The costs to produce energy, has to be lower than the price it costs for the end consumer, otherwise there is no profit. To keep costs as low as possible, sensors measure marginal aspects and gather information, to improve the production of energy. The end consumer therefore benefits of efficient and energy saving processes, thanks to the help of IoT and computers.

[52] https://www.statista.com/statistics/184024/us-energy-consumption-from-fossil-fuels-and-renewables-since-1999/

[53] http://www.ioti.com/industrial-iot-iiot/shell-boosts-business-drilling-data

[54] https://internetofbusiness.com/shell-reportedly-saves-1m-using-iot/

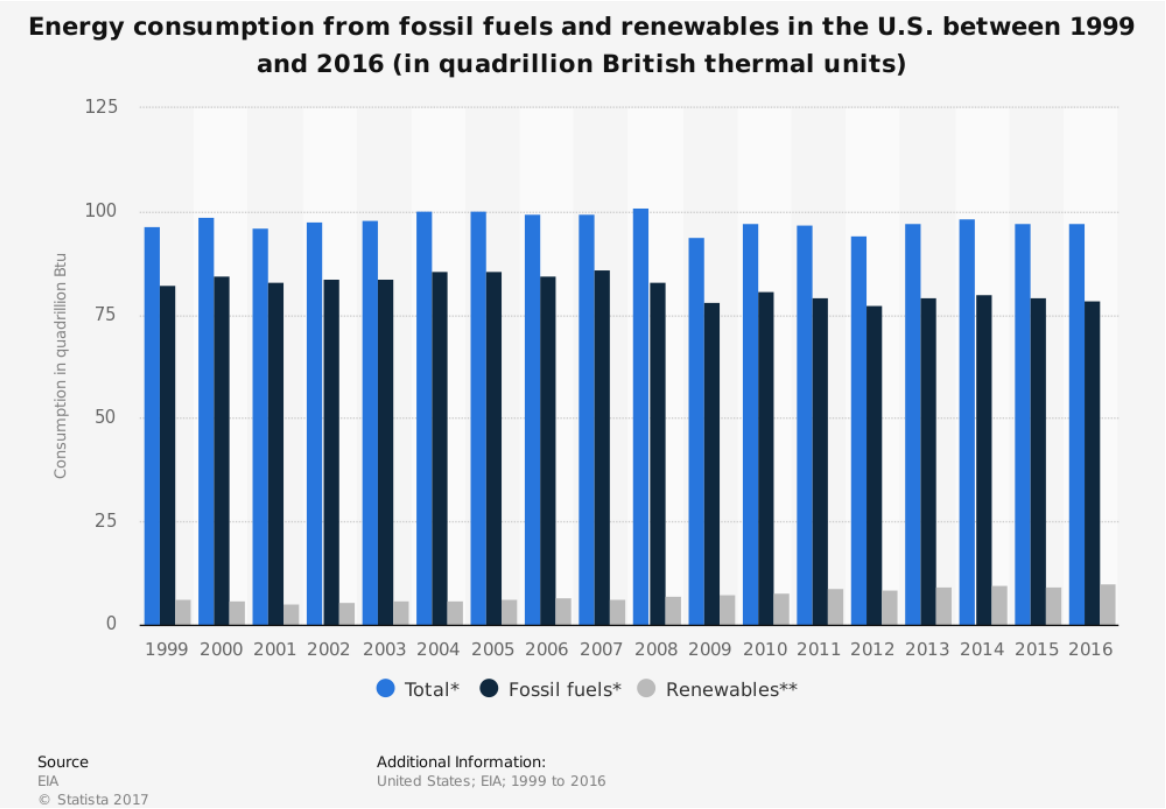

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Figure 5: Statistic: Energy consumption U.S. fossil fuels and renewables

5.1.3 Cost and Time Reduction

As mentioned before, costs and price are what the economy is interested in. Lean management and process organization are terms often used in today´s companies. There is always a way of improving certain things and IoT certainly is one important factor. Before things can be improved, they have to be analyzed and therefore information has to be gathered and processes have to be measured. Because of the complexity and the digitalization of processes, measurement through IoT networks is the only way. This forms the base for improvements, information and data.

Time is as crucial for processes as costs and they are tightly correlated with each other. The time a worker needs to finish a certain process or the time a machine has to run directly, effects the costs. Not only the variable costs and the fixed costs have to be covered, also the workload of the machine is dependent on the time a process needs. Computers are very good

[55] https://www.statista.com/statistics/184024/us-energy-consumption-from-fossil-fuels-and-renewables-since-1999/

at repeating things at a very low time, which makes them perfect for the use in production. Less time leads to lower manufacturing costs, which ultimately results in lower prices for the consumer.

5.1.4 Complexity

The flexibility and scalability of IoT networks enable complex and sophisticated use cases. A variety of sensors, network devices and data mining tools are available and certain processes need sophisticated combinations and solutions. The fast-changing market also has an effect on complexity. The more power and capacity new technologies have, the more complex tasks can be operated. Many different devices also mean different services and different software and different connectivity. This leads to the problem of complexity. Complex systems are the solution for complex problems, but with complex systems there is also a complex development process and different interfaces and software involved. Unified systems and solutions are therefore required to break down complexity[56].

6 Recent field of studies and products in the IoT sector

The following paragraph shows recent IoT solutions from top leading companies of different sectors. According to statistics published by Gartner, 8.4 billion devices will be in use in 2017, which is a 31 percent increase compared to the previous year[57]. 284.8 billion dollars were invested in this sector in 2017[5859]. This shows the immense potential and growth of this field. Because of the many different solutions on the market, this is just a summary of some recent topics and does not display all the products and companies researching in this sector.

6.1 Intel

Intel is one of the leading companies in the computer sector and is one of the top investor in IoT. Several products and solutions are developed, to push the IoT network.

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[56] http://www.psikick.com/technology/

[57] https://www.gartner.com/newsroom/id/3598917

[58] https://www.statista.com/statistics/485252/iot-endpoint-spending-by-category-worldwide/

[59] https://www.statista.com/statistics/299980/size-of-the-global-connected-device-market/

6.1.1 Autonomous driving

Together with the German car manufacturer Audi, Intel is working on autonomous driving cars[60]. By fitting the car with many sensors and huge computational capacity, the car can make decisions on its own and drives autonomous without the interference of a driver. Many other companies are focusing in this sector of IoT for example Google, Microsoft and Volkswagen.

6.1.2 Energy[61]

Intel provides solutions in the oil and gas sector with smart IoT devices and networks[62]. The data gathering process should provide the workers with real time data and the knowledge of the retiring workforce should also be retained by IoT solutions. A connected environment and data flow between the customers demand and the oil and gas industry is the result.

6.1.3 HealthCare

Several Intel healthcare solutions improve the system with technology, boosting computational power and fitting sensors[63]. Remote care is one of those concepts which monitors the health with the help of wearable sensors[64]. This gives live feedback about the consumers health status.

6.1.4 Lightning

Together with AT&T and GE, Intel provides universal intelligent nodes, which can be installed on streetlights. With the help of cameras, microphones and environmental sensor, these nodes can gather data, which is provided to the city departments.

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[60] https://www.intel.com/content/www/us/en/automotive/automotive-overview.html

[61] https://www.intel.com/content/www/us/en/energy/energy-overview.html

[62] https://www.intel.com/content/www/us/en/energy/solutions/mobile-energy-worker-oil-and-gas.html

[63] https://www.intel.com/content/www/us/en/healthcare-it/transforming-healthcare.html

[64] https://www.intel.com/content/www/us/en/healthcare-it/consumer-health.html

6.1.5 Smart parking

To reduce traffic congestion in cities, Siemens developed together with Intel smart parking systems to indicate empty parking spaces on mobile phones[65].

6.2 Microsoft

Microsoft started its business with computer programs and personal computers and today offers different solutions in sectors like cloud computing, hosting, office solutions and of course IoT.

6.2.1 Smart Buildings

Microsoft is working on technologies to make buildings smarter[66]. Efficiency, maintenance and utility costs should be improved by learning out of data. Furthermore, there are sensors for lightning, cooling, room utilization and heating. The goal is to reduce the energy consumption and make data visible at a central device.

6.2.2 Connected Factory

Improving efficiency by connecting the factory with IoT sensors and networks is the main goal of this solution[67]. Processes and manufacturing steps can be made more efficient by monitoring them and analyzing the data. The data can be displayed on multiple central places and actions based on the data can be taken.

6.3 IBM

IBM is a renowned company in the IT sector and is researching and developing on AI solutions.

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[65] https://www.intel.com/content/www/us/en/internet-of-things/overview.html

[66] https://www.microsoft.com/en-us/internet-of-things/smart-building

[67] https://www.microsoft.com/en-us/internet-of-things/connected-factory

6.3.1 Watson platform[68]

Watson is an AI platform developed by IBM. Without the analyzation of gathered data, IoT devices are worthless. Smart self-learning algorithms, natural language processing and machine learning are one of the fields Watson is addressing.

6.3.2 IT Security

IBM is one of the few companies mentioning the very important topic of IoT security in their portfolio[69]. The company offers different security solution for its sophisticated Watson AI platform.

6.4 Psikick

Psikick is a company specializing in IoT technology and products. Other than big companies like Microsoft, Intel or IBM, the main product of Psikick is based on this technology.

6.4.1 Sensor technology

Psikick is a IoT company producing self-powered sensor solutions[70]. Energy harvesting over sensors and solar power guarantees efficient power consumption. A wide array of onboard sensors creates a flexible and extensible sensor hub. Integrated programmable processors allow on-board data processing directly in the hub, which saves energy compared to non-local data processing. While many companies specify and target the specific use cases of their products, Psikick creates a universal solution.

6.5 SAP

SAP is the world leader of management and business solutions with many different products for many applications in the field of business processes.

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[68] https://www.ibm.com/internet-of-things/platform/watson-iot-platform/

[69] https://www.ibm.com/internet-of-things/platform/iot-security/

[70] http://www.psikick.com/technology/

6.5.1 IoT Cloud Platform

With the IoT cloud platform, SAP develops a solution, which enables real-time deployment and real-time IoT and machine to machine applications[71]. Together with their newest product SAP Hana, the company integrates IoT solutions in their well-established business software.

7 POSSIBILITIES OF IOT DEVICES IN THE FUTURE

Investment, growth and demand for IoT devices is rising steadily and we are surrounded of networks and digital devices. Processes and problems are getting solved with computational power and efficiency has the highest priority. With more and more powerful algorithms and sophisticated artificial intelligence data mining, IoT will be the next big step in the IT landscape. The possibilities are endless, because of the cheap manufacturing costs of devices and the yet established connectivity through the internet. The global IoT players are constantly working on new products in this field and try to incorporate it in their portfolio. Experts are convinced that this sector will become even bigger in tomorrow´s IT landscape. With all the advantages, also disadvantages and problems like data privacy and security arise. Big data collects enormous amounts of information about users, consumers and the world, and this is a very powerful tool. The future will tell if IoT and its endless possibilities solve our problems or if we become victims of our own data.

8 THREATS/PROBLEMS OF IOT DEVICES

The biggest problem of IoT devices are security issues. As already mentioned in this paper, network and computer security is a continuous game between attacker and defender. The growing demand for digital devices and the growing use cases, give attackers more possibilities. Suddenly smart lightbulbs or fridges can be hacked, because of their connectivity. Digital devices require updates, in order to patch security issues. In the future therefore user will not only update their computer, they also have to update their smart fridges, smart cars and smart light bulbs. All of these things can lead to data privacy issues and because of the ubiquitous surrounding of digital devices that collect data, security leaks can be catastrophic.

[71] https://www.sap.com/products/iot-platform-cloud.html

Another problem currently is the connectivity. Broadband internet still is not available in many areas in Europe. Germany and Austria are not even mentioned in the list of countries with the best broadband connectivity in Europe[72]. This could not be a problem in the future, it already is. All tasks are built on network connectivity and it establishes the foundation for many application areas. No sophisticated broadband connection means that countries are not competitive anymore on the market.

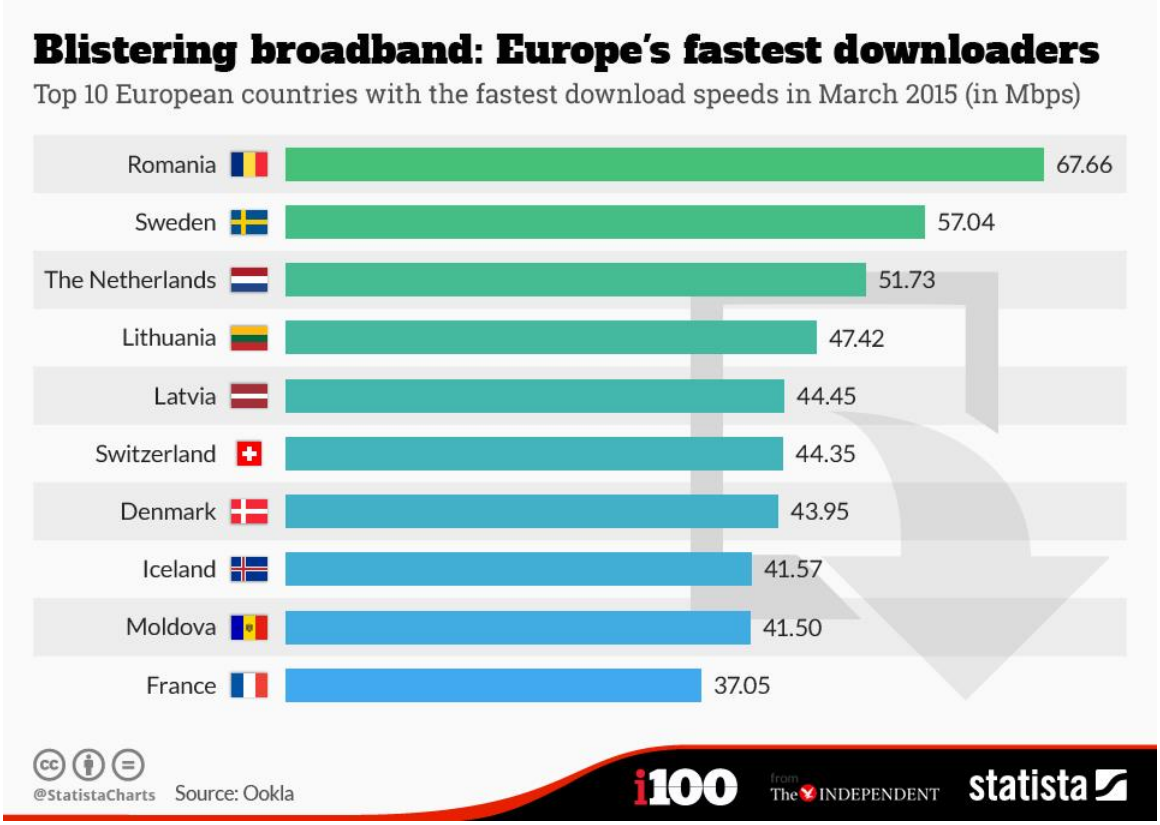

Figure 6: Statistic: Broadband connection in Europe

9 DO WE HAVE TO USE IOT DEVICES - ACCEPTANCE FROM SOCIETY

New use cases and devices are created every day and the consumer has to adopt to the new technology. Some IoT devices work in direct interaction with the consumer and although the technology should seamlessly blend into the environment, consumers have to get used to it.

[72] https://www.statista.com/chart/3348/europes-fastest-downloaders/

The best example are self-checkouts in supermarkets. This system is very popular in supermarket chains in the USA, but it has also caught on in stores in Austria. Interesting is that many people still prefer the old-fashioned checkout, instead of the self-checkout. There are of course different reasons for that, but this brings me to the question, if we have to use digital solutions and if the consumer still has the power over the demand for IoT systems? In the beginning, IoT devices sometimes do not work as intended and are not really accepted from the majority of people. However, analyzing other use cases and systems that seemed to not have worked in the past, showed that they are now indispensable (supermarket checkouts, self-breaking cars, ticket check-ins at airports). I conclude that the crucial factor for acceptance of technology is time. Technology brings many advantages, even if it is not realized in the first place. Because of the fast going economy and the many processes, efficiency is the highest priority and efficiency is reached with technology.

10 CONCLUSION/SUMMARY

IoT is part of our everyday life. It enhances processes and makes them more efficient and solves problems we could not have solved without it. With all its advantages and disadvantages, IoT is the next big thing and according to experts and statistics, the growth in the next years is enormous. My extensive observation of systems and networks reminded me of the various use cases and the sophisticated thinking and logic behind those systems. Airports are nowadays full of digital helpers and we already take them for granted. This research showed me how powerful and what influence and importance computational power has on everyday processes and how much effort there is taken, to create and optimize systems. Big airports like San Francisco or Berlin, are the best examples for high efficient processes and digitalization and in the future we will see many more use cases.

My semester abroad gave me the unique possibility to analyze not only my know surroundings, but also one of the leading technology countries, the United States. While there is a big difference in size and everything is scaled in the USA, the technology used, often is the similar. However, because of the big investments, the size of the country and the many companies in this field, the USA still is a trendsetter for IoT and computer technologies in general. There are countries and cities in Europe too, researching and working on new technologies, however Austria seems not to be one of the leading countries. However, that does not mean small countries cannot be innovative and on the pulse of time. It is very important to keep up with the trend, to invest and to engage people to found new companies in the very

competitive IT and IoT sector. Technology is and will be one of the base factors for competitiveness and success!

This research gave me the possibility to share my observations and my results I gathered over the last months, both in Austria and Germany, as well as at some of the biggest cities and airports in the USA. It should not only provide people with fundamental knowledge about IoT and the fields of IoT, it should also show how huge and how dependent we are from computational power and that nearly every process is digitalized. It shows that there are also problems that have to be addressed and that not everything digitalized has to be an improvement in the first place. It also shows the potential, the growth, the many use cases and most importantly the inevitable use of technology.

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