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Technological Singularity as a way of transition from capitalism to the Universal Basic Income

Bachelor Thesis

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I would like to thank my supervisor Ing. Bc. Martin Machay Ph.D. for enabling me to write this controversial thesis with the proper feedback and interest in the top-ic alone. Additionally, I would like to thank Ray Kurzweil for providing the neces-sary research data and his wisdom in the matter of this topic.

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Abstract

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This bachelor thesis is aiming to evaluate the Technological Singularity impact on economy and its transformation likewise. The thesis provides introduction to the history of Technological Singularity, the characteristics which all theories are based on and its meaning in the economics. The Law of Accelerating Returns proposed by Ray Kurzweil is described in correlation with Technological Singularity to exploit economics' exponential growth primary in computing industry and forecasts its further development. Suggestion are made to the companies for the potential utilization of the current technological utilities.

Keywords
Technological Singularity, Law of Accelerating Returns, Central Processor Unit, Supercomputers, Universal Basic Income, Post-scarcity economy

Abstrakt

Mizerák, M. Technologická Singularita ako nástroj pre transakciu z kapitalizmu na Univerzálny základných príjem. Bakalárska práca. Brno, 2017.

Táto bakalárska práca cieli na evaluáciu Technologickej Singularity v spojení dopadu na hospodárstvo a zároveň i jej transformácie. Práca sa zameriava na úvod do histórie Technologickej Singularity, na základné znaky sprevádzané teóriami zaoberajúce sa týmto termínom a potenciálnu implikáciu pre ekonómiu. Overuje sa zmysel aplikácie umelej inteligencie na trhu a poskytuje sa názor na implementáciu technologických prostriedkov na zefektívnenie hospodárenia podniku.

Kľúčové slová
Technologická Singularita, Zákon exponecionálnych výnosov, Centrálna procesová jednotka, Univerzálny základný príjem, Ekonómia prekonaného nedostatku

Contents

1 Introduction

We are living in the age of constant changes. The world, where the state of the art products of today are becoming obsolete products of tomorrow. Most of us can clearly recall the first mobile phones which have owned, where the name “phone” stayed truth to its purpose thanks to its simple ability to stay in touch with people whenever you went. But the introduction of adjective “smart” changed our view on the possibilities in which these devices can be utilized even further. I clearly remember my first smartphone, the model N95 from that time prestigious mobile company Nokia. The possibility of having the Internet on move, luxury of lots of storage capacity and display with resolution unmatched to other was the prove that my mobile was at that time top of its class. However, my smartphone aged horribly just as well as the marketing of Nokia. We haven’t realized that the paradigm shift is being made from the mechanical keyboards to the touchscreen, which set a new standard in production and overall “view” on purpose of a mobile phone.

Since then I presumed that my lack of awareness and openness to new concepts might be a downfall to my decisions when selecting a correct product to purchase. That’s why I have driven myself to explore the development of the markets with key players in innovation. At that time various technical journals, reports and magazines of leading producers began to provide view on the Technological Singularity, an inevitable event in which artificial intelligence becomes as powerful as that of human. Many sources claimed to be achievable no later than 2035, while others stayed humbler and predicted the change from second half of 21st century to early 22nd century. This took my interest and asked whenever we are able to test the theory according to the current development of the technological markets and find out if the theory possess any credibility on its achievement.

Investigation lead to work of Ray Kurzweil, who proposed Law of accelerating returns theory as a requirement for the Technological Singularity progress development. Kurzweil explored the Moore’s Law and proposed its death of it in the second decade of 2000. This suggested that the new transmission in technology would need to be introduced in markets, new computing method, which would bring revolution, but there was not a single hint in the market of doing so.

Kurzweil made forecasts on the development of these markets and after 15 years I felt the necessity to prove the credibility of these claims and observe, whenever the Law of Accelerating returns is still unveiling according to the milestones Kurzweil proposed and thus estimate the further development of this theory to achieve Technological Singularity.

2 Objectives

The aim of this paper is to empirically test the achievability of Technological Singularity through the observation of the technological markets, mainly CPUs production and observing the implementation of artificial intelligence in the business.

The outcome from these results will provide the background for evaluation of validity of Kurzweil's claims on development and death of Moore's Law and the ability to construct a computer powerful just like a human brain worth $1,000.

3 Methodoloy

The bachelor thesis is conceptually divided into two main parts. The first part deals with definition of the Technological Singularity as a term and provides the historical view on the development of the term in regards of the technology. Introduced are core principles which the various Technological singularity theories have are in common. The review of these characters is important in order to define the way the Ray Kurzweil looks on the Technological Singularity.

Following section of the literature review provides insight of the theory of the Law of Accelerating returns, which provides the necessary background for the development of this theory and align its concept to the economic development in the USA. This theory provides the basic support for reaching the Technological Singularity and provides concepts which are the main driving inputs for the successful continuation of the law. In the second part, we will look on the several claims Kurzweil has made back in 2001 to predict the development of the Law of accelerating returns, in which should be able to reach the Technological Singularity by the year 2035. There are several main points to discuss in order to show the significant of the theory up to these days.

First, we will look on the development of the semiconductor industry via the sales of processors made by Intel and the overall semiconductor market performance according to Semiconductor International Association. This will be done by collecting reports on Intel's quarter total and CPU's revenues from 2006 to 2016 to find the portion of Intel's reliance on CPU revenues. Additionally, time series with seasonality will be plotted for CPUs revenue to identify the performance of this market. Lastly, quarter revenues from 2006 to 2016 of the Semiconductor International association is necessary to plot in order to compare development of industry to Intel's revenue and find similarities in development of these Secondly, we will observe the improvement of CPU performance and the potential death of Moore's law by comparing the current power of a single core in the CPU and the progress of development of the silicon chips. This will be achieved by observing the Intel's microarchitecture development in alignment with Moore's law, starting for the year 2006 with 65nm architecture.

Thirdly, we will look at the computing power necessary to obtain to be able to simulate the raw computing power of a brain. As Kurzweil suggested, by the end of the 2017 we should be able to create a computer worth $1,000 which has a computing power of brain. In first part, we will review the performance of a single TFLOP in dollars of most powerful supercomputers through history. This will be achieved by dividing the overall initial cost for construction and the performance of CPU based on Linpack benchmark. Following we will determine the performance of the 5 most powerful supercomputers on a square meter, received by dividing the performance of computer by a space the computer takes up; and the initial cost for providing 500 TFLOPS of raw power, gained by multiplying the price of 1 TFLOP for a current machine by 500. This way we find out the best performing computer on the market.

Finally, the performance and space requirements of the best supercomputer will be used to determine the space required and money invested in order to simulate the human brain. This will be achieved by dividing the performance of brain (36,800 TFLOPs) by performance of our selected machine on 1 m2 and multiplying the price of a single 1 TFLOP of the selected machine with the performance of brain. In the second part, we will benchmark the performance of Intel's i7-6700k processor using method Linpack to determine the FLOPS of a high-end CPU and determining the percentage of raw computing power of brain the processor can simulate in a machine worth roughly $1,000. Price of the CPUs and RAM necessary for benchmarking are determined from the current market development.

Fourthly, we will look on a less significant unit in measurement of performance, but still relevant in a way of progression and that is core speed of the processors. Kurzweil claimed that if the stagnation in core speed improvement would occur, it would greatly slow down the market and cause chain reaction in other markets, halting down the innovation as the markets revenue would fall. We will therefore look on the history of the development of the computing speed of the high performance Intel's processors through 1972 – 2014 in MHz to observe whenever the slowdown is real. Additionally, we will observe the performance of gaming software in 9 types of processors in regards of core utilization in two games specifically, Ashes of Singularity and Gears of Wars Ultimate Edition. The performance will be shown in frames per seconds (FPS).

Lastly, implication of artificial intelligence in the private market is reviewed to prove the development of AI is important and justified based on the successful examples. We will look on the current AI on the markets, such as IBM's Watson and observe their impact on labour, investment and marketing of the business. Based on the observation, we will provide suggestion for the implication of the AI concept in companies to improve their conditions on the market.

4 Introduction to Singularity

In the first part of the paper we will introduce singularity as a term, define it within boundaries of technology and link it towards the economic hypothesis known as Technological Singularity. Followed will be historical view on this hypothesis and significant characteristics accompanying it.

4.1 Defining Singularity

Singularity as a word has no general interpretation, its meaning varies through the scientific fields. In Mathematics, singularity is seen either as a failure within a unique range of the point where the rules aren't applicable in corresponding form or it is viewed as a defined point without appropriately characterized object of study. (Arnold, 2000) Statistics refers to it as a singular mark; a defined point where the calculated shape becomes dysfunctional or simply degenerates. (Knopp, 1996) Meteorology uses concepts of singularity to describe a rare weather condition which happens in statistically confirmed consistency within rough calendar date. (Barry R.G. Chorley R.J., 1987) Gravitational singularity (known as black holes), is defined in space-time as the area where materialized gravitational field reaches infinite regardless the influence of the coordinate system. (Claes Uggla, 2006)

Although in many definitions the singularity is incoherent, a pair of words repeatedly occurs in the all the statements, point and infinite. These words are the basis for a definition of the singularity, to which also concept of Technological Singularity inclines and follows. Later in the chapter we will expose to which of these theories Technological Singularity takes its concept.

First noticeable address to the singularity in technology was done by mathematician Jon von Neumann in conversation with Stanislaw Ulam, where he declared that "[...] ever accelerating progress of technology and changes in the mode of human life, which gives the appearance of approaching some essential singularity in the history of the race beyond which human affairs, as we know them, could not continue" (Ulam, 1958). Without mentioning the Singularity as an event, a British mathematician Irving John Good (former named Isadore Jacob Gudak) described the 'technological' event in future this way;: "Let an ultraintelligent machine be defined as a machine that can far surpass all the intellectual activities of any any man however clever. Since the design of machines is one of these intellectual activities, an ultraintelligent machine could design even better machines; there would then unquestionably be an "intelligence explosion," and the intelligence of man would be left far behind. Thus, the first ultraintelligent machine is the 'last' invention that man need ever make, provided that the machine is docile enough to tell us how to keep it under control. "[...] It is more probable than not that, within the twentieth century, an ultraintelligent machine will be built and that it will be the last invention that man need make"(I. J. Good, 1965).

The term has been furthermore popularized by Vernor Vinge, mainly in his science-fiction novels *The Peace war*, which depicts world of Technological Singularity postponed by countless economic bubbles and global plaque (Vinge, 1981); *True Names*, where story is placed in a land at the peak of Singularity (Vinge, 1981); *Marooned in Realtime*, which is concentrated on a group of people whom Singularity bypassed even thought that it has been achieved (Vinge, 1986).

Scientifically was Technological Singularity addressed again by Raymond Kurzweil, an American computer scientist and author. His first novel, The *Age of Intelligent Machines* (Kurzweil, 1990), depicted the history of the computing and give insight into development of the technology. Following book, *The Age of Spiritual Machines* (Kurzweil, 1999), introduce the Law of Accelerating Returns, which is most elaborated work in the field of the Technological Singularity due to these days. Third book, *The Singularity is Near* (Kurzweil, 2005), depicts the future predictions in sciencific fileds which will be mainly affected by Technological Singularity and provides deeper look inside them.

Worth to mention is also Calum Chace, who has recent years picked up where Kuzweil left. Unlíke to Kurzweil, who reflected Technological Singularity in many scientific fields, such as healthcare (Kurzweil, 1990), Nanoengineering (Kurzweil, 2005), and Economics (Kurzweil, 1999), Chace focus mainly on the economic impact of the singularity. He strongly defends the idea of Universal Basic Income, which according to his opinion is inevitable social reform in form of Universal Basic Income to the corresponding changes in job infrastructure due to the automatization and computing intelligence (Chace, 2016).

4.2 Concepts of the Technological Singularity

Before the elaboration of the **Law of the Accelerating returns**, we must resolve the coherence of the term **Technological Singularity** to point out the main differences, which are depicted by various authors. They establish the clear rules, according to which will be Kurzweil's Law of Accelerating returns obey.

According to the research paper The Singularity Controversy, coherency was the main objective to discuss to eliminate further misconceptions whenever dealing with scientifically based Technological Singularity. As the Eden states, every theory regarding the discussed subject since the mid 20st century share the three core conceptual characteristics: acceleration, superintelligence and lastly, discontinuity. (Eden, 2016)

Acceleration

Acceleration is described by the rate of growth in a variable against another significant variable, such as computations per second against fixed dollar (Kurzweil), total output of goods and services (Toffler), economic measures of growth rate (Hanson, Bostrom, Miller). Additional graphs depicting acceleration are presented by quantitative measures of biological, cultural, physical and technological process of evolution, all represented by turning point in paradigm shifts whose continuity represents accelerating trend. Such example is well shown of Carl Sagan's Cosmic Calendar (Sagan, 1977), which depicts accelerating speed when linked through paradigm shifts in evolution of the organism, from the simplest form known as eukaryotes to the most developed species, Homo sapiens. Similar attempts have been elaborated in the work of Kurzweil's Law of Accelerating returns (Kurzweil, 2006), where computation power against dollar is wrapped up into the stages of technology used for computing (from electromagnetic principles to integrated circuits), creating successfully paradigm shifts showing an accelerated rate of increase. Visualization of such acceleration is shown on the upward sloping curve in a timeline, whose future predictions based on the collected data implies a discontinuity. (Eden, 2016)

Discontinuity

Discontinuity takes form of a mark, turning point in mankind history. However, we know that Singularity as a term has no finite, directly applicable meaning. Technological Singularity tends to incline the concept of gravitational singularity, known as the black hole. A point, referred to as singularity, mark the centre of gravitational lensing. Here factors, which are commonly applicable (e.g. density and space-time bending), become useless, as their values reaches infinity. In metaphoric meaning, this concept is useful to describe the concept of superintelligence, in which commonly applied measures for intelligence become powerless due to their meaningless. (Eden, 2016)

To further elaborate superintelligence (or omnipotence), we can apply discontinuity on event horizon embraced by the gravitational singularities (black holes). Let's imagine that we are in front of a massive black hole – we cannot see what is happening inside the black hole unless we cross the threshold known as event horizon. This threshold marks the point of no return, as gravitational pull becomes so enormous that nothing can escape it, even light. We observe the black hole's inner structure, however, no longer we can return to bring knowledge acquired. Introduction of superintelligence would therefore create similar mark, the event horizon, forcing discontinuity in intelligence. (Eden, 2016) To mark the words of John Von Neumann: "[...] some essential singularity in the history of the race beyond which human affairs, as we know them, could not continue." (S. Ulam, 1958)

Superintelligence

Superintelligence gathers all singularity scenarios, whose methods for measuring quantitative intelligence by at least traditional methods of IQ (such as Wechsler and Stanford-Binet) tests become pointless as transcended intellectual capabilities way beyond the levels of the human intelligence come to exist. (Eden, 2016)

To furthermore support this concept, any data created after the arrival of superintelligence in terms of IQ score will display radical forms of abnormalities, which will lead to discontinuity. These statements stay relevant whenever the Singularity of AI or IA are implied (further elaborated in next section). The arrival of human-level AI may be in a rapid phase ascends into superintelligence. However, the implication of human elevation on a cognitive and intelligence level due to the "fusion" with technology to become superhuman, resulting in limitless memory and "speed of light" processing. Through this concept many of the common obstruction human kind is facing in regards with ecology, scarcity, aging and disease would be solved. (Eden, 2016)

AI vs IA

We have depicted three core variables which are the basic structure of the Singularity. Although all the Singularity theories created through last decades follow these three characteristics, the clear representation of the correct form of superintelligence is missing. Theories provide two possible scenarios, both which have distinct development and therefore, impact on humankind (Eden, 2016)

First case describes the creation of artificial intelligence (AI). Dystopian future shows the birth of AI on the level of human and within four decades its ascendant, so called "super intelligent agents on software-based synthetic minds" (Eden, 2016). AI becomes physical manifestation of the god and greatly threatens for the human existence due to its sovereignty. (Sandberg, 2014) On the other side resides posthuman singularity implying intelligence amplification (IA). This utopian vision, put into the similar timeframe as the AI scenario, represent humans as ascended beings, which merged with technology to achieve new possibilities. (Kurzweil, 2005) Results would be mirrored in the aging, scarcity, economic deviations and other problems humankind currently faces.

These two scenarios, "bad" and "good" one, are often misused in popular science. Guardian in their report under name Are we already living in the Technological Singularity? (Guardian, 2014) mixes both scenarios of the intelligence, confusing the reader about the clarity of the Technological Singularity possible outcome. What can be because of it? Does the human nature reflect the worst-case scenario as the most liable or is there a deeper psychological meaning behind this? This may be due to the fact that people see superintelligence solely in the form of AI. Idea of fusing biology with technology seems to be disregarded and not accepted due to the human's vision of staying ahead of the technology in every aspect without the necessity to upgrade themselves. However, we somehow forget that we have long ago started undertaking upgrades in the form of biological enhancements, to keep our bodies vital and counter various obstacles to reach longer lives (e.g. pills increasing temporarily intelligence, artificial body parts, vaccination).

Incoherency in theories

In 2013, Eric Chaisson, American astrophysicist, brought to the public Energy Density Rate theory. He supports the Singularity in its two core characteristics, acceleration and superintelligence, but disregard validity of discontinuity. According to Chaisson, energy density rate as a physical variable can describe and reason the evolution of physical (e.g. universe), biological (e.g. life) cultural and technology (e.g. cars), unifying forms of evolution and so supporting accounts of other authors dealing with evolution theories, considering The Law of acceleration Returns (Kurzweil, 1999). Superintelligence is also evaluated as the valid configuration due to the necessity of the intelligence to grow at pace which humans alone won't be capable to achieve. However, discontinuity in his work is regarded as characteristic without potential. He argues that due to the infinity expenditure of universe is unreasonably to claim that the birth of the superintelligence will have much bigger impact than the previous phases of emergency of complex systems. (Chaisson, 2013)

5 The Law of Accelerating returns

In the previous chapter, we have set up the necessary variables Acceleration, Superintelligence and Discontinuity, which defines boundaries of concepts the Technological Singularity. Kurzweil implies all these principles in The Law of Accelerating returns, but doesn't look on the dystopian artificial intelligence as the correct scenario. He claims that the humans are already upgrading themselves biologically and it's only a matter of time when the upgrades will have technological fundamentals. In this chapter, we will look on the closer look on The Law of accelerating return, which characterizes the exponential growth in economy and defines the drive necessary for the Technological Singularity to be achieved.

5.1 Implication for the Law of Accelerating returns

To fully comprehend concept at which Accelerating rate of Return is based on, Kurzweil in his work point out term intuitive linear, long term predictions of technological integrity in the following years. According to Kurzweil, humans tend to look on the future at the rate of today's progression, not tomorrow one. We falsely assume that within year we will have approximately the same rate of acceleration from the day you have read these lines. This biological view is an illusion created by the process of adaptation, enabling certain species to respond to changes and adapt to the whole new process while omitting the less responsive, leaving them behind to eventually die out due to their insufficient response pace to the change. (Potts, R., Sloan, C., 2010) As a human is one of the fastest adapting specie on the Earth, we tend to intuitively react to the technological development at the pace set currently. Even the generations X (since 1966) and Y (since 1977), who can judge the increase rate of technological development from a longer timeframe, their intuitive adaptation creates distortion in the view that progress is set today at the speed similar to that of 30 years ago. (Kurzweil, 2001)

Kurzweil states that any futuristic predictions are misinterpreted and underachieved, as they integrate the linear rate increase than of the exponential rate, regarding to as the historical exponential view. When looked on the Intuitive linear from mathematician point of view, an increase in the exponential curve in short-term period is seen as a linear one. The technological progress is far more superior than it was a decade ago, yet our deduction is overwhelmed by the data received by the current years, ignoring the exponentiality resulting from the decades of historical evolution of technology. Therefore, Kurzweil points the linear view as an important failure in the most of predictions for future movement. Overestimation is done in the short-long trends (as necessary details are left out), but under-estimated long-term prospects (as exponential growth is ignored). To express it in comparison, take the following example Kurzweil provides on the linear versus exponentional view: "[...] it is not the case that we will experience a hundred years of progress in the twenty-first century; rather we will witness on the order of twenty thousand years of progress (at today's rate of progress, that is)." (Kurzweil, 2001)

5.2 Defining principles of the Law of Accelerating Returns

From all the aspects mentioned up to now, Kurzweil formulated The Law of Accelerating Returns, which is built upon the following principles:

1. Evolution provides informational feedback necessary for a certain evolution phase to transcend into next phase successfully;
2. Every following phase provides more proficient approach for transcending exponentially, meaning the information inscribed in the evolutionary pro-cess increase significantly;
3. Correlation of the ability to transcend into following step in evolution and increased information carrier creates "profitable return" (such as cost-effectiveness, speed) increase exponentially over time;
4. Chain reaction are triggered by successive evolutionary processes (e.g. computer performance) in the formed of more effective (e.g. price), signifi-cant resources. These furthermore implode, creating a second wave of exponential growth (i.e. exponential growth itself exponentially supports);
5. A paradigm shift results into the growth until its strength is diminished and cannot provide further development. Such exhaustion in one evolution phase provides fuel in the form of information for innovation (regarded as paradigm shift), enabling the exponential growth again. (Kurzweil, 2001)

Kurzweil supporting arguments begin at understanding the concept of paradigm shifts. Thomas Kuhn, a scientist, brought up this term for the first time in the book he Structure of Scientific Revolutions. (Kuhn, 1970)

Let's imagine a certain time period, a paradigm, within which scientific studies are conducted. According to the Kuhn, the level of importance of the error and anomalies varies through the professionals at different scientific field. During this period (or in already established term, paradigm), anomalies in research occur which cannot be explained by the currently set up scientific ideologies, theories and research methods. These conflicts are seen at the paradigm as an acceptable level of error, or simply ignored. (Kuhn, 1970)

Whenever within the given paradigm an amount of errors reaches certain degree, science becomes irrelevant and put into chaos state. Kuhn describes this phase as a crisis, which is attacked by re-verification of the error, or current ideas are introduced. A shift is conducted by certain protagonists of science, creating a brand-new paradigm, introducing different views on research and reasoning. Paradigms are engaged in a struggle, which example can be an over 300-year conflict defining whenever the light is made of particles (Sir Isaac Newton, Albert Einstein) or waves

(Christian Hyugens). These conflicts are not usually short-term, lasting for many year (even centuries), persuading by using both empirical data, rhetorical or philosophical arguments. To use the quote from Max Planck: "A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it." (Kuhn, 1970)

When the "competing" paradigms results their conflict, shift is made from one paradigm to next one, causing so called scientific revolution or more known, a paradigm shift. Kuhn states that every new paradigm shifts not only results to different views, but also improves it quality at the same time. To quote the Kuhn "Successive transition from one paradigm to another via revolution is the usual developmental pattern of mature science." (Kuhn, 1970)

Basing the predictions on the Kuhn theory, we might possibly clearly see paradigm shift in a scientific field, which has a long historical empirical data to compare from through a significantly big time lapse. In our case, biological evolution. Starting from the first step, the birth of cells, we set the start for the first paradigm. Subsequent DNA occurrence gave the necessary birth for the evolution experiments to occur. Followed the evolution process given by the merger of thought with an opposable appendage (known as thumb) resulted in a paradigm shift from biological to bases of technological evolution. The next suggested important paradigm shift shall occur on the combining biological and artificial intelligence. Resulted fusion will include processes taken from the reverse engineering of our brains. (Kurzweil, 2001)

5.3 Biological paradigms – DNA evolution

If we take into respect the time duration of each of these steps, we see significant acceleration in every consequent phase. It took billions of years for the first evolution of life to create a form of primitive cells (namely eukaryotes), from which the progress started to accelerate. Cambrian explosion is the base for the major paradigm shifts, whose time lapse is long ten millions of years. Followed the evolution of humanoid beings, which once again took significantly less to develop – only millions of years. Homo sapiens mark the last step of the protein syn-thesis driven evolution, where the paradigm shifts were done within hundreds of thousands of years. (Kurzweil, 2001)

Homo sapiens at the same time mark the beginning of technology-creating species era. Biologically conducted DNA evolution lost its pace due to the exponential pace of introduction of technology. As the tool mark the beginning of the acceleration, it is also a way of introducing more developed technology on the basis of the information about the already known tools (this supports the claim that information from previous evolution phase is needed to transcend into the following phase). Humans become distinguished from the other species due to the distinguish and ever-developing craftsmanship. Records of each technology age are made, while

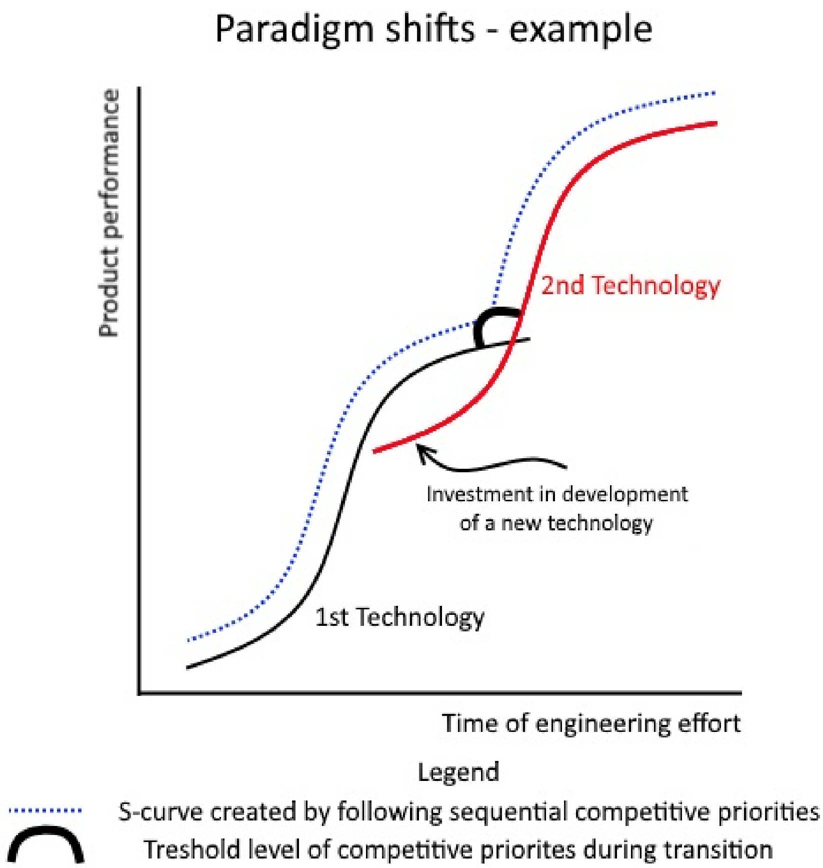

Figure 1: Example of paradigm shift, source: www.anandnair.com

implying that each and every stage builds on the information and technology of the previous one. (Kurzweil, 2001)

First of the tools in the technology as fire, the wheel, as hunting tools took thousands of years to modify. Humans living in that era were unable to notice any of the changes during their lifespan. Paradigm shifts were progressively increased in numbers since 1000 AD. According to Kurzweil's research, technological progress of the nineteenth century was so intensive, that it enveloped nine centuries of technological progress within a single century. Following twenty years of the 20th century has caused technological improvement in such a phase that 19th century in comparison was seen "slow". To show the development of the World Wide Net, it has fully become saturated and used within 20 years. Recent development of virtual reality and augmented reality is moving at faster pace than anyone could have predicted. (Kurzweil, 2001)

Therefore, according to the accumulated knowledge we can depict paradigm shift rate. As we have already outlined, current developing is doubling approximately every decade. This results in paradigm shift to be shortened to the halve every following decade. As Kurzweil notes, 20th century exponential progress will be equivalent to the linear progress of 200 centuries.

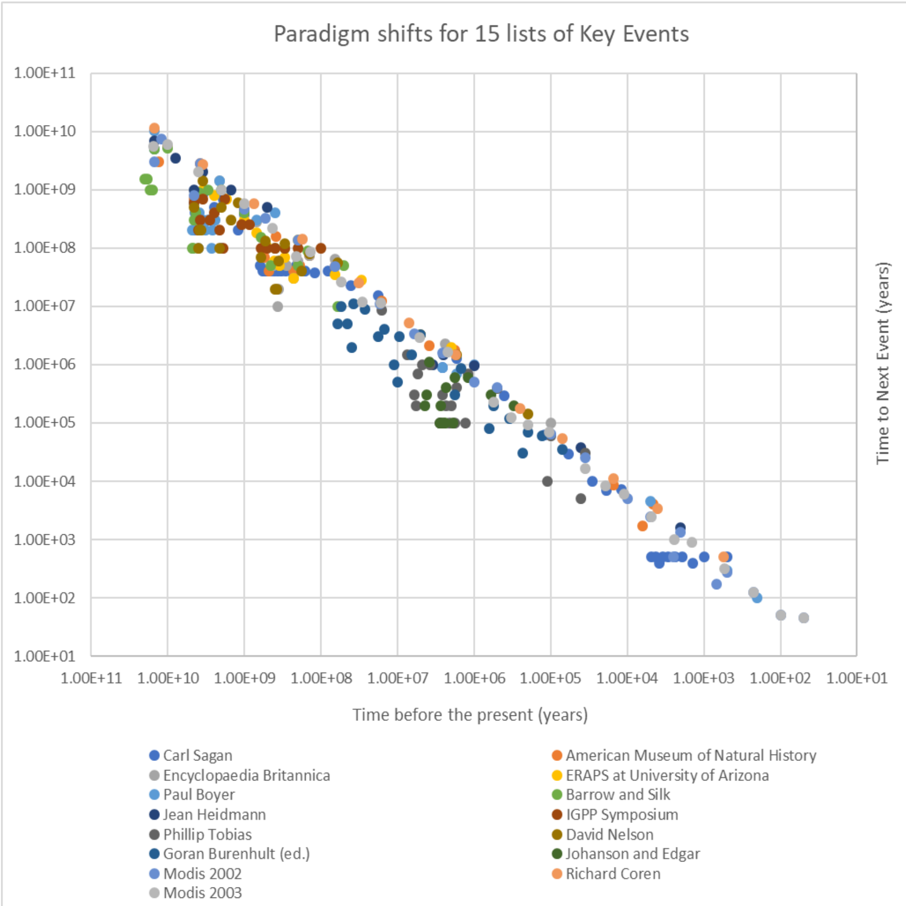

Figure 2: Paradigm shifts for 15 lists of Key Events (double logarithmic function), source: www.singularity.com

5.4 Technological paradigms - Moore's Law

We have observed the paradigm shifts in the biological sphere and also stated, how DNA driven evolution lost its pace due to the ever-increasing technology progress. We will now observe one of the law driving technologies that are create the core for the Law of Acceleration returns.

In 1965, an article named Cramming more components into integrated circuits was written by Gordon E. Moore, that year a current director of Research and Development Laboratories for semiconductor division in Fairchild Camera and Instrument corp. In the article, Moore ambitiously states that "by the 1975 economics may dictate squeezing as many as 65,000 components (i.e. transistors) on a single silicon chip [...] the complexity for minimum component costs has increased at a rate of roughly a factor of two per year." (E. Moor, 1965)

Since the performance of the semiconductor was directly influenced by the number of the transistors, we could have assumed a roughly parallel increase in the performance as well. To support (or reject) the Moore's statement, we can check the most frequently used processors in years 1974/1975. In 1974 Intel produced Intel 8080 with 4,500 transistors, while the RCA produced a chip with 5 ,000 components within. Following year, processor MOS Technology 6502 (referred to as 6502) had transistor count of weak 3,510.

This doesn't correspond with the Moore's statement. However, in 1975 he retraced his claiming, sating the pace of improvement to be double for every two years. This period is sometimes interchanged for 18 months (year and a half), presented by the Intel executive David House. From now on, the Moore's statement became a law, according to which companies producing processors tried to improve their products.

Therefore, we can assume that successful implementation of Moore's law brought steady development, which can be plotted on the graph as a parallel growing line. To support this assumption, we can compare some of the processors made by developing companies after 1975. In Intel, processor named Intel 8088 produced with 29,000 transistors in 1979 was overtaken by its successor Intel 80186 with 55,000 transistors in 1982. Even though this result hasn't followed the prediction and was slightly behind it, in the same year Intel release the processor Intel 80286, composed of 134,000 transistors. Following three years late, Intel released its follow up under name Intel 80386, containing 275,000 components. Motorola was successful too with the model 68020 created of 190,000 transistors in 1984 to its predecessor 68000 from 1979, modelled only from 68,000 transistors.

As we can see, the Moore's law was already in practice. Plotting the most innovative processors since of their age on the graph, we can clearly see how Moore's law was closely incorporated as a progress milestone.

However, Kurzweil takes Moore's law into the next step. He doesn't view the current law as an artificial "set of industry expectations and goals". He states that even thought that Moore's Law is strictly established on the amount of transistor within and integrated circuit of certain size, its application might be much broader. Kurzweil claims that the number of transistors or feature size are not providing the clear information about the technological progress, but rather the computing power per unit cost. This takes into consideration much complex levels of innovation in technology industry, such as parallel processing, memory caching and pipeling to name a few. (Kurzweil, 2001)

Thus, we need to take into consideration a wider spectrum of machines, preferably computers, which could be generating certain computing processes within a specific time period (usually hours). Integrated circuits don't mark the true era for computing machinery, therefore, we need to go to era of electromechanical calcu-

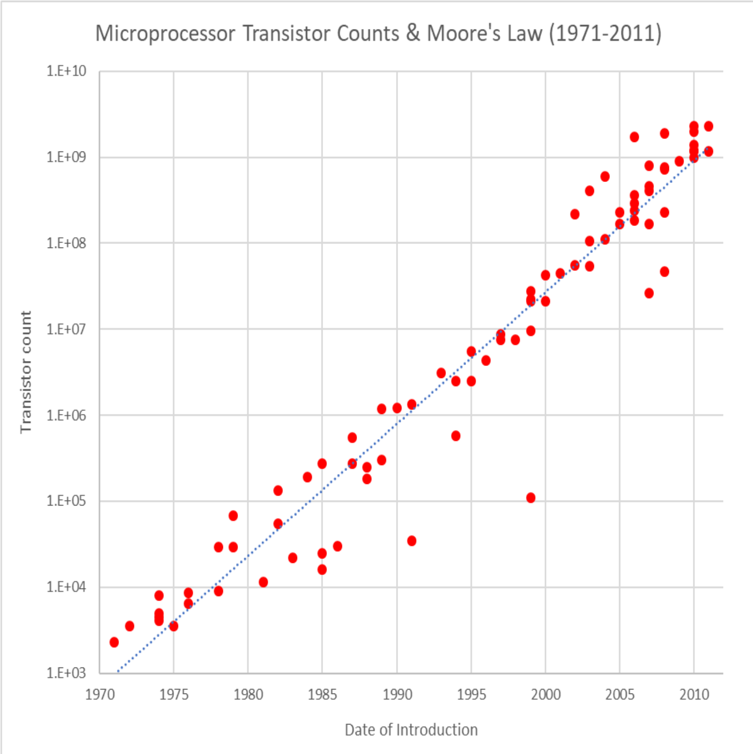

Figure 3: Microprocessor Transistor Counts & Moore's Law 1971 - 2011 (logarithmic function), source: www.wagnercg.com

lators used in the latest year of 20th century. Since electromechanical computing "age", four more paradigm shifts occurred.

In the following graph, we can observe computing ability to calculate (in instructions per second) against $1000 (in constant dollars) of 49 most notable computing machines spanning the entire 20th century, Kurzweil noted an interesting observation.

We can observe from the graph that the straight linear increase resulting from the Moore's law is not present, rather, the lane is exchanged by a slightly exponential curve. Kurzweil points out an exponential growth within an existent exponential growth. Computing speed (per unit cost) was doubled every three years within a time period 1910 to 1950, following by a double increase every two years from 1950 till 1966. Since then the doubling occurs roughly every year. (Kurzweil, 2001).

According to the Kurzweil, this exponential curve is one of the many examples of the exponential growth in the technology. Additional to the view Kurzweil proposed to support exponential growth, we can also express the computing progress in the terms of accelerating pace. To reach the first million instructions per second (MIPS)/thousand dollars, we needed 90 years. These days, our potential to increase MIPS/thousand dollars squeezed to just one day. (Kurzweil, 2001)

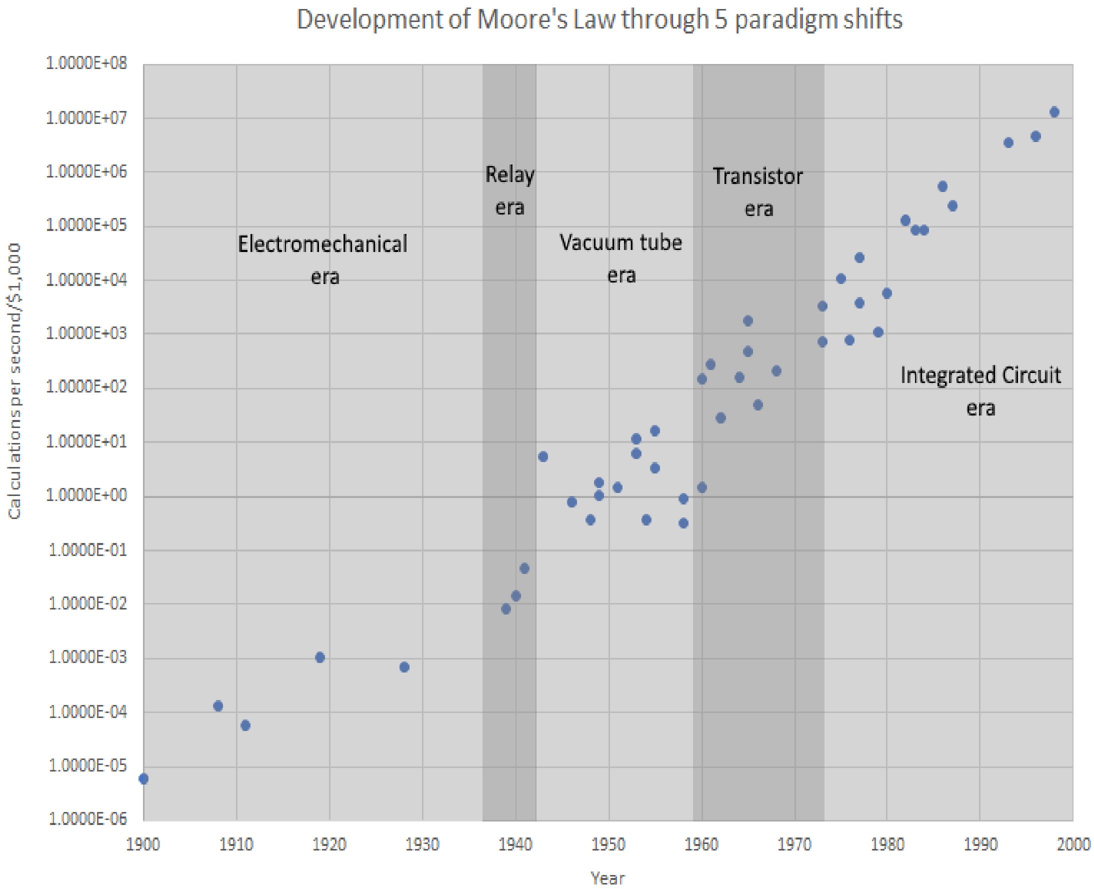

Figure 4: Development of Moore's Law through 5 paradigm shifts, source: www.singularity.com

Kurzweil at the same time points out the potential death of the Moore's Law in the second decade of the 21th century. As any exponential growth, the computing in broader meaning of Moore's Law set up by Kurzweil has shown, every paradigm reaches its potential, where the new approach (a shift) is needed to be taken based on the information of the current paradigm. In other words, exponential trend is bound to diminish due to the lack of substantial "resources". The classical example is when a species occurs in a new habitat (e.g., rabbits in Australia), the species' numbers will grow exponentially for a time, but then hit a limit when resources such as food and space run out. However, the materials defying the exponential growth are described in the following two states:

1. Phase of the evolution process. Every evolution phase gives necessary advanced tools to transcend into the following phase. In biological merits, such tool can be DNA, which enabled powerful and quicker evolutionary progression. Another example can be shown in the Cambrian era, where a rapid progression of body

organs such as the brain was supported by 'defying' animal body plans. Recent example can be introduction of computers assistant design (CAD) systems which allowed faster development of next-gen computing machinery.

2. By defining the environment as "chaotic", we create a 'place' for evolution and for further diversification. This is observed in biology through muta-tions and constantly changing environment conditions. In technological concept of evolution, human intelligence and flexibility of the market envi-ronment feeds the process of innovation.

Kurzweil also points out the need to distinguish between the "S" curve and the continuing exponential growth that is significant for the everlasting evolution. Paradigm has much more similar cycle as a product – first the phase of "Introduction" phase of the technology, resulting in tiny, small growth; expanding to the "growth" phase, where the technology rapidly takes off, followed by a "Maturity" represented by slowed down growth eventually approaching an asymptote. Like in the case of Moore's Law, paradigm will run to the point, where the feasibility of the technology is no longer liable, creating a "S" curve. However, computing power is not halted, it is still going, even if the paradigm reaches its limit. According to the theory, new paradigm occurs and shift between the paradigms is conducted, allowing a fluent transaction between the old one and new paradigm. As we have observed, four of those shifts have already been done in the history of computing. Such intensity in the paradigms shifts the differences between the tool making of less developed species (animals), where a tool-making process skill is strongly finished in an abruptly S-shaped learning curve, whereas man-made technology follows the exponential growth and steady acceleration since its application. (Kurzweil, 2001)

5.5 Technological Singularity reflected in Economics

Kurzweil points out that the economy is the main drive which enables for paradigms in technology to occur. In his words, economics describes as "a world vital to both the genesis of the law of accelerating returns, and to its implications. It is due to the nature of economy to create a marketplace filled with competition, which encourages the never-ending acceleration, pushing technology progress ahead and contributing to the Law of the Acceleration return. As a response to the active Law of the Acceleration return, Singularity itself is being approached, reworking the way we understand economics. (Kurzweil, 2001)

At the first observation of the Kurzweil suggests that many economic models incorporated in economics are simply useless. As he states, any economic forecasting made by the Government agencies or (in the case of USA) Federal reserve board are in the core biased with an error as they incorporate Intuitive linear view rather than the historical exponential based view. Kurzweil argues that these models may work for the short-term period thanks to the intuitive behaviour the humans perpetuate while looking on the past events. Exponential trend within a short period of time creates an illusion of the linear expanding trend for a brief period of time, mainly in the early stages of a newly created technological paradigm, where the progress is slowly taking up the pace again even though the innovation (shift) has happened. However, once the second stage of the paradigm is incorporated and the exponential growth fully revealed, the linearity breaks down. How the technology puts its mark on the economy can we observe in the following chart depicting the U.S. GDP in constant dollars exponentially throughout this century.

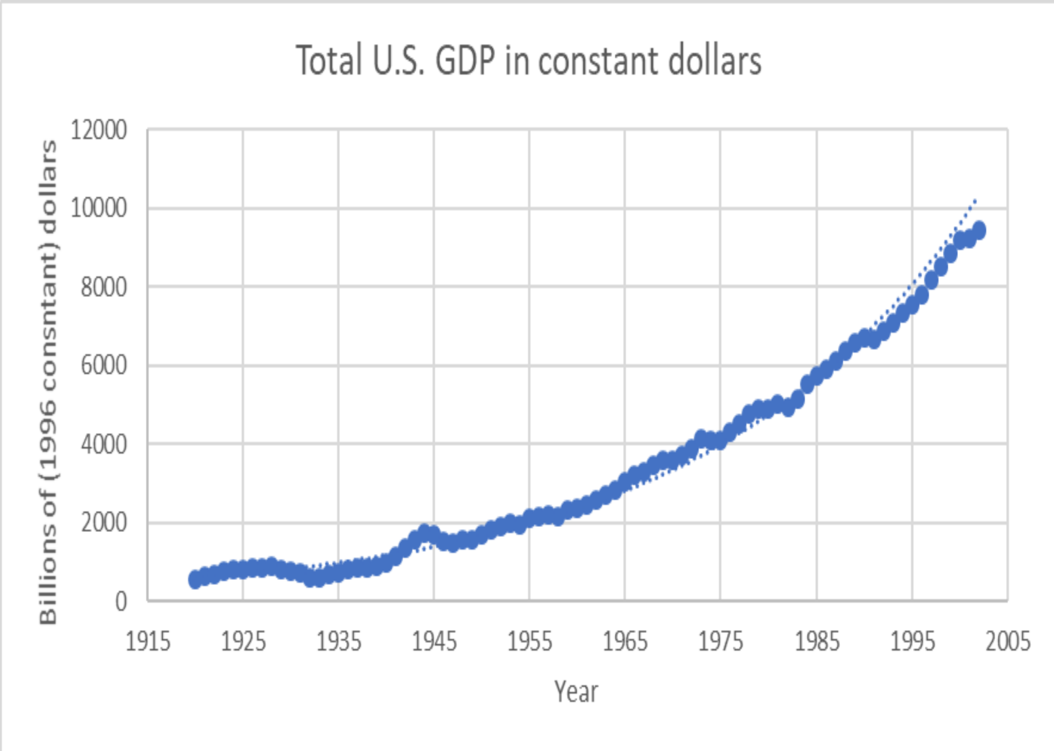

Figure 5: U.S. GDP in billions (constant dollars), source: www.bea.gov

According to the graph, we see how the alignment of nearly 100 year of GDP in constant dollars depicted every year is exponentially rising, even though the economic cycles fluctuations occur.

Another remarkable progress has been observed in the productivity (economic output per worker). However, these statistics are considered with “an open mind” as they do not fully represent the significant impact technology has on quality and features of products or services. Therefore, a computer is not views as a computer, improvement in the quality, cooling, features and life expectancy has been modified to a great extent. It doesn’t end here though. Medical equipment is more precise. Internet e-shopping has enabled simple order of goods and services without the need to step out of the house. 3D printers enable the hobbyist to produce their only manufactured items in a small amount without the need to purchase them in great numbers. These advances are not truly reflected in part of productivity statistics, even though they represent a significant variable in them. (Kurzweil, 2006)

A professor of University of Chicago, Pet Klenow, and a professor Mark Bills of University of Rochester evaluated the approximate rate of goods has been gradually increased at the pace 1.5% per year for the last 20 years due to the qualitative improvements. However, this still doesn't reflect influences that newly introduced produces have had upon the introduction. Other valuable model, showing an estimate of growth of quality conducted by The Bureau of Labour Statistics (in charge of inflation statistics), showing increase of only 0.5% per year, representing "a systematic underestimate of quality improvement and a resulting overestimate of inflation by at least 1 percent per year." (Kurzweil, 2001)

Even though the vulnerability of statistics referring to productivity, the overall increase is currently being defined by the exponential curve. Until 1994, the productivity rates grew roughly at 1.6% per year. Since then, the annual increase has been kept at the pace of 2.4%. Additionally, manufacturing productivity steady itself at 4.4% increase at annual pace from 1995 to 1999, while durables manufacturing at 6.5% per year. (Kurzweil, 2001)

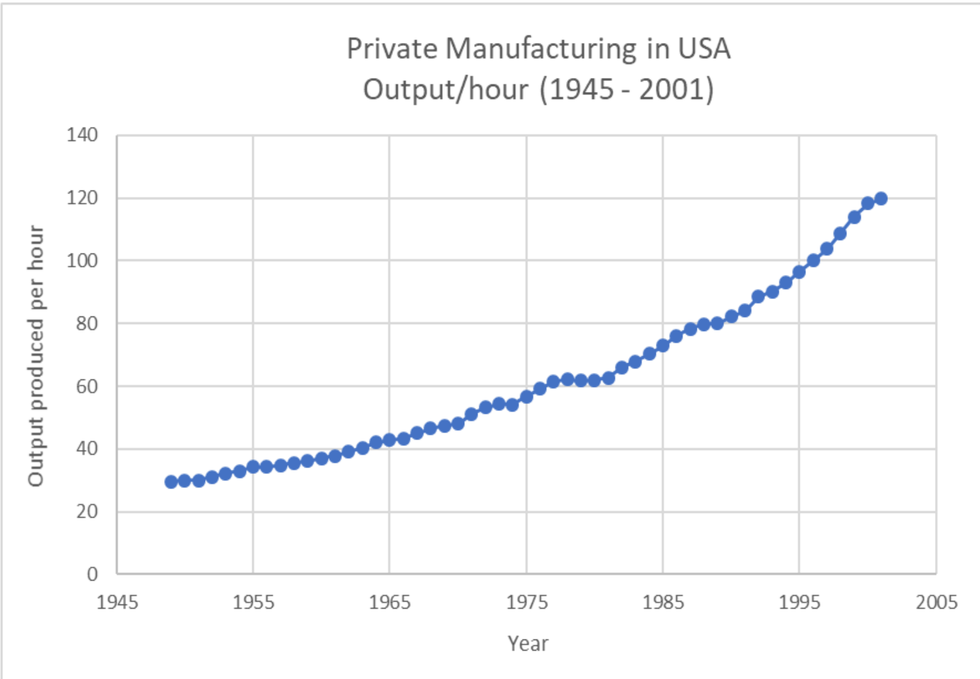

Figure 6: Private Manufacturing in USA Output/hour (1949 - 2005), source: www.singularity.com

As Kurzweil furthermore explain, the deflationary forces in USA have been really strong in the 1990s, therefore we are hardly encountering any inflation. Even due to the inflationary nature of the factors such as low unemployment, high commodity value and economic growth, they are neutralized by the double exponential growth in the performance per value ratio of the currently information: Internet, computation, bioengineering, over watched by the technical progress at global setting. Therefore, every industry is significantly being affected by the technology itself. Great disruption caused technology in the introduction of the distribution channel through the internet. (Kurzweil, 2001)

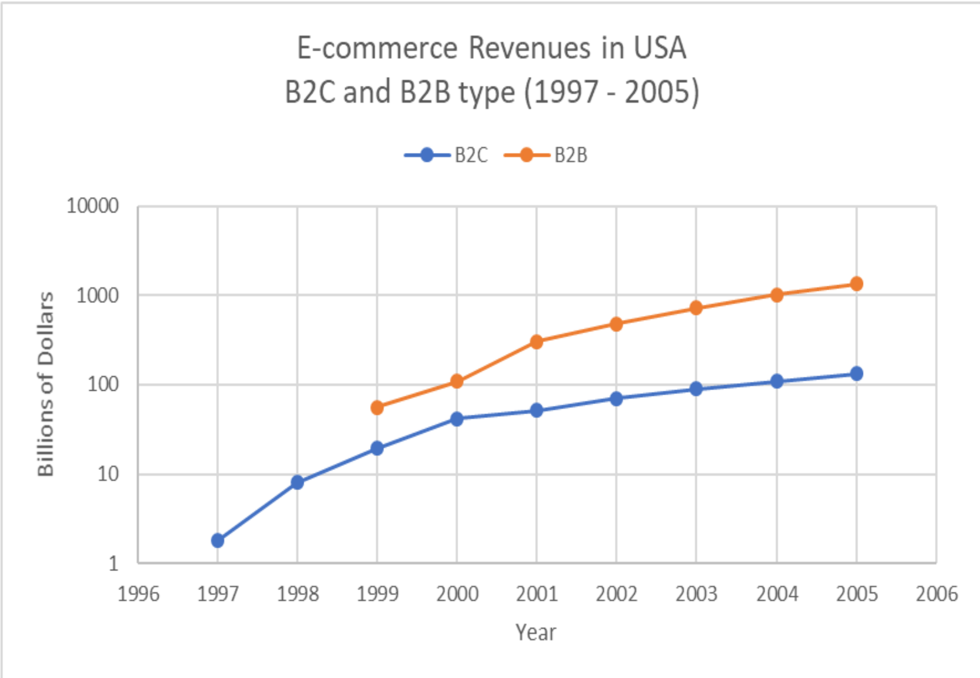

Figure 7: E-commerce revenues in USA in B2C and B2B type of business 1997 - 2005 (logarithmic function), source: www.singularity.com

In 2001, the technology trend was followed by the huge deflation. Various examples can be pointed out, such as the value for finding oil has fallen from nearly $10 to only $1 per barrel. Managing banking accounts through telecommunication cost a bank account owner a mere $1 dollar, while the Internet reduced the costs of handling the bank accounts virtually to a mere 1 penny per transaction. (Kurzweil, 2006)

Kurzweil continuously attacks the decision making on the futuristic proposing on the economic policy. He blames the researchers to use models incorporating the old-fashioned factors such as commodity prices, venture investment or energy prices which do not influence economy in exponential ways. In his words, driving factors of the economy prediction are not considered, therefore implementation of factors such as intellectual property, computing power, Internet speed and knowledge, which increasing crucial value push the economy upward the curve. (Kurzweil, 2001)

Universal basic income If such a follow-up depicted by Kurzweil would continue to exponentionally grow, will be the human labour still required? Fear of technological unemployment has been around us since great Greece Empire. In the this era, 350 B.C., Aristotle stated "[...] the servant is himself an instrument which takes precedence of all other instruments. For if every instrument could accomplish its own work, obeying or anticipating the will of others, like the statues of Daedalus, or the tripods of Hephaestus, [...] if, in like manner, the shuttle would weave and the plectrum touch the lyre without a hand to guide them, chief workmen would not want servants, nor masters slaves." (Aristotle, 350BC) The motion of technology substituting human labor, facilities laying down the workers due to the high investments in the capital has put into the question what would eventually happen with the less skilled labour. According to the research conducted by Riccardo Campa, there are four potential scenarios which may occur. (Campa, 2015)

Typology of possible future scenarios according to Riccardo Campa		Future	
		Unplanned	Planned
Extinction	Workers	Unplanned end of work scenario	Planned end of work scenario
	Robots	Unplanned end of robots scenario	Planned end of robots scenario

Figure 8: Campa's four secnarios of future development, source: Riccardo Campa

As we can see, two of these scenarios depict the end of robots, two of them the end of work. Worst case scenario provides the look on humanity forced to slavery under capitalist elite (dystopia), while the best case portrays humankind as privileged consumers of the goods and services done solely by machinery (utopia). Furthermore, Campa provides utopian in two possibilities: "a social democratic (redistribution based on social policies supported by taxation) and a socialist-capitalist (redistribution of ownership of robotic industries among citizens)." Either way, the forecast aims to the same conclusion – eliminating the need of human labour. However, unless the provided products and services will be for free, the people will still need an income to be able to secure at least the minimal standard of living. This provides the background for the Universal Basic Income (later as BSI). According to the Basic Income Earth Network, the BSI is defined as a regular income to which are liable all without fulfilling certain criteria or being employed. The BSI has following five characteristics:

- **Periodicity**: it is paid continuously, does not take the form of a grant;

- **Cash payment**: It is issued in an appropriate medium of exchange (mostly money) without any strings attached (for specific purpose, only used in certificated sellers);
- **Individuality**: it is paid per head;
- **Universality**: it is paid to everyone, without the subject's need to satisfy any criteria;
- **Unconditionality**: it is paid regardless to the employment status of the individual and its liability and willingness to work.

This solution can be a direct response to the increasing pressure substitution of labour for capital. This tool for securing a regular income without the need to work would lead to the reform of social system in many countries. (BIEN, 2017)

However, UBI is not only a concept. One of the initiative project implementing UBI started in 2017 in Finland. First 2,000 people received the month financial support in exchange for their unemployment benefits. Every suspect of the study will receive a sum of €560 (£478) every month for the following two years. This financial support is supposed to encourage the unemployed to find a partial job and improve their life conditions, whilst also encourage people who want to be self-employed or start a business have a financial background for the time they will need to overcome to get their business going. (The Guardian, 2017) In 2016, Switzerland had an opportunity to talk about minimal income, but the proposal was rejected by 77% of the voters. However, this idea has not caught up only in the developed countries (The Guardian, 2016) In India, UIB is viewed as a tool for fighting the poverty, which almost third of the population of India lives in, particularly in rural areas. A research conducted in the country showed positive attitude towards this idea. (Independent, 2017)

Thus, BSI may provide a first initial step towards the autonomously of production and the help to eliminate the need for labour as an input in the transformation process as a necessity even further.

Post-scarcity economy If the Basic Universal Income and Technological Singularity would fuse and become singular, meaning these two theories wold coexist at the same time and supplement each other, a theory of post-scarcity might result as an "offspring" of these two concepts. Post-scarcity reffers to a hypothesis, in which the final products/services are in sufficiently large amounts with the minimal or none labour input, making them cheaply to produce, or even provided for free (Sadler, 2010). Scarcity is not elmiminated, but the main needs are secured for everyone while leaving the ability to satisfy the want to a great extension. (Burnham, 2015)

Even though this concept is more of the hypothesis of the science fiction rather than real world, there are some concepts which are being implemented towards achieving such a target. One of it is GNU project, created by Richard Stallman, who drives himself to continue the project mainly due to the idea creating a post-scarcity society. The GNU project is a free-software, which was created by a massive amount of dvelopers. The aim of the software is to provide necessary freedom and control to computer users. This results in project, which are being modified continously wiuthout applying any sort of royalty payment on it, securing thus its exponential development which is vital for the Technological Singularity. (GNU, 2017)

6 Development of technological industry

In the previous chapter, we have summarized the development of the market and statistics which showed positive development of the Law of Accelerating Returns with the Technological Singularity. However, since this theory, more than 15 years have passed and the computing market has gone through transformation as well. In the following part, we will focus in this part on some of Kurzweil's predictions made on the development of computing without which we cannot keep up with the Technological Singularity prediction and thus artificial intelligence, which acts as the greatest (Kurzweil, 2001)

6.1 Survival of Moore's Law

As previously mention in the introduction to this chapter, we will firstly tackle review some of the concepts the Kurzweil provided to the core behaviour. According to the Kurzweil, the producers won't keep up with Moore's Law by the second decade of the 21st century, and eventually will die off by no later than 2019. (Kurzweil, 2001)

Up until the year 2011, Intel, as the main innovator in the regards of CPU (beside AMD) has not shown any concerts with keeping up with the More's Law. Up to this year, Intel has been able to release consequently every two years new technology generation. Looking back in 2007, Intel released 45nm microarchitecture coded Penryn, followed in 2 years by 32 nm Nehalem. Following 22nm microarchitecture was in production since Q4 2011. If we would continue in the correspondence with the Moore's Law, we should be able to obtain a new generation in years 2013, 2015 and 2017 correspondently. This prediction was disrupted by a first slowdown occurred in the 14nm microarchitecture known as Skylake, which in correspondents to the Moore's law was supposed to be released in 2013. However, this generation was still in development and released fully in Q2 2014. In 2016, a new line of processors under name Cannonlake opt to be launched in the summer of the same year to the public. This series was supposed to be the direct follow up to the successful previous state-of-the-art 6th generation Skylake series, who are running on the 14nm technology. In the early 2016, Intel reported that It will delay the production of the Cannonlake, running on a new infrastructure allowing to squeeze the components to 10nm, to the late second half of 2017. The setbacks were done due to the instability of the shrinking procedure, making many experts question if the Moore's Law started slowdown would have a greater impact on economy. Meanwhile, Intel released in Q4 2016 a bridging generation, known as Kaby Lake, which is an upgrade 14nm generation (labelled as 14nm+) and is supposed to be having last one transmission generation build on the same infrastructure, known as Coffee Lake with a date of launch confirmed in early second half of 2017 (labelled as 14nm++). This represents a delay of another year in comparison to the original concept of Moore's law. (Wccftech, 2016)

We thus know that the market is struggling in keeping with the tempo, but is Moore's Law also a variable in determining the value of the income for processors? We will therefore look on the Moore's law from financial point of view, comparing revenues of the processors whenever a new architecture is released. Since the Intel is the leading innovator in the CPU industry, it was only essential to choose the statistics of this company for evaluation of the revenues as the market response on introduction of new Intel's microchip architecture should be immediate. Reports are consisted of quarters from 2006 to 2016, therefore we have sample size of 40 revenues in constant dollars, which should provide us with necessary insight into the revenues gained solely from processor production.

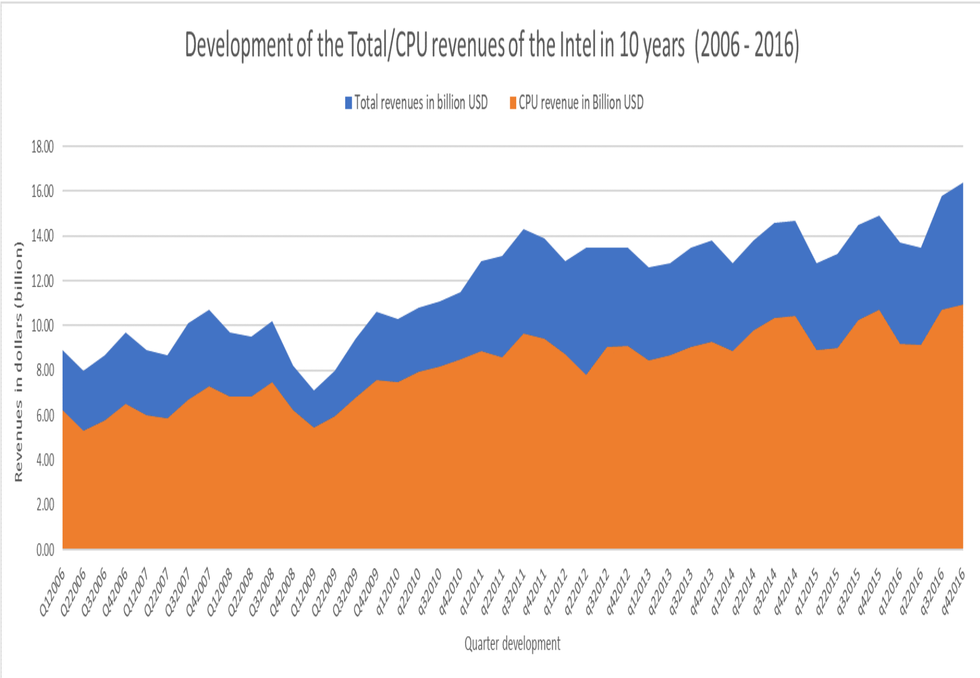

Figure 9: Development of the Total/CPU revenues of the Intel 2006 - 2016

In the simple area chart, we can observe both the total and CPU revenues the Intel has made since 2006 for the past 10 years. Looking on the CPU revenues compared to the total revenues, we can clearly say that the Intel's CPU's division is the primary source of their income, even though the gap has been increased since the 2010. This may be proved as a first hint in the importance of following of Moore's Law, as the share of the CPU on overall profit plays a significant role in Intel's profit.

If we want to look closer on the processors revenues time series, we need to point out some variables which need to be considered before the evaluation of the graph. These are:

1. **Biasness** of the research data due to the inconsistency of quarter financial reports issued by Intel

   In the research, we focused specifically on the central processing units (CPUs), regardless to its usage (mobile, PC, servers). Intel quarter reports provided clear and understandable information about the revenue of the company from microprocessors till the Q3 2011. Meaningful change occurred in Q4 2011, where the microprocessors value has been biased by the revenues from sells of chipset and motherboards, as these revenues were sum upped together without any clear identification what part of revenue correspondents to which product. This was solved by taking past 5 quarters (Q3 2011 to Q3 2010), finding the value of microprocessors compared to the overall revenue from the category they have fallen into in their category (as it was the same as the one from Q4 2011), and then calculating the percental structure of revenue gained by microprocessors on the overall revenue. This has to be done both for the processors for mobile devices and personal computers as well, meaning that for 5 quarters we will have 10 values to calculate. When found out, the percentage is averaged percentage was used to adjust the approximate revenue of microprocessors alone from now on.
   Another change occurred in Q4 2015, where the Intel returned to the similar structure from the Q3 2011 and earlier, however, this time "Processors" category was renamed to "Platform", meaning that once again the revenues were not exclusively those of the CPUs. The revenue of chipset was solved similarly as in the first case. Problem was solved similarly as in the first case, only in this case instead of 5 quarters were used 4, meaning total of 8 samples.

2. **Impact** of sudden change of macroeconomic environment

   To consider any economic influences, which might have an impact on our observation, we need to first look at any events which affected economy worldwide. Major global financial crisis started in Q4 2007, caused by the failure of the US real estate market. (The Economist, 2013) Its biggest effects have been observed in the 1st and 2nd quarter of 2009 simultaneously and in the graph by a sharp decrease in revenues by more than 10% in the Q4 2008, Q1 2009 and Q2 2009 respectively in comparison to the Q1 2015. No additional major global macroeconomic event hasn't since then occurred which might unnaturally influence revenues.

3. **Seasonality**

   It seems from an output that graph follows seasonal trends. While the Q1 and Q2 seems to be weak quarter, 3rd and 4th of every year seem to have increased performance results in all the years compared to the first half of the year. This might be caused by increased price on processors before the summer holidays

(Q2), price reductions on them during the start of the school year (Q3) and the strong sells through the second half of the year due to the special offerings, such as Black Friday, Cyber Monday; focused on the computing technology and Christmas sells, which make the consumer price insensitive (Q3 and Q4), whereas weakest point is usually identified with the deficient performance due to the massive bargains and lack of interest in products due to the high prices on market (Q1). Seasonality stands out as a variable which needs to be considered when considering the timeline series of the graph. Thus, we need to consider the seasonali-ty and recreate the graph to identify whenever there is seasonality.

We have achieved improved and better graph, which show how the development of the industry is developing in comparison to the fitted development which depicts the ideal development of the market. We can clearly see that the seasonality has been predicted correctly and it there are fluctuations during seasons. In 2009 we can see a high decline in profits due to the recession, but a steady improvement in the market till the 3rd quarter of the year 2011, from where the market returned to its more predictable pattern according to the fitted prediction.

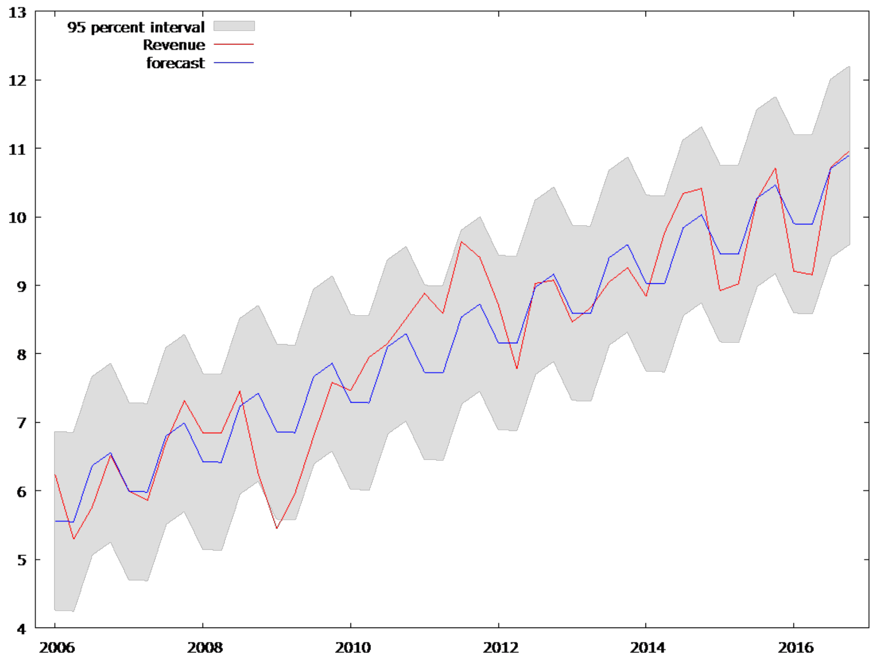

Figure 10: Development of the Intel's revenue of CPU in billions USD

For the proper comparison, we will use a simple roadmap that will tell us whenever introduction of new fabrication process, microarchitecture or even variation of microarchitecture (under codenames) lead to the influence of the microprocessor's market revenue.

Fabrication process	Microarchitecture	Codenames	Release date
65 nm	P6, NetBurst	Presler	January 2006
	Core	Merom	July 2006
45 nm		Penryn	November 2007
	Nehalem	Nehalem	November 2008
32 nm		Westmere	January 2010
	Sandy Bridge	Sandy Bridge (2nd gen)	January 2011
22 nm		Ivy Bridge (3rd gen)	April 2012
	Haswell	Haswell (4th gen)	June 2013
		Devil's Canyon	June 2014
14 nm		Broadwell (5th gen)	September 2014
	Skylake	Skylake	August 2015
		Kaby Lake	January 2017

Figure 11: Procedure of the development of Intel's processors 2006 - 2017, source: www. wikipedia.com

Looking back on the graph and starting back to Q1 2006 with introduction of 65nm process, we see that the market was quite strong for the first quartal, in which the fabrication was introduced. Following introduction of 45m Core microarchitecture in Q3 20007 caused no significant improvement on the market, behaviour rather predictable. Q3 2008 seems to be last strong month before the recession kicks in and destabilises system, therefore trying to object new microarchitecture seems to be irrelevant at this point, as it release was in late Q4 which showed first lost on revenues.

First signs of recovery are being noticed in Q3 2009, where the revenues are getting once again better. In Q1 2010 new 32nm Nehalem architecture is being released, followed by a steadily increasing market revenue. We can object that this effect might be caused on the part of the company's profit return returning to a natural progress after the regression, but the quartal is nevertheless strong compared to other Q1. This same happens with the Q1 2011, where Sandy Bridge microarchitecture is introduced – revenues are higher than those in Q4 and Q3 of previous year.

In late Q2 2013, new 22nm microarchitecture Haswell is released and brings strong Q3 revenues. Additional effect can be observed 14nm Haswell's 5th generation architecture, Broadwell, which boosted 4Q. Even introduction of Skylake brought positive impact on the revenues in the 3Q and 4Q. We can therefore say that the revenues can be influenced by the Moore's Law.

This can be further supported by the actual development of the semiconductor market in the USA. The semiconductor Industry Association (SIA) has members such as Intel, AMD or WesternWide, which deal with manufacturing, developing and researching semiconductors and technology related to it. (SIA, 2017) We have reviewed quarter reports from 2006 to 2016. We must take into account that the data is collected from the all semiconductor productions, that mean from logic (circuits), through memory, MPU (microprocessors), optical and analogic technology to MCU (microcontrollers) and sensors. (SIA, 2017)

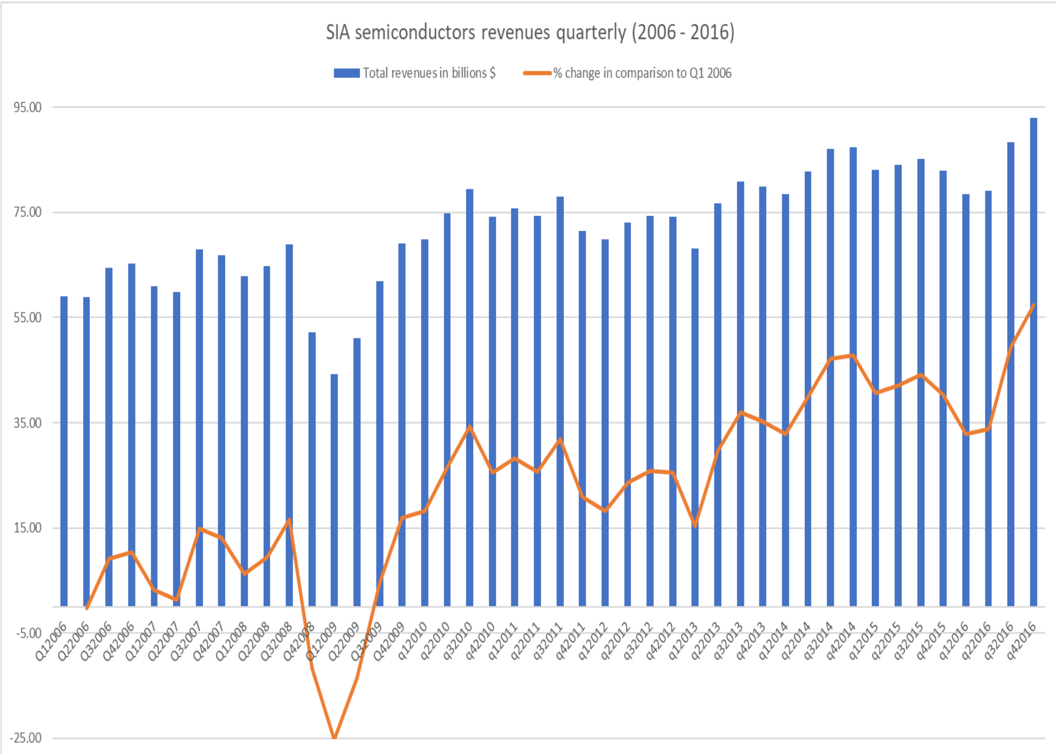

Figure 12: SIA Semiconductors revenues 2006 - 2016, source: semiconductors.org

From a graph, we can see that the development of the market is likewise the development of the Intel's CPUs sales. This prompt that the central processing development act as a great stimulus for the market, with a deeply rooted chain reaction to all the other components on the market. Although the current shift in the microprocessors trend created a reduction in the demand for the CPUs fpr personal computers, an increase in consumption of laptops, 2-in-1 hybrids and smartphones these days have filled the gap and even improved the market with microprocessor units. (SIA, 2017) Even though the reaction to the shift is rather slower from Intel as expected, it is holding strong and improving its revenues which stands for the extraordinary high profits in Q3/Q4 2016.

We can thus assume that the following of Moore's law has a positive effect as on revenues of the overall semiconductor market. Prolonging the time to transfer to next fabrication can have a negative impact not only on the revenues, but also on the stocks of the company as its credibility to keep with the standards will be questioned. Moreover, the trend from the last three years have been rather stagnating and provided no real improvement in the market, which, again, might be the effect of the less successful following of Moore's law. Even though that Intel's reports promise strong alignment to this law, we can applaud to the not so perfect, but yet still a very precise prediction made by Kurzweil, who predicted the death no further than 2019. (Kurzweil, 2009)

6.2 Computer as a brain for $1,000

According to the Kurzweil, the possibility of having a machine which is powerful as our brain at mere $1,000 could be achieved within the year 2019 (Kurzweil, 2001). First of all, if we want to talk about human intelligence being simulated or 'copied' onto a machine, we need to find the power necessary to run such intelligence – we need to find out whenever we have been able to construct a machine comparable to a human brain in regard to the hardware structure. This means we need to look up for a certain calculating unit to which we can compare both brain and computer, find a machine capable of such a performance and provide the costs necessary for simulating the calculation power of brain.

In regards with the second part of the quote, we will look closer on the computing performance of processors of the current generations, both in the mobile processing power (smartphones) and a stationary one (personal computers). We will look at their performance level, the price ratio and all the components which are necessary for a computer to work properly in order to find out whenever the $1,000 claim is justified.

CPU versus GPU: What to judge

As far we have review central processor unit (CPU) as the main input dealing with calculations in a common personal computer, but there is another periphery which is able to make calculations, and that is graphical processor unit (GPU). Graphic cards this age can operate at much higher flops than CPU. The latest generation of the graphics card from NVidia, namely GTX 1080ti, which is able to allow flow of instructions large as 11 TFLOPS (FLOPS represent amount of floating instructions per second the processor(s) can provide). A high-end processor for consumer is able to achieve around 250 GFLOPS, which is 44-times less than of the graphic processor unit. Why don't we then switch from using CPUs to GPUs, as they are more powerful and computing with them would be faster, saving time and accelerating Technological Singularity even faster? Well, it isn't that easy. Both these processor units are made with the different intention on their performance. To put it simple, CPUs are designed to process smaller amount of data on a single stream relatively easily due to the high clock speed (i7-6700k has a performance of single core worth 4,000 MHz in factory settings), while GPUs are pushing single instructions through many calculation streams, which mean they can handle much more data, but the calculation of the instruction has to be simpler due to the much slower clock speed (core speed only at 1582 MHZ at factory settings). To better visualize the concept, imagine yourself driving a car. Through your drive you observe buildings, people, sky, animals, trees and other things you have seen so many times before. While you drive, your eyes must deal with a lot of visual content, similarly as GPU. However, we interpret these stimuli rather unconsciously, making our brain less active as the things we observe repeat in certain form all over again. However, at the time you must hit a sharp turn yet unfamiliar to you, the brain starts to be more active. Question such as *'Is my car heavy enough to make the turn at this speed? How long is the turn? How sharp turn will I have to make? What are the current weather conditions?'* become important, where a small amount of information, but with high demanding 'calculations' are needed to be processed within seconds. This is where the brain increase its activity, just like the CPU would do if he needed to calculate the safe speed at which we can make the turn. That is why the CPUs are needed for calculation of complex calculation tasks, such as heavy demanding rendering and physical laws simulations, while GPU are better at recreation of graphical environment as many tasks must be handled while less information is required at same time, but more stimulants are provided. Therefore, for the demanding calculations are used exactly CPUs and thus the performance reviews will be done exclusively for them.

Processing value of a brain

At the beginning, we need to define the brain's power in the similar computing measurement methods which are used in today's computers for the calculation of their performance. First notable research comes as early as from the 6. August 1989. In the paper, *Energy Limits to the Computation Power of the Human Brain*, conducted by Ralph C. Merkle.

Merkle looked on the synapse operations per second, while acknowledging the limitation factor of them – the propagation of the signal. As the gates becomes faster, smaller and cheaper to create, the ability to transfer signals between two spots will be provided difficult. Brain would be dysfunctional, as the nerve shock would be able to carry information from one synapse to another one. Moreover, measurable amount of energy is needed to create an impulse that a brain requires for information transportation (Ralph C. Merkle, 1989).

Merkle suggested three possible ways of attaining this problem. First scenario suggests counting number of synapses based on the given speed of their operation with intention to evaluate synapse operations per second. As he suggested, brain has almost 10^{15} synapses, which able to operate at approximated 10 impulses per second provides roughly 10^{16} synapse operations per second.

A second approach is based on the evaluation of the computational power of eye's retina, which shall be multiplied by the ratio of year to brain to gain estimated value. Merkle states that output of the retina is driven mainly from retinal ganglion cells, that undertake centre surround computations, which are similar computation process to those of the computer. Based on the prediction that this centre absorb input of 100 analog adds at a speed of 100 times/second and having 1,000,000 axons in optic nerve, retina is able to compute at 10^{10} adds/second. As the brain is bigger hundred to ten thousand times as retina, Merkle concluded that the brain's activity can be measured at 10^{12} to 10^{14} operations per second.

Last approach is showing the level of energy used by brain each second and evaluating the average usage of the energy for a single process operation. As the average amount of usefully spent energy spent around 10 watts, we assume that the protentional computation power. Thus, according to the Merkle, brain can perform at a raw computational power between 10^{13} and 10^{16} operations per second.

At the 1989 Merkle couldn't even imagine such a performance in computers, as the most powerful supercomputer Cray Y-MP was able to only undertake a peak performance of $2.667*10^9$ (GFLOPS), which was significantly lower than of the human brain according to the Merkle's research (Ralph C. Merkle, 1989).

In 2008, a more precise research came from the IMB. In the report, which suggest that human brain is constructed on average by outstanding 22 billion neurons and 220 trillion synapse, researchers conclude that a computer with a 38.6 PFLOPS and a memory capacity of 3.2 petabytes would be necessary to simulate physical environment similar to the of the brain. (Hplusmagazine, 2009)

Supercomputers performance

Previously mentioned research has created a standard according to which the computing power of the brain has been accessed through years. However, even at that time of the research the most powerful supercomputer IBM Blue Gene could computer at mere $478.2 * 10^{12}$ (478.2 TFLOPS) did not get even close to the performance of brain. To compare it perceptually, only 0.013% of the brain was IBM Blu Gene capable of simulating. It took additional 5 years to get really close to the performance with supercomputer Tianhe-2, capable of $33.86 *10^{15}$ (33.86 PFLOPS), capable of handling 92% of human brain. This performance was in 2016 overtaken by the Chinese supercomputer *Sunway TaihuLight*, capable of performing at astonishing $93*10^{15}$ (93 PFLOPS). We have created a supercomputer which can compare with at least two brain in raw computing power. However, this is only one of the two prerequisites of brain simulation, memory needs to be considered as well. The memory size of brain is around 3.2 Petabytes, while Sunway TaihuLight only possesses 1.31 Petabyte of memory. (Top500, 2016)

Now, as we know that there is a supercomputer with the floating power necessary to simulate the processing power of brain (disregarding the memory variable in our case), we will look whenever the price of the computing per single TFLOP through years has increased. Prices will be adjusted to the inflation of the January 2017, to see how well the power output of has in TFLOP has increased regarding the price.

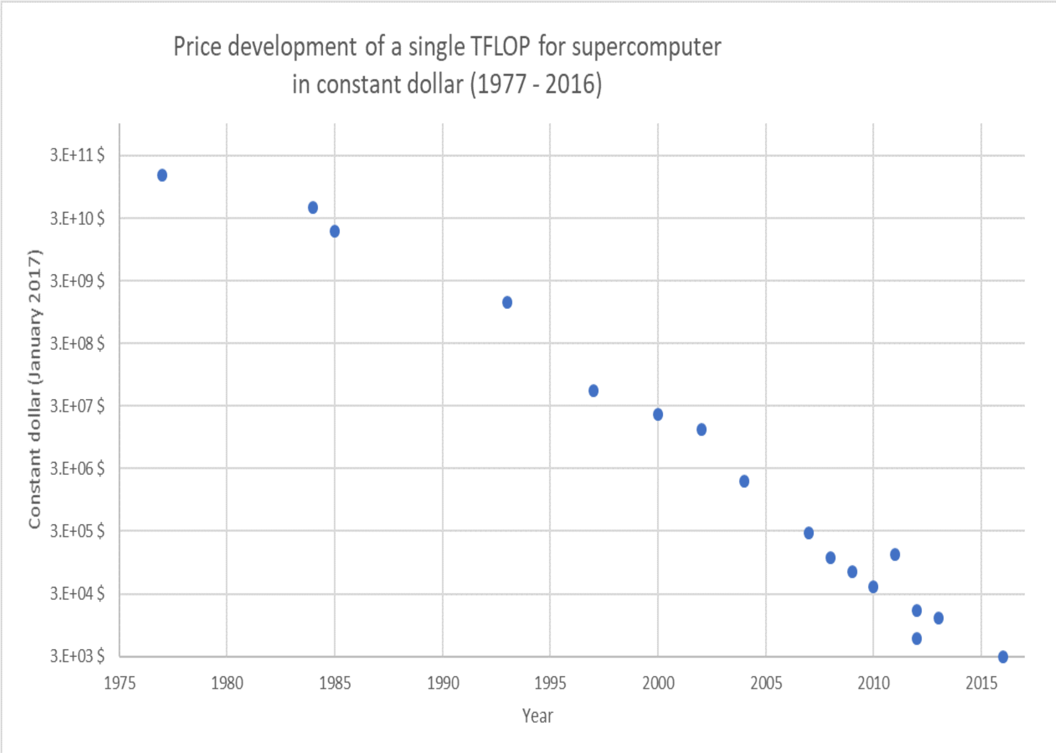

Figure 13: Price development of a single TFLOP for supercomputer in constant dollar (1977 - 2016)

As we can see, there is a significant improvement through the decades in the computing power. We have been able to reduce the price of the one TFLOP production down from millions to not much more than a few thousand dollars, an that only within 15 years. Even though this research showed us the price for the teraflop in the machines through last 50 years, it fails to point one crucial point – it doesn't consider the space machine takes up to be operable.

Let's look at it from this point. Even thought that we know the price to run one teraflop, have we actually received a significant increase in performance on a given area? The most suitable unit for this calculation would be cubic meter, but no data is offered in this matter. Viable way of attending the problem would be to consider output per cabinet, but the cabinets greatly differs in size. Thus, the best solution would be to find out the number of cabinets and multiple this number by an actual size of one cabinet. However, information sources do not include again the size of the cabinets. To at least approach to some results, we will use square metres, which will give us approximate number of petaflops on $1m^2$. We will assume that the most powerful computer shall possess best performance per 1m^2, as it is of the latest generation and implementing the better design solutions.

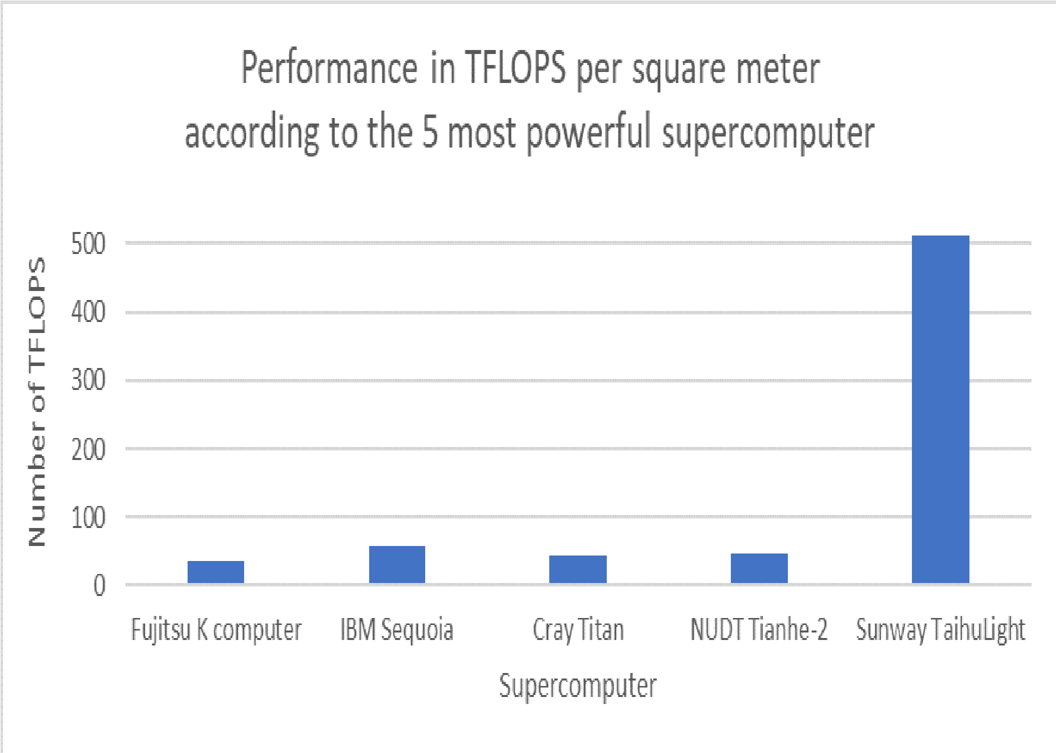

Figure 14: Performance in TFLOPS per square meter according to the 5 most powerful supercomputers

The prediction was fulfilled as we gradually created a better performance on 1 m^2. At Lianghul Sunway, the 1 m^2 can create output of 511 TFLOPS. Comparing it to the previous supercomputers, the increase is enormous (compared to Tiahne-2 more than 1088% increase in efficiency) and it provides an example which shall be followed. But, does it mean that the computer is at the same time the most efficient? We can find this out by taking the price of 1 TFLOP and multiplying it by a constant we decided, in our case, 500 TFLOPS. Way we gain following output for the latest 5 most powerful supercomputers.

Not only is the Lianghul Sunway supercomputer the most powerful, yet it provides the lowest investments for a given set of required performances. If we want to recreate the performance of the brain using Lianghul Sunway, we would need at least 72m^2 (considering the same size of a single cabinet), which would cost us totally $116,142,467.09. Given result unluckily doesn't even get closely to the predicted mark of $1,000. This seems to be way away from the prediction Kurzweil has provided and this far we only got to the performance of the supercomputers, which a mere consumer cannot store, yet not afford. Moreover, we have just dealt with the

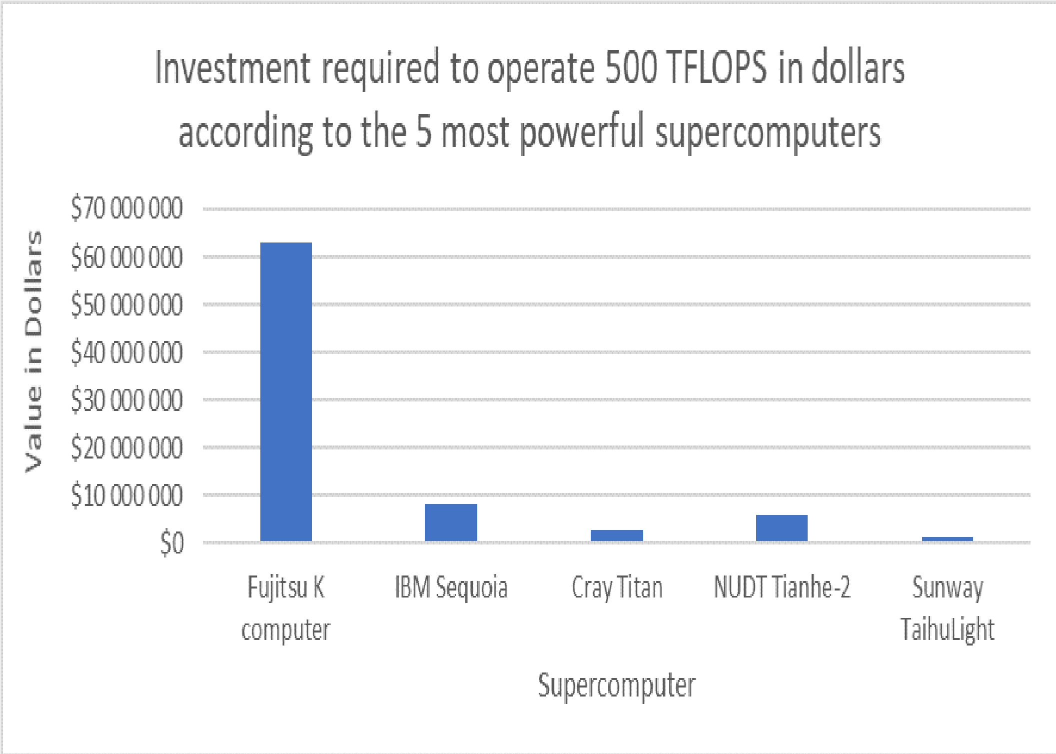

Figure 15: Investment required to operate 500 TFLOPS in dollars according to the 5 most powerful supercomputers

price of the raw computing calculation power. If we wanted to be more relevant, we would also adjust the energy needed to run one single TFLOP, consider the price of other peripheries (memory, mainboard, chipset) and the value of performance of workers. As far as these variables were not included in the prediction Kurzweil has made, we didn't include them in the calculation as well.

In 2013, a research has been carried out on the Fujitsu K (10,510 TFLOPS) to try to simulate the brain activity. They have been able to simulate brain's activity equivalent to one second within 40 minutes of the realtime running of the supercomputer at its 80% capacity load. (Telegraph, 2014)

$1,000 personal computer benchmark

We have found out that is out of the question to ask whenever there is such a possibility of owning a $1,000 computer capable of simulating brain in raw performance, but it is significant for us to find out where does the performance of a single high-end consumer CPU stands at the price of a $1,000 personal computer.

For the calculation, we will look at the processors of the current generation and find their FLOPs performance. There are available two methods for calculation: Whetstone and Linpack. While Whetstone is based solely on performance of CPU, Linpack implements random accessible memory to provide more relevant information. This method has been used for the performance review of supercomputers as well, thus it is only logical to exploit this method to better compare the results between high-end consumer computer and supercomputer.

The test subject will be personal computer which I have bought early in Q4 2016. Following are the specifics of CPU and memory, which are required for the test. The prices were average to the current biggest resellers found on the webpage pcpartpicker.com to the date 10 May 2017.

We assume that the clock speed of both components is in factory settings, meaning no overclocking has been done either for memory or processor. CPU was brought in mind of getting maximum performance to the price from the latest generation of CPUs. There were, for sure, better options in regard of the performance in that time, but the real performance per dollar was most liable at that time for the processor i7-6700k of Intel CPUs according to the benchmarking website PassMark. (PassMark, 2017)

Name of the product	Original clock speed	Avg. price 10 May 2017
Intel i7-6700k	4000 MHZ	$320,86
G.skill Ripjaws F4-3200C14D-16GVK	2133 MHZ	$175

Figure 16: Price and performance of CPU and Memory used for benchmarking

We have chosen for the calculation software called LinX 0.7.0, which is based on the Linpack benchmarking profile developed by Intel, but offers graphical environment for easier use. In order to gain most from the CPU's performance as well to utilized most of the memory accessibility, we had to clear out processes from the computer to increase the maximum available memory capacity. This gave us at the end total available free memory at maximum potential of 14 GB. Thus, we have set up process to calculate the FLOPS for the computer and found out those data which dealt with the information flow of the sample size 42728. We have conducted 5 benchmarks with same settings.

We have found that the computer has been able to provide performance at level of 102 GFLOPS/s at average based on the 5 calculation benchmarks. Compared to the brain, it provides roughly 0,000028% necessary performance ratio. This performance was achieved by the components worth almost $500, which is roughly half of the price the Kurzweil predicted. However, these components cannot operate alone. To run the components alone we need additional peripheries, mainly mainboard (motherboard), power supply, cooling system and one input periphery (keyboard) and output (monitor). If we decide to buy the cheapest components which are compatible with the given CPU and memory, we can add to the amount additional $350

Linpack reading	FLOPS (GFLOPS)
1.	102,3008
2.	102,3483
3.	101,9784
4.	102,0048
5.	101,9867

Figure 17: Benchmark of CPU i7-6700k using Linpack method

- $400, which sum to cca $850 - $900. The set-up I currently own has cost more than $1,200. Where does the Kurzweil's idea stand on? We have been able to achieve a computer which is able to recreate the instructions per cycle as the brain, however, it still lacks on the operating memory. Inaccurate prediction was therefore made on the ability to produce a machine worth $1,000 which would be capable compete with brain in raw computing power. Even though that we are looking on the brain from a raw "physical" computing power, we won't be able to have such a machine at home any time sooner for sure.

6.3 Core speed and multi-cores performance

We will look on one more computing variable, and that is core speed of the microprocessor. This measurement is provided in Hertz and represents the amount of cycles the processor can make at most. Every instruction requires different amount of cycles to be solved. The higher the number of clock speed, the more cycles can be done, thus the more operations (theoretically) can be solved. We have looked on the 78 computing CPUs over last 25 years from Intel and from each microarchitecture we have chosen the processors units with the highest Hertz performance.

From the output, we can see that till the 2000 there was a relatively slow increase in the performance of clock speed. Since than the performance improvement has taken on, but we can observe first slowdown since the 2010. We can see how the performance has been relatively steadily increasing till the year 2008, where it slowed down and become more linear. We can see that even before 2005 there have been extreme values for processors of top class, which reached the clock speed around 3,500 – 3,800 MHz, which are speeds commonly used in today's commercial computers, which can be observed from the values in 2015.

The inability to increase the Hertz is being compensated by increasing the number of cores within one CPU. This has been done since the early 2006. where the processor name Duo from Intel has been implemented on the market. However, this

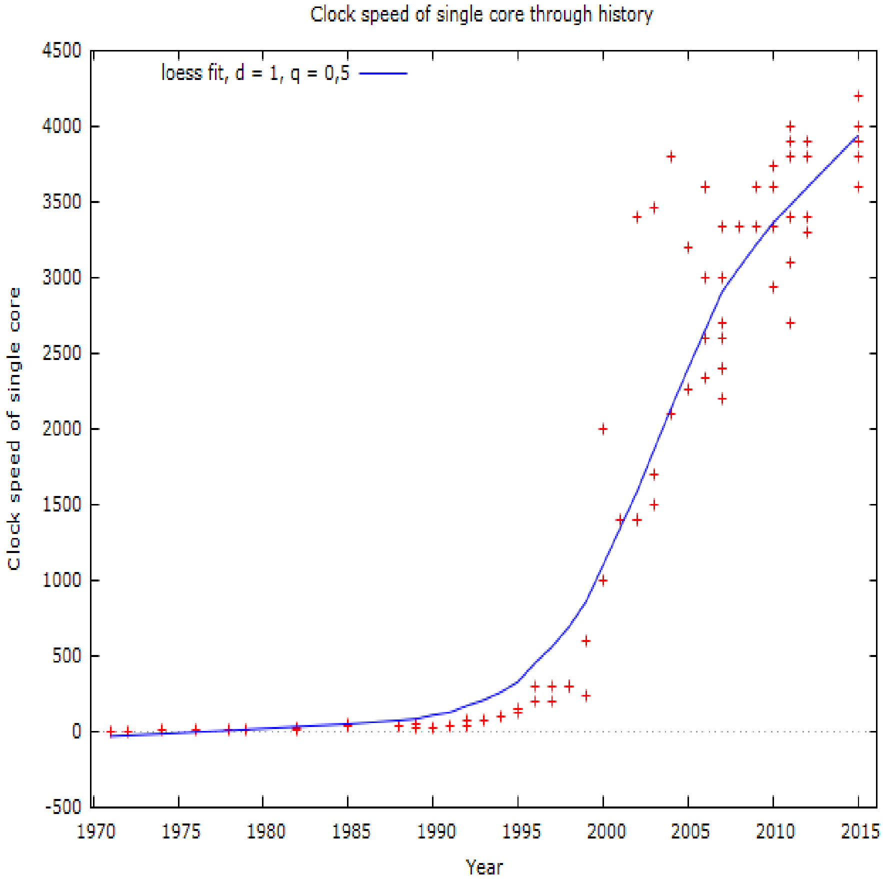

Figure 18: Clock speed of a single core 1970 – 2015

did not solve the problem ideally. Even though it increased power, it forced the software developers to make more complicated programmes which require to utilize more than just one core. If they wouldn't do it, the progress would be halted and the software would stay relative slow, squeezing huge amount of performance only on a single core, overheating it and causing malfunction.

This can be supported by benchmark created by the Gordon Mah Ung, executive editor at PCWorld, who compared the different amount of processor utilization in the gaming industry for the DirectX 12 API platform (Application communication interface; its purpose is to improve the communication of CPU and GPU whenever CPU needs to assign tasks to GPU). (PCWorld, 2016)

Compared have been 9 types of processors commonly found on the consumer market on two games, which were released at the first half of 2016. We assume that every additional core added shall provide more performance.

The first benchmark of a game Gears of War (reboot), launched March 2016, was a re-release of the original game Gears of War from 2006. The benchmarking showed very unpleasant results in the core scaling. The turning point for the game

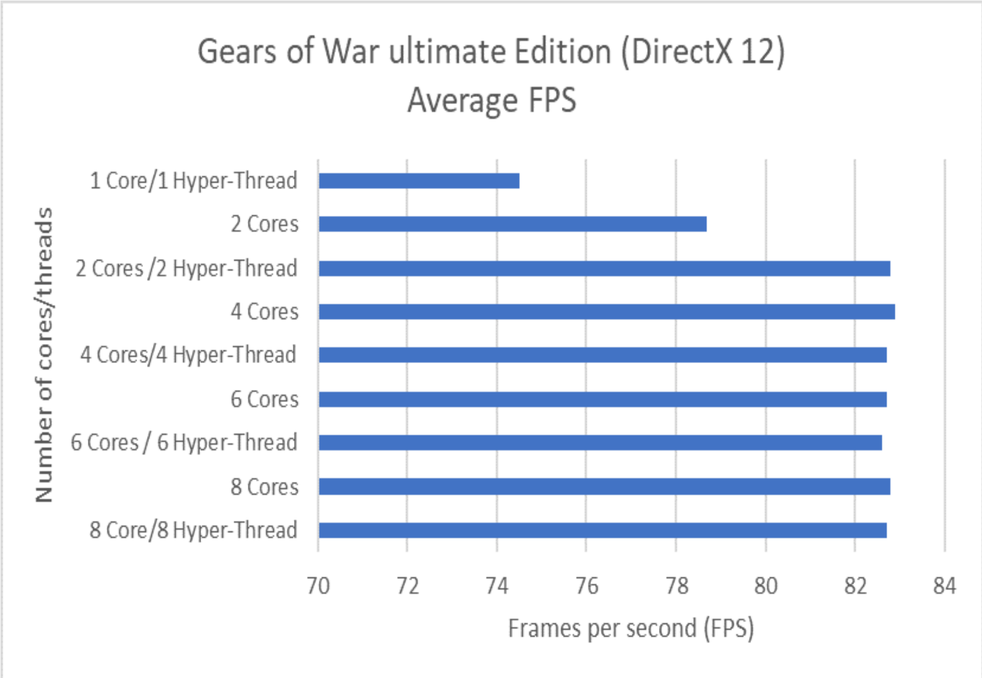

Figure 19: Benchmark of Gears of War Ultimate Edition (DirectX 12), source: PCWorld

are 2 cores with 2 additional threads from which more cores seems to have no effect, or perform even slightly worse (within margin of error). This may be caused by the omitted optimization of the game for more than two cores, as the 4 cores were a processor rarity back in the 2006 and thus only optimization back in those days were made mostly for duo-cores. However, in 2016 standards the game should have had drawn better performance at least on the 4 cores with 4 additional threads, as it was a current standard on the market. The game developers failed to deliver this improvement.

Second benchmarked game, Ashes of Singularity, original new game released in March 2016, was highly regarded as a well-optimised real-time strategy, implementing the latest DirectX 12 potential. From the benchmarks, we can see that the game draws the performance from cores much better, rising almost linearly in performance with each other following processor structure, where the best possible outcome is from the 8 cores CPUs. However, while comparing the 4 cores and 8 cores, the performance increase is only around 40%, in comparison to 6 cores less than 30%. Even though the scaling is visible, it is not significant for the regular consumer to invest much more for the performance not living up to the predictions. And to hit the nail even further, Ashes of Singularity was regarded as one of the 2(!) most optimized games on the market that year from triple A titles, with the second title being Doom.

Our assumption wasn't therefore fulfilled. The performance increase is greatly

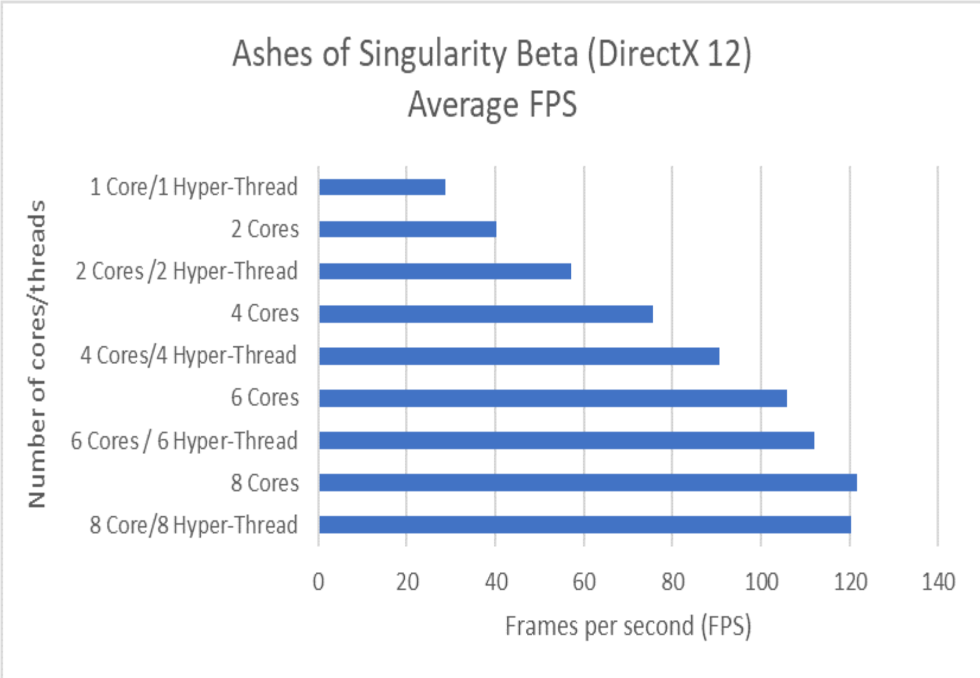

Figure 20: Benchmark of Ashes of Singularity Beta (DirectX 12), source: PCWorld

reduced after the 6 cores/6 threads, in some cases the performance even decrease, even though this might be within the error margin. This only show how complicated and time demanding must be the optimization of the software for more cores, which are becoming a standard in the marketing development (6 cores). This might prove to be a crucial problem as the more skilled programmers will be needed to write software to utilize the CPUs better, increasing the demand and improve average wage on the market even further. However, show how the ineffective is writing for multiple cores for the software and supports the Kurzweil's prediction where the increase in number of cores will not provide a real performance increase, but rather make more difficult to create a well optimized software.

6.4 Artificial intelligence development

We have got crossed some points in the previous chapter which might prove to be a major slowdown in the development of the technology necessary to continuously support the Law or Accelerating returns. We have found out that the development is now stabilized, even though serious problems are facing the development of the CPUs if the transmission from one paradigm to another won't be made within next 2 decades.

We assume that the development of microprocessor creates chain reaction and support the development of other markets, either in the investment or the revenue performance. In 2013, in research paper conducted by Analysis Group Inc. (founded by Facebook Inc.), where the research was focused on the most advancing technologies and the impact they make on the economy. According to the research conducted, the development and implementation of AI as a result shall bring the pessimistic \$359.6 billion impact to optimistic \$773,3 billion economic impact over the following 10 years. This estimation was aligned solely to private industry and venture capital investment at the portion of economy, thus the total generated impact may be much wider. (Analysis Group, Inc., 2017)

But is there really a reason to deal with AI as the lack of computing power, problems with the improvement and the stagnation of Moore's Law may provide difficult to overcome? The answer is yes, there is. Thanks to the Machine Learning, which takes on the concept of the neural system of the human body, has shown some significant contribution to the market these days. Even though that Machine Learning heavily demands on the skills of programmers, once released to operation, it starts to learn on its own and improve by the information it receives every day. In 2011, Watson, and AI created by IBM, based on the Machine Learning principle, took part in the quiz show *Jeopardy!*, where it competed with former winners of this came and won. (Guardian, 2011) This project was in 2013 announced as a platform for the commercial use. Since then, various firms have taken the advantage and implemented in their products. *Bon Appétit*, magazine focused on cooking, used Watson to create a recipe generating platform. (IBM, 2016) Music application MusicGeek, developed by company *Decibel*, is using Watson to offer music recommendations to its users. (PR Newswire, 2015) Chain of hotels, *GoMoment*, implements this AI in its Rev1 application, which provides a hotel staff an ability to quickly respond to questions from guests. (HotelOnline, 2015) Recent achievement of Watson was seen in the Japanese insurance company *Fukoku Mutual Life Insurance* in January 2017. In the response to the application of this system, company has laid off 34 employees. The company claims that the system will improve productivity by 30% a see a return on investment within two years. Maintaining the system shall cost £100,000 per year, but the savings are estimated on 140 000 000yen within first and 200 000 000yens, which are to the cost of running such a system neglectable (Guardian, 2017). There are already several results on the market thanks to the Ai implementation and investment, bringing economic results. We will look on a few of them and see their impact.

E-commece

Another great example of the implementation of the AI is for sure in marketing, especially in the way of attaining to the customer's demands and solving the problems with Amazon's AI voice-assisted Alexa was developed for the product *Amazon Echo*. This function similar as the voice assistants used in the smartphones, such as Window's Cortana or Iphone's Siri. However, Amazon Echo is focused more on the e-commerce, suggesting user the products and even creating orders directed only by voice from the Amazon solely. This concept is similar to cookies, where the web browser downloads information from the webpages you attend and then provide you with targeted advertisement. Disadvantages of cookie files lay in their temporarily – they can be deleted and thus a web browser lose the power to target you with better adjusted advertisement, unlike to Amazon's Echo, where the information received are gradually processed and stored perpetually. (Independent, 2016)

Another e-commerce example of utilization AI has been found in the furniture industry. Lack of connection between retailers and consumers was spotted by Kavita Bala and Sean Bell from Cornell University. Their goal is to "bridge the gap between inspiration and purchase, and make it easier to find and buy interesting things that you find online or in the world." This claim is based on the research that even millions of photos of products are located online, however, many times the connection to the supplier has been lost or the access route denied. Therefore, AI has been implied to match the pictures and make the best correlation with the seeking object. This concept can be exploited also in art or clothes industry. (NVidia, 2017)

Marxent is one of the successful companies, which has transported e-commerce into the visual commerce. The company has created multiple platforms, where the main feature is to take advantage of AV and VR technologies for the advertising purposes. Harley-Davidson Augmented Reality App lets the customer modify their bike and see it in a real life thanks to the augmented reality. This way customer can grasp the model even more and deepen the customer service experience with the company. Another example using Augmented reality was built for TimberTech, which uses company's catalogue of decking, railing, lightning products and place them through augmented reality in real time on the position to show if the product would suit the demands of the customer when installed. Similar concept is used also in virtual reality, where the customer is emerged in a virtual room and a full access to the tools to modify the room to its prospects. (MarxentLabs, 2017)

Customer service

A lot of emphasize is put on the AI when dealing with a customer. Lots of companies have observed switch from the telecommunication support to the written form, and that's where the implication of AI comes in play. *DigitalGenius*, company, which has raised more than $4,1 million (The PeHub, 2016), is offering AI which enables to reply customer instead of the employee based on the predefine experience of answering a similar question before. The AI verifies the message on several layers, provide defined answer with a percentage showing the reliability of the answer. If the answer has a percentage beyond the threshold which the company set up, the answer is send to the employee for correction and modification. This just provides additional input to the machine, enabling it to learn from experience and improve its next answers. Although no report has been given about a company using this system, DigitalGenius has a calculator, according to which you can find out return of investment (ROI) by simple by putting the number of employees and the price for the overhead payment as variables. The company claims that the average ROI is more than 50%. (DigitalGenius, 2017)

Transportation industry

Concepts of self-driving vehicles goes back to the 20th year of 19ties, where the vehicle known as “Phantom car” was operated through radio signals, just like a miniature model of a racing card controlled by a remote. Concept of solving autonomous concept for cars varied through years. According to the Business Insider, there are at least 19 important car producers, such as Bosch, Tesla, Google, Ford etc., who have tackled this subject and most of them want to bring autonomous cars by the 2020. (Business Insider, 2017). States in US have already started working on the legislation enabling the autonomous cars to define autonomous cars and the laws they must obey in order to be functional. Five states have already passed, while 15 others are under consideration. These laws not just define the autonomous driving, but regulates it and implies bills for the use, which act as a backlash and slowdown for development. *Uber*, a company famous for the actions driven by taxi services to shut it down, has already shown its movement in the commercial purpose. Its self-driving cars are fully functional in Arizona, which have been moved away from California due to the high regulation. The autonomous cars are already taking people and transporting. (The Verge, 2017)

Insurance industry

In 2016 was created a start-up going under name *Lemon*, raising at all $60 million, which brings innovative attitude towards the insurance market. Lemonade make money by keeping 1/5 of customer’s premium, puts 2/5 goes for buying reinsurance from insurance giants such as Lloyd’s of London to cover any claims over the premium coverage. Remaining part of premium is going to the charity chosen by the customer at the end of the year. This might sound like an original concept of an insurance company trying to improve the thrust factor, but it isn’t so. What is new is the way of attending towards the customers, and that is exclusively only through application. This application is using chatbots connected to AI, which elaborately chat with you to analyse, create and offer insurance according to the information they have received within few minutes from you. If any insurance event happens, you can claim your money once again through app. This concept eliminates bureaucratic processes, which cost time and additional money, increase the amount of premium a client must pay. (The Guardian, 2017)

6.5 Recommendations to the firms

In the previous section, we have reviewed some of the markets, which have already started using artificial intelligence in their companies with nothing less but success. In this part, we will shortly get through some recommendation on the market, which companies shall consider implementing in their business plan to improve their prospects on the market due to the technological progress not only in raw computing, but also on the intelligence level.

First of all, the closest, cheapest and most visible effects seem to have augmented reality and virtual reality as a marketing tool to improve the company's name and improve the loyalty of its customers. As the mobile phone market constantly sells more and more devices, and their overall average performance increase due to the constant technological improvement, the new way of advertising the products through specific apps seems to be a solution worth to invest into. Not only it provides portfolio in which customer are more likely to buy the company's products, but at the same time it keeps the customer in closer contact with the customer. Disadvantage of these services may be in the way that the customer may think that the company may access to the sensitive information and might be annoying, therefore, I would advise to think about the application rather as a marketing tool getting your brand across rather as a platform where the purchases can be done. Moreover, I would recommend focussing on augmented reality. Augmented reality is not hardware demanding and thus can be operable on much wider spectrum of devices. Unlike to virtual reality, which is dependent on the high-performance computer and limits movability (such as Oculus Rift and HTC), products using augmented reality like HoloLens from Microsoft are wire-less googles without which can operate on their own. This provides much more freedom in creativity. Supporting this point of view is the increase in the investment Augmented reality in 2016, which reached $1.07 billion in venture, over 4 times more than in the 2015 and at the same time $350 million more than VR technology (UploadVR, 2017). Finally, the application should be for free to download, consumer shouldn't pay for a more interactive advertising.

In the business dealing with a lot of data and heavily implying on the outcome of the research data, based on the statistics such as financing, stocks and insuring, can greatly benefit from machine learning. By enabling into the systems artificial intelligence, which can read from the past developments of the prices, inflation, markets development, creating better forecast to future than humans. This can lead to decrease of risk on the markets, reducing the price for the product and helping the market to better predict the upcoming events, which can be even suggested by the artificial intelligence in a way of which stocks to buy/sell and significantly adjust the price for premium to each customer.

7 Conclusion

We have found that the following of this law is being slowed by the increasing difficulty to produce a new manufacturing process, which cause a chain reaction in other parts of semiconductor market, aligned to the development of the processors. Thus, there are two possible outcomes for the further development of this law as the silicon material is no longer sufficient for the production due to its limitations. First one offers the continuation of the Moore's law after the 2025, when a substitution in the materials will be made and thus prolong the Moore's law. Second scenario provides an overall paradigm shift to a new production method, such as quantum computing methodology or optic 3D computing. Through the research conducted I would incline towards the first possibility, as up to these days the alternative technological methods are far too expensive to produce, they lack in consistency and need a lot of space to operate. Therefore, we can say that the longer it will take the paradigm shift to occur, the more the Technological Singularity will suffer as the paradigm shift will be required for it to ascend towards a greater performance, even though it might cause a minor set-back during the shift. This may be supported by our research in empirical manner which has stated that we are yet unable to produce a personal computer similar to brain at the current technology and the cheapest option costs more than $116 million. Linpack showed that the ordinary consumer CPUs are just too slow and the halt in the increase of core speed compensated by the increased number of cores just results in the more time and budget demanding software writing.

Thus, we get to the validity of the theory. The development of the Law of Accelerating returns performs worse than it was suggested by Kurzweil, and the achievement of Artificial Intelligence might take another two decades than eventually predicted from the initial 2035 year prediction, as the common affordable computing machine with the ability to simulate brain performance are nearby to perfection. This therefore compromises the development of the artificial intelligence to its maximum potential, though we have successfully shown examples of the machine learning. Kurzweil's predictions seemed to be rather utopian than optimistic, and resulted in claims which conditions we are not able to fulfil yet.

Suggestion for the further study of this theory would be in the development of machine learning, by consideration price investment, time needed to write and the complexity of learning progress in comparison with the market implementation results should be reviewed to see how promptly we are able to develop such a system and the response on the market which this system will provide. Another prospective should be in calculation of a particularly selected product's price before and after the implementation of artificial intelligence and robotics.

To conclude it all, we can hereby proclaim that the Kurzweil's prediction on development of the markets were too optimistic and the exponential growth is being greatly influenced by the transmission to the next paradigm shift in computing. Technological Singularity will be achieved, but much later than anticipated.

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