

NANOTECHNOLOGY – CHALLENGES AND PERSPECTIVES WORLDWIDE

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Abstract

In our paper “Nanotechnology – Challenges and Perspectives Worldwide” the intention is to present the importance of the nanotechnology and its increasing role in the cyberworld. Our study starts with presenting very convincing data that takes into account the launch of the iPhone and increasing use of smartphones that are causing a big shake-up in the mobile phone market. That is why the iPad and tablet PC are expected to have a similar effect on the PC market.

Then, the study focuses on similar trends in the market for tablet PCs. Although tablet PCs have been around on the market for longer, they have so far been considered a niche product designed primarily for business clients.

At the end of our paper, we present the fact that the mass-production of nano-enabled products is currently taking off, due to superior life quality and sustainable characteristics like resource savings and as a result, the annual sales of nano-enabled products are likely to triple by 2015. The paper also stresses which is the great common denominator for young people living in developed or very developed countries, meaning the aspects of the cyberworld such as SMS and Facebook, email and smartphones. The context of sustainable development is the key issue in our society.

Key words: nanotechnology, cyberworld, business sustainability, sustainable development, competitiveness

JEL Classification: F1, I15, O

1. INTRODUCTION

Nowadays, the smartphones and the tablet PCs are “shaking up” the IT Sector. Specialists believe that the launch of the iPhone and the increasing use of smartphones are causing a big change in the mobile phone market. The iPad and tablet PC are expected to have a similar effect on the PC market. It is well known that the trend is being fueled by the growing convergence between the world of the PC and the world of the cell phone, as well as the growing importance of an attractive operating system for mobile internet.

According to all this important matters, **the paper covers the subject of nanotechnology** as an important part of the cyber world, which is today **dominated by giants such as Hewlett Packard, Research in Motion, and Samsung.**

The **studied matter is of extreme importance** because right now, **there is no end in sight for the boom in the smartphone market**, as recent figures state. Industry estimates say more than 400 million smartphones were sold worldwide in 2010, representing an increase of nearly 50 percent on the previous year. Due to this fact, the industry **expects a gradual saturation of the market in developed countries by 2013 to 2015 at the earliest**, when market penetration is likely to have reached 70 percent of all households (which is currently only 17 percent). A similar trend is predicted in the market for tablet PCs.

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In order **to prove the extreme importance of the nanotechnology and its growing role** these days, our intention is **to present the latest studies that were made in the IT Sector** by well-known specialists and representative parties. We are also presenting numerous graphics and tables in order to show the latest trends in the matter of nanotechnology.

The existing specialized literature is extremely important for the subject that we intent to present in our paper and **the general believe is that the IT Sector is in a permanent motion and in a strong developing process** that might never reach its terminal point as long as it takes into **account the importance of sustainable development and increasing competitiveness at all the levels possible.**

2. LITERATURE REVIEW

The **existing specialized literature is extremely important for the subject** that we intent to present in our paper and the general believe is that **the IT Sector is in a permanent motion and in a strong developing process that might never reach its terminal point** as long as it takes into account **the importance of sustainable development and increasing competitiveness at all the levels possible.**

Nanomaterials possess various new properties and their industrial use creates new opportunities, but they also present new risks and uncertainties. Growing production and use of nanomaterials result in an increasing number of workers and consumers exposed to nanomaterials. This leads to a greater need for information on possible health and environmental effects of nanomaterials.

Nanotechnology development is in its early phase and there is a growing debate on its potential benefits and risks.

General knowledge of nanotechnology among people is currently very low, but various studies suggest that people are able to consider complicated technological and scientific developments from wide perspectives, if they are provided with proper possibilities for that.

The analysis indicates that nanotechnology can be regarded not only from the perspective of health and safety, but also from the perspective of its societal implications. That is why, the importance of public transparency and societal relevance of nanotechnology research and development are believed to be of crucial importance.

In the 19th and 20th centuries several technical and economic evolutions like the development and spread of steam engines, railways (19th century) as well as automobiles, computers, biotechnology and information & communication technology (20th century) have emerged. In the 21st century - nanotechnology is seen as one of the key technologies [1, 2]. The previous industrial revolution has taught us that rapid technological change impacts on society in a variety of ways. One of the challenges – still to be overcome - is the issue of occupational diseases and accidents resulting from industrial processes. Recent introduction of new technologies – such as nanotechnology – presents the same challenges [3] Within its work program, the European Risk Observatory of the European Agency for Safety and Health at Work carried out a series of expert forecasts providing a picture of the potential emerging risks in the world of work (physical, biological, psychosocial and chemical risks) [4]. Among the top ten chemical emerging risks, three have in common their physico-chemical state as particles: nanoparticles and ultrafine particles; diesel exhaust; and man-made mineral fibres. The risks posed by nanoparticles and ultrafine particles are by far the strongest agreed as emerging by the experts.

Nanotechnology offers on the one hand various new properties and opportunities and on the other hand - brings new risks and uncertainties. The current report gives an overview on occupational health and safety aspects that have to be considered in case of exposure to engineered nanomaterials.

Nanotechnology is mainly defined by size and comprises the visualisation, characterisation, production and manipulation of structures which are smaller than 100 nanometers (nm) [5, 6].

Nanoparticles are particles with one or more dimensions at the nanoscale [7]. According to the ISO / TR 27628 nanoparticles are particles with a nominal diameter smaller than 100 nm [8]. These particles originate from primary sources (natural sources, e.g. sea-air, volcanic ashes / pumicite) and / or secondary sources (artificial sources, such as. technical products and by-products, cigarette smoke, diesel engine exhaust, cutting and welding fumes, open fire) [5, 9]. Engineered nanoparticles are intentionally engineered and produced with specific properties [8]. Nanomaterials are materials with one or more external dimensions / internal structure on the nanoscale [6]. Nanomaterials / nanoparticles possess novel properties and characteristics that differ from the same non-nanoscale materials [6]. Nanoparticles / nanomaterials include, for example, metals or metal oxides, carbon black, carbon nanotubes, fullerenes, silicate, organic nanoparticles or nano composites [1, 10]. The term “nanoparticles” means only solitaire nanoparticles. Aggregates and agglomerates are not covered by this term. However in practice, aggregates and agglomerates are mostly also part of an investigated “nano-substance”. Currently many authors use the term “nanoparticles” including also agglomerates and aggregates.

The term “**nanotechnology**” was first introduced in **1974**, by Japanese engineer **Norio Taniguchi** [11].

3. NANOTECHNOLOGY - A TECHNOLOGY THAT ENABLES PEOPLE TO CONTROL OR TO MANIPULATE MATTERS

3.1. Nanotechnology – strong points for a better future

Nanotechnology is a technology that enables people to control or to manipulate matters or processes at the nanometer (*1 nanometer = 0.000001 millimeter*) or atomic scale to obtain materials or products with new and/or enhanced features or functionalities.

Nowadays, the mass-production of nano-enabled products is currently taking off, due to superior life quality and sustainable characteristics like resource savings and that is why the annual sales of nano-enabled products are likely to triple by 2015.

The increasing use of **nanotechnology** will affect various environmental, economic and social issues, such as the ones presented below:

- a) growing energy and resource scarcity;
- b) health care needs;
- c) higher quality-of-life expectations;
- d) greater mobility;
- e) living in a more information - intensive world.

For example from an economic perspective nanotechnology features enables the development of other innovative technologies in the past recent years such as Cloud Computing which provides the immediate and direct access to all information you need from any device (iPhone, tablet or PC) with an Internet connection.

Therefore Cloud computing will become more of a strategic tool in order to improve the Companies business model through changes in the business approach from the simple costs and efforts reduction and up to the ability to entry new markets. It will also represent an inovative and revolutionary change in the way IT solutions and services are sold. Cloud computing is slowly but surely transforming accounting industry through increasing the efficiency of the accounting processes in order to reduce costs and adoption of services with a higher added value through a system that works on a subscription basis.

The markets for nanotechnology can be divided into five key sectors (*see, in this matter, Figure no. 1: “Nanotechnology key sectors”*). This trend has been identified at both public and private levels.

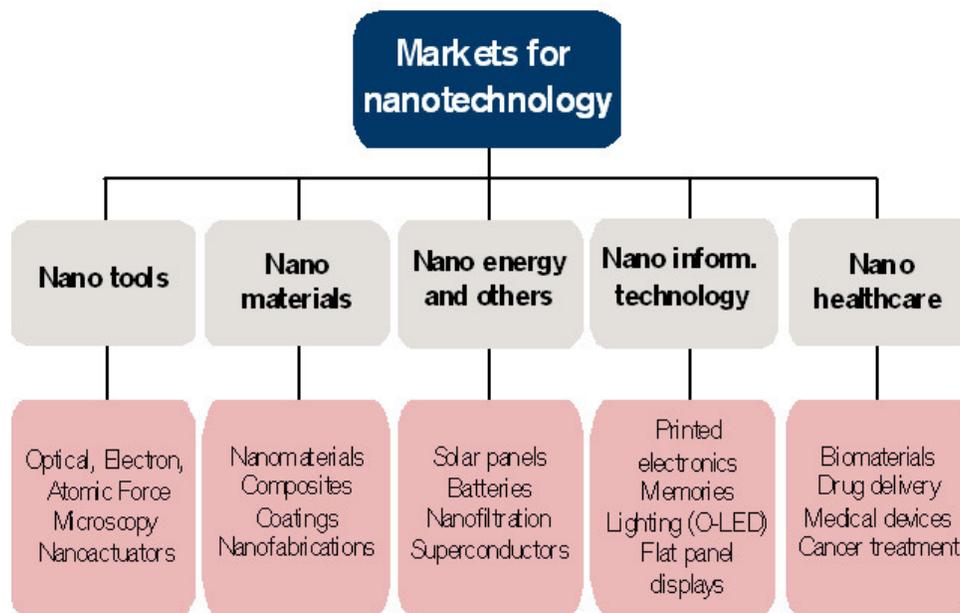


Figure no. 1: “Nanotechnology key sectors”
Source: Bloomberg, Credit Suisse/IDC

Nanotechnology is considered by specialists a **long - term growth driver** and that is the reason why it can be expected to be one of the key innovative technologies in the 21st century to help insure sustainable economic growth.

Nanotechnology enables certain matters such as:

- a) the development of many new, lighter and smarter products;
- b) the rise of quality – of – life expectations;
- c) the preservation of resources;
- d) the continuous reduction of pollution and health care costs.

Strong growth is expected in the markets for nanotechnology across its main sectors. The strong demand for new smartphones, laptops, tablets, LED products, LED and organic LED TVs, many electronic or medical devices, new water treatment solutions, lithium-ion batteries, thin-film solar cells, air pollution and drug-delivery systems is expected to continue in the coming years. Many nano-based products are already available on an industrial scale, but innovation and production optimization is an ongoing process. Also the spending on research and development in this field is expected to more than double to 70 billion dollars in 2013, compared with 2010.

Due to a very favorable context of increasing spending on research and development, combined with a promising horizon for further technological gains, production optimization and economies of scale, the markets for nanotechnology are projected to more than triple to exceed 380 billion by 2015.

3.2. iPhones, iPads, mobile phones, smartphones, laptops and tablet PCs in the world of sustainable development and increased competitiveness

A. iPhones

The iPhone is a new generation of mobile phones, which implicates faster networks,

new applications and innovative user concepts.

About the iPhone specialists believe that:

- ✓ it was initially launched as a device for conversation and evolving to become a portable music and video player;
- ✓ is opening up avenues to a networked world thanks to Internet connectivity, becoming widespread today;
- ✓ the International Telecom Union (ITU) showed there are now more than four billion mobile phone users around the world;
- ✓ forecasts by the research company Gartner Group show that 80 percent of mobile phones will be equipped for data communication by 2013, and new applications will see mobile Internet use really take off.;
- ✓ the US provider AT&T has seen data traffic grow by around 7,000 percent in three years;
- ✓ in the near future, the fourth generation (4G) of mobile telephone technology is expected to bring some relief, but more powerful networks are also an industry necessity;
- ✓ IBM predicts that mobile data traffic will increase more than tenfold between 2010 and 2013, amounting to more than 2,000 petabytes (billion gigabytes) a month. Swisscom has already launched tests for the new 4G network, which at 150 MBit/s will increase speeds even in the initial phase by a factor of roughly 10 to 20. This bandwidth will enable users to exploit applications such as HDTV and online gaming in 3D worlds. Another imminent development is Near Field Communication (NFC) radio technology, which will help electronic payment by mobile phone get off the ground. Thanks to comparable technology, the mobile-mad Japanese have had the luxury of contactless payment by mobile phone for several years now. Osaifu-Keitai is the name of the electronic wallet that allows the user to purchase tickets and newspapers, acts as an electronic key for doors, and serves as both an ID and a credit card simultaneously.

B. iPad

With its iPad, Apple has set new standards in this market too and attracted a lot of attention from private consumers interested in this type of IT product. In the first two quarters since the product was launched at the start of April 2010, Apple has sold five million iPads.

C. mobile phone and smartphone

- ✓ In 1983, with approval of the DynaTAC series by the US Communications Commission, Motorola commercially launched the first line of **modern portable phones**.
- ✓ This product was regarded as a high and very valuable resource and it is intensively compared to today's **Samsung Galaxy smartphone**.
- ✓ The Galaxy phone uses over 80 percent less raw material (*plastics, ceramics and metals*) than its Motorola predecessor, which implies huge resource, energy, and waste and pollution savings.
- ✓ Moreover, this phone has numerous new functionalities like enhanced data processing and visualization, Internet - based applications, camera and GPS, which were not available before the year 2000. Its retail price starts at 500 US dollars, more than 90 percent cheaper than its Motorola predecessor. This breakthrough has only been possible thanks to the introduction of numerous nano-enabled solutions, such as an organic light-emitting diode (OLED) display, 45 nm silicon technology and a lithium-ion battery. Since its launch in June 2010, over 8 million smartphones have been sold as of early December 2010, according to specialists estimates.

- ✓ Given the number of rival players, the battle for market share is likely to be fought over price – and in the long term this is likely to come at the expense of margins for all suppliers of smartphones and tablet PCs. Besides price, however, the chosen operating system (OS) and application platform will be crucially significant to success or failure. This is corroborated by research undertaken by the industry. Besides Apple's "gold standard" OS, the Android OS launched by Google is increasingly seen as attractive. Both are used for smartphones and tablet PCs. Besides these two OS, there are another seven operating systems in the "Mobile Internet World."
- ✓ Applications of a very different nature will be made possible by sensors, radio frequency identification (RFID) tags and radio chips for networks with greater reach. Objects that are equipped with this technology will be able to establish contact with other objects. For example, cars will be able to exchange traffic data with one another, vehicles will be able to communicate with traffic lights, and parking garage columns with mobile phones.
- ✓ A corresponding pilot project is currently under way in the US. Sensors buried in the asphalt register the parking places that are still available and provide the corresponding "live" map to be called up by mobile telephone. Urban planners hope that this will help limit the traffic caused by people driving around searching for a free space. The integrated parking meter will one day also eliminate unnecessary trips on foot, by enabling us to conveniently pay for an extended parking period via a phone app from a café, for example, in the event that our original period has expired.
- ✓ Many applications already use the localization function of GPS mobile phones, but according to market observers, the real boom in applications using geo-localization has yet to take off. Route tracking of a company vehicle or the tour route of a cyclist are now just as much a part of everyday life as applications that inform us if friends are in the vicinity.
- ✓ One highly promising area is that of "reality mining," whereby the data of activities is captured in space and time, visualized on a map and then analyzed. The anonymized data of mobile phone locations is already used by the navigation system manufacturer TomTom, while the company Skyhook Wireless goes even further and has just launched a service in the US: It gathers data on movements of people via WiFi hotspots and the location of millions of mobile phones. Thanks to this data, you can now establish on an Internet map precisely where large numbers of people are congregating in urban areas. As Skyhook is also looking to make this information available to third parties, a number of applications that can exploit this data are expected to appear. The positioning information also makes further scenarios possible, such as the linking of personal data with a particular location. An idea of how this might work is given by the application Geominder, which reminds the user of an unfinished errand. The trigger for the reminder is not a particular time, however, but the place itself. For example, your mobile phone might remind you of the items you still need to purchase when you enter a particular store.

The smartphones are able to do many things, such as the ones presented in **Table no. 1: "What can smartphones do and be in the same time"**.

Smartphone's functions:	Proprieties:	Sample app.:
Schedules	Whether someone is traveling by bus, train or plane, the smartphone can show the best travel connections and usually also lets the person purchase tickets, too.	NYC Subway
Satellite	Look at the whole world with a bird's eye view.	Google Earth
Product scanner	Use the smartphone at the supermarket to scan barcodes and receive detailed information on products.	Codecheck
Radio receiver	Thousands of radio stations to suit every taste, available on the smartphone.	Radiobox
Book reader	Special app to download electronic books to the smartphone in reader friendly format.	Book reader
Shopping cart	Online shopping from the office is followed by smartphone shopping en route.	Tesco
Painting	Creative finger painting on the display.	Painting
Mountain guide	Helps a person remember which peak is which, by pointing the phone at any mountain. The phones app from ETH will tell the person its name.	Swiss Peaks
Green conscience	Analyzes the ecological impact of a journey.	greenMeter
Star gazer	Smartphones also make handy companions for amateur astronomers.	Pocket Universe
Gaming	Use the smartphone as a console to play hundreds of games.	SimCity
Outdoor guide	GPS lets someone record hiking, jogging and cycling routes, and displays relevant maps.	Endomondo
Free calls	With the Skype app, smartphone users can call anyone in the world for free.	Skype
Music encyclopedia	This app tells the smartphone the name of musical works and provides information on them.	Shazam
Video player	Wireless video transfer from PC to smartphone.	Air Video
Navigation device	As it has permanent contact with satellites, the smartphone also acts as a navigation device.	TomTom
Networker	Let's a person know which friends are nearby.	Foursquare

Table no. 1: "What can smartphones do and be in the same time"

The most significant new entrant in this market was and remains Apple, with its iPhone. Launched in 2007, the iPhone has ignited the market and significantly boosted consumer interest in smartphones.

Though significant shifts in market share can be seen in the smartphone, the new tablet PC market is still very young and relatively insignificant. However, the expectation is that tablet PCs will penetrate the laptop and netbook markets in particular and that a crowding-out process will occur – particularly among private consumers (*see, in this matter, Figure no. 2: "Smartphone Market Driving Growth in Global Mobile Phone Business"*).

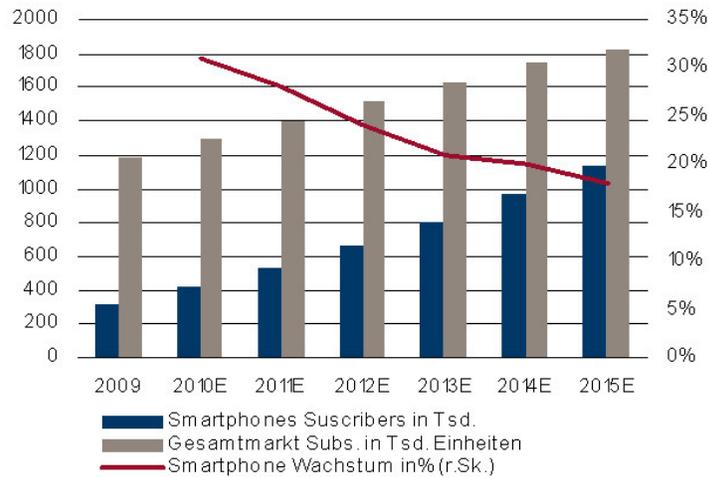


Figure no. 2: “Smartphone Market Driving Growth in Global Mobile Phone Business”
Source: Gartner, Credit Suisse

D. laptop

Laptop cannibalization is unlikely to be as significant in the business client segment. For the time being, the laptop's computing power and desktop PC-compatible operating system (*Windows or Linux*) would still seem to be indispensable. The computing power of a laptop/netbook is likely to become increasingly insignificant for private users, however, as this particular advantage will be more than offset by the tablet PC's rapid internet access (no slow startup), handiness, attractive applications, and ease of use. Industry experts believe tablet PCs will account for about 15-20 percent of the total PC market by 2014.

E. tablet PC

Tablet PCs have been around on the market for a long time and until now they have been considered a niche product designed primarily for business clients (*see, in this matter, Figure no. 3: “Tablet PCs”*).

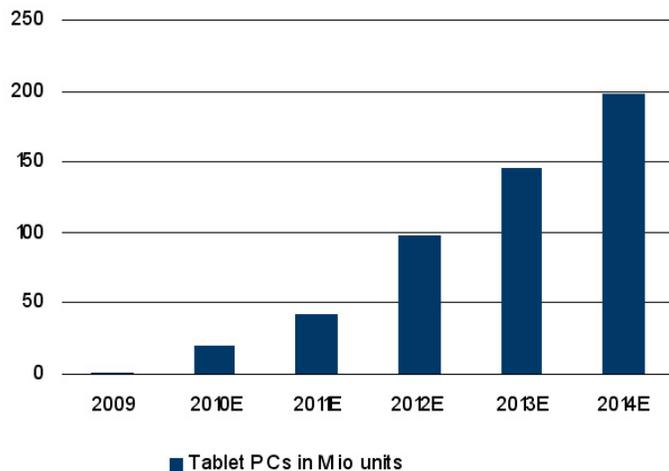


Figure no. 3: “Tablet PCs”
Source: Credit Suisse

Apple is still virtually alone in the market place with a 95 percent share, though its rivals are far from asleep. Firms like Hewlett Packard, Research in Motion, and Samsung have brought similar products to market during the Christmas quarter: It is expected that nearly every PC and mobile phone manufacturer will have a tablet PC on the market in 2011. Market research institute Gartner expects the market to grow from 20 million in 2010 to nearly 200 million units sold in 2014, representing an average annual growth of 66 percent (*see, in this matter, Figure no. 4: „Market Share of Android Operating System Likely to See Strongest Growth”*).

The flipside to these attractive growth prospects is the fact that in both these new markets competition will likely become tighter than in any other segment of the information technology sector. That's because the two most important markets in the IT sector (*PCs and mobile phones*) are converging in the form of the smartphone and tablet PC. This convergence is fueled above all by a growing demand for mobile end-devices that make maximum use of the advantages of mobile internet access and are easy to use. PC and mobile phone manufacturers are therefore fighting over the same customer base in these two fast-growing segments. The number of competitors has more than doubled compared with the two previously separate markets. Apple was the first to recognize this trend, and with its iPhone and iPad has set the benchmark for its competitors.

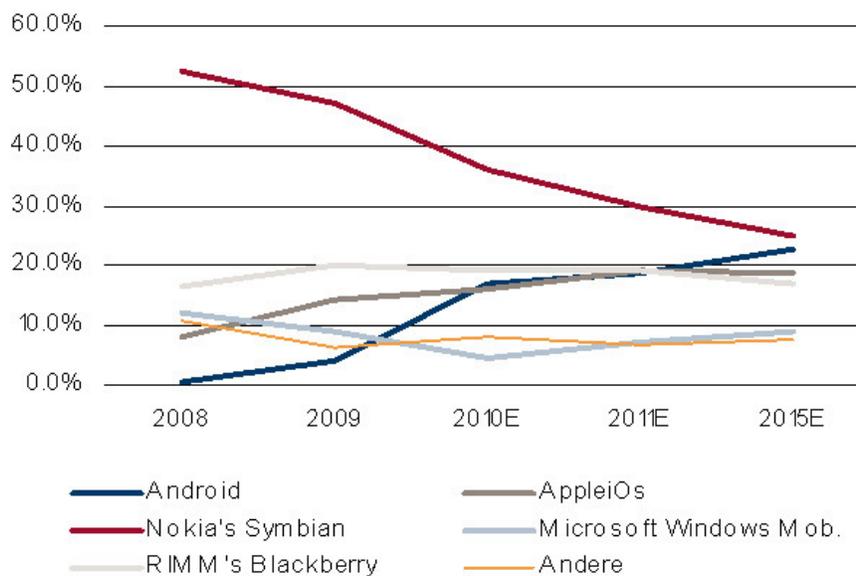


Figure no. 4: „Market Share of Android Operating System Likely to See Strongest Growth”

Source: Credit Suisse

4. Conclusions and implications

In order to conclude to the ideas expressed in our study, we would like to stress upon the following main ideas:

- a) On one hand, statistics show that Research in Motion's OS, Nokia's MeeGo, and Microsoft's Windows Mobile will be able to secure significant market share alongside Apple's iOS and Google's Android.
- b) On the other hand, Nokia and Microsoft were relatively late with their market launch (Q4 2010) and are initially likely to find the going tough:

- The Android operating system is clearly the most highly trusted.
 - Many smartphone and tablet PC manufacturers – including Samsung too – have opted to use this operating system for their mobile end-devices.
 - Consumers will decide who wins the battle that is set to take place in the coming years.
 - Firms like Apple and Samsung – which already have extensive experience in both segments (PCs and mobile phones) – are likely to stay one step ahead in the battle for mobile internet. Other leading IT giants such as Hewlett-Packard, Microsoft, Dell, Research in Motion, Nokia, and Acer – whose activities and success have so far been confined to a single segment – will need to make sure they don't miss the boat.
- c) Samsung for instance earlier this year announced it would spend around 21 billion dollars by 2020 on the development of novel technologies such as lithium-ion batteries for future hybrid and electric cars, advanced memories for many electronic devices like tablets and laptops, and light-emitting diodes (LED) for lighting and display purposes. Most of these technologies are expected to be nano-enhanced solutions.

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