An industrial revolution now on barricade –case: virtualization technology in the telecom industry

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Abstract

The virtualization technology shapes our understanding how our products are manufactured, sold, purchased and used, for example, in a case of the cloud computing. This study discusses if the virtualization represents the new industrial revolution. First, this study examines if the virtualization technology exemplifies the General Purpose Technology (GPT). Secondly, the dissemination of the virtualization technology, especially cloud technology, into the telecom industry is investigated. Thirdly, it is studied how the virtualization technology can create further business opportunities for extant and new actors in the telecom industry. A set of initial statements on virtual technology is created, and, then, this study investigates these assumptions to come up with propositions with the help of Hegel's thesis-antithesis-synthesis approach. The practical question of this study is to look for how we can be prepared for the on-going changes and coming changes in the telecom industry's business environment. Our endeavor on this topic is started by looking the characteristics of the previous industrial revolutions. It is also discussed how and why the virtualization technologies seem to beat the existing business models.

Introduction

The extant virtualization technology affects our daily life. We employ mobile computers to use virtualized devices: we can save our photos into cloud storage, we can watch foreign TVs from an internet service without owning a TV and we can even have virtualized PCs on the top of the smart mobile phones. The virtualization technology impacts also in business-to-business relationships, for example, the cloud computing enables to buy computing power for our business purposes instead of owning it. This virtualization is well demonstrated by the cloud computing: for example, we do not know where our data is geographically located or in which computer it runs. More utterly, we have no ideas and control how the metadata related to our information is commercialized or employed by the various relatively new actors. Virtualization technology diffuses from the IT industry into other industrial sectors in which the device digitalization has already occurred previously e.g. telecommunication and hospital technology. In order to be prepared now for on-going changes and coming changes, we need to deepen our understanding about if this phenomenon as it creates new and new type actors with their business models and governmental control models. Many of our daily concepts are also reshaped as their connotations can be extended, for example, in several multinational companies teams are distributed around the globe with the support of the extensive electronic communication i.e. virtualized teams (e.g. Ruokolainen & Uusitalo, 2011).

The first industrial revolution was a consequence of inventing a steam engine. The technology gradually diffused in the society and impacted on everyday life and on how businesses were run. This first industrial revolution started to occur since the late 18th century (Bruland & Smith, 2013). The next industrial revolution was caused by the mass production along with the invention of the combustion engine and the electrical energy technology that affected travelling and increased the level of the automation since the late of the 19th century (Li & Molina, 2014). The third industrial revolution was created by the device digitalization that had reduced our world since the 1970s with the advanced communication technology and the speed of data processing.

Since the first industrial revolution, the diffusion of these General Purpose Technologies (Enflo, 2008), such steam machine, combustion engine and silicon ships, have changed how the business is managed and how the companies interact (Lind, 2014). In this study, I propose that the virtualization technology represents the new industrial revolution or definitely has remarkable impact on it. Scholars have also discussed that the next industrial revolution might be caused by the 3D printing as it enables, for example, effective mass customization (e.g. Garrett, 2014; Holmström & Partanen, 2014). I see that 3D printing enhances the virtualization revolution, as it makes possible to implement the devices and objects that first existed in a virtualized environment. The Internet of Things can also have an impact from virtualization as the various real objects can be logically virtualized and new virtual objects can be built on the top of the concrete group of the Internet of Things such in the case of Network Function Virtualization. However, as it seems that the virtualization as such has not been discussed as being the entry of the new industrial revolution, I need to investigate this topic further in this study. Here I see a reach gap, and, thus, our research question is if the virtualization technology represents the new industrial revolution. I note also that much of today's service production is heavily depending on IT. Changes in IT paradigms impact on the industry's productivity.

In this study, I focus on the telecom industry and how the virtualization, cloud, technology is emerging there and what kind of new business opportunities it might create. Technology wised, I focus on the technology that enables us to run multiple operating systems in the same computerized devices i.e. it is called virtualization (Uhlig et al., 2006). I create two propositions to be employed through Hegel's thesis-antithesis- synthesis –discussion by those who would attempt to step into the employment of virtualization and, thus, to be part of this new industrial revolution of the

virtualization in the telecom industry by helping this technology to diffuse. At the beginning of this study, I discuss the characteristics of the previous three industrial revolutions and then compared them with this on-going virtualization theme. The purpose of that is to gain a preunderstanding of the topic. Based on this preunderstanding, I introduce four statements that were used in studying the topic further. I interviewed several experts inside and outside of Nokia. I employed so called Delphi –method along with a method similar to the case study approach to introduce the propositions.

Literature review with reflection on virtualization technology

Prestatements

In order to gain an understanding about the industrial revolutions I study the characteristics of the previous three industrial revolutions based on the literature study. Magnusson (1999) discusses that the most important characteristics of the industrial revolution are the radical changes in the industrial processes. Several scholars also propose that industrial revolution follows the regular patterns that are identified from the technology diffusion of the three previous industrial revolution cases.

(1) According to them, the growth of the society is triggered by limited radical technologies and the diffusion process of these technologies throughout the society. These technologies are called General Purpose Technologies (GPTs). The GPTs emerge from one industry sector to other one with the help of the complementary technologies and innovations. Lind (2014) mentioned that in order to be classified as GPT, the technology is needed to be widely used as an intermediate, and several industrial sectors should profit from the GTP based innovations. The impact of the GPT on the growth rate can be evaluated by the diffusion speed and extent of the use of it.

(2) The industrial revolutions are reported having two sequential periods. The GTPs impact on the production processes during the first period. During the second period, the impact is on infrastructure and institutional changes largely. These two periods can be submerged into the cycle of structural-renewal-rationalization phases.

In order to further investigate if virtualization technology represents GPTs I introduced two prerequisites for the virtualization. The first prerequisite is that in order to extensively use the virtualization technologies, HWs used in the telecom industry are needed to be replaced by standard IT HWs. The telecom industry uses already widely the same components that are used in IT devices such microprocessors, memories, hard disks, operating systems. However, in order to meet some of the telecom industry's requirements related to the speed and the reliability, the special telecommunication HWs still exist. They seem to prevent of using the same standard virtualization technologies that IT employs. Therefore, I introduce the first prestatement (PS 1) that proposes that Telco HWs are needed to be replaced by standard IT HWs.

PS 1: Telecommunication HWs are replaced by IT HWs.

This statement facilitated the further discussions about the topic with experts.

The second prerequisite deals with the business models, and it is related to the point two above. The IT and telecommunication convergence have been discussed widely. Therefore, one of the questions to further investigate the topic is to gain more understanding if the telecom industries' business models and IT business models are merging or substituting. It can be proposed that we need to discuss these tow industrial sectors' convergence instead of the industrial revolution or both. In this

study, it can be assumed that IT business models are replacing telecom industries' business models, and the same IT business benefits can be gained in the telecom industry. This addresses the point two of the impact on infrastructure and institutional changes in enterprises. Therefore, in order to conduct further discussions with experts I propose as follows:

> PS 2: Telecom industries' business models are replaced by IT business models.

Prepropositions

The additional innovations of the second industrial revolution related to the development of the new energy sources, such as coal and oil, and enhancements in materials such as in steel. The enhanced mechanical, chemical and electrical knowledge created new possibilities for additional product innovations. Lind (2014) states that in order to develop these products and in order to create innovations it was necessary to integrate knowledge from several areas inside and outside the companies. Many of the technologies are complementary to GPTs and thus supported the industrial revolutions initiated by the GPTs.

The main growth force in the third industrial revolution was generated by microelectronics based on silicon chips and related programming technologies. It affected business boundaries and caused wider changes in the society. Moore's Law proposes that the silicon chips bring more computing power to be employed and it generates complementary innovations based increased capacity to crunch numbers by the silicon chips. However, it has been proposed for sometimes that Moore's Law is not as applicable as earlier. For examples, the clock speed of the microprocessors can be only limitedly increased. Despite the setbacks coming from discontinuity of Moore's Law and in order to further investigate the virtualization technology capacity, I propose the following preproposition (see PP1) in which the virtualization technology is proposed to replace the digitalized products gradually:

> PP 1: The virtualized technologies replace digitalized device technologies in producing new products.

The technology development of a GPT in one industrial sector can help revolutionize that GPT which then generate a new industrial revolution. The third industrial revolution would have not been possible without the innovations related to electricity in the second industrial revolution. In the same manner, the virtualization technology revolution could not have been possible without the development of the silicon ship technology.

Several scholars discuss the benefits of the previous industrial revolutions widely. For example, according to Lind (2014), McCarthy and Anagnostou (2004) describe that the main consequences of the second industrial revolution were (a) to force control, (b) to reduce uncertainty, and (c) to rationalize through internal specialization. Thus, the production processes were able to be integrated backwards through the procurement of raw materials and transportation. This gave the opportunity not only to gain control, but also to benefit from the economy of scale. In addition, for example, Mowery and Rosenberg (1989) prove that the mass production and the vertically integrated manufacturing reduced transport costs.

The benefits of the third industrial revolution are related to the reduced internal hierarchies that were replaced by the transactions between the companies i.e. outsourcing. The GPTs related to the third industrial revolution enables an efficient coordination of these production processes with enhanced communication. The consequence of this is that the production processes are more automated and at the same time more integrated and decentralized than before in supply chains. The productivity was able to be improved without the scale of the production.

The virtualization technology especially in case of cloud computing is expected to bring benefits in the forms letting companies to do less capital investments as they can buy computer capacity based on the use. The other benefits that are brought in relates to the fact that the computer capacity is more effectively in use as it can be shared with several customers who do not need the capacity at the same time (e.g. Tsai and Huang, 2014). The cloud technology would allow setting-up new business models and start-ups without preinvestments in the technology, and with the easy scale-up in the case of the business of the start-up starts to fly. This could revolutionize the production process of the services that are heavily dependent on information technology. In order to study and to discuss the topic further, I propose the following preproposition:

> PP 2: Business models valid in virtualized ecosystems would beat gradually non-virtualized business models.

It can be proposed that the diffusion of the virtualization technologies in the telecom industry occurs in two waves. In the first phase, IT technologies emerge into the telecom industry along with virtualization technologies. In the second phase, the business models enabled virtualization technologies would replace the old business models valid in the telecom industry businesses.

Methodology

In this study, the thesis-antithesis-synthesis research approach that is introduced in Hegel's philosophy of the discourse is applied. Rodrigues and Craig (2007) write that a thesis possesses an incompleteness that brings up an antithesis that is an opposing idea. Because of the conflict, a synthesis or a third point of view arises. A synthesis resolves the truth as expressed in the thesis and antithesis. It then becomes a new thesis that in turn generates another antithesis that leads to a new synthesis.

The initial thesis in this study's iteration is called prestatements and they are based on the first interviews of the experts, on the initial literature study or on an author preundestading working in this business area for several decays. The prestatments represent the understanding about the prerequisite for the diffusion of the virtualization technology from the IT industry to the telecom industry. The prepropostion represents the understanding gained on virtualization technology learnt from the literature. Based on the prestatements and prepropositions I coded the literature and interview material to the supporting statements i.e.thesis or not supporting statements i.e. antithesis. As I was able to identify contradictions between the previous statements I introduced the propositions, i.e. synthesis, to find out on if the prepropositions can be supported or not. The propositions represent the second iteration in the Delphi methodology. The Delphi methodology that is used for predict the coming changes (Keeney, 2001). It fits well with the study approach as it is also based on the interviews of the experts and the synthesizing their outcome. In this study, I enlarged the approach taking into account the literature on the top of the empirical evidence from the interviews. This is a known method in qualitative case study to increase the credibility of the empirical findings.

For sampling of this study, I interviewed several telecom operators, their supplier's, Nokia Networks', account teams and product and R&D experts both inside and outside of Nokia Networks. Some of the experts I interviewed more than once as proposed by the Delphi - methodology. With these experts, I shared the consolidated outcome of the previous step and collected their feedbacks. The interviews were coded based on their positions on the initial statement: supporting them or not and based on given reasons. Then these arguments were further studied with the help of the literature on the topics in order to present the propositions to be further studied. I discussed the cloudification topic with several IT suppliers such as Red Hat, Microsoft, Oracle and Amazon in order to gain more profound understanding, where the industry of cloud

computing was headed. Totally about 20 people were interviewed both from Nokia and outside of Nokia.

Receptivity Gambling

Next, the topics introduced by the prestatements and prepropositions are further discussed in the light of the interviews and virtualization studies. I conclude the argumentation by proposing a proposition on that topic. I call the interviews based on the prestatements or prepropositions as Receptivity Gambling according to Drucker (2014) to reflect the pro- and counter argumentations on new ideas and innovations.

The virtualized technologies replace digitalized technologies in producing new products

As the prestatement was that the telecom industry HWs would be replaced by IT HW, I interviewed several persons from various sources. According to a telecom product expert's view, the IT HW's technology can be matured hardly in the same level in terms efficiency and cost effectiveness as the specialized telecom industry's HW is currently. His view was as follows:

"The same efficiency is hard to achieve with standard HW and the cloudification makes the system even more complex and slower: without seeing [hard evidence] it is hard to believe."

(based on a product expert's comment)

Another telecom product expert described the complexity of the telecom industry systems. Based on the discussion he stated as follows:

"An operator was able to finally a achieve state that they managed their telecommunications systems from end-to-end. Now they are pretty reluctant to increase complexity again. Cloudification will definitely do it. It takes its time to mature."

"The telecom industry equipment has five nines requirement for its operations secure. Normal IT HW can have difficulties in meeting this requirement."

(based on a product expert's comment)

According to an account manager, the CTO of that account was against the virtualization. The account manager described the concerns of the CTO as follows:

"The cloudification will cause a total mess in our telecom networks. We already have difficulties in finding the problem and the root cause for it. With the virtualized elements, we would not be even capable of identifying the right HW element behind the problem."

(based an operator's CTO's comments)

According to a telecom industry and an IT technology experts there were no reasons to employ IT HWs in the telecom industry:

"There is no exact reason why not all computing in the telecom equipment can be codified expect the antennas in the base stations. In the history, the common HWs have always beaten the special HWs. It is expected to happen also in this case – this comes from Moore's law."

(based on the interview of an IT industry expert)

"There are no real limitations why a telecom equipment cannot be cloudificated in large terms. In the rare cases, the replacement of some special HWs might slow down the data processing speed.

In addition, there are time critical events meaning that the cloud servers are needed to located proximity to telecom equipment. However, the whole European signaling can be managed by a single cloudified switch center."

(based on the interview of a telecom industry expert)

According to a study (Tsai & Huang, 2014), the following factors affect the success of the cloud technology diffusion in IT industry. The first criterion is the quality of the cloud services. The other nearly equal important criteria are the infra structure that support for the cloud solution, the maturity of the technology and the price. In addition, Khanagha et al. (2013) write that the experimentation is employed by the telecom industry operators to learn new technologies and thus it proposes that the experimentation affect the diffusion of the new technology. Therefore, the propositions below are constructed on the idea of the experimentations. The importance experimentation is also highlighted by, for example, the enterprise Google. Wu et al. (2013) write that those organizations that entrepreneurial are oriented and have modular service structure in their ITs can adopt more easily the cloud approaches.

The interview proposes that the personals' views are contradicting on the success of virtual technology, cloudification, in the telecom industry. The literature proposes some of the facts that might help in the cloud diffusion in IT industry. Currently, there is not clear understanding based on the interviews how the cloudification diffuses successfully in the telecom industry. In order to further investigate the topic, the following proposition, P1, is proposed:

> P1: Right customer references to support the diffusion of the virtual technology into telecommunication market
>
> Those telecom cloudifications, that introduce services with quality in established infra with clear benefits in an entrepreneur-oriented operators' organization, serve the best customer references, and, thus support the diffusion of the virtualization technology in the telecom industry.

The propositions can be tested with the individual applications, for example, with Multi Media Entity network element that can be cloudified quite easily and then tested with selected customers as proposed in P1.

Business models valid in virtualized would beat gradually non-virtualized business models

First I interviewed the experts on their opinion, whether IT industries' business models will replace the telecom industries' business models or not. An account manager's opinion expressed his view based on his experience from the working with an operator:

"Customers already have some or extensive experiences of the cloud technology through their ITs. IT is showing the way of cloudifications among the operators, telecom industry manufactures are following, not leading the development. The telecom cloud is coming slowly behind with limited HW capabilities i.e. not really the cloud."

(based on the interview of an account manager)

"Players like CISCO, IBM etc. might have opportunities to come in the telecom industry business with their cloud technology products as some discontinues in telecommunication technology seem to occur."

(Based on the interview of an IT expert)

Several various experts stated that the cloudification would beat gradually the existing business models in telecom industry. The cloudification will change the telecom industry's business environment by lowering the step to come a virtual operator. The virtual operator does not own the telecommunication network and uses the other operators' networks instead.

"The cloudification of the telecom functionalities will lower the step to come a virtual telecommunication operator."

(based on the interview of an IT expert)

However, another expert in the field gave a contradicting advice. He stated that the problem of coming as an operator is not technology related but more on commercial know-how related as making the deals with the extant operators of using their networks.

"Cloudification does not simplify the becoming a virtual operator, problems are related to contracting, in the past virtual operators cannibalized the market pricing from traditional players."

(based on the interview of a telecom industry expert)

Especially the business models related to Platform as a Service (PaaS) solutions have lowered the step to start the businesses with new business models on IT business side. As the need for minimal capital (CAPEX) and minimal operation (OPEX) investment, it would also boost the creation of new start-ups and business models in the telecom industry. This was based on the interviews of several IT suppliers such RedHat, Microsoft etc.

"The shift is nevertheless from the CAPEX to scalable business models without need or minor need for cash for OPEX: easy to start for new green grass root players or easy to enter for extant players in this telecom business area. The shift is towards to innovations, social capital and business knowledge with faster implementations."

(based on the author's expertise)

Especially software vendors provide PaaS systems to attract third party users to their innovation environment for benefiting from the collective intelligence of these users (Baek et al. , 2014; Ojala & Helander, 2014). They continue by stating that their results suggest that the platform provider should lead the innovation in the initial period of introduction of their PaaS system, and, then, third party developers become gradually innovation leaders in these PaaS ecosystems.

In order to test the IT cloud's business models, diffusions to the telecom industry I propose that PaaS systems should be extended to have the telecommunication functionalities.

> P2: Extant IT models, such as PaaS, boosts the new business opportunities in the telecom industry.
>
> If the telecom functionalities can be introduced in a PaaS system on the top of its IT functionalities, these PaaS systems will boost the telecom industry by introducing new players and creating new types of business networks.

Discussions and conclusions

In this study, I investigated the possible extant and coming changes by interviewing the experts of the telecom industry, virtualization and cloud computing. The outcome from interviews proposed various views whether the virtualization especially cloudification would take place in the telecom industry and on what speed. I made two propositions to study and to test whether the diffusion of

the virtualization technology would happen in the telecom industry would cause a major shift in the industrial paradigms that can be called an industrial revolution. I based our propositions on literature studies including elements and experience of cloudification from IT industry. I interviewed totally more than 20 experts.

In order to figure out if the virtualization technology represents industrial revolution I investigated first whether the virtualization represents general purpose technology or not. I introduce two prerequisites for it: (1) telecom industry HWs are needed to be replaced by general IT HWs. (2) IT business models replace the telecom business models.

I can find support for the statement that the virtualization technology represent industrial revolution based on following terms:

> (1) There is less need to produce physical digital devices if general IT HWs can replace them. The first proposition is addressing this statement in the telecom industry.
>
> (2) The business models in the digital product industry will be replaced by ITs' business models. The second proposition is addressing this statement in the telecom industry.
>
> (3) The diffusion virtualization technology occurs from IT industry to the digital industries. Both this study's propositions are addressing this statement.

Virtualization technology based on IT technology means radical changes in the production, marketing and purchasing of the services. This technology can be employed in the telecom industry producing its services, therefore, it supports the statement of the industrial revolution caused by the virtualization technology. PaaS incarnation of the virtualization supports the creation of new businesses and innovations in other industries, for example, if PaaS concept can be introduced successfully in the telecom industry as it now is occurring in IT industry.

The change is remarkable as a new major players and change in existing businesses is happening or going to happen. New industries and new players are introduced or have been introduced such Amazon (Ritala at al., 2014) or Heroku. Recently Google announced its intent to enter the telecom business as a virtual operator. It can be forecasted that diffusion of this virtualization technology seems to occur in other industry sector such as the telecom industry despite there are evidences that it would be as straight forward as planned.

This study contributes also to extant knowledge by introducing a new methodology to study the impact of the new technology changes by employing Hegel's thesis-antithesis-synthesis -approach in this context. The same approach might also use in other study other industrial changes and their related studies.

Contribution to IMP literature

The industrial revolutions are discussed deeply surprisingly scantly in IMP context. Gadde (2014) refers to his writing how first industrial revolution started at the end of the 1700s affected the trade patterns and the actors involved in these operations. Especially in that article, it is discussed about the establishment of the banking sector and specialization in insurance, shipping and transportation. The impacts of the second and third industrial revolutions are discussed hardly as the topic itself in IMP context. It would be very beneficial to discuss if the ongoing changes such virtualization would influence the business networks and what way: it would let us to be better prepared on coming

social changes caused by the various technologies. According to the literature review of this study, industrial revolutions have affected the business networks significantly as follows:

> (1) by letting the actors to specialize in the business networks(first industrial revolution, Gadde, 2014),
>
> (2) by letting the actors to integrate backwards through procurement and transportation (second industrial revolution, McCarthy and Anagostou, 2004),
>
> (3) by letting the actors to reduce internal hierarchies through replacing them with transactions i.e. outsourcing (third industrial revolution, Lind 2014),

By this study's empirical part, it might be anticipated what kind of impacts the virtualization can bring. With the help of this study, following themes can be proposed:

> (1) virtualization technology let the actors to buy or/and use products or/and services in practice unlimitedly in real time from a global market place i.e. can be called 'unlimited and borderless with no-delivery time – purchasing market',
>
> (2) virtualization technology let new and extant actors to introduce new services and products globally as soon as available based on distributed offerings that scales-up automatically without the need for capital expenditure .i.e. can be 'knowledge based R&D without delivery restrictions – offering market'.

From business networks' perspective, we will have those who offer global distribution channel providers in several layers (e.g. IaaS, PaaS) and unlimited number of new actors that offer the services and virtual products through these providers and with the help of the other actors. The knowledge is the main driver in this market, which means that operators might end to be bit pipes and large computer companies might concentrate on numbers crunching. A large number of small expert companies will provide the content.

Managerial implications

The implication of this study is that the telecom industry needs to start to be prepared on the changes in its businesses. New roles and new value generation solutions to end customers are needed among the telecom operators. New business opportunities for new players might occur as the traditional industries might have hard to accept the coming changes (e.g. Drucker's (2014) unexpected success). In the telecom industry, one of the questions is that what kind of competence they need for surviving. Some of telecom functionalities will definitely be needed but IT's based competences especially related to understanding about the future business possibilities are needed.

Limitations of the study

In this study, I did not look at the industry in terms of the revenue or market sizes. These materials are available for example from Gartner. I focus on this study on the diffusion from IT industry to the telecom industry, and it might limit the generalization of the observations. However, the results can nevertheless be indicative. I did not discuss the other virtualization technologies that are emerging in the telecom business such as Network Functions Virtualization and Network as a Service.

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