ISSN 1598-0170 (Print)
ISSN 2287-1136 (Online)
http://www.jksii.or.kr

3DTV방송기술 표준화과정의 참여자간 상호작용 : 행위자 네트워크 이론기반 사례연구☆

A Study on the Interactions between the Actors of the 3D Broadcasting Standardization Process

송 경 희[1] 곽 규 태[2] 박 수 경[1] 이 봉 규[3*]
Kyung Hee Song Kyu Tae Kwak Soo Kyung Park Bong Gyou Lee

요 약

본 연구는 기존의 표준관련 연구가 실제로 표준이 만들어지고 보급되는 제반 사회적 환경과 다중 이해관계자가 존재하는 복합적인 사회시스템에서의 행위자 역할 및 변화과정을 조망하는 작업이 충분히 이루어지지 못했다는 데에서 문제의식을 갖고 출발한다. 이를 배경으로 본 연구는 사회-기술적 제도 환경의 맥락에서 각기 다른 이해관계를 가진 참여자들이 혁신적인 기술을 개발해 표준화해가는 동태적 과정을 사회-기술적 접근으로 재구성하는 것을 목적으로 수행되었다. 이를 위한 세부 목표는 첫째, 표준화 과정을 둘러싼 사회-기술적 네트워크에서 인간 행위자 간, 인간과 비인간 행위자와의 상호작용 관계의 특징을 살펴보는 것이다. 둘째로는 표준화 과정을 선도한 핵심 행위자의 활동과 역할의 변화를 관찰하고자 하였다. 이를 위하여, 행위자-네트워크 이론(Actor Network Theory)에 기초하여 한국에서 진행된 고화질 3DTV방송기술의 표준화 과정의 동태적 속성을 분석하였다. 분석방법은 연구자가 행위자-네트워크에 직접 참여하여 동태적 특성을 분석하고, 설문 인터뷰와 심층 인터뷰를 통한 질적 연구의 방법을 적용, 표준 형성과정에 나타난 제반 환경-행위-기술 동학을 고찰하였다.

☞ 주제어 : 표준화, 행위자-네트워크 이론, 사회기술적 접근, 3D방송

ABSTRACT

This study is devised out of the recognition that the existing standardization-related research has not sufficiently examined the overall social environment where a standard is actually made and diffused and the roles of the actors and the changes in them in the complex social system where multiple stakeholders exist. Against this backdrop, this study purports to reconstruct the dynamic process of developing and standardizing an innovative technology through a socio-technical approach involved by multiple stakeholders with different interests in the context of a socio-technical institutional environment. The specific goals to achieve the purpose include first, inspecting the characteristics of the interactions between the human actors and between the human and non-human actors in the socio-technical network surrounding a standardization process. Second, the study aimed to observe the activities of the focal actor who led the standardization process and its changing role. To that end, it analyzed the dynamic features of the process of standardizing a HD 3DTV broadcasting technology that took place in South Korea based on the actor network theory. As for the analysis method, the researchers personally took part in the actor network involving the new technology to analyze the dynamic characteristics of the network, applying the qualitative research method of survey and in-depth interviews and exploring the overall dynamics of environment, behavior and technology observed over the course of the entire standardization process.

☞ keyword : Standardization, Actor Network Theory, Socio-Technical Interpretation, 3D Broadcasting

1. Introduction

While the full-scale research on standards, technical ones in particular, only started in the early 1990s, related research

1 Graduate School of Management of Technology, Yonsei University, Seoul, 120-749, Korea.
2 College of Business, Dept. of Cultural Industry Management, Honam University, Gwangju, 506-714, Korea
3 Graduate School of Information, Yonsei University, Seoul, 120-749, Korea.
* Corresponding author (bglee@yonsei.ac.kr)
[Received 4 November 2013, Reviewed 5 November 2013, Accepted 17 January 2014]

☆ A preliminary version of this paper appeared in APIC-IST 2013, Aug 12-14, Jeju Island, Korea. This version is improved considerably from the previous version by including new results and features.

had been active in the diverse disciplines such as business administration, economics, engineering, and public administration. They were generally focused on the technical role of a standard as a mechanism to bring about an innovation and the acts of a standard in the standard competition together with the economic performance derived therefrom [1,2,3,4,5]. Such research from the strategic perspective was led by the business administration community and explored the competitive edge presented by technical compatibility and its meaning [3,6]. It also looked at the relation between the investment in a revolutionary technology and the competitive edge out of it [7] with the stress on the standard being a strategic tool to reap the network effect and forge an affiliation or alliance between the related organizations for the network effect [8,9].

Although the discussion on standards has been introduced through research on technology itself or from the approach of economics and business administration, there has been some research that attempted to study the standardization process itself and the related context, not the standard as a means for competition [7,10,11]. Such research tried to deal with the politics and conflicts, and the arbitration and conciliation of the actors involved in the standardization process, and shifted the context of the standardization discussion from the business to social environment. According to these studies, standard issues can be understood as part of the social rationalization process approachable from both the supplier and consumer perspective, not only being a strategic means confined to the corporate competition context [12,13]. They can explain the motivation of the governmental or public intervention for the purpose of market protection and public interest in the increasingly globalizing market environment, and suggest that the standardization process is not only determined by technical superiority and reasonable rationality for the advancement of technological development [14,15]. These studies were highly meaningful, considering that most of the research at the time was relatively negligent in not looking at the mid- and long-term environmental dynamism where a technology is developed and the developed technology is set as a standard, and subsequently adopted and diffused in the society. Moreover, conflicts between stakeholders arising from the standardization process and their resolutions, and the environmental factors that govern the stakeholders' acts were dealt with extremely minimally back then [16,17]. The recent approach, however, is used quite restrictively even now, and more discussions are wanting about the overall social environment where a standard is actually made and distributed, and about the actors' roles and the change in such roles in the social system of multiple stakeholders [18,19]. Many studies have pointed out that the mechanism where a standard is adopted and diffused need to be identified clearly, separately from the viewpoints of technological edge or economic motivation. Despite the suggestions that the external aspects of the standardization for which even nations are competing against each other going beyond the corporate world should also be examined in the context of a more complex social system [10,19], there have not been many studies on these topics.

In recognition of this background, this study purports to reconstruct the dynamic process of the development of an innovative technology and the subsequent standardization process joined by stakeholders with diverse interests in the socio-technical environment. To this end, it aims to examine the interactions among human actors and between human and non-human actors in a socio-technical network surrounding standardization, and observe the activities and changing roles of the focal actor who leads the standardization.

To achieve the aforementioned purpose and explore the research problems, this study takes the Actor Network Theory (ANT) as the base theory for the discussions later on and applies the qualitative research method through survey and in-depth interviews, with the purpose of examining the dynamics of the general environmental, behavioral and technological aspects observed in the standardization process. For the case study, the standardization of the HD 3DTV broadcasting technology that went on in Korea was selected, for it is an exemplary case that shows the dynamic process of standardization where participants with different interests from the industrial field of 3DTV, including the Government, worked together to develop and test a technology, and reached an agreement after continuous discussions and conflicts to make it a domestic and international standard. In particular, the case will showcase the institutional characteristics embedded in the

technical-social network around standardization and the activities of the focal actor.

2. Theoretical Background

2.1 The Meaning of a Standard and the Character-istics of the Standardization Process

The definition of the standard varies. Among them, the International Organization for Standardization (ISO), a Standard Setting Organization (SSO), provides the conceptual meaning of the standard: “The provision of the characteristics, specifications, and so on of a product or process, or technical specifications that are in formal agreement for the purpose of using them commonly and repetitively with the aim of achieving optimal quality in the given scope” [20]. The Korean SSO has also specified the standard as the “decisions made on an object, performance, capability, movement, procedure, method, process, responsibility, thinking, method, and so forth, for the purpose of standardization and simplification, so that the benefits or conveniences may be obtained fairly between the related persons” [21]. While no single and explicit concept of the standard agreed exists at the moment, the general tendency is that a standard is understood as a set of reasonable criteria of an object, concept, method, procedure and so on approved by the certified organization, for the optimal facilitation of community interests based on the overall discoveries of science, technology and experience [22].

Setting a standard as such is perceived to play a positive role of providing compatibility and interoperability necessary for mass production and cost cutting through activities to prevent duplicate investment into a certain technological field and facilitate technological development in the relevant area, as well as presenting the methods of measurement, test and analysis and maximizing consumer utility by preventing the circulation of the poor-quality products. To the contrary of course, a standard may act negatively, slowing down technological innovation by blocking the development of other possibly superior technologies and reducing diversity from the perspective of the utility of a product or service [4,22].

As for the classification and types of standards as well, the discussions are widely different from scholar to scholar. Accordingly, there are highly diverse types or definitions of the standard, among which most of the researchers by and large choose between either de jure standard or de facto standard depending on who determines the standard concerned [22,23,24]. De jure standard is written by international law or official standardization bodies such as the ISO, and decided upon through agreement and coordination between the related countries or agencies, and stakeholders, which makes the content of standard clear and open. In the meantime, de facto standard is likened as the dominant design which tends to be decided upon through market competition among businesses and therefore the writing and sharing of the standard is done in a closed manner and comes to act as a means for an enterprise’s competition and strategic manoeuvre [24,25]. Unlike them, the classifications based on the influence and applicable scope of a standard [20] generally distinguish a standard by region, such as international, national or regional standards. In case standards are classified according to the forms, they may be divided into a design-based and performance-based standard [1]. Aside from them, a standard is also classified as an ex-ante and ex-post standard based on the time when the standard takes effect. In case of the standards set by the SSOs in Korea and abroad, a standard tends to be ex-ante, and the standards set through market competition after a product is manufactured are classified as ex-post.

In the meantime, standardization can be defined as a series of acts in the dynamic process where a standard is set, a product or service is realized according to the standard, and they are made available and used afterwards [3,24]. As such, standardization is an organizational behavior that sets up and utilizes a standard and thus includes even the acts by multiple persons to fit an object to the base standard from the time of setting up the standard. It therefore implies in its concept a series of processes to reach agreements to create an optimal order in the given scope and to make the standard concerned adopted and diffused [16]. Generally, the standardization process is known as a mix of the formal standardization characteristic of a procedure based on technological rationality and the societal standardization that aims to coordinate interests and conflicts [16,24,26]. Accordingly, while the specific processes of standardization

may proceed simultaneously without any mutual conflict or segmentation, there are many conflicts, ruptures and discontinuities occurring in the process of formal and societal standardization from time to time [3]. That is, there have been many cases where the formal standardization process failed to lead to the societal standardization process and sometimes the standardization was justified in the society regardless of the formal standardization process. After all, the standardization process presupposes the participation of multiple stakeholders, and they demonstrate certain patterns of behavior in the technical and social environment surrounding the standardization concerned and work hard to lead the standardization efforts [16,26]. For this reason, technological advancement through standardization has not always led to an optical decision that is based on rationality and public good and many times, such a decision was made by the power involved in the decision and the politics of interests [14,15]. These points allow us to take a perspective of a way forward to understand the standardization process, considering technology-economics text as well as interaction and communication mechanisms occurring in the social and political network at the same time [12,27].

In the meantime, this study will provide an even richer explanation as opposed to the existing research body, if the theoretical discussions on the standardization are combined with the theory of diffusion of innovation, neo-institutional theory, and above all network theory. Historically first, the discussion can come closer to the true nature of standardization when it is done through the lens of innovation-related theories [2,28,29]. “If innovation is defined as an idea, practice or thing being newly recognized by an individual or any other entity” [30], or “as a new idea developed and implemented by an actor in relationship with others under the institutional order” [31], innovation and standard can be substituted for each other as almost similar notions. Therefore, an attempt to understand a standard as an innovation may provide an additional explanation on the social environment and institutional structure where the standard is placed as an innovative technology or unit [12,13], and also assists us telling who the innovators and opinion leaders are who will play a critical role in diffusing the standard under such a structure [17,30,32]. This enables us to look in perspective at the actors, the standardization process, structural features, or behavioral strategy of the actors, all embedded in the technical and social environment [31]. Accordingly, standardization-related discussions naturally lead to the discussions on the social system that influences the production, adoption and diffusion of an innovative technology [28], and therefore the point of view broadens our understanding of the social system where standardization takes place with an innovation being diffused focused on the relations between the actors engaging within the social system and their interactions, rather than on the individual characteristics of the analysis units [29,33]. Here, social system means the social structure of overall units that are interrelated and engaging in the joint problem solving for the achievement of a common goal. Rogers [30] contended that the social system has three sub-structures comprising social structure, social norm, and the role of opinion leaders and innovators. Meanwhile, trying to understand innovation, Van de Ven [31] emphasized that supportive leadership is an important element in creating and diffusing innovations in the social network, stressing the role of institutional leadership that tries to form a network within and between organizations. This is because technological innovation takes place in an structural environment where multiple stakeholders participate with their own keen interests and persistent competition and conflicts arising from them [34].

Next, the concept of isomorphism enables us to understand the standardization process as a socialization process. DiMaggio and Powell [35] maintained that every organization is placed in the process where it becomes isomorphic under the institutional influence in the organizational field. Isomorphism refers to the phenomenon that organizations under the influence of institution become similar to each other, and it is triggered by three mechanisms mainly, with regard to which DiMaggio and Powell [35] suggested coercive isomorphism caused by the political influence, mimetic process that occurs in the form of standardization as a response to the uncertainty, and normative pressure that is derived from the norms and values internalized by experts. As such, isomorphism explains how organizations become similar by adopting a single institution and what are the roles of the elite or focal actors involved in the process and their conflicting interests

are. That is, the three causal mechanisms of isomorphism provide an analytic framework to explain what happens in the process of standardization. Moreover, the standardization process can be substituted by the institutionalization process accompanied by conflicts, institutional change or deinstitutionalization process, and the institutional theory explains that in such a situation, the role of agency gets all the more important, further maximizing the structural politics [36]. In other words, it means that in the process where the existing standard is replaced by a new one, a new standard is adopted or it is diffused, the conflicts between stakeholders and the focal actors get to take a far more important role than usual [36].

Lastly, the network theory recognizes that standardization takes place in a comprehensive network-based society where the economic, technical and social characteristics are all condensed. In this regard, Granovetter [37] emphasized that an actor in the network neither conducts his/her activities solely from the economic viewpoint, nor solely under the influence of social institution, but the motivation and his/her actual acts tend to be impacted by the structure of social relations in which they are placed. This argument means that the acts in a networked structure are influenced by the structure of the network or relations with other actors and therefore it implies that in the standardization environment, not only competition but also reciprocal social relations are also hidden in the social structure concerned. This approach is highly differentiated from the standardization process that economics and strategic management attempted to explain in the aspect of competition based on the innovation mechanism. It is also slightly different from the neo-institutionalism that emphasized the standardization process as being under the institutional and social influence without competition in the working generally. As such, it explains all the better the dynamics of the standardization process alternating between competition and collaboration.

Based on the discussions so far, this study tries to recognize standardization as a structural process in the network-based society, with the aim of taking a look later on at how the combination of the environmental characteristics of the network concerned, actors and technology reaches a standard in what process. In particular, for the purpose of taking into account the technological innovation and institutional leadership elements at the same time, of the network theories, this research takes the ANT that highlights the characteristics of actors and the process of forming a network as a basis theory for the discussion hereinafter.

2.2 Actor Network Theory

The ANT looks at the outcome of interactions between actors, organizations, and technology and tools being the non-human actor, through the lens of network formation and diffusion [38,39,40]. Above all, it proposes to see non-human elements like technology as an actor as having the same value as humans. Namely, this theory reinterprets the society as an aggregate of humans and non-humans, and therefore it has an underlying belief in it that technology is not incidental or passive being but has activeness that can change human behavior [38,41,42,43].

Accordingly, standardization discussions through the ANT can be said as a kind of network formation process, for it examines what kind of network individual actors build and expand. More than anything else, the theory takes an ultimate interest in the activities of the focal actor within the network where standardization is discussed, other than the attributes of technology themselves and institutional influence. In other words, the primary interest lies in looking into what kind of relations the actors aim to forge with other stakeholders or technological elements when forming the actor network [42,43,44]. Unlike other theories, the ANT perceives an actor in the network as a dynamic being more than a social actor, and also includes non-human actors like technology as part of the objects to be analyzed [39,42]. This point of view assumes a network has both social and technological factors in it, which makes it possible to deal with uncertainties without any hypothesis beforehand, thus being used in many studies of technological innovation trying to explain the advancement of a certain technology and failure of another [45,46].

Among others, the process to build and expand a connected network is called ‘translation,’ the key point of the ANT [39,42,43]. Translation takes place in four stages, of which the first is ‘problematization.’ In this first stage, each actor defines problems they have to resolve and

proposes solutions, and what is important at this stage is forming an obligatory passage point, which is to disturb the existing network and make other actors their allies. The next stage is named 'interessement,' or offering interests. In this process, the strategy for standardization is offered and actors are attracted to participate in the process. In other words, the process is to build a safety apparatus by isolating the actors forming a potential alliance from other stakeholders and luring them to be on the same side. The third is the 'enrollment,' or role-assigning stage that can be perceived as the process where diverse negotiations, competition and trading take place to perpetuate individual actors' interests in the network. In this stage that follows successful interessement and leads to alliance or de facto enrollment, a standard is agreed as a solution to the problem raised in the beginning and standardization happens. The final fourth stage is 'mobilization,' where a few actors earn legitimacy to represent all.

According to the ANT perspective, by the way, in order for a new technology to be standardized, the efforts and role of the focal actor to have the new technology adopted as a standard are more important than technological edge or sociocultural environment, and undergoing the aforementioned four 'translation' processes, the focal actor should absorb both human and non-human actors in the network as allies to expand its network [44,47].

3. Method

3.1 Analysis Object

As for the core technological factor or non-human actor, this research selects the Service Compatible Hybrid Coded* (SCHC) method, the HD 3DTV technology developed and adopted as an international standard by the Republic of Korea and analyzes the internal and external interactions between the human actors who participated in the standardization process of SCHC. The SCHC method was made the domestic standard in Korea in December 2011 and adopted as an Advanced Technology Standard Committee (ATSC) international standard in December 2012. The HD 3DTV technology standard means a technological standard to transmit and receive 3D content, and the SCHC method enables the homes with an ordinary TV set to watch 2D television and those with a 3DTV to enjoy either 2D or 3D by choice [48]. In the Korean circumstances, the adoption of SCHC as an international standard marked the first such case where Korean-developed broadcasting technology is adopted as an international standard. Until SCHC, Korea's broadcasting and telecommunications services and policies were provided only after the global standard was made and according to it, as underdeveloped countries do when it comes to standardization. That means Korea had only a limited role to play. With the adoption of SCHC as an international standard, however, Korea is allowed the potential to take the lead in the next-generation broadcasting industry both at home and abroad. What differentiated the standardization of SCHC was that the Government (Korea Communications Commission) initiated a network named 'HD 3D Experimental Broadcasting Group' launched in December 2009 and '3DTV Experimental Broadcasting Working-level Task Force.' The Government prepared the framework to earn a 3DTV broadcasting technology standard and formed the experimental group and the working-level task force with human actors comprising the stakeholders from the 3DTV industry including a state-funded research institute, TV manufacturers, and broadcasters (terrestrial, satellite and cable) for the verification and advancement of the SCHC method, the non-human actor.

This research analyzes the period from the formation of the experimental group in 2009 until the adoption of SCHC as an international standard in 2012, and examines the dynamic process where the actors with different goals and interests gathered together, agreed on the common goal of earning the domestic and international 3D broadcasting technology standard and built a network to earn the standards.

3.2 Analysis Method

This study explores interactions between the actors, and

* The existing 3DTV broadcasting technology, the sidy-by-side or top down method, does not ensure backward compatibility with 2D broadcasting. Thus, when watching 3D content in 2D, the screen is divided into two sections. SCHC supplements this and is also called as the dual stream method.

(Table 1) The Actors and the Affiliation and Role of those Actors Surveyed and Interviewed in Depth

	Actor	Main Role	Title	Code	Surveyed	Interviewed in depth
Human Actor	Government	Supporting the standardi-zation of the SCHC method	Deputy Director	A	√	
			Assistant Director	B	√	√
	State-funded research institute	Developing the SCHC technology	Manager-general	C	√	√
			Team head	D	√	
			Senior researcher	E	√	
	TV Manufacturers	Introducing a new technology for manufacturing televisions and applying the SCHC method	Chief	F	√	√
			Chief	G	√	√
			Chief	H	√	√
			Chief	I	√	
			Chief	J	√	
			Chief	K	√	√
	Broadcasting business operators	Implementing 3D broadcasting using the SCHC method	Deputy director-general	L	√	√
			Deputy manager-general	M	√	√
			Deputy manager-general	N	√	√
			Team head	O	√	
			Executive director	P	√	
	Academia	Supporting the standardi-zation of the SCHC method	Professor	Q	√	√
			Professor	R	√	
			Professor	S	√	
Non-Human Actor	3DTV broadcasting technology	Testing and further developing the SCHC method				

the network building and internalization process, i.e. ‘translation’ by applying the four stages of the ANT to the standardization of SCHC. As the key to the ANT is the formation of relations between the actors and the exploration of the translation process, interactions between the actors in the process could be analyzed in depth if the researchers get to observe the process inside the network [47]. In this study, hence, the researchers took part in the standardization process of SCHC, and referred to the secondary data such as press releases, policy reports and standard documents when interpreting the process. The merit of this method is that the researchers can identify the influential relations between the actors accurately while only analyzing secondary data may leave the interactions between the network actors as if in a black box. If the researchers are involved in the network deeply, however, it may result in the research outcome biased toward certain actors. Therefore, for the purpose of preventing bias toward certain actors and instead describing the perception and intention of the actors objectively, this study conducted a survey and in-depth interviews with the researchers involved in the network excluded. The survey was carried out on January 25, 2013, questioning those actors who directly participated in the standardization process as part of the HD 3D experimental broadcasting group and the working-level task force. The questionnaire for the survey was sent to 25 actors, among which 19 responded. The details of the respondents are specified in (Table 1). The questions included their expectations of human and non-human (the technology to be standardized) actors, the interactions between them and their intentions according to the four stages of the ANT, and all of the questions were open-ended ones. Open-ended questions do not confine the scope of the answers unlike those with multiple choice, and thus they allow the respondents to answer freely, which fits an exploratory research like this one [49]. Still, it is hard to get significant answers regarding the perception and intention of the actors at a certain time. This being the case, this research also conducted in-depth

interviews to induce the actors to look back on certain periods in the past and talk about what their recognition and intention were at the time. The in-depth interviews were carried out on March 25, 2013, for which ten actors were selected, who had the highest understanding of the standardization process and thus played key roles. This was a purposive sampling, a sampling method used in the qualitative studies with a limited number of samples. As such, the samples who are likely to give the best answers were purposedly selected [50]. The in-depth interviews were conducted under the voluntary consent of the actors, who were induced to recall a certain period of time before answering. The interview included specific questions not only about the interactions with the non-human actor but also the experiences of interacting with other human actors and the difficulties back at the time.

To ensure internal validity, the study went through the member-check process where the researchers showed the interpretation of the collected data to the actors interviewed in depth and checked whether the interpretation was consistent with what the actors had intended. To enhance reliability, this study underwent peer examination between the researchers involved in the collection of the research materials and data, by cross-examining whether the collected data and the research outcome were consistent. In addition, those researchers who were excluded from the surveying due to their participation in the network were shown the collected data and materials and research outcome to double check if the actual deeds of the actors in the network were correctly described by themselves.

4. Analysis Results

4.1 Problematization

The Government established a policy goal of ‘fostering the next-generation broadcasting industry such as 3D and UHD’ in recognition of the changes in the demand and market landscape in the video and broadcasting field, represented by the success of the movie Avatar. As a way of realizing the goal, the Government set up a plan to raise the viewers’ satisfaction level with the domestic 3D broadcasting, lead the international standardization efforts and support the relevant operators to take an preemptive foothold in the overseas 3D market, by verifying the 3D broadcasting technology in Korea and pushing for its standardization. The stakeholders in the 3D broadcasting field, however, had different expectations and strategies depending on the attributes of their resources including technology, human resources, and spectrum and their market position. This meant difficulty in setting up a single strategy shared by the Government and the private sector to boost the 3D industry. Against this backdrop, the Government commenced the work to help the stakeholders recognize that fostering the 3D industry through standardizing the domestic technology serves the interests of each stakeholder.

This corresponds with the problematization stage of the ANT. Problematization is the stage where the focal actor defines the actors and the network, utilizing its own resources and proposes a certain problem be solved [38,39,45]. In this stage, the focal actor makes the case to attract the actors into the network by demonstrating only it can resolve the problem in question.

The Government began problematization by reflecting its plan to set up a 3D standard onto the framework plan on the promotion of spectrum in May 2009, and started to define the network with a state-funded research institute, TV manufacturers, broadcasting business operators, and other actors. The Government being the focal actor, however, had to get the message across to the actors that the network was in their interest, since some of them were skeptical of the growth potential of the 3D industry and the SCHC method, the non-human actor. The Government stressed that the 3DTVs in the market had the backward compatibility issue with 2D and then-current side-by-side technology required separate spectrum to be assigned to terrestrial broadcasters for 3D services, which was not a viable option at the time. In other countries as well, it was true that 3D content was broadcast only through satellite or cable services and it was difficult to deliver 3D content through terrestial television. Without 3D content produced large-scale, however, it was difficult to have a vibrant 3D industry. In the case of Korea, in particular, most of the broadcast content is produced by terrestrial networks. Under these circumstances, the Government began persuading the actors to participate in the network by letting them know terrestrial 3D broadcasting is

a must. One of the actors working in the Government looked back on what happened and said:

"I persuaded the broadcasters and manufacturers that a new technology enabling 3D broadcasting was being developed and three-dimensional images could be broadcast that the public wanted, and they also knew that fostering the next-generation broadcasting was the huge trend of the times. Avatar swept the country with 3D fever and 3DTV sets were out in the market, and there was the consensus that broadcasting would also have to change (Government A)."

The issues were that TV manufacturers were already selling 3DTVs in the market, and to them a new technology being adopted as a standard meant the existing method would become legacy technology, presenting the likelihood of consumers raising complaints about that. Terrestrial broadcast networks, on the other hand, were concerned about the potential overlap of their business scope with cable and satellite operators if 3D broadcasting was to come in service. As such, in the initial stage of problematization, the actors had different interests and perceptions from each other. The Government formed the HD 3D experimental broadcasting group* so that the actors could make an 'alliance' to pursue the same goal toward the standardization of a 3D broadcasting technology by developing and experimenting the technology. According to Callon [51], the focal actor forms an obligatory passage point by using its own resources including funding, staff and technology to lure diverse stakeholders into the network for the resolution of a problem, by which it can secure control in the network and form an alliance between the actors [38,39,45]. The Government-suggested HD 3D experimental broadcasting group became the obligatory passage point for the actors (after this point, stakeholders are called actors).

The biggest incentive that linked the actors into the network past the obligatory passage point was the fact that the focal actor was the Government. The actors joined the 3D experimental group despite some skepticism about the potential of the 3D industry and SCHC method, for fear of lagging behind the competitors in the preparation for 3D broadcasting if they were excluded from the network. Of the statements by the actors, the deputy manger-general of a TV manufacturer said that "unlike in the past, we are not joining the project because the Government told us to do so. Korea's technological capacity convinced us the potential of the service and we thought the Government's clear-cut policy direction would eliminate much of the uncertainty in the market (TV manufacturer J)." An actor from a broadcaster, in the meantime, said as a leading broadcaster, they had the big goal to provide the viewers with the best available service and the experimental group fitted that purpose.

"3D television was yet to be out in the market and thus making profits out of 3D was not ensured. We have joined the project even though the dual-stream SCHC method was not tested, because the terrestrial networks could take the lead in 3D and we had the expectation that 3D might bring additional revenue in the future (Broadcaster L)."

Aside from them, the actors participated in the network for a variety of reasons. An actor said that "we had the burden of the TV sets already sold but we thought for the development of 3D broadcasting, a balanced end-to-end system that includes 3D content was necessary (TV manufacturer F)." Another actor said "for practical reasons, we do not think 3D broadcasting will be possible in full swing, and we are just curious about the outcome of the experiment (Broadcaster L)," when asked why they joined the network. Other reasons cited included "the SCHC method may cause visual fatigue but it is tremendously important to make the Korean-developed technology accredited by the ATSC (TV manufacturer K)." The motivations were diverse but what was commonly cited was the fact that the Government was leading the efforts.

A state-funded research institute, the standardization association and academia as well as manufacturers and broadcasters joined the network. The standardization association played the role of checking on and monitoring the standardization process. Academia stated like the

2) The goup was set up to test the technology by transmitting and receiving 3D signals in the real-life environment such as through terrestrial, cable and satellite television.

following about the Government's role being the focal actor in the process of problematization:

"Broadcasters and manufacturers wanted to promote 3D broadcasting but they were not in a favorable environment to take the initiative in making investments even without a set standard. Had the Government not moved, it would have been stuck in the middle of nowhere, only making the controversy snowball. Back then, manufacturers and broadcast networks were all looking at the other to make the necessary investment. In this situation, it was crucial for the Government to induce both manufacturers and broadcasters' active participation (Academia R)."

The increasing number of actors also served as an incentive to attract new actors to the experimental group and the working-level task force. Asked whether the participation of other actors such as competitors, other broadcasters or third-party actors had any influence on the decision to join the project, an actor from a broadcaster said "Other companies' participation means relative decrease in our risk in the joint project (Broadcaster M)," so they decided to take part. Another responded that "a large number of organizations being in the network gave us the justification for our participation (Broadcaster L)."

While the interactions between the human actors in the problematization process were observed as described above, the skeptical view of the non-human actor was still there among the human actors. The most problematic were deterioration of the images and visual fatigue. A senior researcher from a TV manufacturer expressed the following concern, pointing out the limitations of the SCHC method itself:

"The problem of the dual-stream method SCHC was that 3D fusion, a phenomenon that the image quality of one part of the screen gets inferior to the main image quality, made eyes tired (TV manufacturer K)."

In the sense that SCHC is the only method that ensures backward compatibility with 2D broadcasting, however, it was not an issue whether to adopt SCHC as a standard. Hence, the focus shifted to the picture deterioration and visual fatigue. As for the deterioration, the state-funded research institute revealed through an expert test and a separate blind test of ordinary people that it does not make a big difference and presented this outcome to the human actors, helping the controversy over deterioration subside. Then, they commenced the stage to get the consent of the human actors about the direction in which the non-human actor is verified and developed. As such, in the problematization process, the focal actor Government began diffusing the notion that the interactions between the human and non-human actors in the actor network would bring the benefits for both the individual participants and the entire community.

4.2 Interessement

Over the course of problematization, the alliance was made in the form of the 3DTV experimental group. Still, the network was unstable because each actor was not linked with a strong bond. Under the circumstances, the focal actor comes to play a role to help the actors build their identity and stabilize, and this is the interessement process introduced by Callon [51]. The key here is to sever the actors from the existing network and provide interests for them to do so [38,39,45,51].

In the past, Government-led technological development and standardization was usually joined by the private sector, but recently private enterprises show a tendency not to follow the Government's lead if benefits are not expected or going with the Government policy harms their bottom line even in the short term. The 3D experimental group network was also initiated by the Government and joined by the actors later on, and there was the possibility that the actors might not play their role or even leave the network in case the network did not meet the interests of each actor or risk was inherent. An actor from the Government who operated the 3D experimental group explained the risk recognized as follows:

"Those working at the broadcasting companies are somewhat conservative. In particular, the first thing technical engineers do, faced with the movement to change the current way even to the slightest possible extent, is to start worrying, because if the change

results in a broadcasting failure, it is going to be a big problem. It was true for the deterioration issue as well. When you compress 18M on 6MHz for transmission, if the image is quick and fancy, it tends to deteriorate even in 2D with a single stream. Then, sending two streams at the same time for 3D image naturally increases the risk multiple times (Government B)."

Thus, the Government began to motivate and assign interests and roles to the actors by persuading them the goal of the 3D experimental group is to standardize the SCHC method and boost the 3D industry, and it is in the same line with the objective of each actor's existing network. The plan was to complete the development of the technology and start experimental broadcasting in 2010 with the view of demonstrating in a tangible manner the possibility of SCHC-based 3D broadcasting. For this, a working-level task force for 3DTV experimental broadcasting was launched in January 2010 with the mandate to work on the HD 3DTV broadcasting preparations at the working level and to forge a strong network within the experimental group. The task force discussed the 3DTV transmission method, conformity standard for 3DTV transmission and reception, and 3DTV-STB interface. For experimental broadcasting, from October 2010 through the end of 2011, terrestrial broadcasters were given an experimental channel and some content for testing 3D broadcasting. It was confirmed by the following statement that the launch of the task force became the opportunity when the actors could build a strong network:

"The most difficult was to talk the management into joining the experimentation 'cause they thought it would not help the revenue much. Equally difficult was to dispel concerns about the fact that a number of staff members had to work overtime until late at night not for profits but for testing a technology, i.e. experimental broadcasting, and those from other business units also expressed concerns about the possible negative impact of the test service such as broadcasting failure on a regular channel (Broadcaster M)."

The actors had a stronger bond with their existing network, i.e. companies or research institutes, rather than with the network of experimental broadcasting. After recognizing the goal of the new network and assimilating into it, however, they began to think about the relation with the existing network. As a result, terrestrial broadcasters began to accept the network as a means to reduce the risk of investing in 3D broadcasting by participating in the experiment with the support from the Government and as an opportunity to experiment the compatibility between 2D and 3D for the first time in the world. Over the course of experimental broadcasting, the interactions between the human and non-human actors were strengthened. During the period, the state-funded research institute tested and verified the SCHC method by discussing the 3DTV transmission method, conformity standard for transmission and reception, 3DTV-STB interface, and so forth.

"With the test broadcasting, the technology was completed down to every detail. Converting content from 2D to 3D requires a seamless technology to synchronize delay in audio and video signals. The technology will become our greatest knowhow when entering the global market (Academia Q)."

With the exhibitions on the occasion of the G20 Seoul Summit in November 2010 and at the ITU Telecom World 2011, and the live broadcasting of the IAAF World Champion hosted by Daegu, Korea in August 2011, the actors were assured of the potential of implementing SCHC and turned more positive toward the standardization of the technology. As such, in the interessement stage, the actors got involved with the new network in a gradual manner and started to find the incentives to be part of or to be 'translated' into the new network.

4.3 Enrollment

Through the interessement process, once-independently acting actors gradually became part of or 'translated' into a single network, and began to recognize what they commonly wanted. To act as one network, the actors are given a certain role, in other words registered with the network, which

becomes the process where the actors are verified their identity [38,39,45,51]. In the 3D experimental group, this came down to the following task. Although the experiment with the SCHC broadcasting was successful, it was conducted on a temporary channel, which only confirmed the potential of 3D broadcasting at the fundamental level. For full-scale 3D broadcasting, trial broadcasting was necessary to test compatibility and conformity with the existing 2D broadcasting by airing content on a regular channel. After discussions about trial broadcasting, the network assigned roles to each actor. The roles of each actor were similar to those for the experimental broadcasting, but more systematic and specific, and the trial was carried out in 2012. Through the trial, the actors began to perceive that the SCHC method as a standard would lead to the commercial use of the technology and boost corporate performance. The following statement confirms this point:

"Technically, the trial broadcasting was no different from the experiment we already did, but it was a trial broadcasting in the sense that if successful, it would allow us to predict possible revenue streams such as from additional advertising, in addition to the fruitful outcome in the form of the promotion of new media Going on the trial stage meant we reached a point where we could make money out of it in the form of advertising sales, etc. (Broadcaster L)."

" For technical test, the experimental broadcasting on a temporary channel was limited to regional receivers. The trial broadcasting on a regular channel, however, was transmitted to every TV in the country, which made us feel that we were getting ready for a full-scale commercial service (TV manufacturer I)."

With the start of trial broadcasting, the actors in the network began to display three-dimensional behavior. That is, in the initial stage where they were forming an alliance after joining the network, conflicts between themselves were not visible. At the trial broadcasting stage, however, conflicts began to rise. This can be attributed to the fact that they felt burdened with finding resources necessary for the trial service and perceived an increase in the risk.

" When we were doing the experiment, it could be done with the help of only some of the technical researchers since it was testing with the temporary transmitter on a temporary channel. The regular-channel trial service, however, had to utilize the channel equipment and facilities at the repeater stations that are used for regular service. Numerous departments involved in transmission reacted sensitively about that, so in terms of increased manhour input and the level of difficulty of the test, it was never comparable at all to the experiment on a temporary channel (Broadcaster M)."

When the trial service was approaching, conflicts between the human actors began to deepen. Among terrestrial broadcasters, each of them began to express their own idea about how to supply and transmit the content.

"Terrestrial, satellite and cable began to differ from each other about how to proceed with the preparations for the trial service. At the core lied content supply. Technically no problem but what to carry in terms of content. There were a few videos filmed with the support of the Government, but it was ridiculously insufficient. Terrestrials had already filmed a few clips but they mentioned copyright. All were sensitive because the retransmission issue was looming large at the time between terrestrial and cable operators. We said this is a test service and it is to promote the 3D ecosystem but they would not budge (Government B)."

As for the content, it was agreed to air 3D images filmed with the Government's support and other content owned by the broadcasters individually. This served as an incentive for the terrestrial operators but cable and satellite operators were forced to transmit the same content for 30 minutes due to the lack of content. This is well testified by the statement that "we had a high risk in 3D broadcasting but we could justify it as content could be sourced by participating in the Government task (Broadcaster L)." In the meantime, from the cable and satellite TV operators, an actor said "we are short of cable TV-formatted content. We requested post-production modification but it didn't happen. Content

sharing by the terrestrial operators was the most wanting (Broadcaster P)."

The human actors caused conflicts among themselves but they also served as an inducement to entice other actors' participation. Manufacturers began to embed an SCHC chip in all 3D televisions affected by the 2D compatibility test result, and supported the reception of SCHC content by providing free software upgrade or attaching an USB in legacy 3DTVs. Once SCHC-available 3D televisions appeared in the market, broadcasters also showed change in their position.

> "Domestic TV manufacturers' production of SCHC televisions was the key reason behind the change in broadcasters' stance on the trial broadcasting. They began to take extra care in terms of content production, transmission, and so on, because viewers could watch 3D content directly (Broadcaster M)."

Over the course of the enrollment process, the focal actor also changed in character. In the problematization and interessement stages, the focal actor Government took the lead in changing the actors' perception and assigned roles to them. When the enrollment began, however, the focal actor then coordinated the differing views of the actors to maximize their interactions.

> "It was hard to lead both the industry and broadcasters for trial broadcasting. Coordinating the interests of the different business operators was a bigger issue than the technical aspect, although we tried our best to resolve problems and gather wisdom through the experimental group and the task force. It was the most difficult to deal with the TV manufacturers' mind games (Government B)."

The concern over the non-human actor raised in the problematization and interessement stages was rather dying down. While some of the actors pointed to visual fatigue likely to be caused by SCHC broadcasting, they all accepted the SCHC method considering the necessity of compatibility with 2D service. The actor from a TV manufacturer who was skeptical of the SCHC method acknowledged that "although dual-stream SCHC technology may deteriorate quality of digital content and cause a safety concern arising from quality difference in the left and right eye image formats, it is the only technology that ensures backward compatibility (TV manufacturer I)." While new problems were raised after the trial SCHC service such as delay in image transmission and quality deterioration in a limited amount of bandwidth, "there has been change in the company's stance that 3D could never be accepted in the regular channel, with the demonstration through the trial service of the possibility of minimizing discontinuance of images during regular 2D broadcasting or converting to 3D seamlessly (Broadcaster M)." As such, the concern over the technology began to subside.

In summary, in the enrollment stage, the network actors were assigned specific roles and began interactions, and as a result, conflicts also emerged. Rising conflicts and interactions between the actors increased the likelihood that the act of an actor is influenced by other actors, which resulted in the natural reduction in the role of the focal actor. Moreover, such interactions were happening focused on the non-human actor in the initial stage of standardization, but as time passed by, the interactions took place more between the human actors.

4.4 Mobilization

The fourth is the last stage to complete the standardization and where the built network starts to show tangible outcome. Callon [38,39,45,51] named this last stage of the ANT as mobilization, and said it is where the network formed through the previous three stages becomes powerful and the existing network actors make good on the promises with the focal actor, luring more actors into the network. The key element in the mobilization process of the SCHC standardization is make the technology a domestic and international ATSC standard, and in this stage, the focal actor who reduced its role in the enrollment process to maximizing interactions between the actors took the leading role again. The role of the focal actor was to entice an external actor with a standardization-related network to the SCHC network.

While testing the technology through experimental broadcasting, the Government induced the domestic standardization association to the network to monitor the work of the HD 3DTV experimental group and the working-level task force and use the results for the domestic standardization. An actor from the state-funded research institute said this process was the most essential in making a domestic standard.

"Through the first experimental service, we verified the proposed technology and at the same time pushed to make it a TTA standard with a domestic standard proposal. By completing the TTA standardization with the second experiment (trial broadcasting), experimental broadcasting and domestic standardization were implemented closely linked to each other, making a good case of collaboration (State-funded research institute D)."

In December 2011, the Telecommunications Technology Association (TTA) adopted SCHC as the HD 3DTV broadcasting standard in Korea. For the international standardization, similar to the domestic one, technical verification through experimental and trial broadcasting was effective, and the most critical was the focal actor induced to the SCHC network the actor who had a network with the international standardization association. The actors were hardly aware of the need for an international standard. This was because after a standard was adopted in the country, they thought content sourcing was more important for the promotion of the 3D industry. Nonetheless, since the Government had the goal of promoting Korean-developed technology and leading the global 3D broadcasting market from the problematization stage, it requested the actors join the efforts to earn an international standard.

"The Government was strongly committed to an international standard. The Government's request to participate in the international standardization efforts had the biggest impact on our decision to be part of the project (Broadcaster L)."

Through the new actor, the Government conveyed to the ATSC the message that it was high time to adopt a 3D broadcasting standard and made the 3DTV new work item proposal (NWIP). With this, it suggested a new study group be made for the 3DTV standard, and created a 3DTV planning team. SCHC testing was completed in Korea and it earned a local standard, which had a positive impact on the international standardization of the technology despite competition with Japan.

"Earning the TTA standard and trial broadcasting had a tremendous impact on the ATSC standardization. Although the ATSC usually requires the candidate standard process, the dual-stream method (SCHC) completed technical verification through local experimental broadcasting. So, it bypassed the additional verification stage and entered the proposed standard stage right away (State-funded research institute D)."

As such, the focal actor mobilized the actors for the end goal and induced a new actor to the network, making the tangible achievement of earning the local and international standard. Still, it should not be overlooked that it could be possible because the Government played the focal actor role. Actor M from a broadcaster who was directly involved in the international standardization process stated the following:

"Japanese companies were surprised and embarrassed to see Korea's proposal and standardization efforts bore fruit. Japan could not raise an objection, since the Korean Government came up with a standard proposal complete with testing from the 3D content production to transmission and reception, by encouraging manufacturers to supply dual-stream (SCHC) TVs and inducing broadcasters to take part in the experiment actively. It was obvious that Japanese companies were envious of the Korean Government's initiative. Afterwards, the Japanese Government rolled up its sleeves to push for UHD, presumably affected by Korea's success in the 3D international standard (Broadcaster M)."

4.5 Evaluation by the Actors on the Standardization Process

The study examined the international standardization of SCHC by analyzing the network from both inside and outside from the formation of the HD 3D experimental broadcasting group in 2009 to the adoption as an international standard in 2012 through the lens of the four stages of problematization, interessement, enrollment and mobilization. Going through each stage, the human actors were engaged in interactions among themselves and with the non-human actor, being 'translated' toward a dynamic stability.

In the process of making SCHC a standard, the focal actor changed in its role dynamically in each stage. In a stage, its role seemed to have been shifted to another actor. In addition, although the actors involved in the standardization process showed diverse points of view in each stage and were positive or negative from time to time, they were absorbed to the network through the translation process as active actors. In this precess, the interactions between the human actors had a significant impact, and sometimes, the silent majority followed the vocal minority's lead.

Undergoing these processes, SCHC accomplished a tangible result of earning the domestic and international standard, but the whole process is given a mixed reception by the actors at the point when their roles in the network terminated. The first is a positive view that earning an international standard is testament to Korea's technological capacity.

> "In the early 1990s when the ATSC broadcasting system was being selected, Korean organizations scarcely participated in the process. The fact that Korean-led dual-stream SCHC 3D system was adopted as an ATSC standard without modifications showcases Korea's capacity was verified in the global stage in terms of next-generation broadcasting technology and standardization (State-funded research institute C)."

> "Participants think that earning an international standard holds an immense significance. In the broadcasting field, they even think it was a national achievement after digital multimedia broadcasting. Yet, it does not seem to give us much meaning as even within the country, the achievement is reported only in one or two lines. In the sense that it is the first standard that is backward compatible, it may give momentum to the manufacturing of TVs and broadcasting, though (Broadcaster L)."

In the meantime, skepticism is still around whether an international standard will have a direct impact on the promotion of 3D services and related industries both in Korea and overseas. An actor from a TV manufacturer said "it is positive in terms of 2D compatibility and full HD 3D service provision, but we have reservation about its potential to become a viable commercial model overseas (TV manufacturer F)." The following statement by an actor from a terrestrial broadcaster can also be understood in the same sense:

> "The Korean-proposed method being accepted by the ATSC is sufficiently meaningful in itself. It is doubtful, tough, whether SCHC can be serviced in the United States. SCHC will be diffused when the service is provided in a virtuous cycle. Technology has evolved, but content lags behind in quality and volume to be accepted by the viewers. For broadcasters, we have to deal with the costs and profits. Only when these are addressed, commercial service will be viable (Broadcaster M)."

In summary, the core technology for 3D broadcasting was tested through a series of standardization processes with the Government being the focal actor joined by multiple stakeholders. Nonetheless, the concern has yet to be dispelled about whether the tested technology could invigorate 3D broadcasting and the industry, and the discussions need to continue into the future.

5. Conclusion

The study examined the dynamic process where participants with different interests developed an innovative technology and made it a standard by joining a network

embedded with the social and technical institution. It explored the interactions among human actors and between human and non-human actors in the social and technical network surrounding the standardization of 3D broadcasting technology. It also observed with focus the activities and change in the role of the focal actor who led the standardization process.

The research suggests that the focal actor has a changing role in each stage in the network, although its role was perceived as static in the past. The interactions between the human actors were most vibrant in the form of conflicts in the enrollment stage where each actor was assigned a role, which in turn led to the process of being translated into the network. The interactions between the human and non-human actors as well emerged fairly important in the problematization and interessement stages, and it was confirmed through a series of processes, dynamic relationships are formed in the standardization process between the overall environment, behavior and technology. This showcases complex relations between the human actors in a standardization network, and testifies that standardization is a process where opinion leaders and innovators convinced by technology and the institutional leadership drive the mimetic and normative isomorphism in the majority of stakeholders who are unsettled about the uncertainty of the changing technological environment [30,35,36,52,53]. It also confirms that in the social network in particular, supportive leadership plays an important role in resolving conflicts and problems emerging when an innovation is created and diffused [31]. In addition, the technology adopted as a standard interacted with the actors in a self-reinforcing manner. In some sense, it is in the same line with the existing research body that policy formation for a technical standard is path-dependent [54,55]. But this view begs to differ to a degree from the endogenous evolutionism talked about in the historical institutionalism. Considering that tensions emerged at various points in the network and throughout its expansion, and the standardization process is still underway in terms of the diffusion and continuous use of the standard, it would be correct to say that path-dependency is confined to the discussions within the country. This research also has limitations. First is about the sampling for the ANT analysis and whether a handful of actors who participated in the standardization of SCHC can represent all. In the standardization process, as for cable operators, only two multiple system operators participated with the recommendation of the Korean cable and telecommunications association, while all the terrestrial and satellite operators and TV manufacturers were represented by themselves. Still, the actors who had direct stake in the 3D broadcasting all joined the process, achieving a sense of representation. Second, an issue can be raised about whether the content used for the experiment represents all genres. That is, for experiment, only track and filed events were live broadcast, which leaves an issue of whether it represents the success of other content. Still, it is evaluated that the live broadcasting of the fastest moving images, i.e. sports games, increased the validity of the technical test. Third, with regard to the analysis method, one may raise the issue that the series of processes from problematization to mobilization may not have happened in the temporal order. As Callon [14] said, the four stages are conceptual ones, and therefore they may occur concurrently or a stage may precede another. Thus, the researchers make it clear that the four stages were divided in the temporal sequence according to which the network got strong, but it was not strictly so and the focus was placed on the discussions of the interactions between the network actors.

Nonetheless, the research holds theoretical significance. First of all, the study examined the dynamic process of standardization within the research tradition of the actor network perspective. There has been little progress in the research trying to reconstruct the dynamics of standardization focused on the Government's role in the network-based society with multiple stakeholders. Accordingly, this study seems to offer a supplementary explanation to the existing standardization discussions about the Government's role as the focal actor that exhibits institutional leadership. Second, this research is differentiated in that the researchers observed the standardization process inside the network and analyzed the dynamics of the interactions between the actors and the role of the technology, which had been perceived as a black-boxed area. As for the policy implications from this study, the actors involved in the standardization network need to consider follow-up measures to diffuse the technology they turned into a standard with difficulty, since

establishing a legal standard out of a certain technology does not necessarily mean that the standard will be universally used as the de facto standard. As suggested by the interviewees, above all things, it is imperative to ensure the stable production, distribution and promotion of the 3DTV content, and through these efforts, the actor network need to be expanded on a continuous basis.

References

[1] G. Tassey, "Standardization in Technology-based Markets", Research Policy, vol.29, no,4, 2000, pp.587-602.

[2] R.N. Langlois and D.A. Savage, "Standards, Modularity and Innovation: the Case of Medical Practice", Path Dependence and Path Creation, Hillsdale: Lawrence Erlbaum, 2001, pp.149-168.

[3] C. Matutes, P. Regibeau and K. Rockett, "Optimal Patent Design and the Diffusion of Innovations", The RAND Journal of Economics, 1996, pp.60-83.

[4] A.L. Russell, "Standardization in History: A Review Essay with an Eye to the Future", The Standards Edge: Future Generations, 2005, pp.247-260.

[5] M.J. Oh, Y.S. Cho and S.W. Shin, "A Delphi Survey for Establishment of Standards Development Strategy in Digital Publication", Journal of Internet Computing and Services, vol.14, no.3, 2013, pp.1-13.

[6] M.A. Cusumano, Y. Mylonadis and R.S. Rosenbloom, "Strategic Maneuvering and Mass-market Dynamics: The Triumph of VHS over Beta", Business History Review, vol.66, no.1, 1992, pp.51-94.

[7] J. Farrell and G. Saloner, "Standardization, Compatibility and Innovation", The RAND Journal of Economics, 1985, pp.70-83.

[8] N. Gandal, D. Salant and L. Waverman, "Standards in Wireless Telephone Networks", Telecommunications Policy, vol.27, no.5, 2003, pp.325-332.

[9] C. Shapiro and H.R. Varian, "The Art of Standards Wars", 1999, pp.8-32.

[10] W.E. Bijker and J. Law, eds. Shaping Technology/ Building Society: Studies in Socio-technical Change, MIT press, 1992.

[11] D. MacKenzie and J. Wajcman, The Social Shaping of Technology, Open University Press, 1999.

[12] K. Jakobs, "Shaping User-side Innovation through Standardisation: The Example of ICT", Techno- logical Forecasting and Social Change, vol.73, no.1, 2006, pp.27-40.

[13] K. Lyytinen and J. Damsgaard. What's Wrong with the Diffusion of Innovation Theory?, Springer US, 2001.

[14] M. Callon and B. Latour, "La Science telle qu\'elle se fait", 1991.

[15] M.L. Tushman and L. Rosenkopf, "Organizational Determinants of Technological-Change-toward a Sociology of Technological Evolution", Research in Organizational behavior, vol.14, 1992, pp.311-347.

[16] V. Fomin, T. Keil and K. Lyytinen. "Theorizing about Standardization: Integrating Fragments of Process Theory in Light of Telecommunication Standardization wars", 2003.

[17] C. Wright, A. Sturdy and N. Wylie, "Management Innovation through Standardization: Consultants as Standardizers of Organizational Practice", Research Policy, vol.41, no.3, 2012, pp.652-662.

[18] J.P. Doh and T.R. Guay, "Corporate Social Responsibility, Public Policy, and NGO Activism in Europe and the United States: An Institutional Stakeholder Perspective", Journal of Management Studies, vol.43, no.1, 2006, pp.47-73.

[19] N. Faysse, "Troubles on the Way: An Analysis of the Challenges Faced by Multi Stakeholder Platforms", Natural Resources Forum, vol.30, no.3. Blackwell Publishing Ltd, 2006.

[20] ISO/IEC: Guide2, Standardization and Related Activities - General Vocabulary, ISO/IEC: 2004.

[21] Telecommnunication Technology Association, IT Technology Strandard and Intellectual Property Strategy, 2006.

[22] R.H. Allen, and R.D. Sriram, "The Role of Standards in Innovation", Technological Forecasting and Social Change, vol.64, no.2, 2000, pp.171-181.

[23] P. Belleflamme, "Coordination on Formal vs. De Facto Standards: A Dynamic Approach", European Journal of Political Economy, vol.18, no.1, 2002, pp.153-176.

[24] J. Farrell, and G. Saloner, "Standardization, Compatibility and Innovation", The RAND Journal of Economics, 1985, pp.70-83.

[25] P. Anderson and M.L. Tushman, “Technological Discontinuities and Dominant Designs: A Cyclical Model of Technological Change”, Administrative Science Quarterly, 1990, pp.604-633.

[26] J.W. Meyer and W.R. Scott, Organizational Environments: Ritual and Rationality, Beverly Hills, CA: Sage, 1983.

[27] J.R. Lee, “A Study on the Emergence of New Stakeholders in the European Standardization Process: a Political Dilemma between Supranationalism and National Delegation Principle”, Social Science Studies, vol.19, no.2, 2011, pp.204-234.

[28] E.J. Iversen, “Raising Standards: Innovation and the Emerging Global Standardization Environment for ICTs”, Standardization and Innovation in Information Technology, 2001 2nd IEEE Conference. IEEE, 2001.

[29] S. Kano, “Technical Innovations, Standardization and Regional Comparison－A Case Study in Mobile Communications”, Telecommunications Policy, Vol.24, no.4, 2000, pp.305-321.

[30] E.M. Rogers, “Diffusion of Innovations/Everett M. Rogers”, 2003.

[31] A.H. Van de Ven, “Central Problems in the Management of Innovation”, Management Science, vol.32, no.5, 1986, pp. 590-607.

[32] E.M. Rogers, “Lessons for Guidelines from the Diffusion of Innovations”, The Joint Commission Journal on Quality Improvement, vol.21, no.7, 1995.

[33] A. Giddens, Beyond Left and Right: The Future of Radical Politics, Stanford University Press, 1994.

[34] D. Harrisson and M. Laberge, “Innovation, Identities and Resistance: The Social Construction of an Innovation Network”, Journal of Management Studies, vol.39, no.4, 2002, pp.497-521.

[35] P.J. DiMaggio and W.W. Powell, “The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Frields”, American Sociological Review, vol.48, no.2, 1983, 147-160.

[36] P.J. DiMaggio, “Interest and Agency in Institutional Theory”, Institutional Patterns and Organizations: Culture and Environment, vol.1, 1988, pp.3-22.

[37] M. Granovetter, “Economic Action and Social Structure: the Problem of Embeddedness”, American Journal of Sociology, 1985, pp.481-510.

[38] M. Callon and J. Law, “On Interests and Their Transformation: Enrolment and Counter-enrolment”, Social Studies of Science, vol.12, no.4, 1982, pp.615-625.

[39] M. Callon, “Technological Conception and Adoption Network: Lessons for the CTA Practitioner”, Managing Technology in Society: the Approach of Constructive Technology Assessment, London, Pinter Thomas, 1995.

[40] L.A. Suchman, Plans and Situated Actions: the Problem of Human-machine Communication. Cambridge University press, 1987.

[41] B. Latour, The Powers of Association, Power, Action and Belief: a New Sociology of Knowledge, 1986, pp.264-280.

[42] B. Latour, “Why has Critique Run out of Steam? From Matters of Fact to Matters of Concern”, Critical Inquiry, vol.30, no.2, 2004, pp.225-248.

[43] J. Law, “Notes on the Theory of the Actor-network: Ordering, Strategy and Heterogeneity”, Systems Practice, vol.5, no.4, 1992, pp.379-393.

[44] Y.J. Bae, “Actor-Network Theory and The Politics of Technology Standard: The Case of AVS(Audio Vedio Coding Standard) in China”, Korean Journal of Political Science, vol.19, no.2, 2011, pp. 281-305.

[45] M. Callon, “Actor-network Theory－the Market Test”, Actor Network Theory and After, 1999, pp. 181-195.

[46] J. Welshman, “The Medical Officer of Health in England and Wales, 1900－1974: watchdog or lapdog?”, Journal of Public Health, vol.19, no.4, 1997, pp.443-450.

[47] B. Latour, “Reassembling the Social-an Introduction to Actor-network-theory”, Reassembling the Social-An Introduction to Actor-Network-Theory, by Bruno Latour, Foreword by Bruno Latour. Oxford University Press, 2005, pp.316.

[48] National IT Industry Promotion Agency, “3DTV Broadcasting Standard”, Matket Trend, 2013.

[49] Y.B. Go, Social Dictionary, Social Culture Research Center, 2000.

[50] S.Y. Jang and W.S. Jang, “A Qualitative Study on Organizational Adaptation of College Graduates with Early Careers”, International Journal of Adult & Continuing Education, vol.11, no.3, 2008, pp.105-138.

[51] M. Caollon, “Some Elements of a Sociology of Translation”, Technoscience: The Politics of Interventions,

1986, pp.57-131.
[52] S.N. Oh and B.G. Lee, “Analyzing Standardization Trends and Strategies of Managed Services”, Proceeding of Journal of Internet Computing and Services, 2012, pp.83-84.
[53] H.J. Jung, “On the Application Plan Study of International Standard Tendency in Software Quality Testing”, Journal of Internet Computing and Services, vol.7, no.4, 2006, pp.1-10.
[54] P. Pierson, “Increasing Returns, Path Dependence, and the Study of Politics”, American Political Science Review, 2000, pp.251-267.
[55] D.C. North, Institutions, Institutional Change and Economic Performance. Cambridge University Press, 1990.

◐ 저 자 소 개 ◑

송 경 희
1990년 전남대학교 영어영문학과 (학사)
1999년 서울대학교 행정대학원 정책학과 (석사)
2008년 하버드대학교 행정학과 (석사)
2012년 연세대학교 일반대학원 기술경영학협동과정 (박사수료)
2013년~현재 미래창조과학부 인터넷정책과장
관심분야 : 인터넷산업 및 서비스, 방송통신기술 표준
E-mail : skh232@empal.com

곽 규 태
2001년 연세대학교 신학과 (학사)
2003년 연세대학교 커뮤니케이션대학원 방송영상학 (영상학석사 수료)
2010년 연세대학교 정보대학원 IT정책·산업전공 (정보학석사)
2014년 연세대학교 일반대학원 기술경영학 (경영학박사)
2003년~2013년 한국콘텐츠진흥원 전략기획팀장
2014년~현재 호남대학교 문화산업경영학과 조교수
관심분야 : 이노베이션, 창의성, 조직이론, 문화산업
E-mail : eyedeer@naver.com

박 수 경
2010년 성신여자대학교 정치외교학과 (학사)
2012년 연세대학교 정보대학원 정보통신·미디어산업/정책전공 (석사)
2014년 연세대학교 일반대학원 기술경영학협동과정 (박사수료)
관심분야 : 인터넷산업 및 서비스, 기술경영, 방송통신기술 표준
E-mail : sk.park@yonsei.ac.kr

이 봉 규
1988년 연세대학교 상경대학 (학사)
1992년 Cornell University (석사)
1994년 Cornell University (박사)
1997년~2004년 한성대학교 정보전산학부 교수
2005년~현재 연세대학교 정보대학원 교수
관심분야 : IT 정책·산업, 방송통신융합정책, 방송통신기술 표준
E-mail : bglee@yonsei.ac.kr