

## Korean Mobile Operators' Value Map for LTE D2D

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### ABSTRACT

Managing the wireless data traffic is a main concern for mobile network operators in Internet of Things (IoT) environment. Long Term Evolution Device to Device (LTE D2D) is regarded as the solution for managing the spectrum efficiency problem, which will significantly affect the mobile environment. The main purpose of this study is to analyze the stakeholders, the key players sharing the spectrum broadband with the mobile operators, and to present the value map of Korean mobile operators and other key players in LTE D2D discovery (commercial) channel. Furthermore, this study suggests a scenario for 'Targeted Advertising' service of LTE D2D. The results of this study have implications on the current understanding of the Korean mobile operators' value map and for future researches on strategies for LTE D2D environment.

### KEYWORDS

Long Term Evolution Device to Device (LTE D2D) Spectrum Sharing; Key Players; Mobile Operators; Value Map

### 1 INTRODUCTION

Smart devices such as smartphone, tablet PCs and other wireless connected devices diffuse rapidly. According to Ericsson, smartphone subscription rose up to 2.7 billion in 2014, and expected to keep increasing (Fig. 1) [1]. The mass of information data is also tremendously growing, and mobile operators try to avoid the data traffic by maintaining the wireless network or allocating the new frequency band [2]. Demand of wireless network keeps growing but the

limited resource of spectrum is assumed to cause overcrowded mobile network by the arrival of new services like Internet of Things (IoT). IoT is a new type of service that will share information through connection to mobile network of all things: home appliances, electronic equipment, automobiles and so forth. In order to invigorate IoT service, discovering new frequency band and developing new technology for prevention of data traffic congestion problem are important to solve the spectrum problem. While the government takes initiative for discovering new frequency band, manufacturers develop new technology for increasing the spectrum capacity [3]. Mobile network operators predict Long Term Evolution Device to Device (LTE D2D) as a suitable solution to the spectrum problem for the next generation. The discussions of LTE D2D were first held on the 3<sup>rd</sup> Generation Partnership Project (3GPP) Onwards Workshop. The LTE D2D was taken into consideration as a new candidate technology for 4G LTE Advanced Rel-12.

The possible commercial scenarios predict that LTE D2D holds the potential to provide an opportunity to the players, who plan to provide new services using LTE D2D.

However, it may fall to being used as a mere provider of 'dumb pipe' for others, like mobile network operators. The issue such as network neutrality is possible to surface again [4].

### 2 RESEARCH BACKGROUND

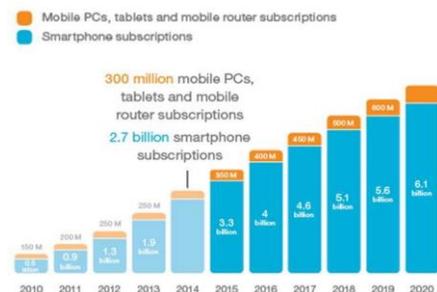


Figure 1. Smartphone Subscriptions in 2014 [1]

A preliminary version of this paper appeared in EECEA 2015 Conference, Feb 12-14, Manila, Philippines. This version is improved considerably from the previous version by including new results and features.

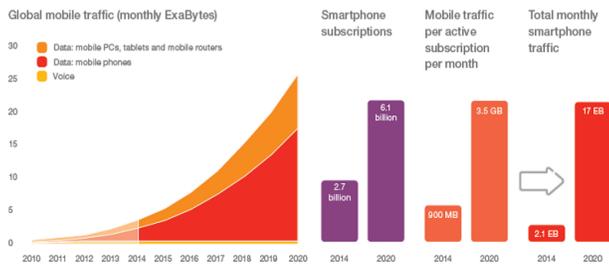


Figure 2. Global Mobile Traffic in 2014 [1]

Currently, South Korea has the highest smartphone penetration rate in the world [5]. One of the reason is the stable and high quality network. The advanced network infrastructure allows Korean access to high quality contents. According to Korea Internet & Security Agency, more than 86.9% mobile internet users in Korea have access to LTE [6].

The advanced network infrastructure and high penetration rate both demonstrate how delivering an advanced network infrastructure and higher quality of contents are critical for the mobile operators. Experts predict that the next business model for LTE is IoT, which creates an environment for devices to connect and share information. Hence, the Korean government attempts to procure the sufficient frequency for broadband mobile services, as the demand for wireless communication is expected to increase with the emergence of IoT.

The Korean government revised the Radio Regulation Law in 2014. The Law stipulates that mobile network operators are allowed to share spectrum with others, such as ventures or small business operators. So far, spectrum in Korea has been exclusively used by broadcasters or mobile network operators. Now, as the Law allows frequency band to be used for ICT business or for social public services, it has created a proper environment for new service communications, such as LTE D2D. LTE D2D allows devices to communicate directly without using cellular network infrastructure. It expects such an appropriate solution to decrease data congestion.

Korea Telecom (KT Corporation) and Qualcomm announced an agreement to jointly develop LTE D2D [7]. KT Corporation is a leading operator that has

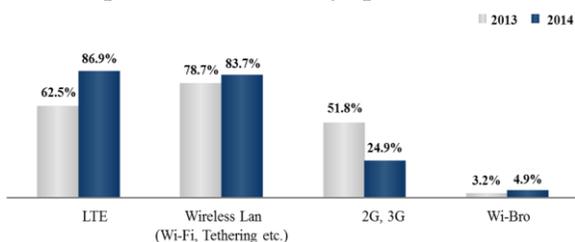


Figure 3. Network Platform Usage for Mobile Internet [6]

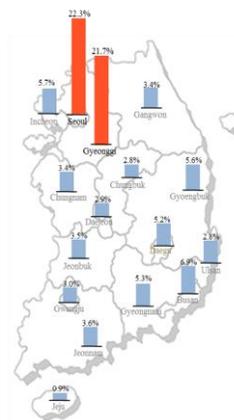


Figure 4. Wireless Data Usage in Main Cities of Korea [11]

already launched world’s first commercial LTE broadcast service. Thus, Qualcomm is planning to start pilot project in South Korea.

LTE D2D seems to have more technical efficiency in the countries with high population density and high rated use of LTE device. Also, application of LTE D2D communication in the places with high population density can bring a significant added value. South Korea has the proper environmental condition for LTE D2D. Fig. 4 shows usage percentage of mobile data in main cities of South Korea. The capital, Seoul and Gyeonggi province illustrates the highest percentage of mobile data traffic congestion. Despite the imminent opportunities the LTE D2D can provide for the mobile network operators, it may also create conflicts between the mobile network operators and competitors attempting to secure the frequency band, as the LTE D2D allow mobile network operators to utilize new frequency band.

### 2.1 Concept of LTE-D2D

LTE D2D communication allows LTE-based devices to communicate without using cellular network infrastructure [8, 9, 10]. The devices communicate directly with one another when they come in close proximity. LTE D2D uses one source (uplink or downlink) of frequency and LTE Time-Division Duplex frequency, which may decrease massive data traffic. At present, technologies such as Bluetooth, Near Field Communications (NFC), and Wi-Fi Direct are used in proximity-based services that are sufficient for short-range communications. However, it is hard for such technologies to support massive proximity-based services. Also, LTE D2D discovers device through only one discovery step and it reduces the battery consumption.



**Figure 5.** Leading Operators of LTE Broadcast [14]

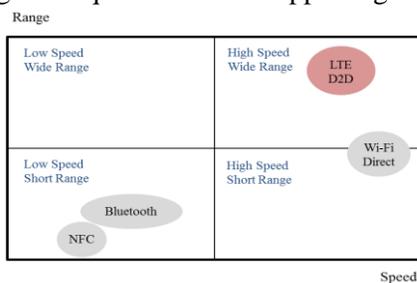
### Process of LTE D2D

- Device Discovery: discover other LTE-D2D based device
- Link Setup: setup link to connect two devices
- Data Communication: transmit data through wireless link to devices

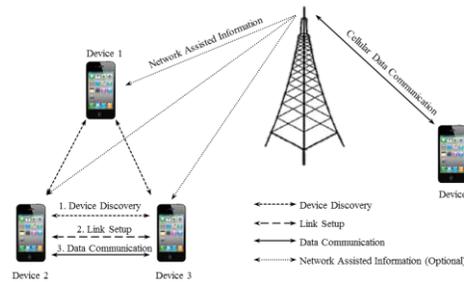
LTE D2D communication process is simple compared to other communication technologies [12, 13]. Through the device discovery step, LTE D2D shares the same spectrum with cellular device and spatial reuse of it to improve system capacity. Through the next two steps, setting up link and transfer data between devices without network-assisted information, LTE D2D will reduce considerable amount of traffic in data-crowded places. LTE D2D also saves power energy. When two devices come in close proximity, there will be lower power requirement for transmission [15]. Apart from technological advantages, LTE D2D also receives showering spotlight in policy-making sectors. It has become a potential technology for IoT standardization in many possible application projects under discussion.

## 2.2 LTE D2D Application Channels

3GPP standardization plan focuses on two application channels of D2D communication service, channels for discovery and communication. Proximity-based services are attractive to such public safety, such as fire-fighting and ambulance [16]. 3GPP complies with a full range of requirements for supporting



**Figure 6.** Comparison of LTE D2D with other D2D [17]



**Figure 7.** Process of LTE D2D [17]

communication channel for national security and public safety [1]. Therefore, it is not proper for business application [17]. Discovery channel is going to be applied for commercial use. This channel permits a mobile device to look around for other devices to ascertain information about it [18]. For example, contents provider can send necessary information and commercial matter of interest to nearby customers, or match information with advertised ones. LTE D2D provides a common language for discovery; while it operates horizontally across apps, operating systems, devices, and operators, exponentially expanding the field of value for proximal discovery. It is also expected to be adopted for many other such services as information delivering service, Geo-Fencing, network games, social matching, and targeted advertisements in the future [19].

## 3 CHANGE OF KEY PLAYERS' ROLE AND ANALYSING THEIR NEEDS

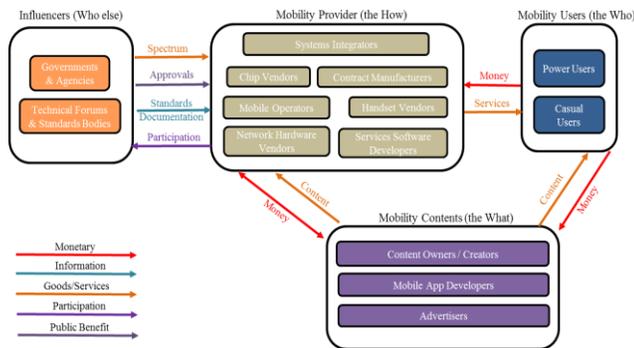
### 3.1 Research Process

To analyze the relationships of key players and suggest the value map of Korean mobile operators for new mobile environment, we followed the next process.

In section 3.2 we select key players for LTE D2D communication through the literature review, which are: mobile operators, hardware & chip vendors, service & contents providers, and influencers. Then, we identify their issues that could cause conflicts in value flow.

Section 3.3 presents value map and value flow of key players' needs in direct relationships with mobile operators. The value flow's factors are monetary, information, goods/services, participation, and public benefit. The needs of key players are classified in common, synergistic, and conflicting needs.

Section 3.4 verifies the value map through in-depth interview of experts from Korean telecommunication companies. Through the interview, we descript



**Figure 8.** Smartphone Ecosystem of Key Players [20]

unknown issues, drawn through literature review, and suggest solutions to this issues.

In the last section 4, this study proposes scenarios by analyzing the relationship flow and technical needs of key players in targeting advertising service, which is the main service flow in LTE D2D. Scenarios present roles of key players in service supplying process, and predict cooperation plan in short and long-term. Also necessary technical requirements are suggested.

### 3.2 Identification Issues and Roles of Key Players

The flow of mobile service ecosystem is illustrated in Fig.8. Avrind (2009) classified stakeholders into four types identified by questions ‘who’, ‘what’, ‘how’, ‘how else’ and illustrated the value flow types [20].

Based on this classification, this study analyses roles of key players of LTE D2D communication ecosystem, focused on mobile operators’ perspective. The key players and their issues in LTE D2D commercial channel are identified by reviewing papers, articles, news and studies, related to the environment [8, 9, 10, 17, 18, 21, 22, 23].

Through the literature review, the study sets key players, who are directly related to the mobile operators. The final key players of the study are mobile operators, hardware & chip vendors, service & contents providers, and influencers (governments, standard bodies, forums etc.).

- *Mobile Operators*

LTE network is appropriate for transmitting multimedia contents that could cause mass of data traffic. In mobile operators’ perspective, LTE D2D will decrease the maintenance costs of wireless network. In addition, by expanding coverage, data provision in coastal areas and mountainous regions becomes possible in stable speed. Three main mobile network

companies in South Korea are KT Corporation, SKT, and LG U+. As people have more than one mobile device, the number of the devices became higher than population in South Korea. Therefore, mobile operators don’t compete with attracting new subscribers, but to lure subscribers from other company. Especially mobile operators’ strategies are more related with transmission and reception speed of the data. Hence, with LTE D2D, they can utilize the acceleration of data speed for marketing and can have competitive advantage in the LTE quality competition and development competition for next 5<sup>th</sup> Generation (5G) mobile technology.

Mobile operators, however, may face two major problems; first, data usage of the users may decrease in the short term and Average Revenue per User (ARPU) may be reduced in the long term [16]. Second, mobile operators may lose their control and domination of the network, because information is not stored in the communications company as the communications between devices do not pass through base stations [17].

- *Hardware & Chip Vendors*

The hardware & chip vendors play an important role in LTE D2D. They can choose one of the strategies that will change the whole profit structure. The hardware & chip vendors can develop devices with embedded technology or just insert a chip into existing devices. Depends on the players, the diffusion method of the technology will be change. Therefore, mobile operators and hardware & chip vendors should cooperate. KT Corporation and Qualcomm started LTE D2D development project together from 2014 and calls it ‘LTE Direct’. Qualcomm is going to make a chip into the LTE D2D device. Also, they are planning to start pilot project in South Korea.

When the LTE D2D is commercialized, hardware & chip vendors will have the benefit of the expanded market. Thus, the development of chips must fit their scale of profit and loss. If the government allows LTE D2D only to be used for public disasters, hardware & chip vendors will have difficulty in making profit with disaster network, because the demand for disaster mobile phone is estimated at 200,000 units in Korea [7]. Therefore, hardware & chip vendors will expect to conduct new commercial service such as advertisement by using discovery channel of LTE D2D. Especially, companies like Qualcomm can use the framework among devices in the future business, such as for IoT environment [14, 23].

- *Service & Contents Providers*

In this study, service & contents providers are including not only content owners/creator, mobile app developers but also advertisers [20]. If service and contents providers use a discovery channel, the devices within the 1km boundary will receive a specific promotion or advertisement. They have it as their purpose to make their information known to as many people as possible. Therefore, they will want to acquire as much information as possible and want their information to be exposed preferentially, which makes various business models possible. As it is still in incipient stage in the introduction of LTE D2D, specific business models are not yet discussed because it is expected that future business models will be different depending on the initial setting. Thus, so far business structures can be predicted within the range of technological possibilities.

Location-based Service (LBS) providers and mobile app developers can participate in this kind of business. Various businesses are engaged in marketing activities such as coupon mailing by using location information of the smart phone users. In the past, this kind of target marketing required passing through specific service platforms. In the case of LTE D2D, information transmission is possible through built-in chips without passing through service platforms. Thus, small businesses or advertisers can deliver their information in cheap cost. Various businesses can participate in the business utilizing LTE D2D by using the network of the mobile operators. As service & contents providers engage in business by utilizing the network of mobile operators, there may be cases when their business models overlay each other. Although it is difficult to predict specific business models, it is possible to predict business structures if the needs required for the player to make profits are analyzed.

- *Influencers (Governments, Standard Bodies, Forums)*

Other than institutions that produce, distribute and promote LTE D2D services, regulations are required so that this technology can be utilized efficiently in the market. The role will be undertaken by governmental institutions, which enact and manage standards and policies, standard bodies and technical forums.

The government should implement policies pertaining to the frequency and standards to vitalize LTE D2D. The government has the most important role as it sets the standards to change the roles of players. They have to continuously provide their backup so that problems

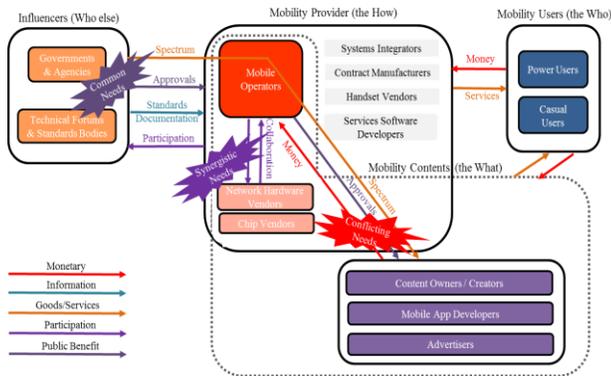
can be prevented after LTE D2D is utilized as well as before. First of all, standards for LTE D2D must be prescribed. Currently, standardization work is being conducted in 3GPP and an institution named Telecommunications Technology Association (TTA) conducts this role in Korea. Standardization work for LTE D2D is still in incipient stage and following problems should be solved in the future. 1) The problem is what kinds of cellular resources will be shared. There can be interruptions which cellular link imposes on D2D link, interruptions which D2D link imposes on cellular link and interruptions among D2D links. 2) Standards for synchronization among terminals are being discussed as a vital issue. 3) As terminals maintain both cellular link and D2D link at the same time, we have to decide whether to uplink or downlink those [15]. According to Alastair Brydon's prediction (2014), we will have to think about and decide the followings; we have to choose static or dynamic allocation for frequency resource [18]. In addition, propagation characteristics for D2D communication should be decided differently from the previous ones. Either general LTE communication should be used or algorithm should be developed that can convert LTE D2D. Besides, we also need to decide on either synchronous D2D discovery to reduce battery or asynchronous D2D discovery for flexibility.

Also one of the important problems will be privacy and security. As LTE D2D discovery channel must provide tailored services, it is expected that there will be privacy problems raised in the future. 3GPP pointed out "Laws related to communication records and anti-hacking measures of each country should be considered" and especially security problem can be raised such as stealing information from a third device during communication between two devices [24]. Even when LTE D2D is vitalized, privacy and security problems should be continuously solved. Influencers must provide backup so that key players can maintain LTE D2D in good condition. As the goal of influencers is to introduce and vitalize LTE D2D in domestic market, they will play the role of helping other key players.

### **3.3 Role and Relationships of Key Players**

To compare pre and post introduction of mobile environment, the study developed Avrand's mobile ecosystem framework.

Subjects of the relationship analysis were limited to mobile operators, hardware & chip vendors, service & contents providers, and influencers. For the parsimony of the study, other players were excluded. In the past,



**Figure 9.** Value Map of LTE D2D Key Players

there was clear distinction between mobility provider and mobility contents. As section 2 reviewed, now mobile operators, hardware & chip vendors, service & contents providers can all provide mobility contents.

In this case, conflicts may arise since business model can overlap one another. This study analyze key player's needs based on classification of Cameron et al. (2008): 1) common needs, 2) synergistic needs, 3) conflicting needs and 4) orthogonal needs [25]. Then, we suggest the value flow map by applying their needs and roles.

Common needs mean that the players have the same goal. That is, as the goal of influencers and mobile communication business is to use LTE D2D in a stable manner, they can be said to have common needs.

Synergistic needs arise when key players are related. It means satisfactory activity of a player also helps another play to achieve satisfactory result or same action satisfies different needs. For example, when the number of LTE D2D subscribers of mobile operators increases, hardware & chip vendors can also reap profits as the number of devices increases accordingly. This means that mobile operators and hardware & chip vendors have synergistic needs each other.

Conflicting needs generally are caused by external constraint and refer to needs that can arise in restricted circumstances. Orthogonal needs are not influenced by the satisfaction of other needs. As this study drew out only the key players that influence one another, players with orthogonal needs were excluded. The roles of key players, which change around mobile operators in LTE D2D environment, are shown in Fig. 9.

### 3.4 Results of Korean Mobile Operation Experts' Interview

To verify the value map of LTE D2D key players, this study conducted in-depth interview of Korean experts from telecommunication companies. Respondents of the interview were 9 experts, who work for major

mobile operators of South Korea, SKT, KT, LG U+. They were restricted to experts in strategy department or research department with minimum 12-year career experience in the field. Represents that has prior knowledge on LTE D2D were selected. Questions were composed of the strengths and weaknesses of LTE D2D in the perspective of mobile operators, verification on the conceptual map and prediction of relationship with key players.

The results can be summarized as follows;

- *Strengths and Weaknesses*

First, mobile operators can maintain the stable wireless network with reduction of traffic burden. Second, new business models are available, such as IoT. With the saturation of mobile communication market, mobile operators try to create new profits through IoT. Mobile operators can secure 'stable and comprehensive connectedness' which is the core factor of IoT by utilizing mobile communication network.

Third, there was prediction that if LTE D2D service is provided by mobile operators, it may be beneficial to the maintenance of subscribers with the expansion of conveniences.

Still, most discussions about strengths and weaknesses focused on the traffic and profitability. For the investment of mobile operators in frequency and access network, realistic source of profit is the price users pay for their usage of traffic (Korea mobile operators paid a total of US 2.4 billion dollars in the auction for LTE frequency). Therefore, although the commercialization of LTE D2D is desirable in term of cost reduction due to decreased traffic burden, it might not be beneficial to profit-making, if it becomes difficult to bill on the traffic. Especially, as current income system or communication system cannot accommodate circulation of information which does not pass through base station, this can work as a burden for development of new technology and investment.

- *Verification on the Value Map*

Then, the value map was conducted by considering the relationship between the mobile operators and other key players.

- 1) Relationship between Mobile Operators and Hardware & Chip Vendors

The relationship between mobile operators and hardware & chip vendors has synergistic needs. There were opinions, however, that they can develop into a

relationship with conflicting needs depending on business model. In addition, in Korea, mobile operators have bargaining power in buying the devices. Distribution structure of cellular phones in Korea is peculiar, in which hardware & chip vendors are in subordinate relationship with mobile operators because consumers can purchase their cellular phones only in agencies of mobile operators. Thus, the sales channel of hardware & chip vendors is not cellular phone users but mobile operators, which means their sales cannot be made without the distribution channel of mobile operators. Even though Hardware & Chip Vendors release a magnificent device, sales cannot be made without the cooperation of distribution network. One of the interviewees compared this relationship to that between the 'crocodile' and the 'crocodile bird'. Hence, there is little possibility for hardware & chip vendors to load functions unfavorable for mobile operators. Therefore, if hardware & chip vendors make profit-making structure in cooperation with mobile operators, they can spread devices much quickly.

## 2) Relationship between Mobile operators and Contents Provider

First, if the contents provider can create paid business model and second, if LTE D2D-based platform is attractive as an advertising medium. In order for LTE D2D service to become an advertising-based business model, securing sufficient number of subscribers is the key for successful entry which can be recognized as stable advertising base by the advertisers. Hence, both securing early subscribers (dissemination rate of device) and creation of ecosystem are important. The most important issue between mobile operators and contents provider was billing system as well. As service & contents providers use mobile operators' network, there has to be the issue of network neutrality. Network neutrality started from the structure in which users' traffic continuously increases in unlimited environment while the network operators bear all the burden of investment in the network. Although some experts had the opinion that commercialization of LTE D2D would cause similar problems, it was predicted that the discussion might be different from existing network neutrality because mobile operators cannot argue their rights (including the burden of traffic) other than use of frequency as LTE D2D conducts direct communication without passing through base stations of mobile operators. In addition, there were worries that in case users of unlimited data cause traffic with the role of gateway or offload through landline, traffic and profit structure of the operators can be changed,

which might be a difficult condition for the mobile operators. In addition, the questions were raised as to whether additional investment is needed for the security of contents which do not pass through network and who's going to make the investment.

## 4 SCENARIO BASED APPROACH

As it was analyzed that the relationship between the players and needs can differ depending on the business model, this section conducts scenario analysis on specific service selected, which is 'Targeted Advertising' in Fig. 8. The targeted advertising was selected because it is the area in which players are expected to most actively participate due to clear profit structure and it is a service in which players could have synergic and conflicting needs.

Scenario means the order of hypothetical things designed to focus on point of decision or causal relationship [26]. In addition, scenario is a methodology which is typically used in studies that predict the future. Scenario includes narration, images and maps, which describe the path from the present to the point of the future [27].

The technique of scenario is first, hypothetical and second, has its purpose in representing simple description or outline. Through this, it enables finding out potential problems which may arise if the planned work is performed. It can inform the necessity of advance preparations to minimize problems and obstacle or opportunity lurking in the work planned and to be executed [26].

Also, scenario technique provides decisive help in establishing systematic plan by actively relieving uncertainties of the future [27].

### 4.1 Service Scenario

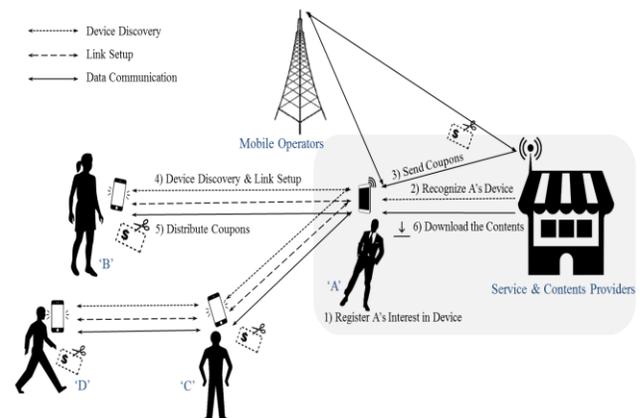


Figure 10. Scenario of Targeted Advertising in LTE D2D

When using LTE D2D in 'Targeted Advertising', the onerous trouble in the past of authorizing and activating provision of location information to receive Targeted Advertising disappears.

It means that users don't have to register or authorize location in advance. In addition, exceedingly fast search of adjacent terminal makes it easy to receive information on the location of nearby stores or discounts available. As its search radius is around 1 km, it can be used to promote products or issue coupons to potential customers far away [17]. Users may receive only the information of their interests by setting categories desired or service providers preferred in advance.

- 1) 'A' possesses a cellular phone loaded with LTE D2D function and is interested in films. 'A' registered his interest in his smart phone.

Various methods can be used to register unique ID and interests in a smart phone. Mobile operators can collect related information or they can be registered as basic information in the device. Besides, one can use other applications provided by service & contents providers. When users use applications which service & contents providers supply or stores information in the device itself, mobile operators have more or less trouble getting involved in users' information.

- 2) When 'A' enters a shopping mall, theatres and film contents businesses in the surrounding area recognize his/her device. They recognize those with LTE D2D device like 'A' within their range.
- 3) The theatres and film contents businesses send necessary advertisements and information by filtering information 'A' prefers. 'A' receives high-capacity multi-media advertisements on films of interest. The advertisements include discount coupons for movie tickets and mobile downloads for those within 300 meters with interest in films and advertisements.
- 4) Receiving interesting advertisements, 'A' wants to relay the advertisements to people in surrounding area. At the same time, A's device goes through device discovery process. A's device creates links with 'B' and 'C' who try to download the same contents in the adjacent location (link-setup stage).

Device discovery process is when each D2D device searches other devices with D2D communication

capability in the surrounding area. Each device must know what are in surrounding area, through which it decides whether to create D2D communication links among devices. Adjacency can be defined by mobile operator first. Device can decide adjacency by using wireless signal or network according to the selection of mobile operators or users.

Link-setup stage is when a device, which tries to transmit data to surrounding D2D devices found in device searching stage, sets up link for data transmission. If A's device sends a signal to other devices requesting link creation, 'B' and 'C's devices receive the signal and send responses.

- 5) A's device distributes contents through D2D communication without using base station.

In this process, the device can send information through its built-in chip without going through additional service platform. Then, 'A' becomes a service platform itself, which can be seen as a change in the concept of service platform. This business model can work properly even in social commerce service, in which transactions are accomplished only when a certain number of people gathers together.

- 6) Deciding to download a film, 'A' accesses related market, buys and downloads the contents. If 'A' can resell the downloaded contents to other adjacent devices, the owners of the devices can expect reduction in both network use and contents purchase cost.

#### **4.2 Cooperation Plan among Key Players (Long-term, Short-term)**

If the players have access to the service above, the players may have access to the following benefits; Mobile operators may use a single communication channel that can provide the same contents for numerous devices within the same location. This allows mobile network operates to reduce the load of network it needs to provide the contents to the users. Hardware & chip vendors will require killer applications to spread D2D devices. A killer application means computer software with the ability to make it mandatory to use a specific platform. From the perspective of marketing, the concept of killer marketing is goods and services produced by specific industry, which work as products that play the role of driving force for the growth of the industry. The existence of this kind of killer applications can lead to creation of demand and sale of the devices. For the

service and contents providers, this enables network access of a bigger number of terminals, which increases opportunity for sales of contents. For example, store owners can deliver tailored sale information by searching mobile terminals of customers in the store. Users can be provided with the services they need, that can be easily found in nearby places and make payment with ease by communicating with server without having to line up. For the services in the above scenario to be possible, coordination of interests among players and cooperation is required. Because mobile operators need to expect profit model from service and contents providers who want to make advertisements.

Long-term cooperation plan among players and direction of cooperation, according to service flow can be suggested as follows; First, long-term cooperation plan requires standardization of method and range of D2D communication, information acquired and recording methods, which in turn requires active participation of influencers (governments, standard bodies, forums) as well as players involved in the business.

Second, it also requires regulations on the methods of D2D communication and service provision. When direct communication link is set up, data transmission between two terminals is conducted exclusively through direct communication link only. Base station, however, must know information such as movement of terminals, channel status and communication condition to manage direct communication among terminals. In addition, as it must know the amount of data transmitted to calculate fares, regulations are required for this. Third, integrated support for communication among players and provision of service is required. The Quality of Service (QoS) users feel decides the success and failure of the service which is first introduced in the market.

In addition, since the service above creates and records payment information, the principal agent and method of management should be clearly established. Cooperation as required is timely provision of related information, immediate search when requested and authorization. The process of exchanging control signals regularly between base station and terminals is required. Besides, in the case of imposition of fare and authorization, security among players is also critical.

### 4.3 Technical Requirements

Solutions for the issues discussed so far were suggested as follows; For LTE D2D to be profit source for the mobile operators, it is necessary to find ways to

measure communication details and amount of data usage by using software. If mobile operators lose control after the commercialization of LTE D2D, they only provide their network and don't get any benefit from it. Although there is possibility for the issue of network neutrality to be raised based on the technology method, it was predicted that the problem is economically soluble. It is an important task for mobile operators to prevent unilateral loss from free business model.

Another technical issue, that can be raised, is the coverage of D2D communication and battery consumption of the devices. Kim and Lee (2014) analyzed how advertisements using D2D communication spread within the desired valid advertisement range [12]. As the result of the analysis, it was found that while setting up a wide transmission range enables wide advertisement range in an environment with low density of terminals, battery consumption of relay terminals increases due to increase in transmission power and unnecessary traffic increases with the increased overlaying range. On the other hand, while setting up a narrow transmission range reduces battery consumption and unnecessary traffic, only a relatively narrow advertisement range is secured. Therefore, if setting up of parameters such as the proper range and number of sectors of terminal transmission and technical development on battery consumption are discussed with hardware & chip vendors, better and improved services can be made possible.

## 5 CONCLUSION

This study discusses the issues and provides solutions pertaining to the LTE D2D discovery channel from the perspective of the mobile operator. Through the literature review, the study selected key players related to mobile operators, which are hardware & chip vendors, service & contents providers, and influencers. Roles and relationships of key players are illustrated, based on Avrind's (2009) framework, and the value flow is suggested, refer to their needs. The proposed needs are as followed: monetary, information, goods/services, participation, and public benefit. The study verified the conceptual value map and presented various solutions to unknown issues from literature review, by conducting the in-depth interview of experts, who works in Korean telecommunication companies. The results are as followed. First, new mobile environment can become an opportunity or threat to mobile operators. LTE D2D will solve the data traffic burden, and mobile operators could maintain the stable

wireless network with less expense. However, the new profit process can effect on the tariff scheme of mobile operators and further on funds for technology development. Second, after LTE D2D service will utilized, mobile operators and influencers are going to have common needs, as efficient use of spectrum resource and widespread of service. However, because channel and service standards are not designed yet, there is a possibility of conflicting relationships, too. Third, mobile operators and hardware & chip vendors are going to have synergetic needs, because mobile operators' role is necessary for hardware & chip vendors. In South Korea, mobile operators have the control power on mobile distribution market. Therefore, the chances are high that hardware & chip vendors will launch new devices with imbedded technologies, such as monitoring or billing structure technology. Forth, key players, who will have conflicting needs with mobile operators are going to be service & contents providers. The main issue is what kind of business model contents providers will distribute, and whether the LTE D2D platform is enough attractive as a medium of advertisement. Another important issue also was a tariff. For example if user of limitless tariff acts as gateway he/she can cause data traffic, or if user offload information through wired network it will effect on mobile operators' income structure. Up until now, LTE D2D technology is going to be used on simple areas, such as connection to accessories. But in the future, it is going to be used in other various fields, such as network games, social matching service, and target advertisement. Therefore, whether it will be an essential technology or not, depends on the roles of these key players.

This study suggested scenario for the future targeting advertisement service, and analyzed cooperation plan and technology requirements. As result, for the active and successful service, it is important to have high demand. Therefore, killer applications and contents are requires. Also, it is necessary to determine the method and scope of LTE D2D communication system. To make the suggested scenario possible, first, standardization for receiving information and for recording information is important. In addition, agreement about service providing process and communication among key players is necessary. Specifically, the authorization of service, deciding session, and payment communications has to be discussed. Finally, for the mobile operators, it is necessary to find ways to measure communication details and amount of data usage by using software, profit source. If mobile operators lose control after the commercialization of LTE D2D, they can only provide

their network and don't get any benefit from it. Although there is a possibility for the issue of network neutrality, based on the technology method the problem is economically soluble. It is a task for mobile operators to prevent unilateral loss from free business model.

In order for LTE D2D to be an attractive service, the roles of mobile operators and contents provider are very important. It will decide whether or not LTE D2D will be a successful advertising platform. The most important issue, however, is none other than billing system. For LTE D2D to be a profit source for mobile operators, it was analyzed that an alternative is required, which can measure the communication details and data usage. As discussed, for successful dissemination of LTE D2D, it is important for the key players to effectively build this service ecosystem.

This study has its limitations of conducting the analysis and scenario at the early discussion stage of LTE D2D, when there is not a specific business models. Still, this study has its meaning in suggesting the perspective of mobile operators, who are the key players of LTE D2D. It provides directions and discusses solutions for the issues among players to help LTE D2D service take firm place as an essential service in the future.

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## 7 REFERENCES

1. Qureshi, R.: Ericsson Mobility Report, Ericsson, pp. 1--32 (2014)
2. Lee, Y.J., Oh, J. and Lee B.G.: Logical Push Framework for Real-time SNS Processing, Proceedings of the The 4<sup>th</sup> IEEE International Conference on Computational Aspects of Social Networks Conference, Sao Carlos, Brazil, pp. 47--51 (2012)
3. Jun, E.S., Park, K.C. and Lee, B.G.: Analyzing Spectrum Management Policy for Utilizing TV White Space, Proceedings of The International Conference on System Electronic Engineering Conference, Phuket, Thailand, pp. 48--52 (2012)
4. Kim, J.Y., Park J.K. and Lee, B.G.: Mobile Network Neutrality in Smart Phone Era, ITS Asia-Pacific Regional Conference, Wellington, New Zealand (2010)
5. MT News, Generation of 40 Million Smartphone Subscribers is Coming,

- [www.mt.co.kr/view/mtview.php?type=1&no=2013122423081279407&outlink=1](http://www.mt.co.kr/view/mtview.php?type=1&no=2013122423081279407&outlink=1)
6. Korea Internet & Security Agency: Survey on Mobile Internet Use in 2014, Korea Internet & Security Agency Statistics Report, pp.1--23 (2014)
  7. Edaily News, Is Qualcomm Going to Start Device-to-device Communication Era, [www.edaily.co.kr/news/NewsRead.edy?SCD=JE31&newsid=01115206609234768&DCD=A00503&OutLnkChk=Y](http://www.edaily.co.kr/news/NewsRead.edy?SCD=JE31&newsid=01115206609234768&DCD=A00503&OutLnkChk=Y)
  8. Korea Communications Agency: D2D Technology and Market Trends, Korea Communications Agency Issues & Prospection, vol. 16, pp. 1--10 (2013)
  9. Doppler, K., Rinne, M., Wijting, C., Ribeiro, C. and Hugl, K.: Device-to-Device Communication as an Underlay to LTE-advanced Networks, *IEEE Communications Magazine*, vol. 47, no. 12, pp. 42--49 (2009)
  10. Asadi, A. and Mancuso, V.: WiFi Direct and LTE D2D in Action, *IEEE In Wireless Days*, pp. 1--8 (2013)
  11. Joongang Daily, If You Know Data Traffic, You Can Get Future Purchasing Power, [article.joins.com/news/article/article.asp?totalid=6793758&cloc=olink|article|defaultsed](http://article.joins.com/news/article/article.asp?totalid=6793758&cloc=olink|article|defaultsed)
  12. Kim, J. and Lee, H.: Advertisement Coverage Analysis of Social Commerce Service with D2D, *Journal of the Korea Institute of Information and Communication Engineering*, vol. 18, no. 7, pp. 1547--1556 (2014)
  13. Sung, S.I., Hong, J.W., Kim, J.S., Park, S.I., Park, C.W., Choi S.H. and Lee, K.B.: Cellular Networks D2D Communications Trends, *Journal of The Korean Institute of Communication Sciences*, vol. 29, no. 7, pp. 97--105 (2012)
  14. Qualcomm: LTE Direct Always-on Device-to-Device Proximal Discovery, Qualcomm Report (2014)
  15. Kang, G.M., Kim, H.M., Nam J.H. and Shin, O.S.: LTE-Advanced Communications and Technology Standardization, *Journal of Electromagnetic Engineering and Science*, vol. 24, no.5, pp. 52--64 (2013)
  16. Park, S.K., Kwak, J.H. and Lee, B.G.: Is ARPU the Right Choice for Wireless Data-based Communication Services?, *Proceedings of the The 4<sup>th</sup> IEEE International Conference on Computational Aspects of Social Networks Conference*, Sao Carlos, Brazil (2012)
  17. Kim, T.J.: D2D, Changes and Implications, *Digienco Issue & Trend* (2014)
  18. Brydon, A.: Opportunities and Threats from LTE Device-to-Device Communication (2014) [www.unwiredinsight.com/2014/lte-d2d](http://www.unwiredinsight.com/2014/lte-d2d)
  19. Multilog Blog: Next Device-to-Device Direct Communication, LTE Direct, Concept and View (2014) <http://donghun.kr/1375>
  20. Arvind, A.S.: Stakeholder Value Network Analysis for the Mobile Services Ecosystem, Doctoral Dissertation, Massachusetts Institute of Technology, Cambridge, United States of America (2009)
  21. Lei, L., Zhong, Z., Lin, C. and Shen, X.: Operator Controlled Device-to-device Communications in LTE-advanced Networks, *IEEE Wireless Communications*, vol. 19, no. 3, pp. 96--104 (2012)
  22. Mumtaz, S. and Rodriguez, J.: Introduction to D2D Communication, *Smart Device to Smart Device Communication*, pp. 1--22 (2014)
  23. Qualcomm: LTE Direct, Operators Enabled Proximity Services, Qualcomm Technologies Report (2014)
  24. ET News, Emerging Issue: LTE-D2D, [www.etnews.com/20140307000077](http://www.etnews.com/20140307000077)
  25. Cameron, B.G., Crawley, E.F., Loureiro G. and Rebutisch, E.S.: Value Flow Mapping: Using Networks to Inform Stakeholder Analysis, *Acta Astronautica*, vol. 62, no. 4, pp. 324--333 (2008)
  26. Noh, D.: A Study on the Forecasting of Library Service with Scenarios, *Korean Library and Information Science Society*, vol. 35, no.4, pp. 361--375 (2005)
  27. Seo, H., Lee, J. and Oh, J.I.: A Study on the Development Methodology of the U-city Service Scenarios which Apply the Scenario Management Techniques, *Information System Review*, vol. 11, no. 2, pp. 23-- 44 (2009)