Mobile Broadband Traffic Forecasts in Korea

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Abstract: During many years, the dominant traffic in mobile broadband networks was voice. However, with the introduction of diverse mobile broadband equipment, the situation has changed. Since mobile broadband devices can allow users to access information instant and connect to web quickly, the mobile world has been revolutionized, where global mobile data traffic has been increasing dramatically. And the changes in the patterns of usage for mobile devices have started to cause traffic jams on the mobile broadband networks. As a result, forecasting the future traffic needs is in urgent need to provide high-quality mobile broadband services. To meet this need, this research aims to suggest a new forecasting method for future mobile broadband traffic. For the purpose, three-round Delphi survey was conducted to identify devices and applications that would affect in the future mobile broadband traffic, and their expected growth rates of users and changes in the patterns of use for each device. Then the total amount of mobile broadband traffic was forecasted based on survey results. The research results are expected to provide the basic research data for a further study.

1 INTRODUCTION

Recently, as various mobile broadband equipments – smart-phones, laptop PCs, tablet PCs, smart TVs and more– have been widely diffused, global mobile broadband traffic has been rapidly increasing (Cisco, 2011), and network traffic jams have resulted. Thus, to maintain the service quality of mobile communications, accurate forecasting results for future mobile broadband traffic are required. When the dominant traffic of mobile broadband networks was voice, the number of subscribers of mobile communication services affected patterns of traffic. Therefore, forecasting results for mobile service subscribers using diffusion models such as Bass model (Bass, 1969), Logistic model (Mansfield, 1968) can be utilized as an alternative way for mobile broadband traffic forecasting (Chu et al., 2009). However, since new mobile broadband services–web browsing, video streaming, online game and more –which can be served by various equipments have emerged and service usage patterns have been diversified, it is hard to derive accurate forecasting results using existing forecasting methods. The need to reflect these changes to forecasting has arisen. Therefore, this research aims to suggest a new traffic forecasting method targeted at the Korean mobile broadband market, considering the number of users and patterns of use for mobile broadband equipment.

The suggested forecasting method is based on a three-round Delphi survey, and relevant actual data was used to complement the survey result. The first Delphi survey was conducted to identify mobile broadband equipment and applications which are expected to affect mobile broadband traffic in the future. The second and third Delphi survey were conducted to acquire further information on the expected increase in of users and usage of applications for each kind of equipment. Mobile broadband traffic in the future was forecasted using various demand forecasting methods that are suitable for the characteristics of each kind of equipment. The research results are expected to provide the basic data for futher studies.

The remainder of this paper is organized as follows. Section 2 reviews existing studies on the demand diffusion model and Delphi survey. The overall research framework and detailed processes are presented in Section 3. Section 4 presents mobile broadband traffic forecasting results. Finally, Section 5 discusses the summary, contributions, limitations, and suggestions for further study of this research.

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2 LITERATURE REVIEW

2.1 Demand Diffusion Models

The purpose of a diffusion model is to exhibit aspects of innovation spreading among adopters in the specific groups (Mahajan and Muller, 1979). Since Bass (1969) suggested the concept, diffusion models have been widely used for demand forecasting. Diffusion models usually reflect internal influence and external influence to forecasting. The logistic model (Mansfield, 1968) and Gompertz model (Steel, 1977) reflect internal influences by imitations such as word-of-mouth to forecasting. The bass model (Bass, 1969) reflects internal and external influences (e.g. advertising effect) simultaneously. Diffusion of mobile broadband equipment is affected by internal and external influences. Therefore, for the purpose of this study, various demand diffusion forecasting models considering mobile equipment' characteristics were used in forecasting.

2.2 Delphi Survey

A Delphi survey is developed as a systematic, interactive forecasting method which relies on a panel of experts. It usually consists of several rounds to build a consensus on unclear things through feedback processes. Thus, it has been used to derive backup data in emerging industries which do not have enough data for quantitative forecasting (Bengisu and Nekhili, 2006; Gerdsri, 2003), or to forecast the future of industries that need experts' opinion to support quantitative forecasting results such as the tourism industry (Yong et al., 1989) and aerospace industry (English and Kernan, 1976). Because mobile broadband equipment such as laptop PCs, tablet PCs, and smart TVs have a lack of relevant data, it is hard to apply existing forecasting methods to them to predict demand or traffic. Furthermore, since they are affected by external factors (e.g. relevant policy) more easily than other kinds of equipment, this fact needs to be considered. Thus, this study utilized a Delphi survey to derive backup data for equipment types which have a lack of actual data.

3 RESEARCH FRAMEWORK

3.1 Overall Research Processes

The overall research processes of this study are as follows (See figure 1.). First of all, the first Delphi survey was conducted to identify *devices* (e.g. smart-phones, tablet PCs, smart TVs) and *applications* (e.g. voice, video streaming) that would affect the future traffic needs. Then for the target devices, the second- and third-round Delphi were carried out to gather further information. Finally, based on the results of the second- and third- Delphi survey, the total amount of mobile broadband traffic in the future was derived by summing up expected traffic for each target device.

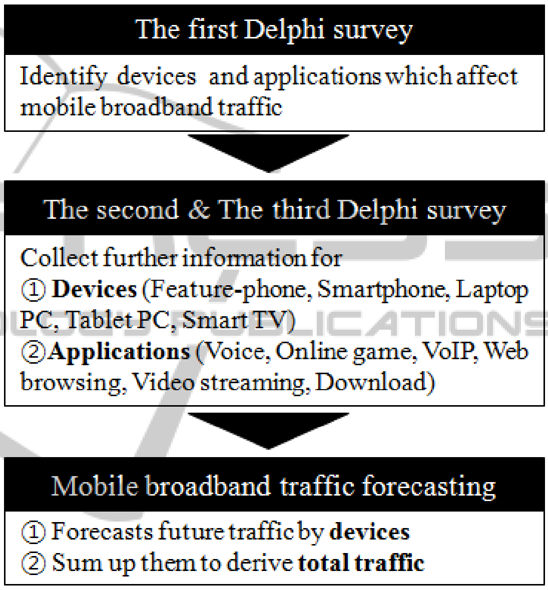

Figure 1: Overall research processes.

3.2 The First-round Delphi Survey

The first Delphi survey investigated the opinion of 18 experts in mobile communication industry. We posed open questions to identify devices and applications of each device. As a result, five mobile broadband devices and three primary applications for each device were identified (See Table 1.).

Table 1: Identified devices and applications.

Devices	Applications
Feature phone	Voice, Online game, VoIP
Smart phone	Online game, Web browsing, Video streaming
Laptop PC	Web browsing, Video streaming, Download
Tablet PC	Web browsing, Video streaming, Download
Smart TV	Online game, Web browsing, Video streaming

3.3 The Second- and Third- Delphi Surveys

The second- and third- Delphi survey was conducted to gather further information about identified devices and applications in the first Delphi survey, and 47 experts were involved to both. The second Delphi survey was an attempt to determine – information about the expected increase in rate of users for each device and their patterns of use in terms of “the type of applications frequently used in the devices”. In the case of smart TV, due to its relatively static usage pattern, the expected increase in the rate of applications reflected the expected increase in the rate of the number of smart TVs. The third Delphi survey sought to build a consensus by asking each participant identical questions, and the survey results were used to forecast the total amount of mobile broadband traffic in the future.

3.4 Mobile Broadband Traffic Forecast

The future mobile broadband traffic was forecasted using the expected increase in the rate of users for each device and the expected increased rate of usage for each application. Traffic increases effects by an increase of users and application usage in this way.

At first, the number of users for each device was estimated according to their characteristics. Forecast for the number of users for mobile phones–feature-phones and smart-phones –was conducted using actual data. For the other three devices, the expected increase in the rate of users and the estimated initial number of users were used. Next, a forecast for the patterns of use for each device utilized the expected rate of increase and weight of usage for each application. Traffic consumptions for each application were estimated using required transmission speed ITU-R (International Telecommunication Union-Radio communication sector) definition. Last, the total amount of mobile broadband traffic was calculated by reflecting forecasts for the number of users and patterns of use. Mobile broadband traffic was influenced by changes in the number of users and usage patterns of applications for each device. Thus, this study developed a formula for the rate of increase in total mobile broadband traffic which reflects the rate of traffic increase by the number of users increase and usage patterns of applications change (See formula (1)).

$$T = U * A \tag{1}$$

the rate of increase in total mobile traffic (T)
the rate of increase in the number of users (U)
the rate of increase by usage pattern changing (A)

4 TRAFFIC FORECASTING

4.1 The Number of Users

The number of users for each device was forecasted by diverse methods suitable for each in terms of their characteristics. First of all, demand diffusion models were used for mobile phones because enough data for a quantitative forecast was available. Among various demand diffusion models, those which could provide powerful prediction and interpretation were selected. The Bass model was selected for feature-phones, and the Gompertz model was chosen for smart-phones. Forecasts for the other three devices were carried out by a panel of experts. This method has been used in cases when relevant data was not fulfilled, precise forecasting results using data-based methods can not be provided, or influences of external factors such as policy and relevant law are extremely. Laptop PC usually has functions which enable use of WiFi and Wireless LAN networks that are easily affected by changes of network policy. Tablet PCs and smart TVs have a lack of data because they have not been widespread. Therefore, a panel of experts attempted to forecast the traffic for these three devices.

All forecasts were developed for five years from 2011 to 2016. Table 2 shows the forecasting results for the increasing rate of users, and Figure 2 represents the expected number of users for each device. While the number of feature-phone users was expected to decrease continuously, the number of the other four devices’ users was expected to increase gradually.

Table 2: Forecasting results: the increasing rate of users.

Devices	2011	2012	2013	2014	2015	2016
Feature-phone	1.00	0.69	0.70	0.82	0.93	0.99
Smart-phone	1.00	1.91	1.32	1.12	1.05	1.02
Laptop	1.00	1.03	1.03	1.03	1.03	1.03
Tablets	1.00	1.15	1.15	1.15	1.15	1.15
Smart-TV	1.00	1.21	1.21	1.21	1.21	1.21

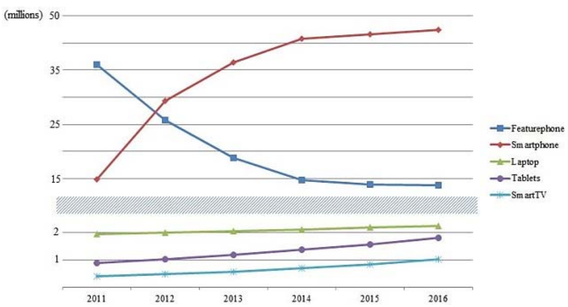

Figure 2: Forecasting results: the expected number of users for each device.

4.2 The Patterns of Use

The forecasting of the patterns of use for each device was developed using the expected increased rate and weight of use for each application. The initial weights of use for each application were assumed to be equal. Table 3 shows the forecasting results for the increasing rate of application usages. For feature-phones, use of VoIP was expected to grow faster than others, as was while video streaming for smart-phones. Video streaming and download were expected to be the primary applications for laptop PCs in the future, as are web browsing and video streaming for tablet PC.

Table 3: Forecasting results: the expected increased rate of application usages.

		Applications					
		Voice	Online game	VoIP	Web browsing	Video Streaming	Download
Devices	Feature-phone	1.01	1.05	1.10	-	-	-
	Smart-phone	-	20	-	1.25	1.30	-
	Laptop PC	-	-	-	1.10	1.15	1.15
	Tablet PC	-	-	-	1.20	1.20	1.15

With the expected increased rate of application usages, estimated traffic consumption of each application was used to forecast the growth rates of traffic due to the changes of usage patterns in applications from 2011 to 2016. Traffic consumption of each application is shown in Table 4. Among six applications, voice and VoIP need the smallest level of traffic, and online games, web browsing, and downloads consume the middle level of traffic. The largest amount of traffic is required for video streaming.

Table 4: Estimated traffic consumption of each application (ITU-R definition, kbps/second).

Applications	Traffic consumption
VoIP	14
Voice	16
Online game	384
Web browsing	384
Download	384
Video streaming	2000

The expected growth rates of traffic due to the changes of usage patterns in applications from 2011 to 2016 are as follows (See Table 5.). The expected growth rates of feature-phones, laptops, and tablet PCs were expected to be fixed while that of smart-phones was expected to change dynamically. The growth rate of traffic due to smart TV was replaced by the growth rate of smart TV sales. It was expected to grow continuously.

Table 5: Forecasting results: the growth rates of traffic due to the changes of usage patterns in applications.

Devices	2011	2012	2013	2014	2015	2016
Feature-phone	1.00	1.05	1.05	1.05	1.05	1.05
Smart-phone	1.00	1.48	1.29	1.10	1.65	1.17
Laptop	1.00	1.14	1.14	1.14	1.14	1.14
Tablet	1.00	1.19	1.19	1.19	1.19	1.19
Smart TV	1.00	1.30	1.30	1.30	1.10	1.10

4.3 Traffic Forecasting Results

To calculate the total amount of mobile broadband traffic with formula (1), the increasing rate of users in Table 2 and the growth rates of traffic due to the changes of usage patterns in applications in Table 5 were used. Actual data were used as the initial traffic for feature-phones and smart-phones. Others used estimated traffic data. Table 6 describes how the initial traffic data was acquired or estimated.

Table 6: The initial traffic of each device.

Devices	Description
Featurephone	Actual data
Smartphone	Actual data
Laptop PC	estimated traffic per laptop * the number of laptop * the number of service subscribers
Tablet PC	estimated traffic per tablet * the number of tablet * the number of service subscribers
Smart TV	estimated traffic per smart TV * sales of smart TV

Mobile broadband traffic including the growth of users and changes of application usages by devices and total traffic is represented in Table 7. The forecasting results have two remarkable characteristics. First, mobile broadband traffic in the future is expected to be centralized to specific devices. In 2011, smart-phones caused 53.4% of mobile broadband traffic, followed by smart TVs (35.4%), tablet PCs (7.4%), feature-phones (1.9%) and laptop PCs (1.7%). But in 2016, top two devices, smart-phones and smart TVs, are expected to cause more than 95% of total mobile broadband traffic (See Figure 3.). This means that mobile broadband traffic forecasting targeted to specific devices can derive feasible results.

Table 7: Total traffic increases and forecasted traffic of devices.

Devices		2011	2012	2013	2014	2015	2016
Feature - phone	T	0.34	0.24	0.18	0.16	0.15	0.16
	R	1.00	0.72	0.74	0.86	0.98	1.04
Smart-phone	T	9.79	27.6	47.1	58.1	100.1	119.6
	R	1.00	2.82	1.71	1.23	1.72	1.19
Laptop PC	T	0.31	0.37	0.43	0.51	0.60	0.71
	R	1.00	1.18	1.18	1.18	1.18	1.18
Table t PC	T	1.35	1.85	2.53	3.46	4.74	5.91
	R	1.00	1.37	1.37	1.37	1.37	1.37
Smart TV	T	6.47	9.31	13.4	19.3	27.7	36.4
	R	1.00	1.44	1.44	1.44	1.44	1.31
Total	T	**18.3**	**39.4**	**63.7**	**81.5**	**133**	**163**
	R	**1.00**	**2.16**	**1.62**	**1.28**	**1.64**	**1.22**

* T: The amount of expected traffic (1000TB)
R: The expected increasing rate of traffic

Second, the expected mobile broadband traffic for each device was affected by changes in patterns of use. In the case of smart-phones, although the growth rate of users was expected to decrease continuously, the growth rate of traffic was expected to increase similarly with the growth rate of traffic due to the changes of usage patterns. This trend also appeared in the case of smart TVs. Thus, patterns of usage and their changes should be considered among the most important aspects for mobile broadband traffic forecasting.

5 CONCLUSIONS

This study aims to suggest a new traffic forecasting method considering the number of users and patterns of use for mobile broadband equipment. For the purpose of this study, a three-round Delphi survey was conducted to identify devices and applications that would affect the future traffic needs. Then, forecasts of the number of users for devices and the growth rates of traffic caused by the changes in usage patterns of applications were accomplished. As a result, smart-phones and smart TVs were identified as requiring most of the traffic needs in the future, and the changes of usage patterns were expected to influence the total amount of mobile broadband traffic considerably. There are two main contributions of this study. First, this study suggests a forecasting method which reflects the changes of usage patterns for mobile broadband devices to support deriving realistic results. Next, this study can provide the basic research data for future studies in the mobile communication area and forecasting in other areas.

However, this study has also a limitation. In the suggested forecasting method, there exist several assumptions. This is inevitable because it was caused by the characteristics of the devices. If actual data is used in the forecasting, better results can be acquired. Therefore, in a further study, this will be complemented to derive more reliable forecasting results.

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