

# 4G TECHNOLOGY AND THE MOBILE TELEPHONE INDUSTRY

*Chatra Kamsaeng\**

## 1. INTRODUCTION

The telecommunications industry underwent a major structural change in 2009 when 3GPP, a group of telecommunications standard development organizations, announced a global standard for Long-term Evolution (LTE) technology. This marked the initiation of the fourth generation (4G) of mobile telephone technology characterized by ultra-broadband Internet access via mobile devices. Since then, LTE has been commonly commercialized as 4G LTE technology. The new technology fosters digital convergence (convergence of telecommunications, information technology, electronics and entertainment), which exposes mobile phone operators to competition from content service providers, or over-the-top (OTT) services.<sup>1</sup>

This 4G technology poses a threat to the profitability of mobile telephones in various coun-

*\*Mr. Chatra Kamsaeng is Researcher, Sectoral Economics Program, TDRI.*

<sup>1</sup> *Consisting of OTT content and OTT messaging. OTT content refers to the delivery of audio, video and other media over the Internet without a system operator, such as a mobile operator, controlling the distribution. Consumers can access OTT content through multiple devices, including laptops, desktop computers and so-called smart phones.*



tries because of its markedly higher mobile Internet speed and its substantially improved quality of services. For example, the short messaging service (SMS)—to a large extent—has been replaced with online messaging applications, such as Whatsapp, WeChat and Line, which are usually available free of charge. Most messaging applications boast the provision of free voice and/or video calls as well. According to Bloomberg, China Mobile is blaming WeChat, the largest Chinese instant messaging application, for creating financial difficulties for the company. Moreover, Ovum reported that the mobile network industry in advanced European countries, such as the United Kingdom, Germany, and Switzerland, as well as some Asian countries have experienced a decline in revenue for this industry. Also, in the United Kingdom, Everything Everywhere slashed the price of its data plan to about two-thirds that of its competitor's comparable plan, which might trigger a price war. Undoubtedly, the introduction of 4G technology has had a non-trivial impact on the competition landscape of the telecommunications industry and thus the strategies of telecommunications companies (telcos).

The purpose of this article is to conduct an



empirical study in order to assess the effect of this specific technological innovation on market competition by focusing on the wireless telecommunication industry in 55 countries.<sup>2</sup> The method of estimation, the fixed-effect model, controls for country-specific economic conditions and market environment such that the direction and the size of the impact of 4G technology can be isolated and verified.

The article is organized as follows: section II contains a description of the 4G technology standard. The third section illustrates the impacts of 4G on the mobile industry. Estimation results are reported in section IV. Finally, conclusions are presented with a brief description of implications.

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<sup>2</sup> Countries included in the study are as follows: Angola, Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, China, Czech Republic, Denmark, Egypt, Finland, France, Germany, Ghana, Greece, Hong Kong, Hungary, India, Indonesia, Ireland, Israel, Italy, Japan, Kenya, Malaysia, Mexico, Netherlands, New Zealand, Nigeria, Norway, Oman, Pakistan, Philippines, Poland, Portugal, Russia, Saudi Arabia, Singapore, Slovakia, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, Tanzania, Thailand, Turkey, Ukraine, United Arab Emirates, United Kingdom, United States, and Vietnam.

## 2. 4G TECHNOLOGY STANDARD

Telecommunications technology researchers have revolutionized technology standards from analog (1G) to digital (2G), and from 3G to 4G currently. According to Ofcom (United Kingdom telecommunications regulator), 2G technology was optimized for voice communications and text messaging. The introduction of 3G enabled Internet connection via mobile devices. Although 4G technology does not provide any new feature for subscribers, it facilitates ultra-high-speed data transmission on mobile devices. Peak download speed is boosted to 100 megabits per second (Mbit/s), which is almost five times faster than the previous standard, namely HSPA+. Peak uplink speed is about eight times faster. Broadband communications facilitate speedier Internet browsing as well as ease of access to OTT services, such as social networking, voice over Internet protocol (VoIP) and video streaming, via the mobile platform. Voice over LTE (VoLTE) technology deploys a new multimedia system and transmission technique, promoting richer and clearer voice calls. In short, the latest technology enables much more efficient

and less costly data communications (Gupta and Patil, 2009).

For operators, employing 4G can substantially reduce operating costs because of its superior spectral efficiency (using less spectrum for the same amount of data transmission) and the most advanced bandwidth-sharing technology. The cost of transmitting data through LTE is estimated to be half that with HSPA+, according to Capgemini (2011). The superior efficiency of 4G technology enables operators to carry 45 VoIP users per MHz as opposed to 25 users per MHz on the 3G standard. More capacity over less bandwidth provides a clear competitive edge over previous technology standards.

How does 4G technology change competition in the telecommunications industry? For a number of reasons, market concentration is possibly reduced due to the deployment of 4G technology.

First, because of its superior spectral efficiency, 4G technology may help reduce the resources required for providing the same services and, hence, the minimum efficient scale (MES), the size of a firm operating at the most efficient level. A smaller MES implies that smaller firms can operate efficiently, allowing in more suppliers in the long run.

Second, because the Internet acts as a platform for valued-added data services, speedier access to the Internet on multiple mobile devices can accelerate competition among OTT communication providers. High-speed data transmission enhances the quality and reliability of VoIP such that it becomes a near-perfect substitute for traditional voice transmission services provided over a public switched telephone network (PSTN). The ability to synchronize data across different devices, such as iPhones, iPads, and computers, is another attractive feature of OTT. Thus, users with only computers but no phones can communicate with one another without involving mobile operators. Most importantly, however, many forms of data and voice communications over the Internet, such as Line, Skype, Facetime, and WeChat, are free of charge as they derive revenue from advertisements and/or

sales. Undoubtedly, the Internet-based communications technology afforded by OTT providers eats into the market share of traditional infrastructure-based telcos. Thus, such technology results in a less integrated mobile service market with more layers of competition.

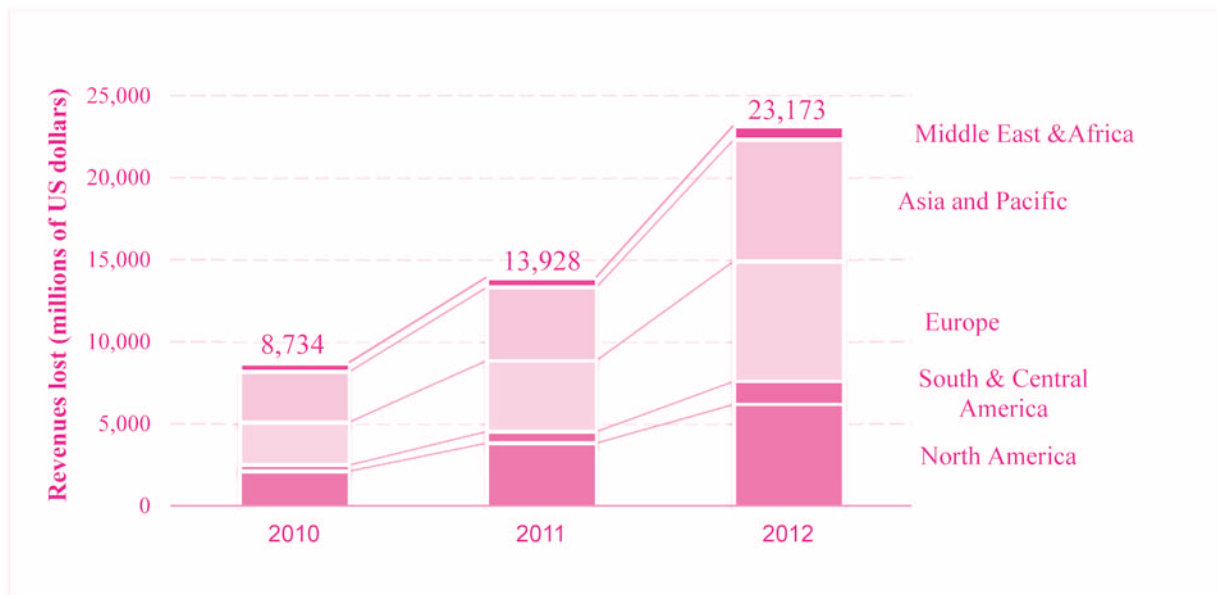
Another benefit stems from the interoperability of LTE technology (Gupta and Patil, 2009). Since LTE dominates 4G technology, there is a unique global standard which enhances mobility and service portability across borders. The technology also leads to digital convergence, meaning the coexistence of voice, data communications and multimedia in a single network with a universal standard. Better interoperability and convergence should increase the ease of switching from one provider to another, thereby enhancing competition in the market.

On the other hand, Sutton (1999) pointed out that innovations which improve the quality of services or reduce marginal costs may lead to greater market concentration, because producers who offer superior-quality products at lower cost will likely gain market share. In addition, large capital investment is still necessary to be able to operate a 4G network, that is, the cost of new infrastructure and operating license. Because profitability tends to fall for the reasons explained previously, the incentive of new telco to enter the market will be lower. The traditional mobile market is likely to undergo consolidation as a result of the new mobile technology.

### 3. IMPACTS ON THE MOBILE NETWORK INDUSTRY

So far, data service has begun to put pressure on traditional services; for instance, mobile Internet access has cannibalized revenue from SMS. Growing numbers of social messaging applications combined with the spread of smartphones encourage people to replace traditional texting with online applications. Ovum has reported a significant upward trend in social messaging usage: in the first quarter of 2013, 10 billion messages were sent daily

**Figure 1 SMS revenue lost to social messaging**



Source: Ovum, with calculations by author.

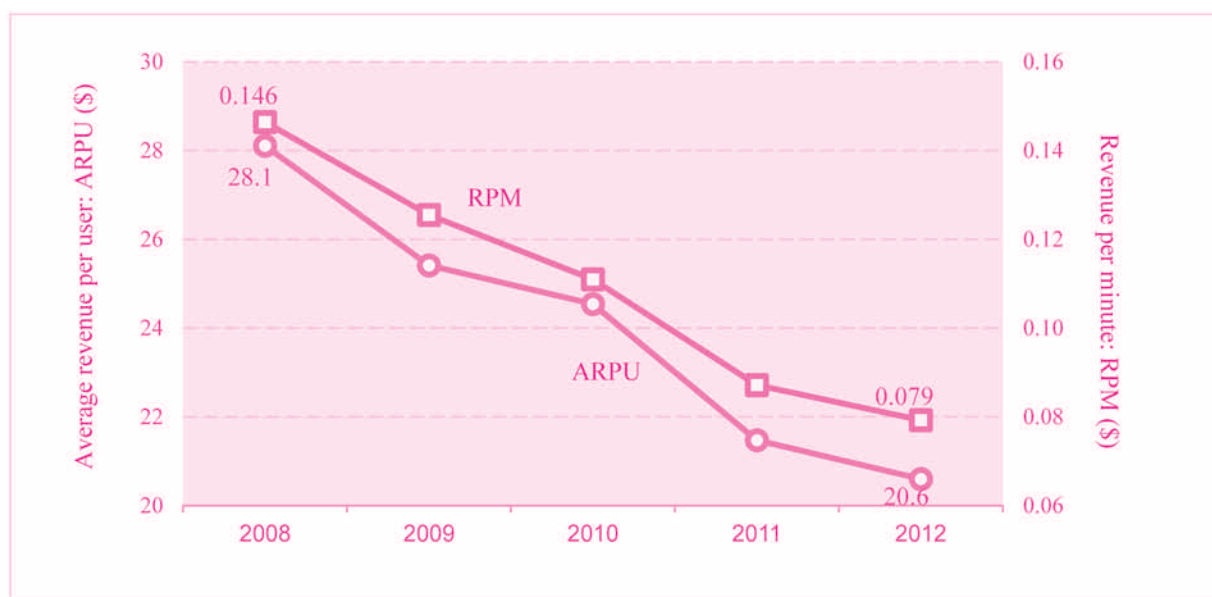
through Facebook; Line experienced 29 percent quarter-to-quarter growth in the number of registrations during the period from the first quarter of 2012 to the second quarter of 2013. The Chinese application WeChat has dominated the country with nearly 300 million users as of the end of 2012. Ovum has estimated that \$23 billion in SMS revenue was lost to social messaging worldwide in 2012, as shown in Figure 1.

In addition, Ovum has estimated that demand for VoIP on mobile will accelerate considerably. VoIP usually has been conducted on a fixed broadband network, i.e., a call from one computer to another. Currently, ultra-high-speed mobile Internet access can escalate demand for VoIP via mobile devices substituting voice services by telcos. Well-known social messaging applications, such as Kakao Talk, Line, Tango, Viber, WeChat and WhatsApp, have developed their own Internet calling feature as well, following the successful example of Skype with this service.

Figure 2 illustrates that both average revenue per user (ARPU) and revenue per minute (RPM) figures from 55 countries had plunged through the period 2008-2012, where 4G became commercialized in 2009. The ARPU fell roughly 30 percent during the period. A decrease in ARPU indicates that people on average are spending less for their subscription; however, this could result from either lower tariffs or a reduction in the volume of usage. Here, the RPM data, used widely as a proxy for phone call tariffs, plummeted almost 50 percent during the particular time period. This indicates that falling tariffs have been the underlying factor of the telcos' revenue decline. In countries such as the United Kingdom, Switzerland and Germany, telecommunications industries are now experiencing a decline in total revenues since the plunge in voice revenues cannot be offset by the increase in data revenues. Therefore, it is evident that the introduction of 4G LTE technology squeezes the revenue base of mobile phone operators.



**Figure 2 Average revenue per user and revenue per minute across year**



Source: Ovum, with calculations by author.

#### 4. ESTIMATION RESULTS

Although the descriptive data depict the changes that have occurred in the telecommunications industry, to isolate the impact of the introduction of 4G LTE technology on the structure and performance of the industry, an econometric tool is required for controlling for other possible factors that may also contribute to the declining revenue and price trend described above.

Table 1 reveals that the introduction of 4G technology has had a negative impact on the voice service market but a positive effect on the data

service market. Overall industry revenue fell on average by 2.7 percent per annum in the sample countries accompanied by a 5.3 percent decrease in ARPU, suggesting a shrinking mobile service market. This is due to a fall in both the price of and demand for traditional services, which account for about 75 percent of the industry’s revenue. The price of the traditional voice service (as proxied by the revenue per minute of voice calls) has been estimated to have fallen by 9 percent per annum, and the demand, or the number of minutes of voice call per user, by 2.4 percent per annum.

**Table 1 Effect of 4G per annum on industry performance and structure**

Industry revenue	Average revenue per user	Revenue per minute of voice call	Minutes per user
-2.7%	-5.3%	-9.0%	-2.4%
Data revenue	Share of data revenue	Data average revenue per user	HHI*
+6.7%	+3.7%	+4.2%	+120.85

\* HHI is a market concentration index calculated from the summation of the squared market share of each operator in the market. An HHI of 10000 means that the market structure is a monopoly. With a large number of firms and equally split market shares, HHI reduces toward 0, which indicates a perfectly competitive market.

By contrast, the introduction of 4G spurs data services. Internet service revenue is estimated to have increased by 6.7 percent per annum. This increase is contributed by both the increase in the number of non-voice service subscribers and the amount of spending of the average subscriber. The econometric exercise revealed that, due to 4G technology, customer spends 4.2 percent per annum more on data services, boosting the data revenue share by 3.7 percent per annum.

Even though consumers are paying more for data services, data revenue is not growing fast enough to offset the revenue lost from traditional services. As a consequence, the mobile industry's total revenue diminishes by 2.7 percent per annum. Undoubtedly, shrinking industry size undermined new mobile operators' incentive to enter the market. Mergers and acquisitions activity is on the other hand more likely to occur to keep the businesses afloat.

The revenue squeeze resulting from greater competition from OTT content providers renders the mobile industry more concentrated. Table 1 reveals that the HHI index of the mobile industry in the sample countries is estimated to increase by more than 120 points annually. However, the association between the introduction of 4G and the increase in the mobile market concentration index can be misleading. This is because the new technology induces competition, not from within the mobile market but from non-mobile operators, namely the OTT content providers. Thus, the measurement of market concentration that includes only traditional mobile operators as widely used among regulators is erroneous.

Application developers face a relatively low cost of investment (ranging from as low as \$3,000 to as high as \$250,000 per application based on an estimation by Crispy Codes) compared with that for 4G infrastructure investment (about \$750 million for initial 4G investment in the United Kingdom, according to a Capgemini report, 2011). Thus, competition is fierce in the Internet-based communication service market, unlike that in traditional



infrastructure-based services. The rise of OTT service providers translates into a fall in the market power and the market share of mobile phone operators in the voice and data communication markets.

Telcos are now faced with the option of either fighting or accommodating OTT services. They can fight by developing their own OTT services or accommodate by providing complementary services to OTT service providers. Because most OTT applications are free, network operators have to cut prices for traditional services, such as SMS and long-distance calls, in order to secure demand. At the same time, telcos need to seek new revenue sources, perhaps from OTT providers. For example, many mobile operators now provide payment services for online game applications or online shopping for a fee. Users can choose to pay for a product purchased online with a credit card or through telephone bills.

**Figure 3 Changes in competition landscape**

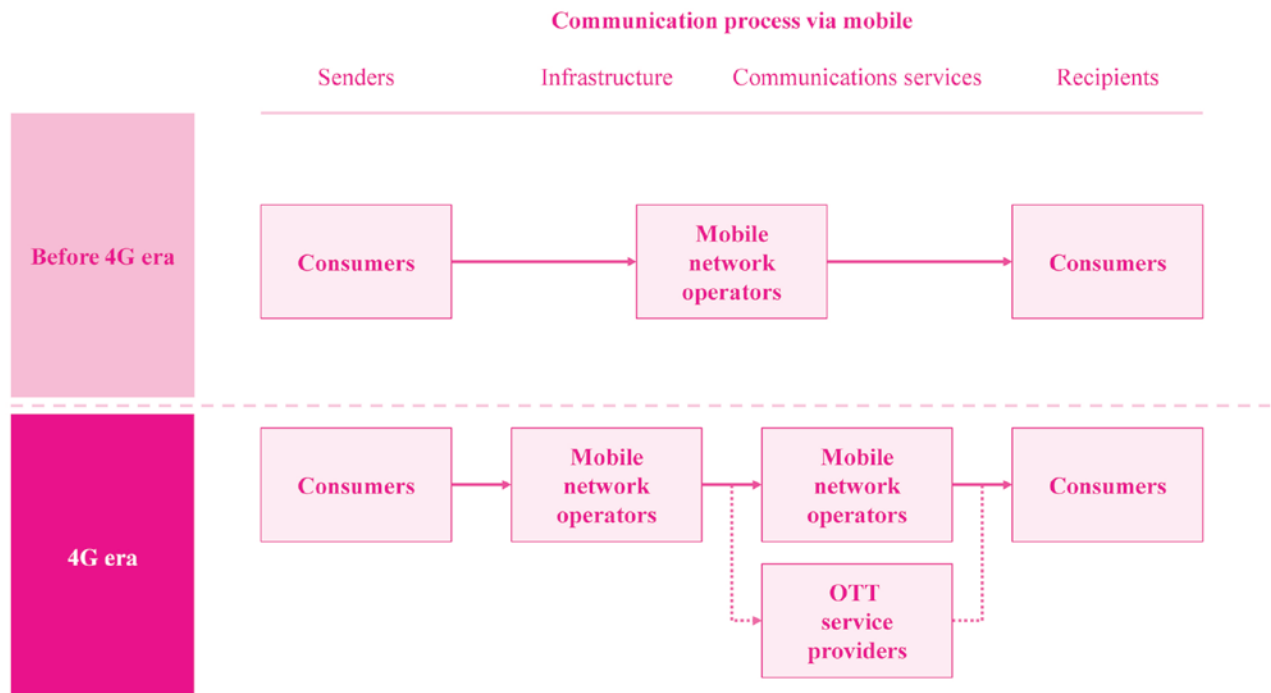


Figure 3 illustrates the change in the competition landscape of the mobile industry. In the past, mobile telephone operators were the sole providers of both the communications network and communication services, be they data or voice. With low mobile Internet speed, the early introduction of communication applications was limited to such non-mobile devices as desktop computers (Skype in times past). Also, with low speed, VoIP is of very low quality, unlike that transmitted over the traditional PSTN system.

With the introduction of 4G technology, which unleashed markedly faster mobile Internet, OTT communications became closer substitutes for mobile calling and texting. Consumers can choose between calling via traditional services or via mobile data, which is less expensive. As a result, mobile operators are gradually confined to the operation of the Internet platform on which

the OTT applications operate. Thus, mobile communications services are effectively split into two different markets: the infrastructure service market, the exclusive domain of telcos; and mobile voice and data service provision, where both telcos and OTT providers compete head on.

## 5. CONCLUSIONS

This study reveals that the introduction of 4G mobile communication technology fosters greater competition in the voice and data communications market by enabling non-infrastructure-based OTT content providers to compete directly with mobile operators. This is because very-high-speed data transmission significantly improves the quality of Internet-based communication service alternatives provided by value-added OTT services, such that they become very close substitutes for equivalent



services provided by mobile operators over PSTN. As a result, network services and communications services are effectively unbundled, with the latter becoming more competitive with non-mobile players in the market. As the market power of mobile operators inevitably dwindled with the vertical disintegration of the infrastructure and value-added services, telcos have had to struggle to cut costs and find new revenue sources.

Greater competition from low-cost OTT providers helps reduce the cost of communications and enables a greater variety of non-voice services with improved ease of access benefiting consumers as well as country competitiveness. Increasing reliance on Internet-based services helps slash operating costs, as this technology is twice as efficient as the previous technology.

This piece of evidence indicates that innovations that are pro-competition can generate significant benefits for the economy over time. Therefore, countries should attempt to adopt such innovations as early as possible, because they would stand to generate greater static as well as dynamic efficiency, and stay ahead of late adopters.

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