

「 The Research of Mobile Access Charge Cost Model and Mobile Access Rate 」

— Final Report —

(English Brief Version)

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1. Introduction

1- 1 Research Background

Access charge is the cost which is calculated on the basis of the usage time of interconnecting between different networks. To promote competition in mobile communication market, the regulators all over the world started to control the access charge in recent years. In this project, we focused on the access charge related to mobile network. National Communications Commission (NCC) has tried to adopt TELRIC model to calculate access charge since 2010. The rate of 2016 is 1.15 NTD/minute which is much lower than the previous rate level. But comparing to the benchmark countries, the rate in Taiwan was still higher than the average.

In order to propose the rate for 2017-2020, we tried to update the parameters used in the mobile access charge model. Also the new service, 4G, has been added into consideration this time. The main benchmark countries for LTE network are United Kingdom and Portugal. Since the public consultation, the telecom operators have raised some suggestions to the calculation algorithm or the parameters in draft model. The stakeholders tried to reflect all the cost occurred in real context. But we tried to distinguish whether the suggestion is reflecting efficiency or not. The rate should be decided on the presumptions of efficient network deployment according to LRIC model. For those suggestions haven't been accepted, we will still list the effects of them on the access charge in the report. The authority could take them as the reason for mark-up.

Under the trend of decreasing voice traffic and the progress of technologies, the access charge in 2017-2020 is expected to maintain the declining trend as the previous period. The user behavior varied severely after the 4G service launch. OTT (Over the Top) became an alternate option for making voice call. And the evolving of mobile technique would also help to reduce both CAPEX (Capital Expenditure) and OPEX (Operating Expenditure) investment.

1-2 Research Scope

The pricing of mobile communication is composed of access cost, calling cost and mark-ups for revenue. In this project, we only discuss about the access charge pricing which is largely related to access cost. The mobile access charge pricing might include the cost and reasonable mark-up which could be calculated in the model. To raise an overall suggestion of the mobile access charge rate, we would calculate the access cost first. Mark-up and implementation strategy would be processed after the result of access cost.

In the previous research, we've already constructed an access charge cost model including 2G and 3G networks. Considering the rising trend of 4G techniques and the launch of VoLTE service by four carriers, we would construct the 4G network cost model and incorporate into the existing one.

There would be also case study research in this project. We survey the countries which are in the similar progression in mobile technique. Their access charge model, access charge rate and the regulations change would all be taken as reference. Thus we could make sure the research method we adopted and the rates would meet the global trend. We selected countries including The United Kingdom, Switzerland, Australia, Japan, Portugal and Sweden as our benchmarking for cost model buildup and comparison. Among these countries, The United Kingdom and Portugal had incorporated 4G network into their latest models. The way of constructing 4G model and the parameters setting in these countries would be our important reference.

Although benchmarking helps us a lot in constructing 4G cost model, the local environment should be taken into account. We collected local data through interviewing, public consultation and public meeting. By exchanging idea with the carriers, we tried to make sure the cost would not be underestimated or overestimated.

2. Worldwide Mobile Access Charge policy

This chapter is designed to elaborate how those selected countries regulate and set their mobile access rate, and the goals behind the policy. In the following, we will focus on the way taken to set the mobile access rate by the United Kingdom, Portugal, Sweden, Japan, Australia, and Switzerland. Among these countries, the U.K. and Portugal are the ones that had already added LTE model into their latest LRIC models, which leads the world. Therefore, the U.K. and Portugal are the two main benchmarking cases for the revision of our model.

2-1 The United Kingdom

Every four years, Ofcom, the British regulator, has to renew the regulations as the environment evolves in order to keep the competition of the mobile communication industry and also to guard the customer welfare. The U.K. had started to adopt the BU-LRIC method in 2003 and switched to the LRIC+ method in 2007. Later in 2011, after several discussions between Pure LRIC and LRIC+ method, Ofcom had decided to gradually decrease the mark-up level, and build the fourth version of the model in 2015.

In the past, Ofcom had only regulated the top four telecom operators' mobile access rate, and require the smaller operators to provide services at a fair price level. However, it is found that part of the smaller operators often charged higher than the level set in 2011. Therefore, Ofcom had renewed the regulation policy. All the operators that Ofcom viewed as having significant market power (SMP) are under the same regulation now, no matter the operator provides the originating service or the terminating service. However, operators in the Channel Islands and the Isle of Man are excluded. They could follow the local government regulation.

To propose the new model in 2015, Ofcom had asked Analysys Mason to design the model since September 2013. Finally, the Ofcom had published their final version at March 2015, and the rate went into effect on May 1st, 2015. The structure of the new model did not change a lot, but LTE model has been include in this version.

The mobile access rate had been decreased for about 42%, dropped from 0.826cpm to 0.476cpm.

	← 2011 Model	2015 Model →		
	2014/04~	2015/04~	2016/04~	2017/04~
pure LRIC	0.826	0.502	0.491	0.476
LRIC+		0.891	0.845	0.788

2-2 Portugal

After the EU Commission’s recommendation in 2009, the Portuguese telecom regulator, ANACOM, asked Analysys Mason to build the mobile access rate model in 2010 by Bottom-Up Pure LRIC method. The model had been partly updated in 2012.

In April 2015, ANACOM announced to lower the access rate not only to get in line with the latest technology and the market changes, but also to stimulate market competition. Therefore, Analysys Mason was required to update the model based on the previous version. In this model, it assumed that telecom operators with more than 20% of the market share would have better cost efficiency. So they should be under regulation. ANACOM adopted pure LRIC method and modified the setting with Scorched-node view. The rate calculated by LRAIC+ (Long-Run Average Incremental Cost plus) would also be provided in the report as a reference to the one by pure LRIC.

There are two main update to the new model. One is the renewal of the input data in both the 2G and 3G networks since 2G network is still one of the main network in Portugal. And there is no plan to close up the 2G network in the near future. Another change is about the adoption of new technique that 4G network has been added into the model and the cell site sharing capability has also been considered. The latest goal for the final access rate is to gradually lower it from 1.27 eurocents to 0.85eurocents per minute.

2-3 Sweden

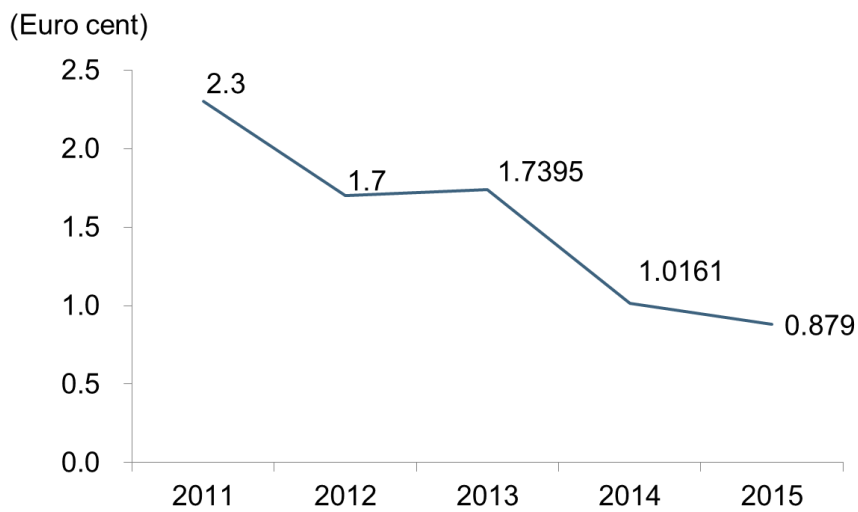
In Sweden, the mobile access rate is set by the PTS (The Swedish Post and Telecom Authority, PTS). PTS had started conducting the pre-stage study from 2001. Since early 2002, following the EC recommendation of using the LRIC model, Sweden had required the consulting firm to build the base model, to modify the factors, and to keep the model up to date. In 2003, the consulting firm had finished model conceptual design under the LRIC method. Later in the next year, PTS had published

the final model of the 1st version model. At that time, it was constructed under the hybrid BU-TSLRIC+ method. PTS had reevaluated the input data in 2005 and 2007. PTS had then changed the model into the one that included UMTS Network Service (3G network) and applied the uniformed rate to all the operators.

After finished several public consultations in 2010, they started to modify the model again in 2011, changing it into the way that could calculate simultaneously under both LRAIC+ and Pure LRIC method. But they decided to follow Pure LRIC method in 2013.

Starting from March 2015, PTS had held a series of public consultations. They had decided to alter the proportion of the GSM and the UMTS network into 32:68. They also calculated the cost for the access service on the 4G VoLTE network, and modified factors such as WACC. It was published in June 2016 and the new rate is supposed to come into effect July 2017.

The rate before 2017 was computed from the model of 2013 version, which is calculated by the Bottom Up Pure LRIC method. The rate of year 2015 it was 0.88 Eurocent per minute.



2-4 Japan

The way how the Japan regulator used to decide the mobile access rate differs from other cases. In Japan, Ministry of Internal Affairs and Communications (MIC) had published the calculation formula, which follows the concept of the Fully Distributed Cost (FDC). MIC will publicize the results submitted by operators every April which is the month Japanese fiscal year starts.

According to the law, telecom operators have the responsibility to provide access service, and the access rate should be under the condition and the calculation method designed by the MIC. Before the rate comes into effect, they should inform the General Secretary of MIC about the outcome. Operators whose terminal equipment's market shares are more than 10% had the responsibility to publicize their technology used for access service and hand in the details of the calculation to MIC. Now the telecom operators under regulation are the three leading operators, which are NTT docomo, KDDI, and Soft Bank.

In recent years, the Japanese government has focused on promoting the MVNO industry. At the end of 2014, the number of MVNO users had reached the 9.1 percent level of the overall mobile user number. Considering this growing trend, MIC had revised the Telecommunications Business Law in 2015 in order to put the MVNO operators under the regulation. Besides that, MIC hopes that the revision of law would help MVNO operators requiring essential telephone lines capacity. By doing so, it is expected to stimulate the development of the MVNO in Japan market, and also helps to lift the competence level of the mobile phone call market. The following graph shows the cost of three leading operators :



2-5 Australia

In the past, Australia used TSLRIC+ model to calculate the access rate from 2007 July to the end of 2011. Since then the Australia telecom regulator, ACCC, decided to switch to the Benchmarking method for calculating the rate, which came into effect in January 2012.

In August 2014, since the condition set in WIK model for estimating the cost was not fit to the latest trend, so ACCC had started public consultations to update the model. Considering that collecting new data and communicating with operators might take one or two years, which may not be able to decide the new rate for 2016 on time. Benchmarking method might be a good alternative method since it can quickly have a result by transforming the rates from benchmarking countries. If only the countries using TSLRIC or Pure LRIC method be taken into benchmarking, benchmarking method has no difference to the previous method.

Besides, ACCC does not transform each country's access rate directly through the exchange rate when applying Benchmarking method. There are still lots of modifications were done considering the difference of the background between Australia and those benchmarks. Benchmarking method still aims to get the recommended access rates from the selected counties with Australian background in the use of reference. ACCC uses the access rate of each benchmarked countries as the calculation base, and modified it with factors like spectrum cost, WACC, network usage, backhaul cost.

Finally, Australia use its' Benchmarking method to calculate the rates, which is 1.46 cpm in 2015, and 1.24cpm in 2020. This finalized rate was expected to be effective from January 2016 to June 2019.

2-6 Switzerland

Since Switzerland is not belonging to the EU, instead of using Pure LRIC method, they use LRIC method. The Swiss telecom regulator, ComCom, did not ask for a uniform rate. Each operator can set their own rate based on their own condition. Although ComCom would review the results submitted, it still mostly accounts on the negotiation between operators. The rates in Switzerland are list below.

Time Operator	till 2016/12/31	2017	2018	2019
Swisscom	5.95	3.10	2.95	2.80
Sunrise	7.35	4.30	3.90	3.50
Salt	7.35	4.30	3.90	3.50
centimes/min.				

3. Mobile Access Charge Model

3-1 Theory Concept

According to the latest “Regulations Governing Network Interconnection among Telecommunications Enterprises”, the access charge cost should be calculated based on the TELRIC (Total Element Long-Run Incremental Cost) method. The LRIC model tries to calculate the cost of an efficient network. There are few assumptions while chasing the efficient cost. One is that the new carrier could use the latest technique and equipment to reach the cost efficiency. Instead of focusing on the large amount of the CAPEX investment, the LRIC model calculates the incremental cost which should occur fully related to the access service. When the cost is calculated on the basis of forward-looking and efficiency, we can keep both the competence and efficiency of the telecommunication market.

There are three main concepts in the LRIC model :

1, Incremental Cost :

According to welfare economics, the price decided by marginal cost would most benefit to the whole society. The incremental cost is defined as the cost needed to pay when tried to increase the service capacity by one unit.

2, Forward Looking Cost :

Assuming the new carrier could have cost competence by adopting the latest equipment, the efficient cost should be calculated based on the current technique capability.

3, Long Run Cost :

The time period of the model should be set long enough to make fixed cost investment into incremental cost.

Following the concepts of LRIC above, we could derive a formula to calculate the access charge rate. The rate is decided assuming total long-run access revenue would equal to total incremental expense. And the time depreciation effect is also considered in the formula to reflect opportunity cost in different time.

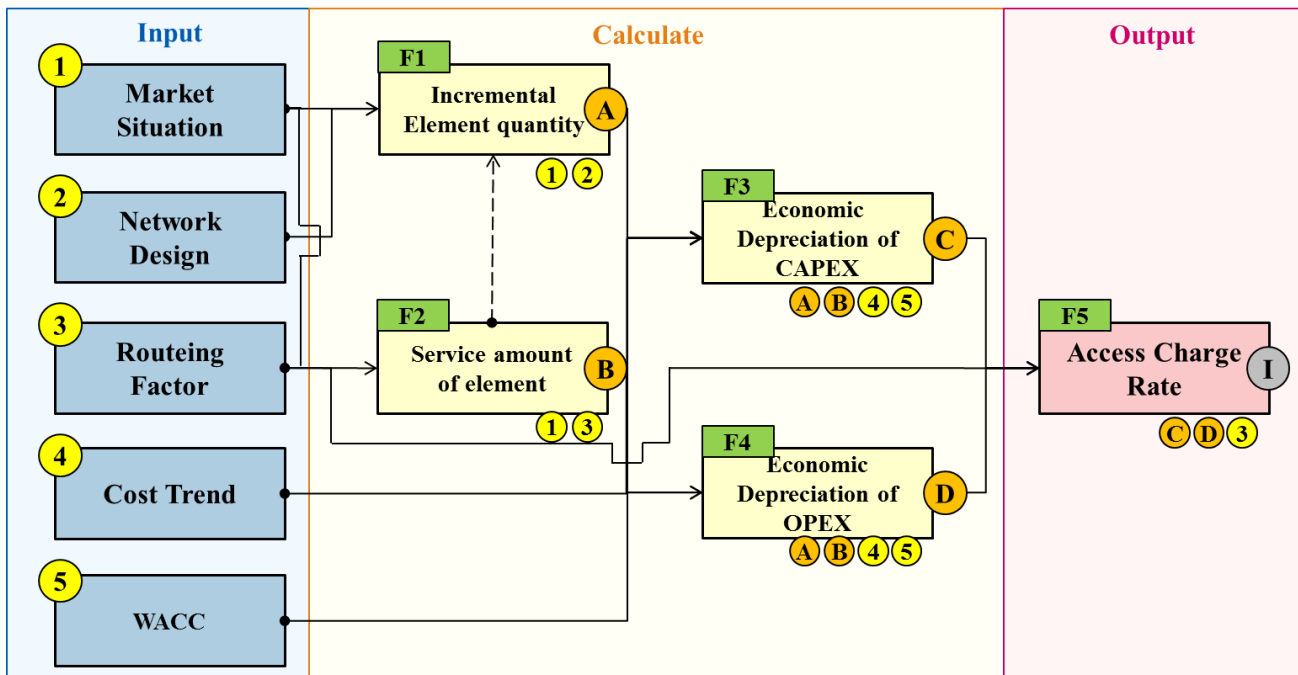
Since we adopted the TELRIC method, we would calculate the cost of every network element then sum up each cost by routing factor. The formula used in model is listed below.

$$\sum_t \frac{1}{(1+r)^t} E_t = \sum_t \frac{1}{(1+r)^t} x_t a_t \quad \Rightarrow \quad a_i = \tilde{P}_i \frac{\sum_t \frac{1}{(1+r)^t} \cdot E_t}{\sum_t \frac{1}{(1+r)^t} \cdot x_t \cdot \tilde{P}_t}$$

<u>Parameter Definition</u>
E : Expense (CAPEX/OPEX)
x : total service amount
a : access charge rate
\tilde{P} : equipment CAPEX Index
r : depreciation rate (WACC)
i : year
t : model period (t = 1~37 , t=1 means it's in 1997)

3-2 Model Algorithm

The model could be cut into three parts : input, calculation, output. The key parameter (input) of mobile access charge model are market situation, network design (technical parameter) , routing factor, cost trend of equipment and WACC. Market situation used to estimate the amount of access service. According to the network design, we could then come out the incremental need of different elements. Routing factor, cost trend and WACC are used to turn the incremental network element amount into incremental cost of providing the access service. The whole algorithm picture is listed below.



Besides the cost of providing access service, some regulator may consider reasonable mark-up to reduce the market impact. It occurs especially when the first time introduced LRIC model. For Taiwan, we adopt common network element, indirect cost like management cost and spectrum fees as mark-up in previous research.

But when the environment changed, adoption of mark-up doesn't seem to be common anymore. European Commission (EC) suggested to adopt Pure LRIC model since 2009. In Pure LRIC model, no mark-up is adopted. In order to calculate an efficient cost of network, only cost fully used to provide access service could be count. It's mean but the result of cost would be pure. In recent years, most of the European countries have changed to use the pure LRIC model.

The cost counted in Pure LRIC also named avoidable costs. The cost could be avoided if the carrier chooses not to provide such service. Based on these criteria, the cost of element such as HLR and HSS should not be included. Another controversial item is the cost of spectrum. Among this issue, EC put stress on that it counts only if the spectrum is acquired to provide the access service. Since that the spectrum is mainly consider to serve the data transmission service or in-net call, European countries tend to exclude the spectrum cost from access charge cost.

Based on the finding above, we suggest Taiwan also to adopt Pure LRIC this time. Another supporting evidence for Pure LRIC model is that the mobile calling

usage has remained declining in recent years. It's quite reasonable to assume that there is no extra need of common network element for access service. So mark-up for common network element should not be counted anymore. From the point of legality, adopting Pure LRIC model would not against the current regulations. Instead, pure LRIC model fits better to the previous legislation motivation.

Although we recommend changing from LRIC+ to Pure LRIC, we would still calculate the result of both methods. Thus we could measure the impact of the change. Also we could still let the regulator to make the final decision whether to adopt the mark-up.

3-3 Adjustment Algorithm

In order to reduce the impact of the market, there might be some adjustments to the rates calculated by the model. Taking United Kingdom and Portugal as examples, they would conduct macroeconomics adjustment and smoothing introduction adjustment.

1, Macroeconomics Adjustment

This adjustment is set to include the potential influence of the macroeconomics changing. Thus the access charge rates should adjust according to the inflation rates each year.

We usually take the annual increase rate of CPI (Customer Purchase Index) as the inflation rates in Taiwan. Since the government does not predict the CPI index, we take the long-term historical data as reference. The average inflation rate between 1997-2015 is 1%. We assume the inflation rates would remain still in 2017-2020. So the access rate should be adjust according to the following formula :

$$\text{Rates}_{2017} (\text{post adjustment}) = \text{Rates}_{2017} (\text{before adjustment}) * (1.01)^2$$

$$\text{Rates}_{2018} (\text{post adjustment}) = \text{Rates}_{2018} (\text{before adjustment}) * (1.01)^3$$

...

2, Smoothing Introduction Adjustment

To avoid dramatic rates change, smoothing introduction adjustment is need.

We usually take a four-year gradually smoothing introduction method. The rates decrease of the same proportion every year and would reach the expected rates in the fourth year. We also see another smoothing introduction method that does only adjust the rate of the first year. It seems reasonable since it's the second time to conduct LRIC model. The rates should not decrease rapidly. But still, we would try to calculate the result of different smoothing introduction adjustment.

3.4 The Suggestion for Mobile Access Charge in Taiwan

This is not the first time to calculate the mobile access charge by TELRIC model in Taiwan. For fully implementing the concept of LRIC model, we propose to use the Pure TELRIC model, excluding the common costs such as spectrum bid amount, frequency usage fee, the cost of HLR and HSS. The results of Pure TELRIC model are shown that the mobile access charges are 0.502, 0.492, 0.482, 0.473 NTD/minute in 2017-2020. In this section, we propose the mobile access charge for next four years in Taiwan.

At first, according to the discussion above and the ways be conducted in United Kingdom and Portugal, we adjust the result from LRIC model by CPI (Customer Purchase Index) and inflation rate. Based on the CPI yearly growth rate which is published by DGBAS (Directorate-General of Budget, Accounting and Statistics), the average annual growth rate of nearly five years fell between -0.31 and 1.93, maintained in a relatively stable status. The compound annual growth rate of nearly five years is about 1%.

Therefore, we assume the CPI yearly growth will grow by 1% per year. The adjustment results are shown below. After adjusting the results from Pure TELRIC model by forecasted CPI, the mobile access charges are 0.512, 0.507, 0.502, 0.497 NTD/minute. In addition, we also add the 5% of the business tax, then the mobile access charges are 0.538, 0.532, 0.527, 0.522 NTD/minute.

Access Charge	2016 (In Force)	2017	2018	2019	2020	Change Rate (2016 v.s. 2020)
Pure (Before Adjustment & Pre Tax)	1.095	0.502	0.492	0.482	0.473	-56.8%

Macroeconomics Adjustment

$$\text{Rate}_{2017}(\text{Post Adjustment}) = \text{Rate}_{2017}(\text{Before Adjustment}) * (1.01)^2$$

$$\text{Rate}_{2018}(\text{Post Adjustment}) = \text{Rate}_{2018}(\text{Before Adjustment}) * (1.01)^3$$

...

Access Charge	2016 (In Force)	2017	2018	2019	2020	Change Rate (2016 v.s. 2020)
Pure (Post Adjustment & Pre Tax)	1.095	0.512	0.507	0.502	0.497	-54.6%
Pure (Post Adjustment & Post Tax)	1.150	0.538	0.532	0.527	0.522	-54.6%

Second, we conduct the smoothing introduction adjustment to avoid dramatic impact on mobile voice market. In the first time we used the TELRIC model, we took a four-year gradually smoothing introduction method. The rates decrease of the same proportion every year and would reach the expected rates in the fourth year (Method 2). However, we realize another more aggressive smoothing method. In United Kingdom, they only conduct smoothing introduction adjustment in the first year. The rate implement in first year is the average of the rate of the last year previous period and the suggestion rate of the first year in the new period (Method 1).

The calculation of Method 1:

- $Rate_{2017} = (Rate(\text{in force})_{2016} + Rate(\text{Post Adjustment \& Post Tax})_{2017}) / 2,$
- $Rate_{2018} = Rate(\text{Post Adjustment \& Post Tax})_{2018},$ and so on.

If we use the Method 1, the rates are 0.841, 0.532, 0.527, 0.522 NTD/minute.

The calculation of Method 2:

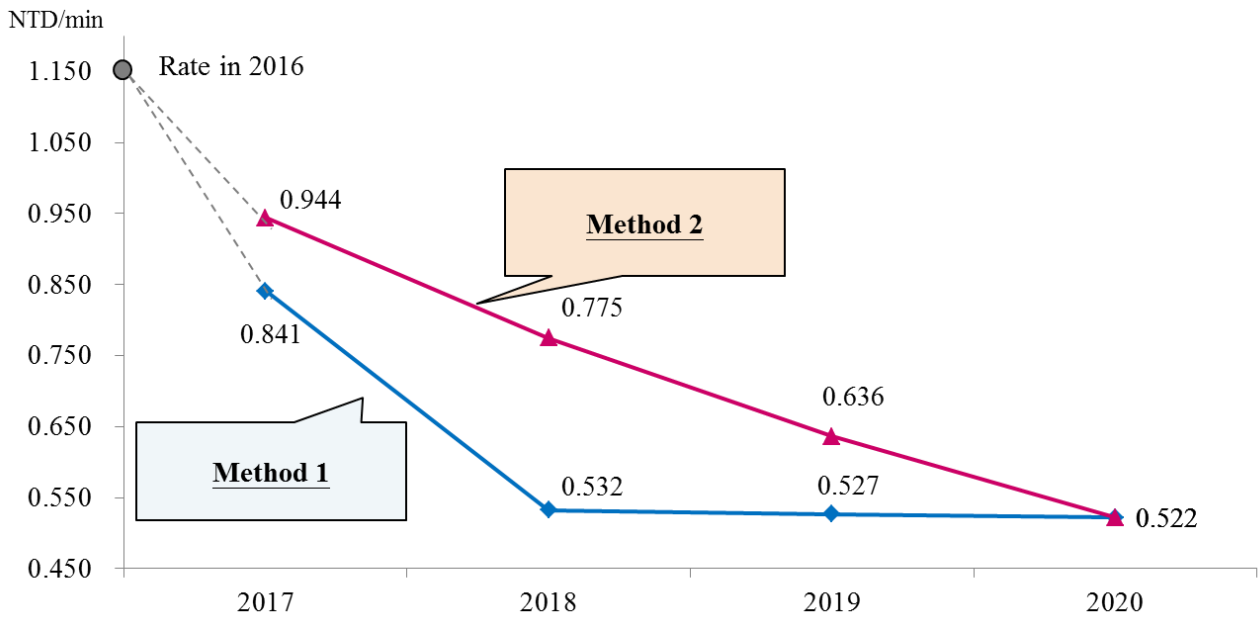
1. Calculate the CAGR (Compound Average Growth Rate) between $Rate(\text{in force})_{2016}$ (1.15 NTD/minute) and $Rate_{2020}$ (0.522 NTD/minute).

2. Based on the CAGR

- $Rate_{2017} = Rate(\text{in force})_{2016} \times (1 + CAGR),$
- $Rate_{2018} = Rate_{2017} \times (1 + CAGR),$ and so on.

If we use the Method 2, the rates are 0.944, 0.775, 0.636, 0.522 NTD/minute.

We compare the two smoothing introduction method in the picture. The Method 1 which is only smoothed in the first year can reach the ideal target of access charge in the second year (2018) and let our access charge close to the level of neighboring countries in Asia. But, Method 1 will affect the income of access charge in the first three years. Especially in 2018, the access charge will decrease 36.7% from 2017, it will significantly affect the income of access charge of operators. The Method 2 which is gradually smoothed for four years will have a stable annual decrease rate as 17.9%. It will slow down the impact on the income of access charge every year. However, it will cost four years to achieve the ideal target of access charge.



Considering the ideal target of access charge is 0.522 NTD/minute in 2020, it has more than 50% difference with 1.15 NTD/minute in 2016. We propose that following the previous period, using gradually smoothing introduction for four years, to decrease the impact on the mobile voice market. Therefore, the suggestion of access charges from 2017 to 2020 is 0.944, 0.775, 0.636, 0.522 NTD/minute. However, if there is more aggressive attitude about ideal access charge in the policy side, choosing the Method 1 and setting the access charges from 2017 to 2020 as 0.944, 0.775, 0.636, 0.522 NTD/minute can reach the ideal access charge quickly.

4. Conclusion

Since 2013, Taiwan has used TELRIC+ model to set the mobile access charge by referring the experiences of benchmarking countries. From 2013 to 2016, the rate dropped gradually from 1.84 NTD/minute to 1.15 NTD/minute. Although it declined significantly, there is still a gap between the rate in Taiwan and in developed countries. In this project, we update some GSM and UMTS network parameters which extended from the previous model, and build LTE network to reflect the development of new technologies. In addition, this is the second time we conduct the TELRIC model in Taiwan, so we propose to use the Pure TELRIC model to let the access charges correspond to the spirit of the LRIC model.

In our model, we calculate access charge by individual network (GSM, UMTS, and LTE), then using the traffic of each network to calculate the weighted average for getting the overall access charge from 2017 to 2020. We choose the total element concept to set up our model, so we have to find out how many elements are need to fulfill the demand from voice and data. At first, we based on the trend of market to forecast the demand in the future, and then calculate the incremental quantity demand of base station, backhaul, router, etc. After that we calculate the CAPEX and OPEX of all elements, and finally using the concept of economic depreciation to get the ideal access charge.

There are five key parameters of our model: market situation, network design (technical parameter) , routeing factor, cost trend of equipment and WACC. According to the trend after 4G launched in Taiwan and the trend of worldwide, we assume that GSM network and UMTS network will still exist in the future and VoLTE service will not launch for interconnection between operators in this model. Network design and routeing factor are set basically based on the previous model for GSM and UMTS network, and refer the model using in United Kingdom and Portugal for LTE network. In addition, we conduct the public consultation to realize the real practice in Taiwan and reflect the localized parameters in model. The stakeholders tried to reflect all the cost occurred in real context. But we tried to distinguish whether the suggestion is efficiency or not. The rate should be decided on the presumptions of efficient network deployment according to LRIC model. For those suggestions haven't been

accepted, we will still list the effects of them on the access charge in the report. The authority could take them as the reason for mark-up.

In conclusion, the rates from Pure TELRIC model are 0.502, 0.492, 0.482, 0.473 NTD/minute in 2017-2020. After CPI adjustment and tax added, the rate in 2020 is 0.522 NTD/minute. Comparing with the rate in 2016, it decreases more than 50%. To avoid dramatic environment change to operators, we propose to use gradually smoothing introduction for four years which also used last time. Therefore, we propose the access charges from 2017 to 2020 is 0.944, 0.775, 0.636, 0.522 NTD/minute. However, if there is more aggressive attitude to reduce the difference between our access charge and benchmarking countries, the competent authority can only conduct smoothing method in the first year and setting the access charges from 2017 to 2020 as 0.944, 0.775, 0.636, 0.522 NTD/minute.

The access charges rate we proposed are lower than existing one. There are two main reasons. One is the reduction of voice traffic volume, so the industry does not need a lot of investment for providing voice services. The other is the technical progress rate setting in model, which reflects the unit price will decline by the time due to the technological progress, so the industry will save the investment and improve their operational efficiency.

We also point out the key factor which will impact the access charge in the future. For example, the time that inter-operator VoLTE service launched, the investment of S-RAN element that can provide variety of technical services in single element. Those factors will decline the CAPEX and OPEX for GSM and UMTS network in the future, so it is worth to pay attention for the next period of access charge.

Because the interconnection service is belong to the exclusive market, the authority should set the access charge to insure operators can recover their investment and reduce customer pay a lot unreasonable cost. With the decline in the access charges, according to the experience when introduce LRIC for the first time, it will drive the mobile operators to reduce the price of calls towards other mobile networks, and provide more space to expand market competition. In addition to that, the new access charges are expected to affect the income and expenditure of access charge.

At the same time, we review the “Regulations Governing Network Interconnection among Telecommunications Enterprises”. In view of the evolution of

technology, the 4G licenses have released in Taiwan in 2013 and 2015, and the penetration rate of 4G is also rapid growth. In addition, 2G licenses and 3G licenses will expire in the next two years. Therefore, we suggest that the “Regulations Governing Network Interconnection among Telecommunications Enterprises” should be updated.