

A Comparison of 4G Telecommunications Tariff Plans in Asia Countries

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Abstract—Long Term Evolution (LTE) has been widely adopted by many 4G network operators. Many countries in America, Europe, and Asia have started LTE services since 2010. In the meantime, some countries (such as Taiwan and China) are in the process of transferring from 3G or Worldwide Interoperability for Microwave Access (WiMAX) to 4G services. In this paper, we investigate the tariff plans of the nine telecommunications operators which own top-three market shares in Singapore, Japan, and Hong Kong, respectively. Several issues, such as market share, tariff strategy, and even customs are discussed. Also, Tier-pricing strategies of LTE, such as *Fair Use Policy (FUP)*, monthly data allowance, and data overage allowance, are discussed and compared. Moreover, we compare different charging plans and examine their price-performance ratios.

Index Terms—LTE, 4G, Tariff, Charging Factor.

I. INTRODUCTION

LTE [1], [2], [3], [4], [5] is designed for high-speed and reliable 4G telecommunications systems. With 4G Long Term Evolution (LTE), our life style will be significantly changed. Watching online high-definition videos on trains and conducting business in constantly moving mobile office will become possible. This paper investigates different ways of migrating to 4G in Asia countries. Notably, the operators in Hong Kong and Singapore have upgraded from 3G to 4G LTE, yet some operators in Japan are migrating from Worldwide Interoperability for Microwave Access (WiMAX) or Advanced eXtended Global Platform (AXGP) to LTE.

Before starting LTE operations, telecommunications operators have to determine their tariff plans for both phone and data services. It is also interesting to observe that tariff plans can also be affected by local customs. For example, people live in Asia tend to hang on Internet in both day and night time, and even on holidays. On the contrary, in Europe, the peak of network-usage only appears in working hours.

The operators have to investigate many charging factors, such as *Fair Use Policy (FUP)*, monthly data allowance and data overage allowance, etc. to set their 4G LTE tariff plans.

FUP is a set of rules applied by operators to ensure QoS for all for fairness reason. Under FUP, users who have used over their monthly data allowances may be forced to decrease their transmit rates. Users may buy value-added packages to extend their data overage allowances for maintaining their QoS.

Similar to 3G, LTE has limited resources. In spite of providing unlimited data plans, operators normally adopt overage charging with degraded QoS, which means that users can surf Internet for unlimited time, but only with guaranteed QoS in a limited quota. Therefore, operators have to determine their FUP and make more profit by promoting some value-added packages.

In this paper, we survey essential charging factors such as FUP and overcharge pricing of various countries in Asia. We also consider the customs of different countries and collect information such as the working hours, market shares, frequency bands, etc.; and observe their impacts on tariff plans. Besides, we compare different charging plans and examine their price-performance ratios. The rest of this paper is organized as follows. Section II introduces related works such as specifications, reports and papers. We analyze tariff plans of the nine telecommunications operators in Section III and compares their price-performance ratios in Section VI. Section V gives a conclusion of this paper.

II. RELATED WORKS

3GPP defines its *Online Charging System (OCS)* and charging control architectures [1], [2]. The Diameter protocol is chosen by 3GPP for negotiating among OCS components [3], [4], [5]. In [6], the interaction between OCS and the policy server is discussed and a direct interface between them is proposed to facilitate information exchange through the Policy and *Control Enforcement Function (PCEF)*.

Reference [7] develops an analytic model to investigate the performance of *Recharge Threshold-based Credit Reservation*

(*RTCR*) mechanism for Universal Mobile Telecommunications System (UMTS). Therefore, network operators can select the appropriate recharge thresholds to reduce the probability of in-progress service sessions being forced-terminated. To avoid session suspension during credit reservation of the OCS prepaid mechanism. Reference [8] proposes a *Credit Pre-reservation Mechanism (CPM)* before the credits at the GGSN are actually depleted.

More pricing issues are studied in [9], [10], [11], [12], [13]. Reference [9] suggests to use Dynamic Services Pricing to provide value-based pricing options to users based on their context and network usage patterns. This requires real-time information so that customers can immediately see when they are approaching their thresholds and select the available options (e.g., to purchase additional data entitlements or accept a slower network speed). Reference [10] shows how service providers can better integrate charging and billing with policy management and analytics capabilities. Since pricing and billing of data services is the most pressing issue facing mobile operators today, [11] proposes future mobile data billing models depending on Network Controls and Real-Time Policy Management. Besides, [12] defines Internet service providers as an organization whose principal business is to provide service delivery across communications networks. Reference [13] proposes three key aspects of online charging with respect to information utilization, namely signaling, inter-domain, and service-based and component-based aspects. It also compares works in the literature based on the proposed criteria.

Although the *Over The Top (OTT)* companies are prospering, reference [14] points out that the operators are experiencing rapidly declining revenues for voice and messaging services since OTT companies are paying modest and fixed fees to operators for delivery of their users, traffics, which compete with the operators own services. As discussed in [15], to develop a successful OTT strategy, organizations must address the issues of fundamental business models, direct-to-consumer delivery architectures, and related customer service and support issues.

Below we surveys the 4G telecommunications tariff plans in Asia countries so as to reflect how tariff plans should be made. Our survey is based on data collected from these companies official webpages during November, 2013.

III. TARIFF PLANS IN ASIAN COUNTRIES

A. Singapore

In Singapore, there are three main telecommunications operators, Singtel, StarHub and M1. Singtel has more than 130

year of history on providing telecom services. The operator has played a significant role in Singapore's telecommunications development and services. It commercially launched its LTE service in December, 2011, on the 1.8 GHz and 2.6 GHz frequency bands. StarHub, which also has a large market share, provides High-Definition (HD) voice services on mobile devices so as to increase user experience and attract potential customers. It is the first telecommunications operator in Southeast Asia to successfully launch VoLTE (Voice on LTE) services [16]. It runs on the 1.8 GHz frequency band since September, 2012. M1, is the first telecommunications operator to commercially launch LTE services in Singapore. It provides LTE services on the 1.8 GHz and 2.6 GHz frequency bands since June, 2011. In order to make itself more competitive in the mobile telecom market, the company has recently put a lot of effort on LTE-A related development. All these operators have achieved nation-wide scale of coverage by 2013. Next, we will survey the tariff plans of these three companies.

For new subscribers, Singtel gives the same price for each level of data-bundled plans, independent of 3G or 4G subscriptions. We believe that this is a good strategy to attract more 4G usage and improve user experiences. The monthly quotas of local calls range from 100 minutes to 500 minutes, while those of short messages ranges from 500 Short Message Service (SMS) to 1000 SMS. This may reflect the phenomenon that people nowadays tend to communicate by short messages rather than phone calls. Singtel also provides a tariff plan including unlimited local calls and SMS/Multimedia Messaging Service (MMS) combined with a large amount of data usage to satisfy heavy users. When a subscriber exceeds his/her quota in the plan that he/she subscribed, Singtel will charge on a per GB basis. However, the overage charges is not infinite. The exceeded payment is bounded by a monthly-capped value, after which further usage is not charged.

StarHub also tries to attract their new 4G subscribers by providing a FREE 4G speed boost on all of their 3G data-bundled plans. Subscribers can select some tariff plans to have unlimited quota on local calls and SMS/MMS services. On the other hand, subscribers can choose plans with restricted amounts of local calls and SMS/MMS services, but with more data usage available per month. Among these plans, the quota of SMS/MMS seems to be higher, ranging from 800 to 2500. All tariff plans provide HD voice service. Overcharge policies are similar, which have a monthly-capped value with upper bounds to limit the exceeded payment. However, overage is charged at a per KB basis.

M1 provides several promotions on their tariff plans to attract potential customers. We have noticed that with the same prices, M1 usually provides more quotas on local calls and SMS/MMS. Furthermore, in order to keep their original subscribers, the company provides additional 1 GB of data usage for re-contracting subscribers. Although its LTE service is a *Value-Added Service (VAS)* based on its 3G basic plan, the company announced that its LTE service will not be charged until the end of 2014. On the overage part, M1 charges at a per GB basis with a monthly-capped value.

Our survey shows that these telecommunications operators all provide similar basic plans but with their own strategies to attract different types of customers. While Singtel emphasizes on their stable services, StarHub and M1 lay stress on their HD voice services and larger quotas, respectively. All operators also provide student promotions by giving students unlimited SMS/MMS quota. By the fact that all operators set their SMS/MMS quota in plans at a high amount, we suppose that people in Singapore are already accustomed to communicating by using text messages, giving a high SMS/MMS amount in plans may attract more customers. On the other hand, as people are getting more familiar with social network applications (such as Facebook and Line), whether SMS/MMS is still the key charging factor remains to be observed. Although these operators all do not provide any unlimited data usage under their basic plans, users can pay extra charges for overage and after it exceeds some monthly-capped values, no more charge will be applied. Therefore, there is no FUP introduced by these operators.

B. Japan

We next survey the tariff plans of NTT Docomo, KDDI, SoftBank in Japan. NTT Docomo, which is the largest telecommunications operator in Japan, terminated its 2G services (mova and DoPa) in March 31, 2012, and started its 4G services on 1.5 GHz and 2 GHz in December, 2010. An important data service of NTT Docomo is i-mode, which was launched in February 1999 and has been upgraded to a new version called sp-mode since 2010. i-mode allows users to surf the Internet on mobile phones by viewing compatible websites [17]. With successful i-mode services, NTT Docomo has dominated the telecom market in Japan. Impacted by the popularity of smart phones, the company launched new plans with Sony and Samsung, in June 2013 and also launches a new series of iPhone plans in Sep 20, 2013 [18]. As of March 2014, Apple has a smart phone market share of 57.6% in Japan [19].

KDDI, also a large telecommunications operator in Japan, was consolidated from DDI, KDD, and IDO in 2000. KDDI has offered mobile services with its own brand cell phones called au phone. KDDI started to provide 4G service on 0.8 GHz and 1.5 GHz in December 2012, and is planning to enhance its LTE speed up to 220 Mbps in the summer of 2014. According to [20], the KDDI research institute has developed advanced MIMO, which is able to upgrade spectral efficiency to more than two times, as opposed to 100 Mbps of typical LTE.

SoftBank entered the telecommunications business by purchasing Telcom and Cable & Wireless IDC in 2004. SoftBank started to provide 4G services on 2 GHz in July 2011. Being the first agent of Apple Inc. in Japan, the company is able to provide steady quality of services and has attracted a lot of customers. In July 11, 2013, SoftBank officially purchased Sprint Nextel in the United States with 216 million dollars [21] and has been developing its overseas business actively.

Each of the three operators offers only one 4G plan (see Table I). They all take similar charging factors but different prices. However, monthly charge in Japan is different from Singapore and Hong Kong. Services, such as voice call, SMS and data communication, are optionally charged by Pay-As-You-Go. The 4G plan of KDDI and SoftBank provide intra-network free calls from 1 AM to 9 PM and unlimited intra-network SMS service. On the other hand, NTT Docomo and KDDI offer unlimited calls in their flat-rate plans. All these operators have additional entitlements for data communications (see Table II). NTT Docomo provides flat-rate data plans with upper bound of 3 GB and 7 GB while KDDI only has one such plan with an upper bound of 7 GB. SoftBank has a flat-rate data plan and a two-tiered data plan of 5 MB to 15.5 MB both with an upper bound of 7 GB. All operators have the same FUP strategy; if data usage in the current month exceeds the upper bound, the transmission rate will be limited to a maximum of 128 kbps until the end of charging period. Subscribers can apply to the operators for 2 GB with normal transmission rates to cancel the 128 kbps limit at a cost of \$24.62. However, there is another limit on usage of data. If data usage exceeds 1 GB in three days, subscribers will be limited to access some services such as video streaming. Besides, all operators have their own family plans, where customers can get discount with basic monthly charge and call family members for free. There are also student plans, in which the basic monthly charge is free in three years and the family plan can still be used. All operators provide discount on application for *Mobile Number Portability*

(MNP), which enables subscribers to retain their own mobile phone numbers when moving to a new operator.

TABLE I
COMPARISON OF 4G TARIFF PLANS IN JAPAN.

	Monthly Basic Charge	Pay-As-You-Go			
		Domestic Calling Charge (Basic Charge \$2.945)		Data Communication Charge	Domestic SMS
		Intra-network (per 30 seconds)	Extra-network or landline (per 30 seconds)		
NTT docomo	\$7.293	\$0.196 All day	\$0.196 All day	\$0.006/KB	\$0.029/message
KDDI	\$9.167	1am to 9pm: free ; 9pm to 1am: \$0.196	\$0.196 All day	\$0.006/KB	Intra-network: free; extra-network: \$0.029/message
SoftBank	\$9.167	1am to 9pm: free ; 9pm to 1am: \$0.196	\$0.196 All day	\$0.006/KB	Intra-network: free; extra-network: \$0.029/message

TABLE II
COMPARISON OF FLAT-RATE PLANS IN JAPAN.

		Monthly Charge	Upper Bound
NTT docomo	Flat-rate data plan(light)	\$46.131	3GB
	Flat-rate data plan(heavy)	\$55.946	7GB
KDDI	Flat-rate data plan	\$55.946	7GB
SoftBank	Flat-rate data plan	\$55.946	7GB
	two-tiered data plan	\$19.630 - \$60.854 (5MB-15.5MB;\$0.004/KB)	7GB

C. Hong Kong

For Hong Kong, we first discuss two telecommunications operators, CSL and PCCW. In February 2011, PCCW released CSL to Telstra in Australia. However, Telstra decided to release CSL back to PCCW as a subsidiary company with \$2.43 billion [22]. PCCW is one of the dominating telecommunications operators with a market share of 31% in Hong Kong. After PCCW acquired CSL, it possesses the frequency bands of 2.1 GHz and 2.6 GHz. Although CSL was purchased by PCCW, these two operators are still considered as independent ones. In February 2014, CSL combined 2.6 GHz and 1.8 GHz to provide LTE-A service with a download speed of 300 Mbps [23]. Both PCCW and CSL claimed that they will provide VoLTE service in the 2014 [24]. Another telecommunications operator is Hutchison 3 where 3 means 3G, Hutchison 3 was the first operator which provided 3G services in 2004. It has the widest frequency band included 0.8 GHz, 0.9 GHz, 2.1 GHz, 1.8 GHz, 2.3 GHz, and 2.6 GHz. Note that 2.3 GHz is adopted by China for TDD LTE. This may attract customers from China for dual band services (TDD LTE and FDD LTE) in the future. The third telecom operator is China Mobile. Since the company does not have its own 3G

network, subscribers are forced to use 2G networks when they move to areas without 4G signal. The situation is improved after China Mobile rented some 3G networks from PCCW and decided to buy its own 3G frequency in the end of 2014. On the other hand, China Mobile has launched the first dual band services with two frequencies (2.6 GHz for FDD-LTE; 2.3 GHz for TD-LTE) in Hong Kong in December 2012 [25]. And it upgrade its 1.8 GHz frequency to 4G in 2013.

In Hong Kong, we can find that their 3G and 4G tariff plans are similar. For example, the price of the 3G plan is the same as that of the 4G plan. Besides, there is a large free quota for voice calls(e.g. 5000 minute), or even unlimited one (e.g. China Mobile). On the other hand, in 2014, all operators in Hong Kong decided to cancel their unlimited data plans perhaps to avoid network misusing. One2free, a subsidiary company of CSL, provides a plan of 5 GB with additional data entitlement. Thus, subscribers can choose to extend the quota as need, or be limited by their transmission rates due to the FUP. Also, CSL has a plan with unlimited intra-phone calls for heavy phone call user. On the other hand, we see that Hutchison 3 put more emphasis in data usage; it has a plan with a large quota of 10 GB and FUP with 25 GB. it means that the transmit rates wont be constrained until subscribers use data quota more than 25 GB. It also has a upper bound of payment per charging period. Unlimited voice call plans are also available.

For China Mobile, they provide plans with 10 GB quota. when reaching the quota, China Mobile will disconnect the subscribers from the network to prevent bill shock. Besides, It also has plans with unlimited voice calls similar to CSL and Hutchison 3.

IV. PRICE-PERFORMANCE ANALYSIS

Below, we make some price-performance comparisons among operators. All prices are translated to USA dollars based on the exchange rates at a certain period. Since report [26] shows that monthly average cellular data usage of android smartphone is 2GB in Asia (Japan and South Korea), we try to pick most matching plans to compare.

A. Singapore

We compare the three plans: Lite (Singtel), SmartSurf Lite (StarHub), and Value Surf+ (M1). These plans all include a basic data usage amount of 2 GB. Lite from Singtel and SmartSurf from StarHub provide the same quota of outgoing local calls and SMS/MMS, while Value Surf+ from M1 provides a higher quota of outgoing local calls but a lower

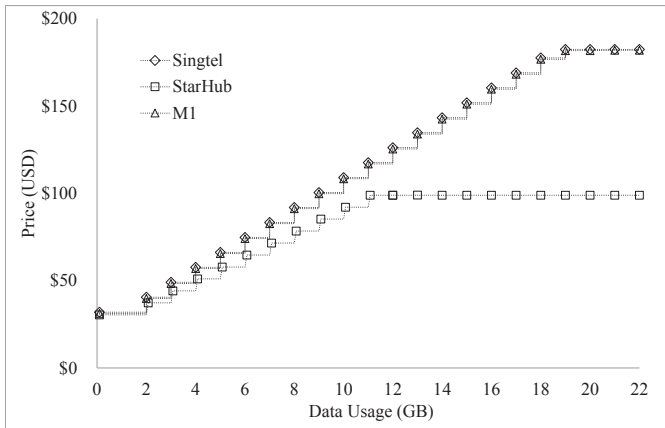


Fig. 1. Price-Performance Analysis in Singapore

quota of SMS/MMS than other two operators. Fig. 1 shows that within 2 GB, there are only slight differences of payments among these operators. All three operators have monthly-capped values of \$150.4 (Singtel), \$68.5 (StarHub), \$150.66 (M1) of excess data payment. After reaching these payments, there is no further charge on any excess data usage. These strategies cause the horizontal lines in Fig.1. Obviously, we can tell from the figure that StarHub is much cheaper than other operators. However, this may be a temporary discount for StarHub subscribers since the operator has announced overage will be capped at promotional rate of \$68.5/month for customers just for now. Promotion is valid till a date predetermined by StarHub [27].

B. Japan

For Japan, we compare three plans of NTT Docomo, KDDI and SoftBank, respectively. More details of the plans are shown in Table I. All data communication of plans are charged by pay-as-you-go, so we choose the most matching additional data entitlements, respectively. More details of the additional data entitlements are shown in Table II. In NTT Docomo, we choose the flat-rate data plan with light upper bound of 3 GB. For KDDI and SoftBank, we choose the flat-rate data plans with the upper bound of 7 GB. The comparison is shown in Fig. 2. NTT Docomo has the cheapest plan before 3 GB. The reason is that KDDI and SoftBank offer intra-network free calls and unlimited intra-network SMS service, but NTT Docomo does not. However, it is more expensive after 3 GB. The reason for the phenomenon is that we choose the light upper bound in NTT Docomo. The light upper bound is more matching 2GB usage than others. Besides, the price of KDDI and Softbank are constant before 7 GB since their upper bounds are fixed 7 GB.

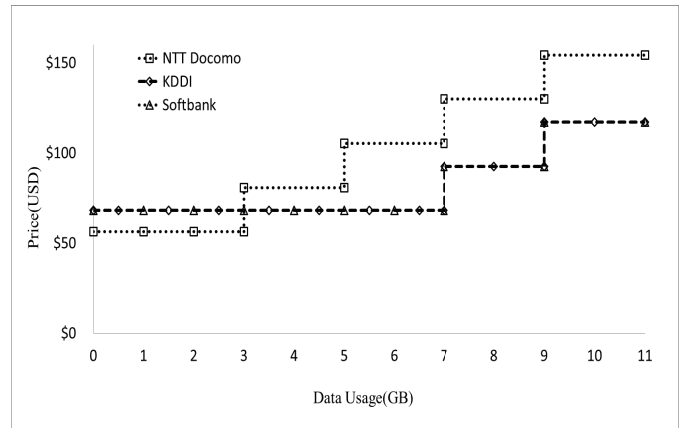


Fig. 2. Price-Performance Analysis in Japan

C. Hong Kong

For Hong kong, One2free (a sub-brand of CSL) provides a \$32 plan which give subscribers 2 GB data quota and 4000 minutes for voice call, 10000 free SMS service, and two kinds of data overage (\$3.5/100MB and \$12.5/GB, we use the latter in here). Secondly, China Mobile provides a \$16.6 plan gives subscribers 1 GB data quota and 1800 minutes for voice call, 10000 free SMS service, and charging over use of data with \$7.6/GB. Thirdly, Hutchison 3 provides a \$25.7 plan which give subscribers 2 GB data quota, 2500 minutes free call, 1500 minutes for intra-voice call, 10000 free SMS service, overage with \$12.6/GB and upper bound of payment up to \$116.

After compare One2free and Huchison 3 in Fig. 3 , we can find that the gap difference between them is constant before 9 GB and increase later. The reason is Hutchison 3 has upper bound of payment but One2free has not. For China Mobile, it always get the lowest price before 13 GB since it provides less voice call minutes than the others. After data usage over than 13 GB, price of China Mobiles plan will be higher than Hutchisons one because Huchison 3 has the upper bound of payment. In other words, China Mobiles plan is more suitable for subscribers who use less than 13 GB data quota but dial less voice call.

V. CONCLUSIONS

In this paper, we have surveyed the tariff plans of nine telecommunications operators in Singapore, Japan, and Hong Kong and compared their price-performance ratios. We can observe that: (1) tier-pricing strategies, such as FUP, local custom, monthly data allowance, etc., play important roles in the 4G market. (2) several issues, such as coverage, penetration, market share, tariff strategy, and even working hours and

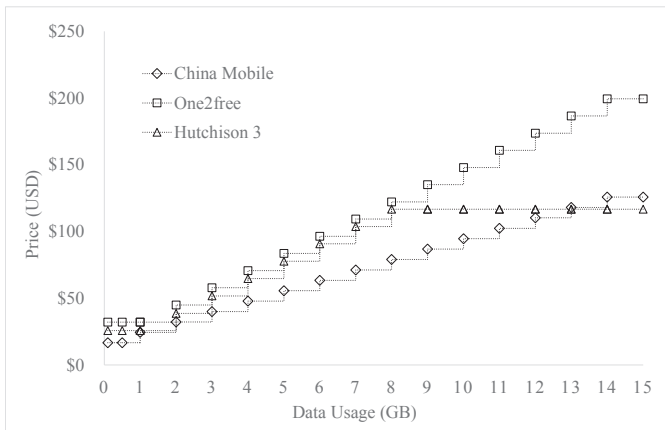


Fig. 3. Price-Performance Analysis in Hong Kong

customs, deeply influence how telecommunications operators set their tariff plans for 4G LTE. Moreover, discuss how FUP can affect operator and customer.

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