Individual Telecommunications Tariffs in Chinese Communities:

History as a Mirror of the Future, and Relevance for Mobile Service Development in China

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ERIM REPORT SERIES *RESEARCH IN MANAGEMENT*	
ERIM Report Series reference number	ERS-2004-057-LIS (Business Telecom)
Publication	July 2004
Number of pages	13
Email address corresponding author	lpau@fbk.eur.nl
Address	Erasmus Research Institute of Management (ERIM) Rotterdam School of Management / Rotterdam School of Economics Erasmus Universiteit Rotterdam P.O. Box 1738 3000 DR Rotterdam, The Netherlands Phone: +31 10 408 1182 Fax: +31 10 408 9640 Email: info@erim.eur.nl Internet: www.erim.eur.nl

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Library of Congress Classification (LCC) http://lcweb.loc.gov/catdir/cpso/lcco/lcco_h.pdf	Mission: HF 5001-6182	
	Programme: HE 9713+	
	Paper: HE 9713+	Wireless Telephone
Journal of Economic Literature (JEL) http://www.aeaweb.org/journal/jel_class_system.html	Mission: M	
	Programme : L 63, L 96	
	Paper: L 96, O53	Telecommunication Asia
Gemeenschappelijke Onderwerpsontsluiting (GOO)		
Classification GOO	Mission: 85.00	
	Programme: 05.42	
	Paper: 05.42	Telecommunicatie
Keywords GOO	Mission: Bedrijfskunde / Bedrijfseconomie	
	Programme: Draadloze Communicatie	
	Paper: Draadloze Communicatie, Tarieven, China	
Free keywords	Individual Telecommunications Tariffs, Wireless Services, Wireless Communities, Telecommunication History	

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History as a Mirror of the Future, and Relevance for Mobile Service Development in China

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Abstract—This paper addresses the mobile service pricing and affordability issues in China. Taking history as a mirror, it shows individual tariffs existed at the dawn of telephony. A vision of future mobile services with individual tariffs is formalized which will suit specially well the culture of communities rooted in Chinese traditions. An analysis of current tariff conditions in China, and of technologies developments worldwide, shows community-based indiviudal tariifs will speed up the diffusion of moible services to the majority of populations and benefit both economically and sociologically the development in China.

Index Terms—Individual Telecommunications Tariffs, Wireless Services, Wireless Communities, Telecommunication History.

(Word count: 4398, excluding abstract, footnotes and references)

I. Introduction

The focus of this paper is on pricing and affordability of mobile services, addressing especially factors essential to a sustainable adoption of wireless communication in China. Taking a historical perspective around the world, it shows first that telecommunication services started in the 1880's with prices set for each user individually; an analysis of current situation in

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mobile communications especially in China is followed by a vista of the situation in approx. year 2030 (Section II); it then presents (Section III) a visionary version of mobile user pricing suiting especially well the Chinese culture of communities and the service dependencies therein (礼尚往来). The present day technical approaches supporting individual tariffs are briefly discussed in Section IV. The paper concludes in Section V with the suggestions that the adequacy of individual tariffs inside Chinese communities, further compounded with growing service creation skills, will fuel a fast improving affordability and use of mobile services.

The economic theory of pricing has traditionally been derived for physical goods, and from different angles:

1. either from a static equilibrium between supply and demand [1], including auction;
2. or taking in consideration ranked preferences for individual price formation [2];
3. or reflecting price dynamics with endogenous fluctuations due to market restructuring [3].

Most traditional telecommunication pricing schemes have been variants of the above, assuming limited capacity in either bandwidth or transmission capacity; these two assumptions have been made largely erroneous with the advent first of fiber optic transmission, and next of advanced radio coding/modulation/spectrum usage techniques.

Unfortunately, in general only little has been published around service pricing and affordability for end users, which furthermore takes social networks into account, as in this paper.

II. The History, Present and Future of Wireless Service Tariffing and Affordability

This section is successively addressing the telephony usage and pricing in general in the 1880's, thereafter the current situation in China for wireless communications, and proposes finally a vision about wireless service pricing in e.g. the 2030's. (Date picked randomly to reflect the social and technology legacy and adoption curves.)

A. Users, demand and supply in the 1880's

At the dawn of the telephony services history, there were individual tariffs! The telephone was patented by Alexander Graham Bell in 1876. For quite some years, and in some markets, it served mainly some high level civil servants and privileged people (trade, news), and was the symbol of wealth and social rank. Telephone subscribers were not designated by a number, but by their name; picking up the phone would get the operator, who would then ring and connect the desired party by a polite support staff protocol.

As a luxury service at that time, the demand for telephony was limited (lack of network capacity effect). Phone calls were mainly local, with national and international calls a rare phenomenon except in some key cities. The demand patterns by called party, between office and home, or between national parties and international parties, were by and large not analyzed, as their influence

on telephone company tariffs was minimal. Each individual was eventually satisfied, or not, in a binary way with whatever the telephone companies offered (since the person was rich or the services were paid by the government). The individual demands were price insensitive, which resulted in an inelastic demand curve as shown in Figure 1.

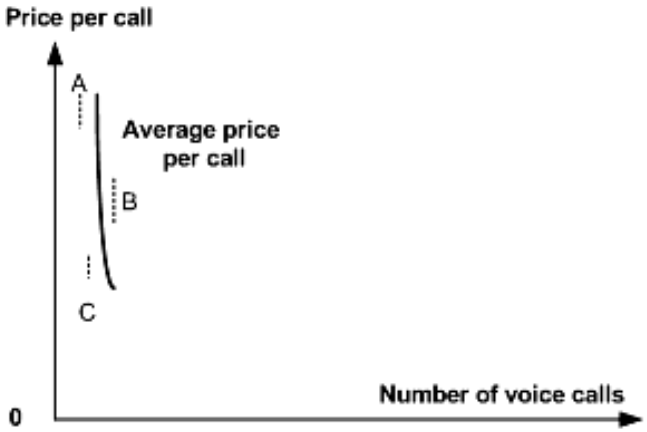

Figure 1: Service demands at the dawn of telephony;
A, B, C represents the individual demands, which were limited and price insensitive. The average telephony demand curve at the dawn of telephony is also shown in the bold curve, which is inelastic. All voice calls here are assumed for the same destination/distance.

Regarding the supply of telephony services, there were in general only geographically limited pure monopolies, and the capacity in each country was dominated by two or three local companies able to invest in interconnections.

From the very beginning, although the reduced sets of telephone users and suppliers were restricted, charging patterns diverged very early between flat rates and individual usage-based rates. Numbers of call attempts, and physical destination as well as the duration were manually recorded – But the pricing of the calls was a matter between the telephone company sales person and the service customer (who was then not a subscriber); usage, rank, fame, location were all taken into account, and the settlement was done by a bank note or cash. In some countries, an annual contract fee was charged, while others started with flat rates for a fixed number of calls (not even based on duration or distance

Case 1: In Sweden, year 1881, the city of Gävle called for bids to supply a local telephone system. The Bell Company in Stockholm offered to install and operate a system for SEK 200 per user per year (2004 value = SEK 9102)[1], based on a minimum of fifty five-year user contracts. The local enterprise Ericsson offered SEK 275 per user (2004 value = SEK 12514) and thereafter to operate it for SEK 56 (2004 value = SEK 2458) per user per year[2]. The rate of annual operation cost, to Gross National Product (GNP) of SEK 310/capita in 1881[3], is 18%.

Case 2: In Los Angeles, in 1888 the common policy of the telephone company was high-quality service and high costs. “The minimum flat rate in central Los Angeles in 1888, for example, was USD 4 per month (2004 value = USD 80.37)[4] plus two cents a connection after the fortieth call (2004 value = USD 0.40). This rate equaled about 10% of the average nonfarm employee’s wages” [4]. At the time, the penetration rate of telephone in the U.S is 1.08%[5].

[1] "Consumer Price Index," Statistics Sweden, 2004. Available: www.scb.se.
[2] "Lars Magnus Ericsson - A brief biography," Ericsson. Available: http://www.ericsson.com/about/compfacts/history/lars_magnus_ericsson/company_born.shtml.
[3] Östen Johansson, "The gross domestic product of Sweden and its composition 1861-1955.
[4] "Consumer Price Indexes," Bureau of Labor Statistics, U.S. Department of Labor, 2004. Available: http://www.bls.gov/cpi/.
[5] “Penetration rate of Consumer Technologies (1876-present)”, FCC, U.S Available: http://www.fcc.gov/Bureaus/Common_Carrier/Notices/2000/index2.html

In all cases, the supply was scarce and inelastic to prices (See Figure 2), as there was no choice, nor competitive mechanisms. And, although prices were fixed individually or bundled into packages with fixed numbers of calls, they were extremely high, which resulted in the exclusion of the majority of population from accessing the services due to unaffordability.

B. Current situation for mobile communications and especially in relation to China:

The worldwide GSM mobile phone users reached 1 billion in February 2004, almost one sixth of the world's population[1]**;** besides other mobile communications standards also have user and subscriber bases adding up to that number, for a worldwide grand total of approximately 1.4 Billion (1,340,667.7) at the end of 2003[2].

In China, the first public mobile operator China Telecom started its services in 1987 under heavy government involvement and as a state-owned enterprise, with 700 subscribers. With a fierce growth (Figure 3), in October 2003, the number of mobile users exceeds the number of fixed telephone users[3]. By the end of 2003, the over all penetration rate among the total population is approximately 20.9%[4] . There were approximately 290.31 Million mobile users at the end of March 2004[5], with a growth of 60 millions of users per year, according to MII statistics.

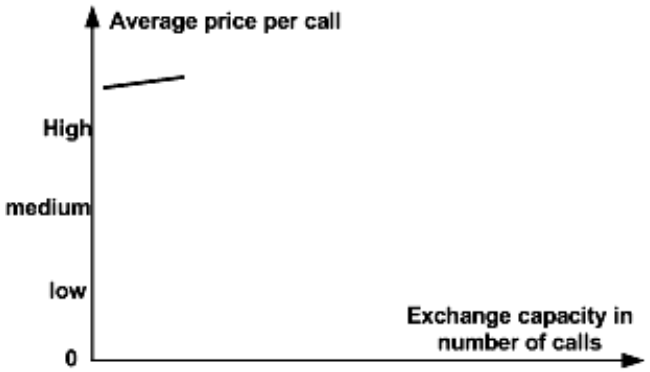

Figure 2: Supply curve at the dawn of telephony: Average price per call vs. Exchange capacity in number of calls. The telephone exchanges were mechanical and human operated; further more the number of suppliers of exchanges was limited and the production runs as well.

In China, mobile tariffs, as part of the telecommunication tariffs, are guided by "Regulations of the People's Republic of China on Telecommunications" [5]. A Telecommunications Law is supposed to be promulgated in 2005. Tariffs are divided into three categories:

1. Government-set tariffs;
2. Government-guided tariffs;
3. Market-based tariffs.

Basic mobile services (voice call, roaming, and long distance call) can follow either government-set tariffs, government-guided tariffs or market-based tariffs. Value-added mobile services (call forward, line identification, SMS, etc) can follow government-guided

[1] "GSM: the business of a billion people." Cannes: GSM Association Press Release, 2004. Available: http://www.gsmworld.com/news/press_2004/index.shtml.

[2] "World Telecommunication Indicators - Basic indicators," ITU, 2003. Available: http://www.itu.int/ITU-D/ict/statistics/at_glance/basic03.pdf.

[3] Telecommunication Industry Monthly Statistics, October 2003," Ministry of Information Industry, China. Available: http://www.mii.gov.cn/mii/hyzw/tongji/yb/tongjiyuebao200310.htm.

[4] Telecommunication Industry Monthly Statistics, December 2003," Ministry of Information Industry, China. Available: http://www.mii.gov.cn/mii/hyzw/tongji/yb/tongjiyuebao200312.htm.

[5] "Telecommunication Industry Indicator, 1st quarter 2004," Ministry of Information Industry, China. Available:

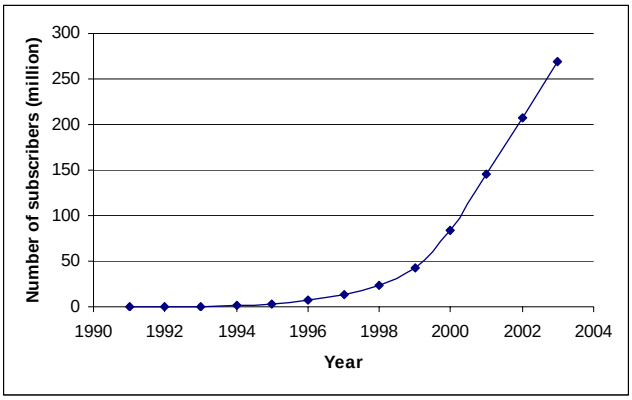

Figure 3: Evolution of demand in China: Year vs. number of subscribers. (Data source: National Bureau of Statistics of China).

	Urban usage	Rural usage
Weighted ARPU (CNY)/month	129.93	56.38
Disposable income (CNY/year)	8472	2622
(Weighted ARPU)*12/ Disposable income	18.40%	26%

Table1: Ratio of ARPU to disposable income. We approximate urban users to be the postpaid users, and rural users to be the prepaid users. The weighted ARPU is the average revenue per user, weighted within each population category (urban/postpaid, rural/prepaid) by weight equal to market share applied to published ARPU of two large mobile operators: China mobile and China Unicom.

tariffs or market-based tariffs. When there is intensive competition, the tariffs can be set based on the market mechanism. "State-aid" operators are entitled to set price fluctuating within 10% of the government-set tariffs. There are two dominant mobile operators (China Mobile and China Unicom), plus two minor ones.

The current mobile tariffs are based on a regulation issued in 1994 by the former Ministry of Posts and Telecommunications. Postpaid users pay a monthly subscription fee of CNY 50 and the tariff is CNY 0.40/minute for local calls, CNY 0.60/minute when roaming. Prepaid users do not pay the monthly subscription fee, and the corresponding tariffs are CNY 0.60/minute for local calls and CNY 0.80/minute when roaming.

Due to high income disparity in China today, the ratio of the ARPU[1] to disposable income urban and rural[2] (see table 1) reminds closely of the situation in the 1880's described above in section II.a, with a ratio of 18.40% and 26% respectively. The overall average ARPU is CNY 76.3/month (2003). The ratio of the overall average mobile voice usage cost per year, to Chinese GDP per inhabitant CNY 9025 (2003) is of 10.14 %. Whereas the overall mobile penetration rate in China among the total population was approximately 20.9% at the end of 2003, with high usage subscribers representing an estimated 20% of the subscriber base, or 4.2% of the population. For all practical matters, high volume users (privates or enterprises) still largely negotiate their rates. Meanwhile, the majority of the population (79%) still can not afford the expense on wireless communications, reminding of the situation depicted in Section II.a.

Although the regulatory situation has obviously evolved rapidly, in purely economic terms, demand and supply are not yet happening on an equal-access basis and the suppliers are closer to an oligopolistic behavior than to a pure competitive one, partly due to the government directives.

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http://www.mii.gov.cn/mii/hyzw/tongji/2004-051702.htm.

[1] The ARPU data are acquired from the 2003 annual results of China Mobile (Hong Kong) limited and 2003 annual results of China Unicom Limited. Available: http://www.chinamobilehk.com and www.chianunicom.com.hk

[2] "Statistical Communiqué on the 2003 National Economic and Social development," National Bureau of Statistics of China. Available: http://www.stats.gov.cn.

C. A Vision of the Tariffing Situation in Approx. Year 2030 ("The Bright Future")

Twenty years from now on, advanced personal communication technologies enable people to stay connected anytime, anywhere with access network alternatives. Users' devices can seamlessly roam between PAN, WLAN, WAN, with new services yet unknown. With a penetration rate of wireless devices of over 100 percent over the entire population in most countries, how mobile services are provided will be quite different from now.

While connectivity is the most cherished property as in year 2000 (see [6]), the key values of mobile service in the 2030's will be totally different. By a combination of a large number of users, technology improvements, and operator productivity gains, the pure transport and access tariffs for wireless will have plummeted to very low values. Content-based service will generate certain revenue. Content exists in two variants:

1. "static", from data warehouses with only slow modifications;
2. "dynamic", from real-time information sensors and other sources, including user-originated content.

By profiling and data mining, besides personalization selections, the service operators will know in real time much more about users than now. However, in an age with information "overload", static content has no commercial value except for those with copyright of the creators, or information access provisions. Advertisement will generate some revenue for service providers, but it will probably not be sufficient to support a whole mobile communication industry living from the "law of large numbers" and from very low tariffs. User driven service personalization will enhance some tariffs but the cost of provisioning of such services will offset revenue gains [7].

Mirroring the early trend in video/broadcasting industries for dynamic content, the relative share in tariff bundles of the intellectual property right owner will be larger; the multiplication of dynamic content channels will add to tariff bundles price pressure.

Consequently by say 2030, the true value of wireless services lies in the interactions, where the services are formed as a result of multiparty interactions. These interactions can be divided into three categories:

1. Community based human-to-human interactions;
2. Cluster based machine-to-machine interactions;
3. Human-to-machine interactions.

In this paper, we focus on the first category. Sociologist Barry Wellman [8] had defined communities as: "Networks of interpersonal ties that provide sociability, support, information, a sense of belonging, and social identity." We assume that all the members of such a community rely amongst other communication mechanisms, on the usage of mobile technology in the 2030's.

Because of their business, sociological or process-linked nature, the communities mentioned above rely on a membership fee (in

kind or in money, eventually free) and on managed access privileges, akin operators customer care administration, but in diverse forms and with more freedom in the organization thereof. More precisely, belonging to community requires an identity and membership for a user in order to receive services. The community provides collectively information, know-how, and services to members through interactions and access to static or dynamic content. The access to the services inside a community is based on prices and based on competition, or possibly quasi real-time spot service prices [9]. There are also prices for community peering arrangements, or community-to-community interactions, but these may be on a flat basis once a service-level agreement has been enacted between them. One key driver of these communities is obviously the affordability in economic terms, and the obligation in social terms, to join one or several communities. Section III explains in more detail the cost the revenue formation justifying this affordability.

The above analysis leads directly to pointing at the future potential of individual tariffs between now and the 2030's, although these would obviously be provided in a completely different way to the 1880's in terms of user population, technologies and management processes.

In China, the traditional "families" and groups culture (人以群分) leads to more diverse communities. In addition to business, occupations and hobbies, communities are often formed under a same origin, or under a same dialect [10]. The above pricing settlement arrangements suit especially well the various communities. Take the example of a family-based community: the flat rate will be very low (close to zero), similarly within a rural village. But the differences lie in the fact that in a formally organized community, "such as in a village", affordability will be higher as set largely by users themselves in view of their social, economic and information needs, which may result in non-zero membership fees.

III. INDIVIDUAL TARIFFS

A. Definition of individual tariffs for a set of communication services

"*Individual tariff*" means that each individual sets a tariff for himself/herself for a specific set of services provided by the community, whether this service is user-defined or community-defined. Even if that individual belongs, say to an enterprise, the members of the enterprise may have different individual tariffs, simply because their service demand and content flow (contributions and receipts) are different. Even, different users of the identical service (if any such exists) may value and price it differently as they decide to belong to different communities as their choices.

In the definition above each community ends up supplying a number of services of which only some are initiated by consensus at community level or by the service manager. A community does not need to own part or the entire fixed and wireless transmission infrastructure, sourced competitively from an infrastructure owner.

The above definition says nothing about the service provisioning duration the community commits to its members, or which communities commit to between themselves. Duration of the service will be one attribute in the multi-attribute service demand from the user in a community; e.g. sporadic uses are possible, just as are long term ones, but the difference with today is that they can be different and user-specific.

The above definition says nothing either about the transparency of prices and pricing provisions. More precisely, the information disclosure rules are of three types at least, with one between the member and his community (especially if this is managed formally), one within a community, and the last one between communities. These information disclosure rules may lead to price equalization but this effect is twice limited in that it can only happen for the same service, while each community member will have a different service profile.

Very importantly, per this definition, when the end user requests a certain service from a community, he/she is also responsible for the existence and survival of the community through contributions (money, but also information, knowledge). The individual will take and share the risk if the service is underfunded and ceases to exist. So, if the user appreciates the service, he/she may end up paying slightly more than other members, or even than users of the same service in other communities, to ensure the existence of the service. The person can also consider paying an insurance premium to the community to cover against the risk of service loss.

By paying an individually negotiated premium, which can be a very small amount of money, the user maintains his access to services, but also by mutualising this risk, he contributes to the survival of the community [11].

There are several countries where some operators are on an experimental basis, or publicly, having individual tariffs which are not just options inside or outside a wireless “subscription plan/bundle”: Estonia, Norway and South Africa. In first two cases, it is part of business model and last one as part of policy to balance with disposable income (“Universal service provisioning”).

B. Business model of a community

The income of a community will be made up of a combination of:

1. the member fee (once per year);
2. the competitive specific service usage revenues within the community;
3. Service usage revenues generated from non-members;
4. the possible premium income from members who select to cover themselves against specific service disruption;
5. flat fees from other communities;
6. and, last but not least, contributions in kind (work, information, know-how, knowledge, innovation) by members.

On the cost side, they include:

1. costs of managing community memberships; but this cost does not bear marketing and publicity costs, so it will be far less than with today's public operators;
2. investments in infrastructures and possibly service access devices;
3. partial service creation expenses, possibly shared with community users or other communities;
4. service provisioning and operations expenses, with in some cases community members being member-employees;
5. flat fees to other communities;
6. and, last but not least, intellectual property right expense from service creation and innovation, and from access to information or knowledge shared in the community.

We estimate that the community management overhead share will be 25 %, the community service creation share 60% and the transport plus access share (to infrastructure owner) will be 15% of the total costs.

C. The demand analysis

The total demand will be large, as people can personalize their services according to their needs, and furthermore because community proliferation may multiply the effect. Compared to the situation with generic public services in limited number, used by very many, communities offer viable alternatives in terms of revenue and demand. The reason is that within a community, the above two multiplicity factors are replaced by four:

1. number of community members;
2. overlapped sub-communities that share some common interests but have some interests and service demands different from others;
3. number of specific services for a sub-community;
4. number of common services to all members in the community.

These four distributions allow to replace flat rates for all, by individual tariffs, subject to the condition that each community has detailed network management and monitoring tools to be able in real-time as well over membership durations to quantify equilibrium break-even tariffs (see [12]). People will pay the amount of money, and put in their individual contributions, exactly according to how they value the personalized service bundles offered or requested by them. This results in price insensitive individual demands. Although for each specific service, the preference from each user will be different, but the average demand across large number of user again leads to a price inelastic demand curve (see Figure 4), in this way, we are back in history (see Figure 1). However, the new demand curve is much more to the right of in absolute value in the "number of service requests" axis and much lower in the price axis.

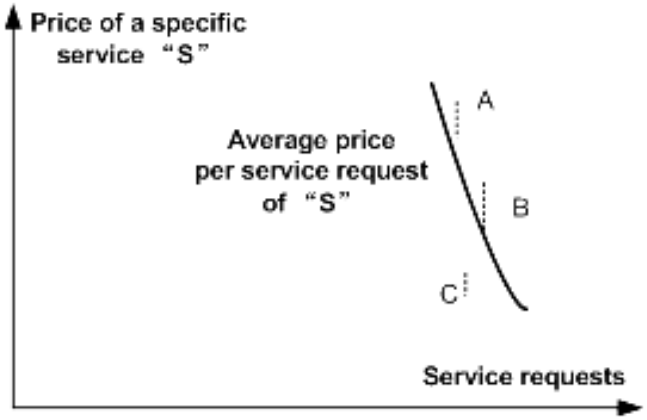

Figure 4: Service demand for one specific service "S" at 2030's. A, B and C represent individual A's service profile: (S, A1, A2, etc), individual B's service profile: (S, B1, B2, etc) and individual C's service profile: (S, C1, C2, etc). The average demand for service "S" is shown in the bold curve. Note there is a "service proliferation effect" driving the curve slope.

Case 3: A good example of community services are from the largest Chinese game community "Lian Zhong" (联众世界)[1]. It offers online and mobile gaming, which include board games, card games and arcade games. It has over 130 million members, including 1 million paid members. Member fees are CNY 35 (90 days) or CNY 120 (1 year). However, Membership days can be traded into credits which can be spent in the games. (E.g. 10 days of membership for 300 credits.) Paid members can, among other services, buy credits, have privilege joining and selecting the games, set up their sub-communities and can enter the "hall of fame" based on their scores and credits. Normal members can access common game services, with limited capability; they can not buy credits but have to earn them in the games. There are over 3600 sub-communities which are formed under different basis. An average sub-community has 600 members, and over 20% are paid members. Besides the common services, members in each sub-community can have their own specific services. Generally, each sub-community offers 2-3 specific services, like monthly training or tournaments but tailored to their favorite games and within a closed community. Currently, the access to services offered by sub-communities is free.

D. The Supply Analysis

The supply of services will be abundant, and the price will be low, driven not only by the deregulation of telecommunication services and technology advances, but above all by the freedom to define, request and bear a share of the risk around service creation (see Figure 5). In the Chinese case, and maybe others, additional factors are the traditions within a community and their closed nature.

Still backbone transmission will be essential, as will be different authentication/roaming/settlement functions, but it remains to be seen if traditional operators born in mindset in the 1880's (analog voice) or 2000's (wireless) can offer competitive services in flexibility, price, quality and scalability to what some larger communities may do themselves. Do not forget that due to exploding traffic demand, and competition driven by many community-clients, the revenue from pure transport or access will become minimal compared to the added value of personalized services.

[1] Lian Zhong: www.ourgame.com

IV. Technical Means for Achieving Individual Tariffs

Already today technical means exist to achieve individual tariffs, and the wireless infrastructure industry together with the billing platform industries, have shown that the complexity and costs involved in individual user multi-service and multiple access demand monitoring and control are surmountable now. But in the future, traffic and service aggregation and filtering solution for communities coupled with service creation platforms will allow to do this better and cheaper. And the demand for such solution will grow despite legacy from existing platforms. Future means are derived from research and standards in the following fields, and include (among others):

A. Linking the service profile of the user to adaptations in the billing/rating system

At the time the user identity, as recorded in the call data records, (with their time stamps and information or QoS labels) is linked to a service tariff table, the default public rates would be replaced for calculation purposes by the individual price list.

The reason why this is not implemented has to do with:

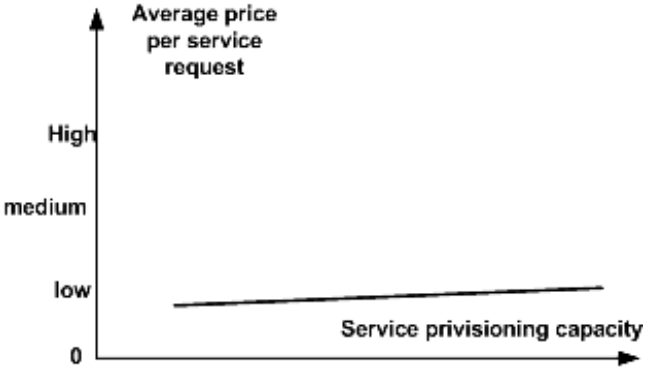

Figure 5: Average price per service request vs. Service provisioning capacity.

1. the fact that billing systems are not scalable enough, nor powerful enough, nor have enough data storage, to execute such operations in general;
2. the provisioning of such facilities would be largely manual and would be too costly.

B. Active networks

They allow to some extent to program network services when the packet processing is distributed and performed by the routers along the path (or tree) to a destination (see [13]). Senders at active nodes expecting special processing to their packets by the network simply address the packets to their destination, and routers recognize them as special packets and process them according to a given code.

In this code may reside the label or tag which the individual tariff represents and which would be tied to the active node at which such tariffs are executed. The propagation of the tariff labels can be either the node hierarchy control or via additional fields in the routing tables.

C. Flow label

In the IPv6 protocol, and not in IPv4, a field is reserved in all packets for a label on each packet.

Whereas some have proposed using this field for QoS features, some others [14] have proposed its use in part to encode the

individual tariff information for this packet.

This approach offers the added advantage over the previous approaches that the packet to which this individual tariff code applies, do not have to originate in some service node, but only in those who have the decoding key to this field. The key itself would be distributed via IPv6 protocol's IPSEC feature with PKE.

A standard would have to be designed for the coding of this flow label, when used for this purpose. Some skeptics criticize the data overhead failing to note that the flow label must be carried anyway in IPv6 unless compression is used.

D. SIP

SIP (Session Initiation Protocol) is a text based control protocol intended for creating, modifying and terminating sessions with one or more participants, it is designed to be independent of the lower-layer transport protocol. In SIP, a P-Charging-Vector header [15] is defined to convey charging related information. The information inside the vector can be filled in and retrieved by multiple network entities during the establishment of a dialog or standalone transaction outside a dialog. In this way, charging related data processing is reduced to session-base.

V. CONCLUSION: INDIVIDUAL TARIFFS IN CHINA?

The above analysis and evolution is highly relevant to the cultural, technical and sociological evolution in China – It shows a pattern in China today as to mobile adoption and affordability similar to the early days in the 1880's for fixed telephony on the user side.

A graduate adoption of community-based individual tariffs, first on connectivity, then on content and finally on interactions, will speed up the diffusion of mobile services for the majority of population in China. While various demands are met individually by user-set affordability, China can avoid the competitive model between large operators offering reduced set of standardized services and at the same time obtain a sustainable development in economic aspect.

One the other hand, the importance of individual and community pricing scheme is furthermore compounded by the importance in China of regional dialect and regional traditions as well as community demographics.

Community-based individual tariffs can be fueled by the very fast adoption of new technologies (WLAN etc.), and cultural linked services (e.g. mobile gaming). Furthermore, the skills base in software for service creation is a pre-requisite, the very presence of which in China may further accelerate this evolution by community based service needs.

However, the vision of individual tariffs envisioned here is not implemented in China, nor yet supported by regulatory policies. A balance must have to be found between the emergence of communities, government policies and the opening up of Chinese communication market.

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