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The Development and Evolution of China's Mobile Phone Industry

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Abstract

This paper examines the development and evolution of China's mobile phone industry, with a special focus on the effect of migration to smartphones on the industrial ecosystem and industrial transformation. The Chinese market was dominated not long ago by Shanzhai handset makers, which were often associated with notorious elements of bandit, copy cats, piracy, and illegal network access. However, in the migration from 2G to 3G and smartphones in China, a few home-grown brands have become the leading suppliers of smartphones, outperforming international premium brands, such as Nokia, Motorola and even Apple. With an intensive case study, the paper takes into account the significance of layered platform-based development in the migration towards smartphones and mobile digital services to examine the rise of the Chinese brands for smartphones. In addition, the paper discusses a co-evolution process of social and market factors in shaping Chinese "good-enough innovations", highlighting the role of distinct demands in the Chinese market and the growing popularity of mobile internet services within Chinese walled garden with heavy regulations and censorship. Moreover, the paper discusses the role of industrial standards in the Chinese migration of smartphones, by referring to a "three-level model for standards and innovation in ICT", including the infrastructure, middleware (service platform) and application levels. In short, TD-SCDMA can only be part of Chinese indigenous innovations and solutions for migration towards 3G broadband mobile internet services and smartphones; those at the middleware and application levels are indispensable and become more important as the mobile communications sector, in terms of both service and device, has become more application driven than ever. Therefore, China's quest for indigenous innovations and industrial standards has to be viewed in a broader context than just the infrastructure level (3G standards per se), when it comes to migration towards smartphones and broadband mobile communications services.

Key words: Smartphone, co-evolution of market and technology, mobile phone industry, platform, good-enough innovation, TD-SCDMA, Shanzhai handset

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1. Introduction

The communications industry can be considered as a landmark sector for China in terms of innovation. Not only are Huawei and ZTE, two leading Chinese and international communication equipment manufacturers, but also China's flagship international industrial standard, TD-SCDMA (Time Division-Synchronous Code Division Multiple Access) for the third generation mobile phone (3G), emerged out of this sector. However, as late as around 2008, China's market in the second generation (2G) mobile communications period was dominated by "Shanzhai (also called guerilla) handsets"[1], with some questionable reputations regarding fake, unprofessional or brand imitation in terms of appearance, design and brand name. The rapid development of Shanzhai handsets had brought about the progressive expansion of China's mobile communications market and an army of local handset producers who gained a strong market foothold, against leading international branded firms and legitimate local brands. In a word, the development of the Shanzhai handset sector amounted to a bottom-up approach to innovation in China, compared to the government's top-down approach to indigenous innovations and industrial standards, often involving generous government support and a few national champions. Some authors have shown that this distinct flavor of innovation in China had much to do with the role played by the diverse demand from the grassroots, local proliferation and adaption in terms of the production system required, and the cross-strait innovation network, involving Taiwanese firms such as Mediatek, a leading IC (Integrated Circuit) design house (Chen, Wen and Tai, 2013; Liu and Chao, 2009; Sheng and Shi, 2010; Tse, Ma and Huang, 2009). In fact, Shanzhai handsets per se can be considered as indigenous innovations in China, with strong links with demands from the grassroots, particularly those in the lower tiers of the market and entrepreneurial innovations of the masses. Elsewhere, we (Chen et al., 2013) even went further to argue that out of the Shanzhai handset phenomenon, the so-called "Shanzhai Economy" might prevail with Chinese flavor of innovation, which may now

[1] Shanzhai handset makers were mostly clustered in Shenzhen, Guangdong Province. There, thousands of small-sized "guerrilla" (at least initially) phone workshops used to form a comprehensive supply chain, ranging from project designing, software development, assembling, printing, packaging, logistic distribution to sales and after-sales service. However, the ecosystem of the Shanzhai handset sector had a much bigger and more meaningful picture than local clustering, bandit, copy cats and piracy. For detailed discussions on the Chinese way of innovation by Shanzhai handset makers, see Chen, Wen and Tai (2013).

be better termed as “good-enough innovation (economy)” (see also Brandt and Thun, 2010; Gadiesh, Leung, and Vestring, 2007).

In sharp contrast, in the migration towards 3G and smartphones, a few home-grown brands, such as Lenovo, Coolpad, Huawei and ZTE, have gained a strong market foothold in the Chinese market, against not only Shanzhai handset makers but also their international rivals, like Apple and Nokia, except Samsung. Of interest to note is the advent and proliferation of low-cost smartphones with price tags below CNY 2,000 and even around CNY 1,000, smartphones for the masses, in China. On surface, the emergence of those Chinese home-grown brands has benefitted from this factor, but it has much to do with the trend of platform-based development in the migration towards smartphones and mobile digital services (Eaton Elaluf-Calderwood, Sørensen, and Yoo, 2011; Kenney and Pon, 2011) and the role of grassroots demands in the Chinese market and the growing popularity of mobile internet services with Chinese versions and flavors. As a result, there have been profound changes in the Chinese ecosystem of the smartphone and mobile communications service sectors.

As to be shown in the paper, the diverse demand from the grassroots in both spatial and social terms, particularly those in the lower tiers of the market, is an important factor underlying the latest development of the smartphone sector (smartphones for the masses) as well as the Shanzhai handset phenomenon in China. However, in the migration from 2G to 3G, the mobile communications sector, in terms of both service and device, has become more application driven than ever, bringing about platform-based development and competition (Ballon, 2009; Ballon and Walravens, 2009; Hammershøj, Sapuppo and Tadayoni, 2009; Tilson, Sørensen and Lyytinen, 2012). One hence has to take into account a shift in the source of competitiveness for mobile phone players from the sphere of architectural design (the infrastructure level) to that of middleware/service platform (for example, Apple’s App Store) and applications, in the migration from 2G to 3G, as shown in the case of Apple’s rise with iPhone and iPad. As a result, the Chinese market for smartphones has consolidated and become more institutionalized than before, at the expense of the Shanzhai handset makers. Therefore, one has to develop better appreciation of the role of industrial evolution towards platform-based development and the social and market factors in shaping the Chinese innovations and industrial ecosystem, going beyond a simplified view around indigenous industrial standards, such as TD-SCDMA.

This paper is structured as follows. Section 2 reviews literature on the rise of China to present a perspective of the co-evolution of market and technology for indigenous

innovations in China, giving rise to “good-enough innovation”. Section 3 gives an overview on the uptake of 3G mobile communications and smartphones in China to highlight the rise of a few home-grown brands. Section 4 portrays the new ecosystem and industrial transformation, resulting from the migration from 2G to 3G in China, by discussing the key factors and facilitators. Further discussions are made in Section 5, referring particularly to the role of industrial standards in the Chinese migration of smartphones. The paper is concluded with Section 6.

2. The Rise of China: A Perspective of the Co-evolution of Market and Technology

With consistent and remarkable economic growth over decades, China has surged and become a manufacturing powerhouse in the world (Holz, 2008). Arguably, China’s economic achievements have had much to do with its export-oriented industrialization (Lemoine and Unal-Kesenci, 2004), driven substantially by foreign direct investment (FDI) and technology transfer (Chen and Chang, 1995; Ge, 2009; Lemoine and Unal-Kesenci, 2004; Liu and Buck, 2007; Liu and Wang, 2003). In addition, this process has involved not only the labor-intensive sectors but also high tech industries such as the ICT sector, and more recently, not only in manufacturing but also R&D (Chen, 2004; Chen and Liu, 2007; Ernst, 2008; von Zedtwitz, 2004; Walsh, 2003). China has consequently become the leading ICT exporting country world-wide, which to quite an extent has much to do with the formation of global production networks and global innovation networks (Ernst, 2008), involving not only developed countries but also Taiwan (Chen, 2002).

On the other hand, China’s economic development has come to a new stage that calls for different ingredients and recipes for future prosperity. Apart from some other elements highlighted in China’s Twelfth-five-year Plan, such as the stimulation of domestic demand and industrial restructuring, China has begun its quest for innovation (Rowen and Hancock, 2008) and technological leadership (Sigurdson, 2005), through its “market for technology” strategy (Mu and Lee, 2005) and the promotion of indigenous innovation (Sigurdson, 2005; Suttmeier and Yao, 2004). Indeed, a few indigenous firms, such as Huawei, have managed to catch up on technological ladder by taking advantage of the domestic market and the distinct feature of the technological regime in the telecommunications (switching system) industry (Mu and Lee, 2005). In addition, China’s quest for technological leadership gives high priority to indigenous innovations and industrial standards (Suttmeier and Yao, 2004). This often involves generous government support and a few national champions, with TD-SCDMA for 3G approved by the International Telecommunication Union (ITU) as a typical example.

On balance, a substantial body of the literature attributes China's economic achievement and industrial innovation to a few factors such as FDI, MNCs' offshoring of manufacturing and R&D and even the promotion of indigenous innovations and industrial standards. These factors are by nature derived from the supply side and quite often related to well-established firms both domestically and internationally.

However, some recent studies have begun to draw attention to the role of domestic demand (Christensen, 2003; Brandt and Thun, 2010; Gadiesh et al., 2007; Zhou, 2008) and entrepreneurs in the non-state sectors (Minagawa, Trott and Hoecht, 2007; Yueh, 2009) in China's economic and industrial development. For example, Brandt and Thun (2010) have shown that after China's accession to the World Trade Organization (WTO), domestic firms (mostly private ones) in a few (automotive, construction, and machine tool) sectors are able to stand up with foreign well-established firms, leading to local industrial upgrading. They have done so by taking advantage of the sheer size of the low-end segments and the strong pre-existing capabilities in those sectors. What's more, in their fighting for the middle, these are so called growing "good-enough" (middle) market segments, "home of reliable-enough products at low-enough prices to attract the cream of China's fast-growing cohort of midlevel consumers" (Gadiesh et al., 2007, 82).

Indeed, China, together with India and Brazil, has been marked as "emerging market", with distinct features. Apart from rapid pace of economic development, China is featured by high income inequity, market diversity, and price dominance or price sensitiveness (Dawar and Chattopadhyay, 2000; Walters and Samiee, 2003). This can bring about a massive market space that is underserved or cannot be duly served by products developed in the context of the developed world. Although there is a good portion of Chinese population rich enough to consume the-state-of-art and premium products as marketed in the developed world, the Chinese market remains diverse in spatial and social terms, leaving a much larger cohort of midlevel consumers underserved and underexplored by premium brands. Prahalad (2005) and Christensen Craig and Hart (2001), were among the leading authors to draw our attention to innovation and the creation of a new business model around this spectrum of the underserved market segments in emerging markets (in Prahalad's terms, bottom of the pyramid; BOP). In particular, Christensen et al. (2001) argue that "(e)xactly what kinds of disruptive technologies might emerge within countries such as India and China cannot be easily extrapolated from the market needs and success stories of developed economies…. technologies emerging from these

countries may have profound but unpredictable implications for the rich world's markets." Christensen (2003) goes further to highlight disruptive technologies versus sustaining technologies in the context of BOP innovations. While disruptive technologies may be considered as "innovations that result in worse product performance, at least in the near term, but are generally cheaper, simpler, smaller, and frequently, more convenient to use", they could be the appropriate means and playing field for new entrants to serve and expand the lower tiers of the market overlook by the incumbents.

In other words, China's uneven development in both spatial and social terms, particularly grassroots demands in the lower tiers of the market, matters for the promotion of indigenous innovations. With the approach to BOP and good-enough innovation, local firms in China and other emerging markets may be able to set up their own playing field by taking advantage of specific and often diverse local demands. The authors (Chen et al., 2013) have indeed shown that Shanzhai handsets, which used to dominate the Chinese market, can be considered as an intriguing aspect of China's BOP and good-enough innovation. It is, however, an industrial upgrading process, involving the co-evolution of diverse market demands and technologies, with distinct national favor. The paper intends to go further to show that the co-evolution process continues in China's migration towards 3G and smartphones, in a way to the home-grown brands' advantage, at the expense of Shanzhai handset makers. It has become so because of the growing importance of service platforms and mobile internet applications in the migration. One therefore has to take a broader view in discussing the changing ecosystem and landscape.

3. The Uptake of 3G Mobile Communications and Smartphones in China

Not until 2009, when its indigenous standard of TD-SCDMA became technologically ready, did China launch its 3G mobile communications services. As of October, 2012, out of 1.10 billion subscribers of mobile phone in China, 212.42 million subscribers used 3G mobile phones[2]. Despite a low 3G penetration of around 20%, China has overtaken the U.S.A. to become the largest smartphone market in the world, with the smartphone shipment in China being expected reach over 150 million in 2012, according to various sources[3].

[2] Source: http://www.miit.gov.cn/n11293472/n11293832/n11294132/n12858447/15036653.html, accessed on 2013/1/29.

[3] For example, see an IDC press release covered by Forbes, titled "China now the world's largest smartphone market", source: http://www.forbes.com/sites/ericsavitz/2012/08/30/china-now-the-worlds-largest-smartphone-market/, accessed on 2013/1/8.

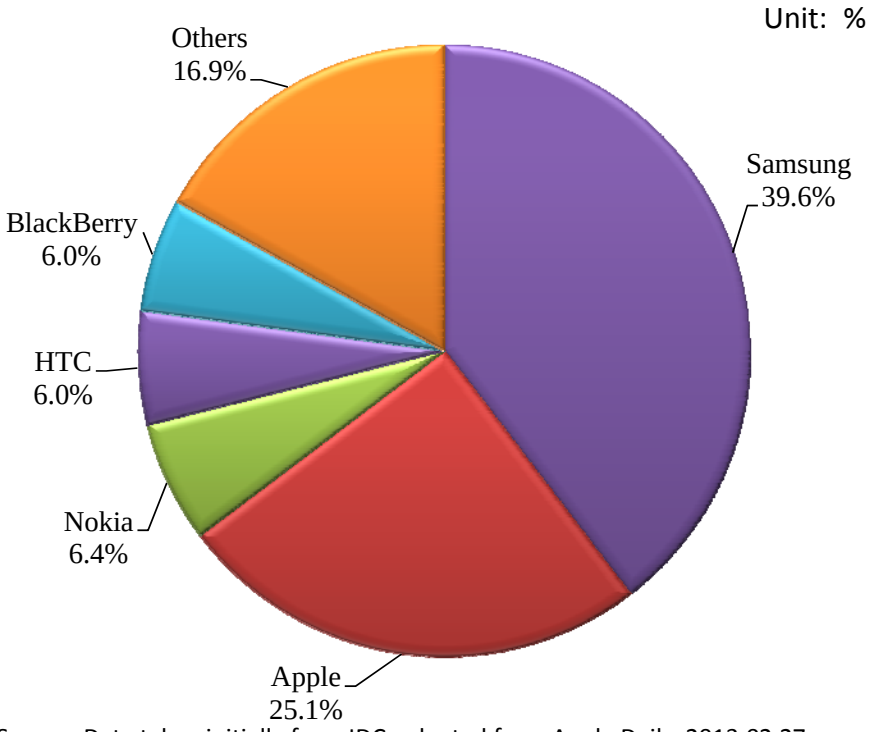
Arguably, the massive uptake of smartphones in China has more to do with the advent of low-cost smartphones with price tags below CNY 2,000 and even around CNY 1,000, smartphones for the masses, than just the indigenous standard of TD-SCDMA. On the one hand, as of the end of 2012, China Mobile, the business champion of TD-SCDMA, just captured 38% of the 3G market share, as compared to 33% for China Unicom and 29% for China Telecom. On the other hand, the number of low-cost smartphones penetration varies across different marketing sources, but the bottom line is that the low-cost smartphone is a key driver in the Chinese market (Huang, 2011), thanks to a marketing campaign of CNY 1,000 smartphones pioneered by China Telecom, since September, 2009 onwards. For example, according to Canalysys, a local analyst house, entry-level smartphones were estimated to make up 25% of smartphones sold in the Chinese market in 2012 and expected to reach 40% in 2015[4]. In a same vein, a report by Eguan, another local marketing consultant, suggests that the average price for Android-based smartphones in China had declined from CNY 2,020 in the second quarter of 2011 to CNY 1,560 in the second quarter of 2012[5].

Along with this trend, the Chinese market has witnessed the surge of home-grown smartphone manufacturers. Figure 1 makes a market-share comparison of leading smartphone brands in the global and Chinese markets. While the global market is dominated by internationally premium brands, such as Samsung (39.6%), Apple (25.1%), BlackBerry (6.0%) and HTC (6.0%), according to IDC, a few local brands, such as Lenovo (13.0%), Coolpad (10.4%), ZTE (10.1%) and Huawei (10.0%), are among the leading players, along with Samsung (14%), in the Chinese market. In particular, as the pioneer of the "App Economy" and a pop culture icon in the U.S.A. and elsewhere, Apple is outperformed in market share in the Chinese market by the domestic brands mentioned above. Among those local brands, ZTE and Huawei have had strong market foothold in the communications equipment industry and Lenovo was a domestic player for 2G handsets as well as personal computers, while Coolpad (also known as China Wireless) is a newcomer to the mobile device industry.

[4] Source: http://micgadget.com/27390/sub-200-smartphones-expecting-to-proliferate-in-china-by-2015/, accessed on 2013/1/25.

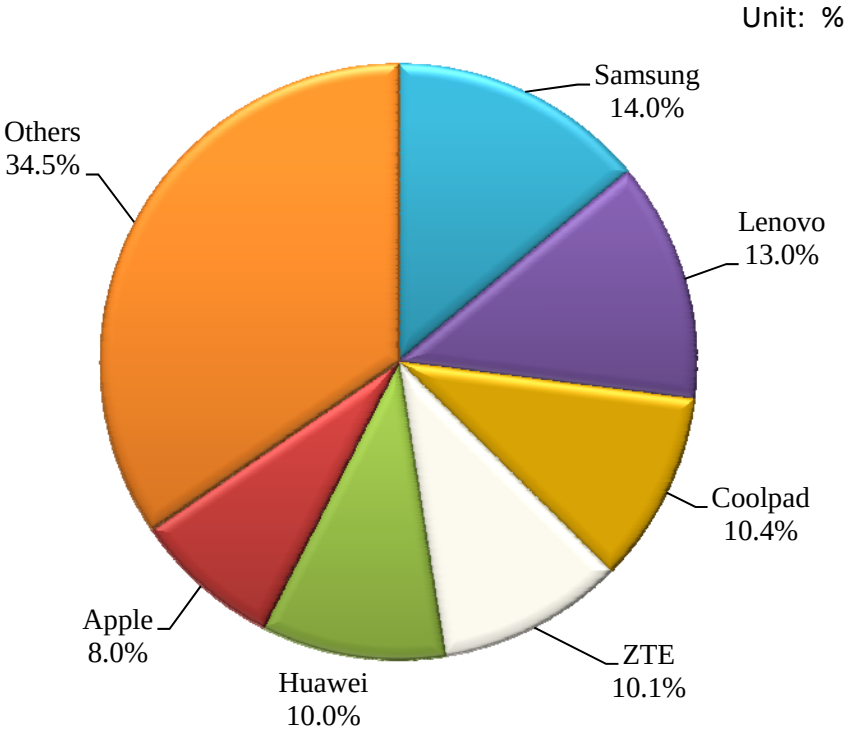
[5] Source: "The low priced, Android based smartphones of China will change the global market", http://lazure2.wordpress.com/2012/09/10/the-low-priced-android-based-smartphones-of-china-will-change-the-global-market/, accessed on 2013/1/20.

(A) The Globe Market



Source: Data taken initially from IDC, adapted from Apple Daily, 2013.02.27.

(B) The Chinese Market



Source: Data taken initially from Canalys, adapted from Commercial Times, 2013.02.01.

Figure 1 A Market-share Comparison of Leading Smartphone Brands in the Global and Chinese Markets

In addition, out of the category of “others”, which claims about a market share of 34% in the Chinese market, they are some new local players still largely unknown in the developed world. Handset vendors such as K-Touch, Gionee, Meizu, Tianyu, Oppo and Bubugao have also built their brands, as well as served as white-box handset OEM (Original Equipment Manufacturing) producers. Also emerging in the playing field are some Chinese internet companies, such as Baidu (known as “the Google of China”), Qihoo and Alibaba, which have entered the marketplace with customized smartphones to take advantage of their popular and distinct contents. In other words, there are nowadays a few home-grown smartphone vendors in China, with some of them becoming dominant branded players in the domestic market.

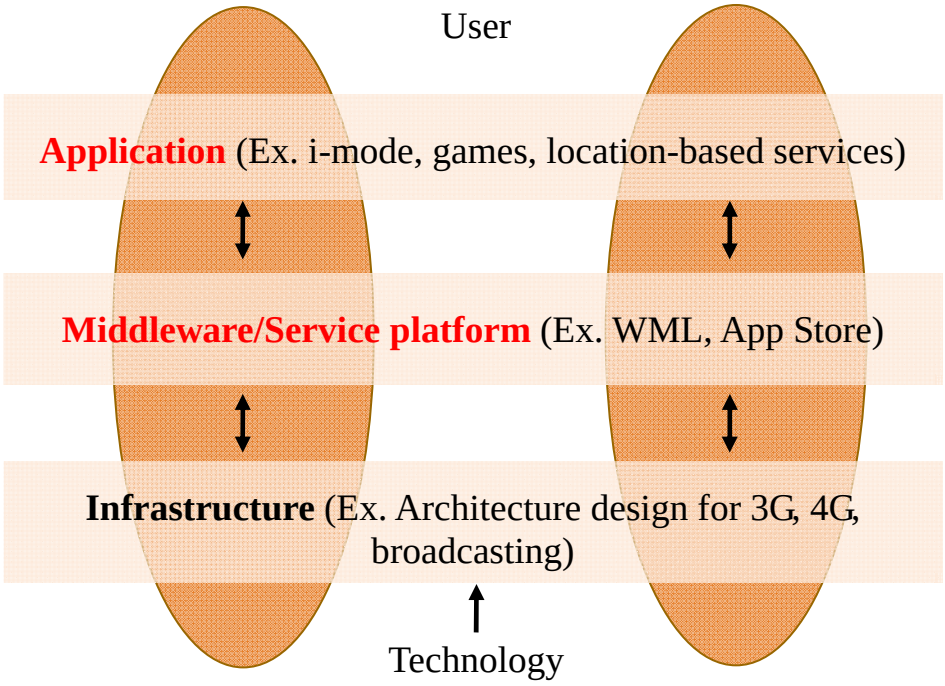
It should be noted that the Chinese firms named above are just the tip of the iceberg, as far as the ecosystem of the Chinese smartphone and 3G mobile communications service sectors are concerned. In terms of the hardware manufacturing, according to a latest report by China Academy of Telecommunication Research (2013; p.13), an important research institute under the Ministry of Industry and Information Technology (MIIT), about 73% (more than 380 firms) of some 529 handset makers in China are engaged in the manufacturing of smartphones, clustering mainly in Guangdong, followed with distance by Beijing, Tianjin and Fujian (p.40). In addition, an overwhelming share (97.7%) of smartphones produced by the domestic firms is Android-based.

More importantly, smartphones, as an advance out of feature phones, signify a profound change from mainly voice telephony terminals to multimedia data communications and mobile internet devices. As a result, the industrial ecosystem has become more complex than was the feature phone and 2G period. Yoo, Henfridsson and Lyytinen (2010) have argued that the advent of digital innovation, such as mobile internet and e-book, has brought about a new type of product architecture: “the layered modular architecture”, which is a hybrid of the modular architecture of a physical product and the layered architecture of digital technology. The modular architecture provides a scheme by which a physical product is decomposed into loosely coupled components, is attributed functionality, and is then interconnected through prespecified interfaces, while the layered architecture of digital technology is embedded into physical products, enhancing product functionality with software-based capabilities (p.725). A typical example at issue is the mobile operating system (OS), such as Google’s Android and Apple’s iOS, which have become pivotal platforms for creating mobile service ecologies and the proliferation of new mobile internet services (Ballon, 2009; Ballon and Walravens,

2009; Hammershøj et al., 2009; Tilson et al., 2012). The owners of those mobile OSs and service platforms (for example, Apple's App Store and China Mobile's Mobile Market) differ in their gatekeeper role for mobile service development and provisions and network control (Ballon, 2009; Ballon and Walravens, 2009; Hammershøj et al., 2009), which are influenced by their trajectories and strategies as well as by the evolution of the wider technological and social ecologies within which the ecosystems evolve (Eaton et al., 2011; Tilson et al., 2012). In other words, to understand the developmental dynamics of the Chinese smartphone and 3G mobile communications service sectors, one needs to look beyond the hardware part of the ecosystem, as to be discussed below.

For our following analyses, we would like to mention a "three level model for standards and innovation in ICT", including the infrastructure, middleware and applications levels, proposed by scholars working for China-European Union Standards project. In a narrow sense, middleware is a software platform between the smartphone OS and third party applications, which can make software OS independent. Sun's J2ME and Qualcomm's BREW are typical examples at issue. For the purpose of our analyses, we tend to, as the model was initially meant to, interpret the middleware level in a broader sense and add service platform to the middleware level, as shown in Figure 2. For this moment, it is sufficient to say that the revised model can be considered as a simplified version[6] of the conceptual framework of Yoo et al. (2010) about the new industrial ecosystem of mobile digital services.

[6] In professional terms of the mobile communications industry, Yoo et al. (2010) classify layered architecture into four layers: devices, networks, services, and contents. The device layer can be further divided into a physical machinery layer and a logical capability layer, while the network player is similarly divided into a physical transport layer and a logical transmission layer.



Source: Adapted from China EU Information Technology Standards research partnership. http://www.china-eu-standards.org/details.htm.

Figure 2 The Three Level Model for Standards and Innovation in ICT

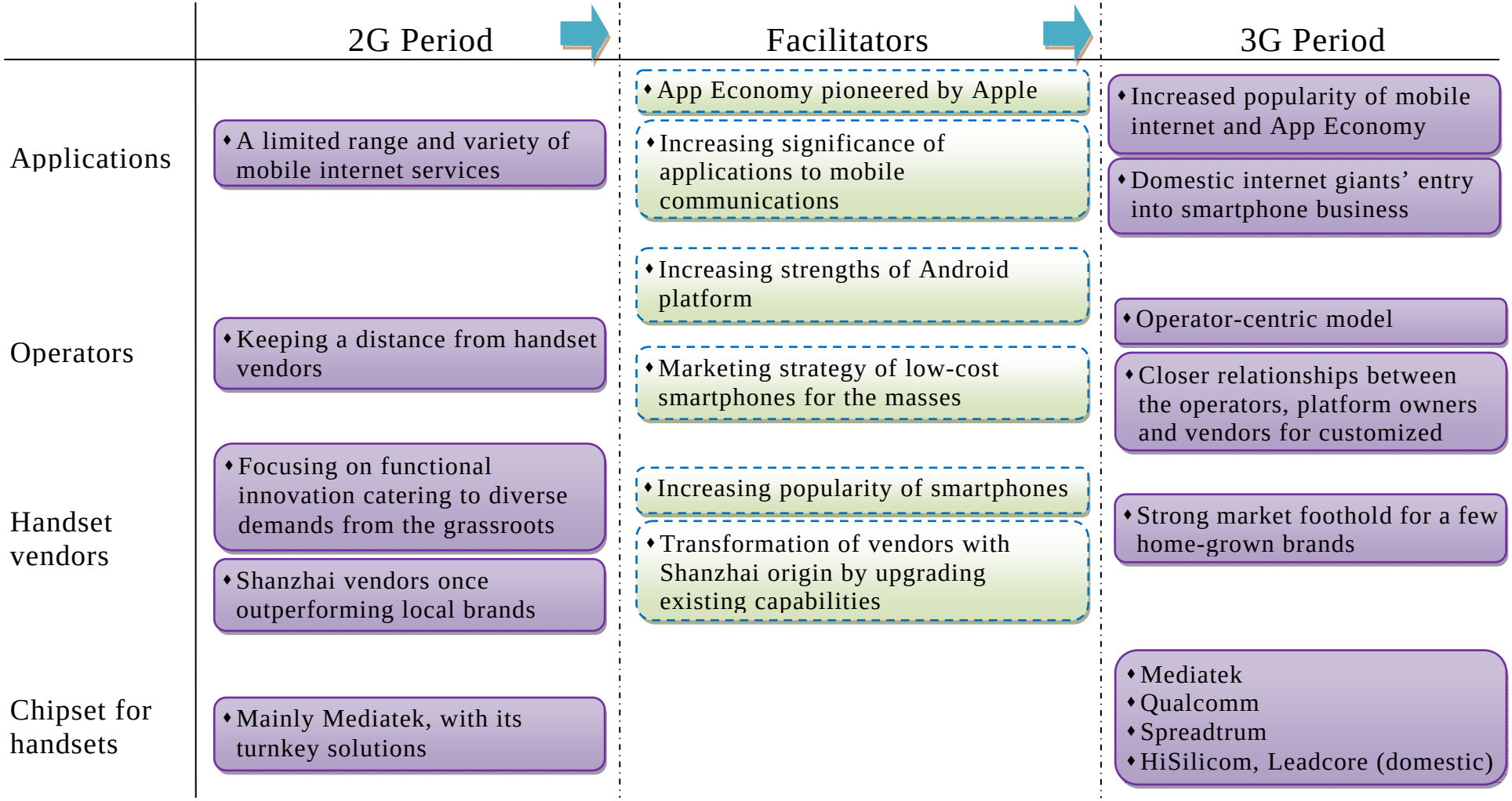
4. The New Ecosystem and Industrial Transformation

The migration from 2G to 3G marks a turning point for the mobile communication service sector. In the 2G period, most of contents, mainly voice communications and short messages, delivered over the mobile communications network were produced by the user. The service operator hence could sit back, without paying much attention to the application and even the handset. In fact, the three mobile carriers in China did not offer subsidized service plans to their customers until the launch of their 3G services. In the meantime, manufacturers of feature handsets for 2G mobile communications services tended to focus on micro functional innovations of hardware to lure consumers. Especially, in their own way some of Chinese Shanzhai handset makers deployed as many (but different) features and innovations as their legitimate counterparts. They quickly produced a variety of trendy handsets that were affordable, fashionable, and even tailor-made for migrant workers, rural farmers and even urban young white-collared workers. A few Shanzhai handsets makers, such as Tianyu, had already grown into a strong presence in the market before the arrival of smartphones. At the turn towards 3G, Apple pioneered “App Economy”, with a strong fight back, which has not only boosted the popularity and proliferation of smartphones but also demonstrated the significance of applications

and user experiences to mobile communications. Application-driven and software-based innovations for handsets are hence stimulated. Regarding China, apart from its scio-economic features of emerging markets, it also needs to mention that internet and e-commerce services have been developing fast within "walled garden" because mainly of censorship, leading to the dominance of domestic internet companies, such as Baidu, Tencent and Alibaba in the Chinese market[7]. Many popular internet services and applications in the developed world, such as Facebook, Twitter, Google Market, have in fact been fended off in the Chinese market. Cultural and language differences also have resulted in large differences in user behaviors, such as handwriting. This requires smartphone vendors and service providers to develop localized user interfaces dedicated to the Chinese market. It is against the above backdrop that the new Chinese ecosystem and industrial transformation at issue is taking place with strong local flavors.

Figure 3 illustrates the new ecosystem and industrial transformation, resulting from the migration from 2G to 3G in China, by itemizing the key factors and facilitators. In the 2G period, as mentioned above, because of users as the main content providers plus a limited range and variety of mobile internet services, the mobile operators tended to keep a distance from the handset vendors. This gave ample room for the Shanzhai vendors to generate various "micro" functional innovations of hardware catering to diverse demands from the grassroots, as compared to the overshooting of function by branded firms. They were once also able to outperform local brands as well as international brands by taking advantage of Mediatek's turnkey solutions, which incorporated operating systems and application software into a single chip and made it much easier for handset makers to design and produce a wide variety of mobile phones (Chen et al., 2013; Rong and Shi, 2009).

[7] In China, mobile internet is not far from as popular as desktop internet. According to the official statistics of the Ministry of Industry and Information Technology (MIIT), as of the end of 2012, China had 420 million mobile internet users, compared to 564 million desktop internet users. Also, according to China Academy of Telecommunication Research (2013; p.16), China is secondary only to the U.S.A. in terms of the number of downloads of mobile applications.



Source: The study.

Figure 3 The New Ecosystem and Industrial Transformation of Smartphones and Services in China

In contrast, in the migration from 2G to 3G and from feature phones to smartphones, firms with different domains have sought to establish platforms of different types to be the gatekeeper and value capturer for the development and provision of mobile digital services, resulting in a typology of platforms, as suggested by Ballon (2009), including the teleco-centric (also known as operator-centric) platform model (for example Vodafone Live!), device-centric platform model (for example iPhone) and aggregator-centric platform (for example Google) model. In China, the operator-centric model has prevailed (Huang, 2011), because the three operators use different 3G technologies, they are hence actively involved in smartphone sourcing and distribution. Especially, China Mobile has to effectively mobilize external suppliers and developers for the development and provision of smartphones and mobile digital services, compatible with its unique TD-SCDMA standards and its OPhone OS platform and Mobile Market service platform. This gives rise to increased attention of the operators paid to the development and marketing of customized smartphones. The operators also opt to promote low-cost and/or entry-level smartphones for the masses in order to increase the penetration rate of 3G services. This has resulted in a closer relationship between the operators and domestic smartphone vendors for customized handsets.

In addition, as elsewhere in the world, there are more than just operator-centric model in China. Major domestic internet firms, such as Baidu, Tencent, Qihoo and Alibaba also come out with customized smartphones to take advantage of their popular social network services (for example, QQ services) and e-commerce services (for example, Taobao Mall), giving rise to the aggregator-centric platform model in China. Also, Xiaomi follows Apple's device-centric platform model to promote its premium smartphones and its MIUI OS platform.

All of the models mentioned above require the smartphone vendors to establish strong interactions in the design process with either the operators or the content aggregators at issue. It is also essential for the operators and content aggregators to get involved in the sourcing and marketing of customized smartphones in order to capture value from their OS platforms and/or service platforms (Eaton et al., 2011; Kenney and Pon, 2011). Although both the Chinese legitimate handset vendors and numerous Shanzhai handset makers can take advantage of accumulated low-cost design and manufacturing knowledge from their previous low-end GSM handset businesses, the shift in 3G services and smartphones to the platform-based models tends to work in favor of larger smartphone vendors.

As a result, China's smartphone industry has witnessed the rise of a few home-grown brands. Among them, Huawei and ZTE have long established strong customer relationships with Chinese as well as international operators via their existing telecom equipment business, and their operator-branded handsets (with Vodafone and Orange). In contrast, some other currently dominant players have succeeded in shedding their Shanzhai origins, becoming famous household names in China. For example, China Wireless (under Coolpad) now establishes major R&D center in Shenzhen, with more than 1,700 R&D engineers, as of 2012. The company's dual-mode dual-working handsets (or four-channel handset under China Telecom's brand name) is a distinctive type of handset for the China market, which supports simultaneous call waiting and phone calls on both the GSM and CDMA networks. Coolpad has developed close relationships with all three Chinese mobile carriers in order to tap the growing 3G boom in China. In short, the availability and popularity of affordable, capable entry-level smartphones has led to consolidation in the domestic handset industry, at the expense of the Shanzhai handset makers[8].

It should be noted that such a turnkey solution as Mediatek's chipset remains indispensable to this transformation. Actually, this has prompted new players' entry. It is estimated that Mediatek has captured about 50% of the market share of chipsets for smartphones in China. This has resulted in part from the company's shift in customer target from mainly Shanzhai handset makers to the well-established Chinese smartphone vendors and/or brands. Apart from Mediatek and Spreadtrum, the two existing players, Qualcomm has penetrated into the market with the Qualcomm Reference Design (QRD), for the belief that entry-level smartphones will drive future mobile growth[9]. The company has also invested in Xiaomi, a Chinese internet firm, with a famous i-Phone-like model. In addition, a few local players have surged in this market segments, including HiSilicon, a local IC design house and a spin-off of Huawei and Leadcore, the chip design arm of Chinese communications equipment company Datang Group.

One should not play down the significance of a few facilitators of this migration. On the demand side, apart from well-known "App Economy", initiated by Apple, there has been growing popularity of applications to mobile communications in China, with

[8] In the Chinese market, there are still such smartphones as MEOX 1 and Android iPhone 4S (fake iPhone 4S), HDC Galaxy S3 (fake Samsung Galaxy S3) and HDC One X (fake HTC One X) that imitate premium models from Apple, Samsung and HTC. For more information, see http://www.shanzhaiji.com/.

[9] See Qualcomm's PowerPoint presentation titled "The Qualcomm Reference Design App Ecosystem Opportunity", by Yan Zhuang at Upling 2012 Conference. https://www.uplinq.com/.../The_QC_Reference_Design_App_Ecosyst...

Chinese flavor and versions. This has benefitted from the overwhelming significance of Google's Android OS in the Chinese market, with a market share about 86%, because Android OS platform has lowered the technology barriers between handset brand vendors capable of high-end product development and handset OEMs capable only of handset manufacturing and low-end handset design. On the supply side, transformation of vendors with Shanzhai origin by upgrading their existing capabilities, as the case of China Wireless, is also an important factor.

5. Discussions

On surface, the new ecosystem and industrial transformation in China, discussed above, has much to do with the advent and growing popularity of low-cost smartphones. However, for the authors, the new ecosystem of Chinese smartphone and 3G services has a much bigger and more meaningful picture than this.

Indeed, affordable pricing and attractive features are currently key issues for quite a portion of Chinese smartphone users. Chinese 3G subscribers have a different affordability level for handsets compared with developed countries, reflecting differing income levels, as well as different user behavior for handsets and mobile applications, on account of language and cultural differences (Huang, 2011). On the one hand, the global leading smartphone brands tend to equip their smartphones with many attractive features and/or functions, which tend to be global models to lure consumers in the developed countries and the elite in Tier 1 cities inside China but may turn out to be "too much of a good thing" for the less wealthy population and rural residents (the sluggish tiers of the market; Christensen et al., 2001, 81-82). On the other hand, the rising local brands have managed to build their portfolio with feature-rich, multi-SIM handsets which span across ultra-low and entry-tier segments, catering to growing rural subscribers, bringing about smartphones for the masses in China. Some of them also launch mid-tier 3G handsets and Android smartphones, targeting the growing category of urban and suburban 3G users.

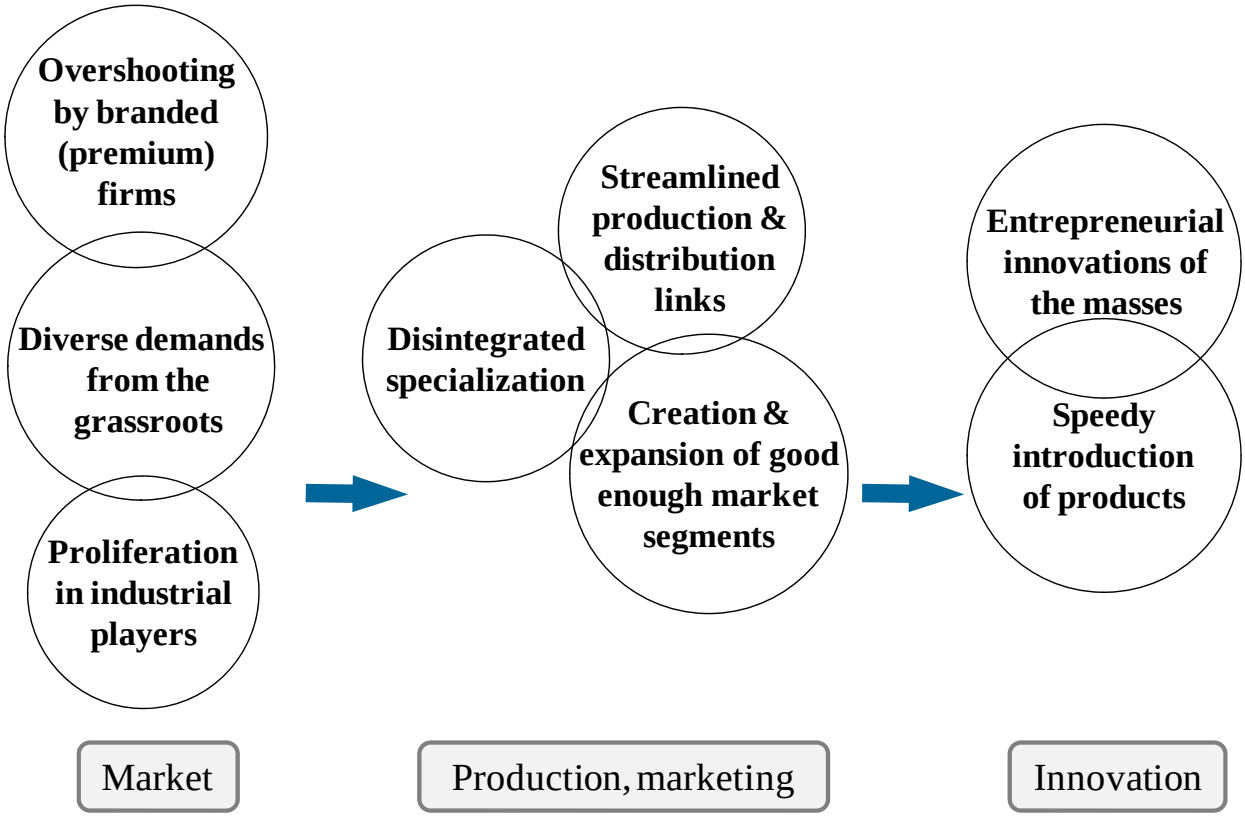
In a study on Japan's mobile phone market, Chen, Watanabe and Griffy-Brown (2007) have found that the prevailing customized handset collaboration model between handset vendors and operators has resulted in a high concentration of high-end handsets in the Japanese market because "the demanding nature of Japan's customers for well-functioned mobile phones" (p.17). However, in the Chinese case, though the customized handset collaboration model also prevails, China is after all a booming market with high income inequity and diverse demands from the grassroots. This requires the home-grown brands, together with the operators, to produce a

variety of trendy smartphones in the lower- to mid-price range that are affordable, fashionable for migrant workers, rural farmers and urban young white-collared workers, leading to the creation and expansion of “good-enough” market segments. In addition, as mentioned earlier, since there are more than three hundred handset makers in China engaged in the manufacturing of smartphones, most of them form a camp of white-box, without close relationships with the operators and the major content-aggregators investing in mobile service platforms. To fight for their fortune, they have to design and manufacture a variety of smartphones with trendy features and micro innovations, by benchmarking their legitimate counterparts, to cater for diverse demands from the grassroots in the less wealthy part of China.

In fact, elsewhere (Chen et al., 2013), in an enquiry into the ecosystem of Shanzhai handsets, we have proposed the essence of the so-called “Shanzhai Economy” (nowadays better termed as “Good-Enough Economy”), by distilling innovation elements from the phenomenon of Shanzhai handsets (Figure 4). We then argued that “while the development of Shanzhai handsets has its own historical context and limitations, “Shanzhai Economy” may be considered a distinct Chinese approach to indigenous innovation, with a strong flavor of the BOP and/or good-enough innovation, which may challenge the existing rule of the game and incumbents in a few industrial sectors. In essence, BOP and good-enough innovation is an industrial upgrading process, involving co-evolving with emerging diverse market demands and technologies, with the diverse market demands at issue showing distinct national flavor”. When it comes to the case of Chinese smartphones, our ideas and arguments about innovative ingredients of “Shanzhai Economy” remain largely intact, but the ingredients are being organized in a more institutionalized manner. Of note is a new factor to streamline production and distribution links in the case of smartphones. In the case of Shanzhai handset, the geographical proximity of the handset makers and channels, mostly at Huaqiangbei Business District in Shenzhen, enabled them to streamline their distribution links. When it comes to the case of smartphones, this link is facilitated by such factors as the “platformization” of smartphones and 3G services and the resultant close relationships between smartphone makers and the operators and the service platform owners (Eaton et al., 2011; Kenney and Pon, 2011).

An interesting question is: will the Chinese smartphones be confined to the domestic market and low-end market segments? Some indications suggest that the answer for it seems to be “no”. For the rising Chinese brands, another area for growth is the overseas market less developed than China, India and Africa in particular. Coolpad

has teamed up with Reliance Webstore, a subsidiary of Reliance Communications to market its dual mode smartphones in India. Give-me-Five, a Chinese handset maker, even grew out of the Indian market from scratch, becoming a well-known household name in India. There is even a case where Coolpad has cooperated with American operator MetroPCS to launch its first LTE (Long Term Evolution) 4G mobile phone named Quattro in the U.S.A.



Source: Adapted from Chen, Wen and Tai (2013).

Figure 4 Innovative Ingredients of "Shanzhai Economy" ("Good-Enough Economy")

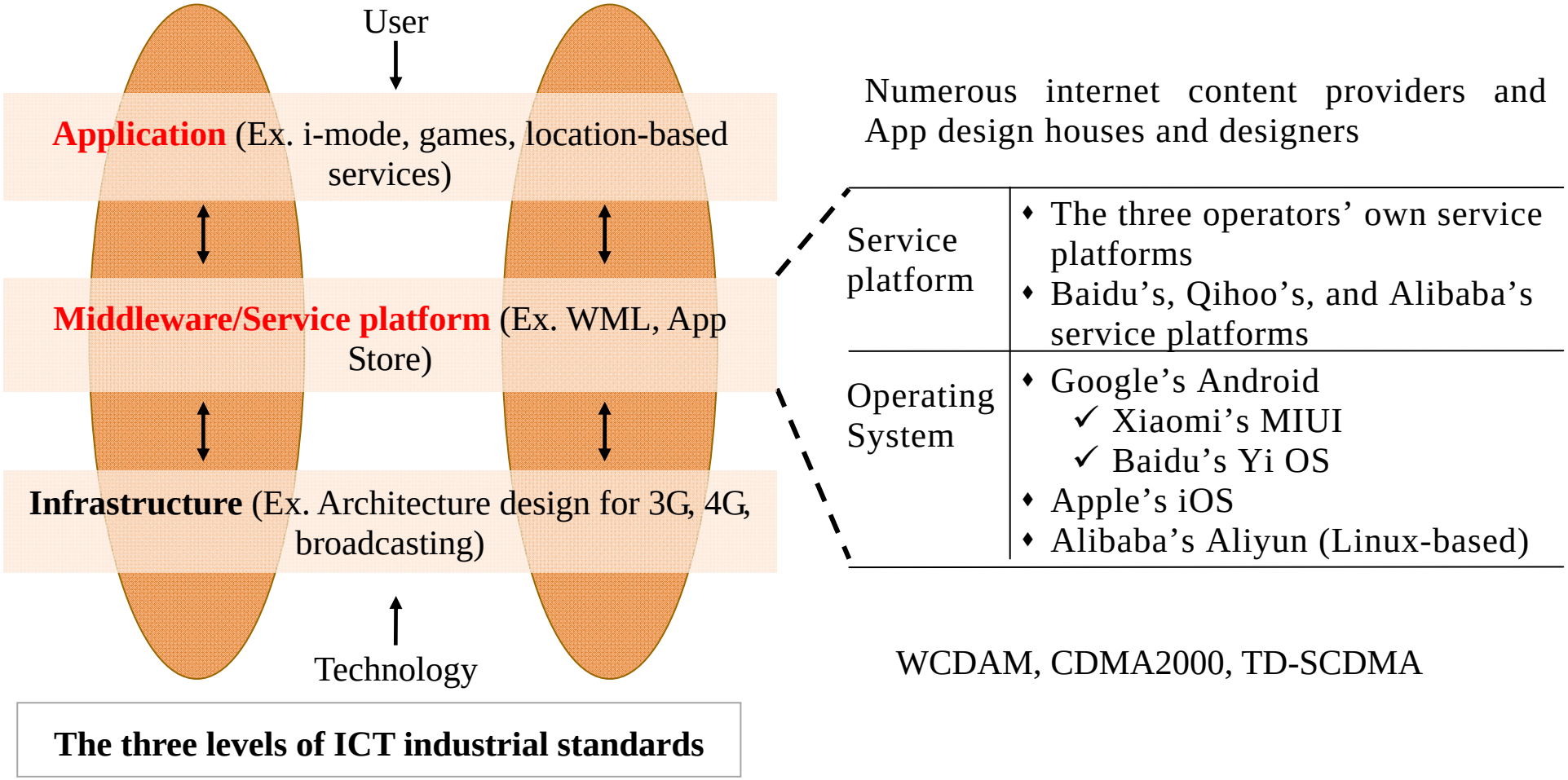
Given China's ambition of TD-SCDMA, it is worth discussing the role of industrial standards in the Chinese migration of smartphones. To do so, one needs to consider broader meanings of industrial standards than what is often referred to, in light of the fact that TD-SCDMA is the Chinese indigenous standard at the infrastructure level. Scholars working for China-European Union Standards project have proposed "three level model for standards and innovation in ICT", including the infrastructure, middleware and applications levels. We modify this model a little bit, by adding service platform to the middleware level, as shown at the left part of Figure 5. Although industrial standards are quite often referred to the infrastructure level, for "App Economy" and broadband mobile communications services to prevail, it takes

more, requiring other (de facto) standards at the middleware/service platform and application levels (Ballon, 2009; Ballon and Walravens, 2009; Hammershøj et al., 2009; Eaton et al., 2011; Tilson et al., 2012 and Yoo et al., 2010). Apple's iOS and App Store are obvious examples at issue. Of interest to note is the sharp contrast in the global revenue of mobile phone business between Apple and Nokia, which implies a shift in the source of competitiveness for mobile phone players from the sphere of architectural design to that of middleware/service platform and applications. Apple follows other players' (for example, Nokia's 3G) industrial standards at the architecture level, but the company's success in iPod, iPhone and iPad lies in its proprietary platforms, iTunes and App Store, and providing software design kits for numerous external developers to design applications with customer experiences. This implies that the mobile communications sector, in terms of both service and device, has become more application driven than ever, even in the context of "the layered modular architecture" (Yoo et al., 2010). In other words, TD-SCDMA, though important it is to China, alone cannot fully support China's migration towards indigenous smartphones and broadband mobile communications services.

Good news is that the China's stakeholders can take advantage of Google's Android, a free and open-source OS, to develop smartphones and mobile internet services. As shown in the right part of Figure 5, there are a few Chinese versions of OSs for smartphones, based on Google's Android platform, such as Baidu's Yi OS and Xiaomi's MIUI. For example, Baidu Yi OS is essentially a forked version of Android, providing a lot of the same functionality and services available from Google, based on which Baidu throws in its own bundle of apps, such as native maps, reader, music, web apps, and even a program similar to Google Places. In addition, Alibaba's Aliyun is Linux-based, enabling Alibaba to take advantage of its popular e-commerce services. As to service platforms, apart from the three operators', a few Chinese internet companies, such as Baidu, Qihoo and Alibaba have jumped on the bandwagon to produce and market their own versions. They may even benefit from China's latest policy to issue licenses for Mobile Virtual Network Operators (MVNO). Although the Chinese players can lend support from the factor that China's cyber world is a walled-garden with heavy regulations, enabling China to fend off many popular Internet applications and services from the developed world, it remains to see how well these Chinese players will prosper and outreach in the future.

More importantly, China's quest for indigenous innovations and industrial standards has to be viewed in a broader context than just the architecture level, when it comes to the migration towards smartphones and broadband mobile communications

services. It is true that the indigenous 3G standard, TD-SCDMA, enables China Mobile to bargain with Apple for the network access of iPhones and facilitates the rise of domestic players, such as HiSilicon and Leadcore. However, a serious concern has been expressed about China's overwhelming dependence on Google's OS platform of Android (China Academy of Telecommunication Research, 2013, p.46). As shown in Figure 6, Nokia's Symbian, which once dominated the Chinese market as well as global market, has lost market share within just few years. In contrast, Android nowadays accounted for 86.4% of the market share for OS platform in China in 2012, while for the Chinese versions of OS, such as Alibaba's Aliyun and Baidu's Yi OS, their market shares were less than 1%. In other words, since the mobile communications sector has become more application driven than ever and layered platforms have become the key to the ecosystem, TD-SCDMA, the industrial standard at the infrastructure level, can only be part of Chinese solutions to indigenous innovations.

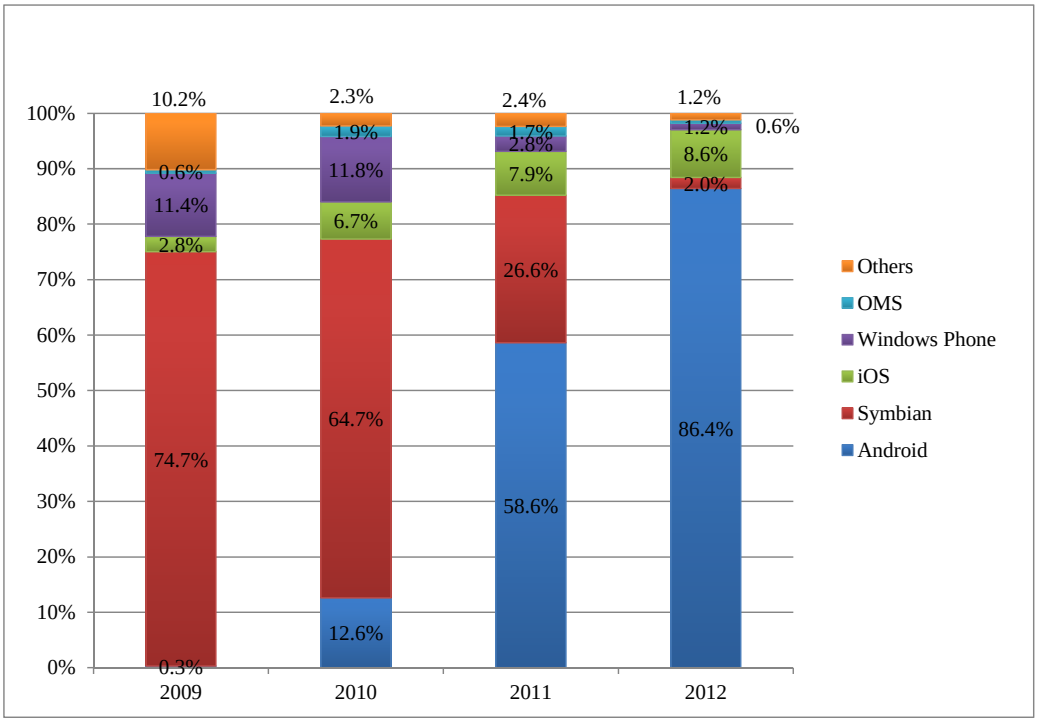


The three levels of ICT industrial standards

Note: The left part the figure is adapted from China EU Information Technology Standards research partnership.

Source: The study.

Figure 5 Industrial Standards and the New Ecosystem of Smartphones and Services in China



Note: Others include Aliyun, BADA, Linux, MeeGo, UniPlus, Baidu, WebOS.

Source: Adapted from China Academy of Telecommunication Research (2013).

Figure 6 The Market Share of Mobile Operating Systems in China, 2009-2012

6. Conclusions

The Chinese government has put much effort and resources in promoting indigenous innovations and industrial standards in the mobile communications sector. How well has this lived up to high expectation. Indeed, TD-SCDMA has been endorsed by ITU and actively promoted by its business champion, China Mobile. What's more, a few home-grown brands have become the leading suppliers of smartphones in the Chinese market, outperforming the once-dominant players of Shanzhai handsets and a few international premium brands. However, to better understand the market dynamics and industrial upgrading process underway in China, one has to look beyond the mainstream views of supply side factors and top-down approach to indigenous innovations.

In fact, the rise of Chinese home-grown brands has taken advantage of the advent and growing popularity of low-cost smartphones in China and they are on track to becoming known players, both domestically and internationally, in supplying affordable, mid-tier and even high-end smartphones, further expanding the territory of their good-enough innovations. Taking a closer look, the good-enough innovations have much to do with the new ecosystem and industrial transformation taking place in China. The migration from 2G to 3G in China has brought about platform-based

development and new business models, rendering new organizing logic between the smartphone vendors and other important stakeholders. The prevailing operator-centric model has given rise to increased attention of the operators paid to the development, sourcing and marketing of customized smartphones. This has resulted in a closer relationship between the operators and the domestic smartphone vendors for customized handsets, leading to the consolidation of the Chinese smartphone industry. In addition, major domestic internet firms, such as Baidu, Tencent, Qihoo and Alibaba also come out with customized smartphones to take advantage of their popular social network services and e-commerce services. As a result, China's smartphone industry has witnessed the rise of a few home-grown brands. What underlies this is a co-evolution process of social and market factors in shaping Chinese innovations, highlighting the role of grassroots demands in the Chinese market and the growing popularity of mobile internet services in the manner of platform-based development within Chinese walled garden.

It is important to note the role of industrial standards in the Chinese migration of smartphones. To do so, one needs to consider broader meanings of industrial standards than what is often referred to, in light of the fact that TD-SCDMA is the Chinese indigenous standard at the infrastructure level. In short, TD-SCDMA can only be part of Chinese indigenous innovations and industrial standards for migration towards 3G services and smartphones. In fact, at the middleware and service platform level, there are a few Chinese versions of operating systems for smartphones, based on Google's Android platform, such as Baidu's Yi OS and Xiaomi's MIUI. As to service platforms, apart from the three operators', Chinese internet companies, such as Baidu, Qihoo and Alibaba have jumped on the bandwagon to produce and market their own versions. Since the mobile communications sector has become more application driven than ever and layered platforms have become the key to the ecosystem, TD-SCDMA, the industrial standard at the infrastructure level, can only be part of Chinese solutions to indigenous innovations. Therefore, China's quest for indigenous innovations and industrial standards has to be viewed in a broader context than just the infrastructure level, when it comes to migration towards smartphones and broadband mobile communications services.

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