The Evolution of China’s Mobile Phone Industry and Good-enough Innovation

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Abstract

This paper examines the 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 companies that engaged in banditry, 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. Through an intensive case study of the rise of Chinese smartphone brands, the paper assesses the significance of layered platform-based development in the migration towards smartphones and mobile digital services. In addition, the paper discusses a co-evolution process of social and market factors, entailing the looped interaction between the two, in shaping Chinese “good-enough innovations”, to highlight 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 to 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, China’s home-grown 3G standard TD-SCDMA can only be part of Chinese indigenous solutions for migration towards 3G broadband mobile internet services and smartphones. In contrast, those at the middleware and application levels are indispensable and increasingly more important parts of the puzzle as both service and device has become more application driven than ever. Therefore, China’s quest for indigenous innovation has to go beyond 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
1. Introduction
The communications industry is a landmark sector for China in terms of innovation. In this sector, not only have Huawei and ZTE become two leading international communication equipment manufacturers, but also China has established own flagship international industrial standard, TD-SCDMA (Time Division-Synchronous Code Division Multiple Access) for the third generation mobile phone (3G). However, as late as 2008, China’s market for second generation (2G) mobile communications devices was dominated by “Shanzhai (also called guerilla) handsets”¹, which were often accused of brand imitation in appearance, design and brand name. The rapid development of Shanzhai handsets had brought about the progressive expansion of China’s mobile communications market and enabled an army of local white-box handset producers to gain a strong market foothold, against leading international brands and legitimate local brands. In essence, China’s mobile phone sector development has embodied two distinctive but connected approaches for innovation. A bottom-up approach was demonstrated by the development of the Shanzhai handset sector while the government adopted top-down approach to indigenous innovations through industrial standards and generous official support for a few national champions, including Tatang, Huawei and China Mobile (Liu and Zhou, 2013). Researchers have argued that this distinct bottom-up innovation in China had much to do with a few factors, such as the role of diverse demands from the grassroots, local proliferation and adaption of the production system, 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, stimulated by strong local 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) have argued that out of

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).
the Shanzhai handset phenomenon, the so-called “Shanzhai Economy” might prevail with Chinese flavor of innovation, now better termed as “good-enough innovation (economy)” (see also Brandt and Thun, 2010; Gadiesh, Leung, and Vestring, 2007).

Yet, the situation changed rather dramatically in the migration towards 3G and smartphones. A few home-grown brands, such as Lenovo, Coolpad, Huawei and ZTE, have gained 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 vast market of lower income users in China. On surface, it seems that the emergence of those Chinese home-grown brands has benefitted from the existence of this particular market. However, it also has had much to do with the trend of platform-based development or “platformization” in the migration towards smartphones and mobile digital services (Eaton, Elaluf-Calderwood, Sørensen, and Yoo, 2011; Feijóo, Pascu, Misuraca and Lusoli, 2009; Kenney and Pon, 2011), to be discussed below. Also related are diverse demands in the Chinese market and the growing popularity of mobile internet services with Chinese versions\(^2\) and flavors\(^3\). As a result, there have been profound changes in the Chinese ecosystem of the smartphone and mobile communications service sectors. Figure 1 shows key milestones for the evolution of China’s mobile phone and mobile communications sectors in recent years.

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\(^2\) Some of the Chinese firms are quite often associated with their counterparts of global leading players. For example, Baidu is called as “the Google of China”; Taobao as “the e-Bay of China”. In addition, most of the Chinese use Tencent’s QQ, Sina Weibo or Weixin, instead of Facebook and Twitter.

\(^3\) For example, Xiaomi has launched Phone Flying Car, called FonCar, controlled with Android or Apple smartphones. For another example, according to an article by Ian Bhullar, “Chinese mobile users mainly connect to the internet through slower GPRS technology due to the high cost of 3G”. Source: [http://www.maxodyssey.com/chinas-mobile-apps-market-by-china-briefing/](http://www.maxodyssey.com/chinas-mobile-apps-market-by-china-briefing/), accessed on 2013/5/17.
The Chinese government liberalized licensing regulations on the manufacturing and sales of handsets, allowing Shanzhai players to become legitimate.

Shanzhai handsets captured a market share of 40%, compared to less than 20% for local brands.

China issued 3G licences and the operators launched marketing campaigns of low-cost smartphones.

Local brands of smartphones became leading players in the Chinese market.

**Figure 1** Key Milestones for the Evolution of China’s Mobile Phone and Mobile Communications Sectors in Recent Years
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 Shanzhai handset phenomenon and the latest development of the smartphone sector (smartphones for the masses) in China. What’s more, in the migration from 2G to 3G, both service and device in the mobile communications sector have become more application driven than ever, bringing about platform-based development and competition (Ballon, 2009; Ballon and Walravens, 2009; Feijóo et al., 2009; Hammershøj, Sapuppo and Tadayoni, 2009; Tilson, Sørensen and Lyttinen, 2012), including mobile operating system (OS) platform and service platform. 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, as shown in the case of Apple’s rise with iPhone and iPad. As a result, the Chinese market for smartphones has consolidated to quite an extent 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 which regards indigenous industrial standards, such as TD-SCDMA as the key landmark (Liu and Zhou, 2013; Yan, 2007).4

This paper is structured as follows. In Section 2, against the theoretical backdrop of the co-evolution of technology and market, we highlight two sets of factors that may be particularly relevant to China’s migration towards 3G and smartphones: firstly, platform-based development or “platformization” in the ecosystem; secondly the role of emerging economy’s market in stimulating 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. Section 5 focuses on the role of industrial standards in the Chinese migration of smartphones. The paper is concluded with Section 6, with a main argument that 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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4 For example, Liu and Zhou (2013) argue that “TD-SCDMA is now considered a national hero in the IT industry. It seems that the climate has helped TD-SCDMA to gain favour over existing multinationals in China in the 3G market, but the technology still faces many uncertainties.”
2. The Changing Ecosystem and Chinese Market for the Smartphone Industry

In the field of technology management and innovation, co-evolution of technology and broader contexts has formed a useful framework (Dosi, 2000) for some researchers to explore interactions and dynamics of technology in conjunction with several other factors, such as the society (Geels, 2005), industrial structure (Nelson, 1994) and market (Struben, 2008), on different scales. Among the pioneer of such studies, Freeman and Perez (1988) coined the term “techno-economic paradigm” to examine how technology shapes and evolves with the broadly-defined production system in a longitudinal manner. Underlying this process is the looped interaction between new technologies and socio-institutional systems (Perez, 1985: 445).

Against the theoretical backdrop of the co-evolution of technology and market, we intend to examine the 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.

With consistent and remarkable economic growth over the past three decades, China has become a manufacturing powerhouse in the world (Holz, 2008). However, China’s economic development has now reached a new stage that calls for different policies to promote future prosperity. In addition to policies highlighted in China’s Twelfth Five-Year Plan, for example the stimulation of domestic demand and industrial restructuring, China has begun its quest for technological leadership through the promotion of indigenous innovation (Sigurdson, 2005; Suttmeier and Yao, 2004; Rowen and Hancock, 2008). Indeed, a few indigenous firms, such as Huawei and ZTE, 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 3G wireless China’s quest for technological leadership has given a high priority to the development of an indigenous industrial standard – TD-SCDMA – as a possible alternative to the two competing global standards, CDMA2000 and W-CDMA (Liu and Zhou, 2013; Yan, 2007).

Although TD-SCDMA is arguably an achievement for China, its R&D project started in the mid-1990s, when not many could foresee what specific digital services could be offered via 3G networks and what this meant to the ecosystem of the mobile communications services. However, it has nowadays become clearer that for broadband mobile communications services to prevail and prosper, things other than the physical network standard, such as TD-SCDMA, are needed. For example, researchers working for China-European Union Standards project have proposed a
“three level model for standards and innovation in ICT”, including the infrastructure, middleware and applications levels, as shown in Figure 2. 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 (Lin and Ye, 2009: 620). In our following analyses, we tend, as the model was initially intended, to interpret the middleware level in a broader sense and add service platform to the middleware level, as shown in Figure 2. In addition, applications have become an essential part of the mobile communications services.


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

More importantly, smartphones, evolving from 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 that for the feature phone and the 2G period. Yoo, Henfridsson and Lyttinen (2010: 725) 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, attributed functionality, and interconnected through prespecified interfaces, while the layered architecture of digital technology is embedded into physical products, enhancing product functionality with software-based capabilities. In professional terms of the mobile communications industry, Yoo et al. (2010) classify layered architecture into four layers: devices, networks, services, and contents. It is worth mentioning that the revised model shown in Figure 2 can be considered as a simplified version of the conceptual framework of Yoo et al. (2010) about the new industrial ecosystem of mobile digital services.

A typical issue is the mobile OS, such as Google’s Android and Apple’s iOS, which has 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, Google Play 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), reflecting the way in which they form their strategies, core competencies and organizational boundaries within the evolving ecosystems (Eaton et al., 2011; Tilson et al., 2012). In particular, compared to Apple’s strategy of proprietary platform, iTunes and App Store, and tight control over its relatively closed ecosystem, Google tends to adopt a hand-off approach and even once publicly announced that they would welcome Shanzhai handset makers to take advantage of Android, Google’s free and open-source OS, to develop smartphones (Chen, et al., 2013). 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.

Moreover, 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 compete with well-established foreign 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 is more, in fighting for the middle market, these are able to produce so called “good-enough” and “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 Russia, India and Brazil, has been marked as “emerging markets”, with distinctive features. In the context of its rapid pace of economic development, China has been characterized by high income inequity, market diversity, and high price elasticity of demand as compared to mature markets (Dawar and Chattopadhyay, 2000; Walters and Samiee, 2003). This suggests that a massive market space is underserved or cannot be duly served by products developed in 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 overlooked by the incumbents.

In other words, China’s uneven development in both spatial and social terms, particularly grassroots demand 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 underserved 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. The paper intends to go further to show that the co-evolution process continues in China’s migration towards 3G and smartphones, which works to home-grown brands’ advantage at the expense of Shanzhai handset makers. This has to do with the changing eco-system with growing importance of service platforms and mobile internet applications in the migration.

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 the end of 2012, out of 1.11 billion subscribers of mobile phone in China, 232.8 million subscribers used 3G mobile phones\(^5\). 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 shipments in China being expected to reach over 150 million in 2012, according to various sources\(^6\).

Arguably, the massive uptake of smartphones in China has something to do with the advent of low-cost smartphones for the masses, with price tags below CNY 2,000 and even around CNY 1,000. Also, the role of China’s indigenous standard TD-SCDMA is debatable in this development. 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\(^7\). In a same vein, a report by Eguan, another local

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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.

Along with this trend, the Chinese market has witnessed the surge of home-grown smartphone manufacturers. Figure 3 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, although Apple is the pioneer of the “App Economy” and a pop culture icon in the U.S.A. and elsewhere, it has been outperformed in market share in China 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.

In addition, included in the category of “others”, which claims about a market share of 34% in China, 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 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 contents. In other words, there are nowadays many potentially promising home-grown smartphone players in China, with some of them becoming dominant branded players in the domestic market.

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(A) The Global Smartphone Market,

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

(B) The Chinese Smartphone Market

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

Figure 3  A Market-share Comparison of Leading Smartphone Brands in the Global and Chinese Markets, 2012
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). The significance of Guangdong in this regard suggests a great degree of continuity, thanks in part to the industrial upgrading of the local Shanzhai handset sector. In addition, an overwhelming share (97.7%) of smartphones produced by the domestic firms is Android-based.

4. The New Ecosystem and Industrial Transformation in China
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 applications and even the capabilities of 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. For example, some of the more exotic Shanzhai handsets at that time looked like watches or a packet of premium cigarettes for the owner to show off, while others provided striking new features, such as solar chargers, telephoto lenses, superloud speakers or ultraviolet lights to detect forged currency (Chen et al., 2013). 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 urban young white-collared workers. A few Shanzhai handsets makers, such as Tianyu, had already grown into a strong brand presence in the market before the arrival of smartphones.

At the turn towards 3G, Apple pioneered app services (known as the App Economy), which have 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. In China, home-grown internet and e-commerce services have been developing rapidly within a “walled garden” mainly because the government’s internet censorship covers a wide range of content issues and behaviors in the cyber world for the sake of broadly-defined “national security and political integrity”. In addition, foreign firms’ participation in Internet Content Services (ICP), such as online sales and mail ordering, is currently restricted according to the Chinese Foreign Investment Industrial Guidance Catalogue. This has led to the dominance of domestic internet companies, such as Baidu, Tencent and Alibaba in the Chinese market. Many popular internet services and applications in the developed world, such as Facebook, Twitter, 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 backdrop that the new Chinese ecosystem and industrial transformation at issue is taking place with strong local flavors.

Figure 4 identifies the key factors and facilitators in the new ecosystem and industrial transformation that has resulted from the migration from 2G to 3G in China. In the 2G period, as mentioned above, with 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 OSs 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).

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9 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.
### 2G Period

<table>
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<th>Applications</th>
<th>Operators</th>
<th>Handset vendors</th>
<th>Chipset for handsets</th>
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<tbody>
<tr>
<td>• A limited range and variety of mobile internet services</td>
<td>• Keeping a distance from handset vendors</td>
<td>• Focusing on functional innovation catering to diverse demands from the grassroots</td>
<td>• Mainly Mediatek, with its turnkey solutions</td>
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<tr>
<td>• Shenzhen vendors once outperforming local brands</td>
<td>• Mainly Mediatek, with its turnkey solutions</td>
<td>• Shenzhen vendors once outperforming local brands</td>
<td>• Mainly Mediatek, with its turnkey solutions</td>
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### 3G Period

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<th>Facilitators</th>
<th>Operators</th>
<th>Handset vendors</th>
<th>Chipset for handsets</th>
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<tr>
<td>• App Economy pioneered by Apple</td>
<td>• Increasing popularity of mobile internet and the App Economy</td>
<td>• Transformation of vendors with Shenzhen origin by upgrading existing capabilities</td>
<td>• Mediatek (Taiwanese)</td>
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<td>• Rising significance of applications to mobile communications</td>
<td>• Domestic internet giants’ entry into smartphone business</td>
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<td>• Qualcomm</td>
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<td>• Entrepreneurship development programs for apps, launched by the domestic key players</td>
<td>• Operator-centric model</td>
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<td>• Spreadtrum (domestic)</td>
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<td>• Increasing strength of Android platform</td>
<td>• Closer relationships between the operators, platform owners and vendors for customized handsets, facilitating branding of a few handset vendors</td>
<td></td>
<td>• HiSilicom, Leadcore (domestic)</td>
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<td>• Increasing popularity of smartphones</td>
<td>• Strong market foothold for a few home-grown brands</td>
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**Source:** The authors.

**Figure 4** 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, by launching entrepreneurship development program of App, for the development and provision of smartphones and mobile digital services, compatible with its unique TD-SCDMA standard 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 models in China. Major domestic internet firms, such as Baidu, Tencent, Qihoo and Alibaba also come out with customized smartphones via outsourcing 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, initially as an internet firm, follows Apple’s device-centric platform model to promote its premium smartphones and its MIUI OS platform. Figure 5 illustrates the value chain coverage of the Chinese key players under the different models.
Note: ● refers to what the individual players initially focused. When drawing this figure, we borrow ideas from Kenny and Pon’s (2011) illustration.

Figure 5  Value Chain Coverage of the Chinese Key Players under the Different Models in China

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 development 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 well known household names in China. For example, in 2012 China Wireless (under Coolpad) established a major R&D center in Shenzhen, with more than 1,700 R&D engineers. The company’s dual-mode dual-working handset (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.10

It should be noted that such a turnkey solution as Mediatek’s chipset remains indispensable to this transformation. Actually, its significance has prompted new players’ entry. It is estimated that Mediatek has captured about 50% of the smartphone chipset market share 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 growth11. 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.

On the application side, apart from the well-known “App Economy”, initiated by Apple, there has been growing popularity of applications to mobile communications in China, with Chinese flavor and versions. For example, Tencent’s Weixin pioneered and made popular voice-recorded message services, nowadays widely copied by other players of social media services. Local on-line payment options, such as Taobao Alipay, also prevail in China partly because of a low penetration rate of credit cards. In addition, the local key players, such as the mobile carriers and content aggregators have put serious efforts into entrepreneurship development programs to cultivate app developers, for example China Mobile’s program to incubate one million app entrepreneurs, bringing about the fast proliferation of home-grown applications.12

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10 In the Chinese market, there are still Shanzhai smartphones, such 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), which imitate premium models from Apple, Samsung and HTC. For more information, see http://www.shanzhaiji.com/.


12 According to an unofficial source, there are actually more than 200 Android app stores because Google Play is not widely available in China. For source, see: http://bambooinnovator.com/2013/04/06/china-is-finally-becoming-a-lucrative-market-for-app-makers/ (accessed on 2013/05/18).
It is important to note that the ecosystem in China has benefitted from the overwhelming dominance of Google’s Android OS in the Chinese market, with a market share of about 86%. In particular, Android OS has facilitated the rise of the home-grown brands and the transformation of some of the Shanzhai vendors 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. Taking advantage of this, such a firm as China Wireless has succeeded in shedding its Shanzhai origin and becoming a leading branded player.

5. Discussions
The 3G transformation of China goes beyond the advent and popularity of low-cost smartphones, but affects the entire industrial eco-system. 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 in China but may turn out to be “too much of a good thing” or at least simply unaffordable 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.

In a study on Japan’s mobile phone market, Chen, Watanabe and Griffy-Brown (2007: 17) 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”. However, though the customized handset collaboration model also prevails in China, a booming market with high income inequity and diverse demands from the grassroots has created new opportunities for lower-cost smartphones. The response to this opportunity has required 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,

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13 With multi-SIM handsets, Chinese mobile phone subscribers can save costs while roaming within China.
fashionable for migrant workers, rural farmers and urban young white-collar 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 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 market share, 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 parts of China.

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, in particular India and Africa. 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.

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 the broader meanings of industrial standards than the usual case, in light of the fact that TD-SCDMA is the Chinese indigenous standard at the infrastructure level. Referring to the revised version of “three level model for standards and innovation in ICT”, discussed in Section 2, one can argue that for the “App Economy” and broadband mobile communications services to prevail, it takes more than the technologies and standards of infrastructure, 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 to China, alone cannot fully support China’s migration towards indigenous smartphones and broadband mobile communications services.

Good news for the China’s stakeholders is that they 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 6, 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 licences for Mobile Virtual Network Operators (MVNO), allowing them to launch their own mobile communications services by leasing airtime capacity from the incumbent operators. Although the Chinese firms 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. Tencent’s Weixin and its voice-recorded message services obviously have done a good job in this regard.

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: 46). As shown in Figure 7, 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 home-developed OSs, 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.

On balance, underlying Chinese efforts to develop and promote its indigenous TD-SCDMA standard are the government’s serious intentions, such as to reduce dependence on foreign technologies and royalties paid to the foreign dominant architecture or standard setters and to set up own playing field (Liu and Zhou, 2013 and Yan, 2007). With its accumulated strengths in mobile communications services, China Mobile has done relatively well in promoting its TD-SCDMA 3G services. However, the advent of 3G services and smartphones has brought about a complicated ecosystem in China, as the rest of the world has witnessed, implying that technologies for 3G infrastructure is only part of the solutions required. The rise of home-grown brands for smartphones, at the expense of Shanzhai handset vendors, has benefitted more from the “sluggish tiers of the market”, in Christensen’s terms (Christensen et al., 2001), and the foreign platform of Android. This has much to do with the “platformization” of smartphones and 3G services (Feijóo et al., 2009) and the resultant close relationships between smartphone makers and the operators and the service platform owners (Eaton et al., 2011; Kenney and Pon, 2011). The proliferation of home-grown app services popular for smartphones has gained a great deal of support from the “walled garden” of the Chinese cyber world, though due credit should also be given to the stakeholders involved. To quite an extent, it is Android platform that has bolstered China’s evolution in both smartphones and OSs for broadband mobile communications services. Therefore, the evolution of China’s mobile phone industry and its currently prevailing good-enough innovations can be better comprehended by referring to the idea of the co-evolution of technology, industrial structure, and supporting institutions (Nelson, 1994).
The three levels of ICT industrial standards

- **Application** (Ex. i-mode, games, location-based services)
- **Middleware/Service platform** (Ex. WML, App Store)
- **Infrastructure** (Ex. Architecture design for 3G, 4G, broadcasting)

**User**

**Technology**

**Current industrial standards**

- WCDMA, CDMA2000, TD-SCDMA

**Numerous internet content providers and app design houses and designers**

<table>
<thead>
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<th>Service platform</th>
<th>Operating System</th>
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<tbody>
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<td>- The three operators’ own service platforms</td>
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Note: The left part the figure is adapted from China EU Information Technology Standards research partnership.
Source: The authors.

**Figure 6**  Industrial Standards and the New Ecosystem of Smartphones and Services in China
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 mobile OSs, 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.
References


