



# IMPACT ASSESSMENT OF OPEN OS ECOSYSTEM FOR DEVICES IN INDIA

A Study by KPMG in India and  
India Cellular & Electronics Association

March 2019



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### Foreword for ICEA-KPMG Report



I compliment the Indian Cellular and Electronics Association (ICEA) for undertaking a detailed study on “Impact Assessment of Open OS Ecosystem for Devices in India” in partnership with KPMG.

Growth in mobile manufacturing is largely driven by the massive demand for smartphones and mobile services. A key contributor to this widespread demand is the use of open OS in mobile devices. With the increase in accessibility and affordability of smartphones, the digital divide between urban and rural India is shrinking. This boost in smartphone penetration has also created expansion of manufacturing facilities, growth of consumer base and establishment of many small, medium and large scale enterprises.

This phenomenon of open OS has been covered comprehensively in this report, detailing its impact on various industries and society at large.

My best wishes to ICEA for their current and all future endeavors.

A handwritten signature in black ink, which appears to read "R.S.Sharma".



सत्यमेव जयते

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भारत सरकार  
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Ministry of Electronics &  
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Government of India



## FOREWORD

First of all, I would like to compliment India Cellular and Electronics Association for a very timely and important initiative of undertaking this study on "**Impact Assessment of Open OS Ecosystem for Devices in India**", in partnership with KPMG.

Building on the 'Phased Manufacturing Programme' (PMP), the manufacturing ecosystem for cellular mobile phones has boomed, giving rise to ancillary ecosystems. Thus, there has been a very significant increase in the number of mobile manufacturing units in India.

The advent of open OS in mobile devices has enabled the widespread use of smartphones. Over the past 3-4 years, there has been a steady growth in the demand for smartphones. Along with this, there has also been a rise in the availability of affordable mobile services.

This report captures the key trends in the mobile ecosystem, along with its implications on players in it such as handset OEMs, ODMs, allied industry manufacturing units, mobile application developers and consumers. This comprehensive study will enrich the current knowledge base of key stakeholders and will help develop and formulate policies for future growth.

(Ajay Sawhney)

Place: New Delhi  
Date: 19<sup>th</sup> February, 2019

अरुणा सुंदरराजन, आई.ए.एस  
सचिव  
**Aruna Sundararajan, I.A.S.**  
Secretary



भारत सरकार  
संचार मंत्रालय  
दूरसंचार विभाग  
**Government of India**  
**Ministry of Communications**  
**Department of Telecommunications**



Dated the 24<sup>th</sup> January, 2019

### FOREWORD

#### **Ministry of Communication, Department of Telecom, Government of India**

I am happy to note that ICEA in partnership with KPMG have conducted an impact analysis study named "**Impact Assessment of Open OS Ecosystem for Devices in India**".

The manufacturing activity related to mobile handsets and components has registered an unprecedented growth during the past 3-4 years, riding on the 'Make in India' initiative of the government and the open OS phenomenon. Approximately 268 new manufacturing units have been set up so far, generating 6.7 lakh direct and indirect jobs.

I strongly believe the current manufacturing growth witnessed in this sector is just the beginning of a massive transformational journey ahead, which can potentially produce better results in export promotion, employment generation, and a host of social-economic advantages. With growing penetration of smartphones, the availability of 3G/4G services has created data highways and increased the ease of access to services. Thus, open OS in mobile devices has provided a boost to the economy by enabling the creation of new industries to cater to growing consumer demand.

I am confident that the impact analysis study done by ICEA along with KPMG has already come up with various strategic insights which should be considered very seriously to protect and promote manufacturing interests of the nation. Some of key aspects which I understand the study has tried to evaluate are the impact of open OS impact on manufacturing, allied and induced businesses, and society. It also covers generation of employment, setting up of component manufacturing ecosystem, and other initiatives with the objective of establishing India as a global mobile manufacturing hub.

A handwritten signature in black ink, appearing to read "Aruna Sundararajan".

(Aruna Sundararajan)



## **FOREWORD**

It is proud and encouraging to know that the mobile handset and components manufacturing eco-system is considered to be the Champion product category under the “Make in India” and “Digital India” flagship programs of the Indian Government. India has surpassed Vietnam in becoming the second largest manufacturer of handsets by volume with production reaching 225 Mn units valued at INR 1,32,000 Crs. by the end of 2017.

The Phased Manufacturing Program (PMP) has been the key strategy for widening and deepening the components manufacturing eco-system in the mobile handset sector, the twin objective of the PMP being value addition and generation of employment in India.

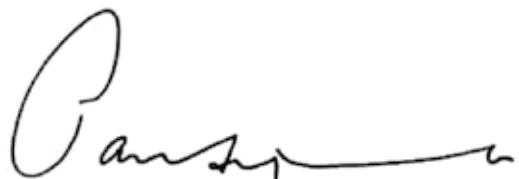
While the Mobile industry is growing, there is a simultaneous evolution in the app industry as well. In today's digital economy, there are 3 major markets prevalent in India –

- 1) A higher segment market comprising of those who have negligible affordability challenge for buying smart phones of premium pricing. Such people need limited digital assistance and cost optimization is not a big challenge for them
- 2) A huge existing market for mid-level segment phones. This segment was initially skeptical about the digital era being dominantly present in India, however the Indian handset market increased massively from 37 Mn units in 2005 to 110 Mn units in 2008 i.e. pre and post open OS ecosystem
- 3) A basic low end, entry level smart phones segment which attracted the entire market towards it post foreign investments into India. This segment however faces acute cost optimization challenges



Post the smart phone revolution, brands created a holistic eco-system in the country for many unicorn companies in the past one decade. Many apps/services are being accessed primarily on smart phones now. Prevalence of the Open OS has also facilitated smart phones supporting multilingual capabilities and also led to enhancement of the Skill India Program by the government. The societal impact of this robust eco-system has led to a growing number of entrepreneurs and start-ups in India. Smart phones and open OS facilitate financial inclusion of the masses and leads to various online capabilities for the consumers such as digital payments, app development and E-commerce. Moreover, Open OS led to not just a growth of the mobile and app ecosystem but an overall rise in the Indian economy. This happened due to an increase in smart phone penetration, thereby leading to an overall GDP growth of the country.

While we embark on this crucial journey with the vision to showcase the various verticals of the mobile and app industry in the country, it would be interesting to observe the impact of Open OS eco-system on Indian consumers. ICEA with the support of KPMG, has undertaken a vivid study on the same.



(Pankaj Mohindroo)

A handwritten signature in black ink, appearing to read "Pankaj", followed by a decorative flourish and the name "Mohindroo" underneath.



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### Foreword – Jaideep Ghosh

Smartphones are helping India leverage the data highways to provide people with unprecedented mobility, as well as foster the entrepreneurial spirit leading to a thriving economy. When the first open source OS based mobile phone was launched a decade back, no one could have fathomed the paradigm shift that the Indian telecom sector was going to witness. Rolling out of new technologies like 4G/5G, crossing the billion-user mark and overtaking the United States to become the second largest mobile phone market in the world are just a few of the recent milestones. These have underscored the immense potential that India's unfolding mobile phone journey holds.

Increased affordability of smartphones and, consequently their enhanced penetration into even the remotest pockets of the country, have indeed been at the heart of this significant change in India's telecommunication landscape. The contribution of open source operating systems has been indispensable with regard to making smartphones more affordable and thus easily accessible. By democratizing technology and bringing it to the palms of the Indian masses, open OS platforms are truly helping smartphones evolve into tools for socio-economic empowerment.

The advent of smartphones has redefined how everything functions on a fundamental level - from transforming the ways in which billions of Indians connect to the way they travel, to challenging prevalent business models. The exponentially increasing proliferation of these

devices has strengthened the manufacturing landscape along with making them access devices to deliver a whole range of solutions like food delivery, cashless payments, health monitoring and fitness, shopping and video streaming.

Open OS has laid the foundation for development of a host of associated ecosystems like application development, connected devices, digital payment, shared economy services etc. It is thus playing a key role in expanding the unicorn club by serving as a potent catalyst for the startup ecosystem. With more than 330 million Indians accessing the internet and a host of online services on their handheld devices, it is also contributing to the government's initiatives like Digital India, Startup India and Make-in-India.

Smartphones have been central to developing ecosystem for evolved technologies like IoT, AR/VR and AI. In the coming years, as evolution and refinement of these existing technologies leads to deeper integration with smartphones, consumer experience will be driven by predictive and adaptive technologies. Although these smart devices have commendably laid the foundation for India's technological transformation, but the mobile-phone landscape still remains replete with a lot of untapped opportunities for companies across various verticals.

This report brings to light, the impact open source operating ecosystems have had on businesses, consumers and society. We hope you find the report an insightful read.

(Jaideep Ghosh)

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# Executive Summary



The Indian mobile journey has come a long way ever since cellphones were first introduced in 1995. The launch of open source operating system (OS) for mobile devices in 2008 ushered in the smartphone revolution.

Between 2014 and 2017, the Indian smart phone market grew at a compounded annual growth rate (CAGR) of 37% in value, i.e. from INR 54,900 crore to INR 1,43,000 crore<sup>1</sup>. Consequently, India overtook USA to become the second largest mobile phone market (in terms of units), after China and is amongst the top 20 fastest growing markets for smartphones globally<sup>2</sup>. Manufacturing facilities for handsets and allied industries have increased from 3 in 2014 to 268 in 2018<sup>1</sup>.

### Open source mobile OS

- The source code is free to download and is customisable
- Users can legally modify, re-distribute and re-invent it
- Main principle is peer production by collaboration with end product blue prints

#### Android is the most widely used open source mobile operating system globally.

Some of the best features of Android would include the ability of OEMs to produce highly customised, innovative devices and the ability of users to tailor devices to their needs to more quickly access content, including by creating multiple home screens and adding widgets.

It also has an excellent capacity for multitasking - making it ideal for application in various business scenarios.

Some of the other open source mobile OSes are – Tizen, Plasma Mobile, Librem, pmOS, Lineage OS, etc.

This impressive growth can be attributed to the prevalence of open mobile OS, which has led to reduced barriers to entry for OEMs. Android is the most widely used open source mobile operating system. It is free of cost and is available for download without any riders.

The open OS ecosystem is also providing additional impetus to Government of India's initiatives such as Make in India, Digital India, Startup India and Skill India (refer to Figure 2 for details). It has catalysed the growth of a vast consumer base, expansion of manufacturing facilities and establishment of a thriving set of small, medium and large scale developers.

### Impact of open source mobile operating

#### Business Benefits

##### Major Handset OEMs

- **Reduced barriers to entry** – The number of smartphone OEMs has increased from **7 in 2009 to ~80 in 2018<sup>3</sup>**
- **Market size expansion** – No. of smartphones sold increased from **2 million units in 2009-10 to 117 million units in 2017-18<sup>1</sup>**
- **Device differentiation** – OEMs can highly customize devices

##### Application Developers

- **Increased talent pool** – Estimated **72% of mobile application developers are using open OS** as the base of their development<sup>4</sup>
- **Access to larger market** – With lower fee to publish and availability of a standardised platform, developers get easy access to user base of **152 countries via ~300 app stores<sup>5</sup>**

Players in the open OS ecosystem include handset OEMs, ODMs, allied industry manufacturing units, mobile application developers and consumers. They constantly interact and co-operate with each other, thus facilitating collaborative development for all. The effects and benefits of this phenomenon have cascaded down to businesses, consumers and the society at large. The constant evolution around open source mobile operating systems is also stimulating an array of complimentary innovations- resulting in an increase in the number of application developers as well as giving rise to a host of connected devices, making IoT a conceivable reality. Digital accessories such as smart devices, wearables, etc. have emerged as catalysts for rapid economic growth and consumer empowerment.

India is a linguistically diverse country with as many as 22 official languages and over 1600 spoken dialects<sup>10</sup>. Majority of Indians use indigenous languages as their first language and this number is growing. Indus OS, a popular modified (but compatible) version of Android has gained a lot of traction due to its focus on local Indian languages.

In line with this trend, the number of users accessing internet in local Indian language reached 234 million by the end of 2016 surpassing those that do so in English. This number has grown at a CAGR of 41% between 2011 and 2016<sup>10</sup>.

More and more people are consuming content in their own language. Growing smartphone penetration is also driving the demand for

## system on businesses, consumers & economy

### Consumer Benefits

- **Increased affordability** – The ASP of smartphones has reduced by 16% from INR 14,000 in 2009 to reach INR 11,800 in 2017-18<sup>1</sup>
- **Retail price of entry level smartphones has fallen from INR 12,000 in 2008-09 to INR 1,400 in 2017-18<sup>6</sup>**
- **Increased choices** – Reduced time to market has resulted in more smartphone models across price ranges; average number of smartphone models per OEM has increased by **5X in the last 5 years<sup>7</sup>**
- **Access to more apps** – ~ 2.8 million apps\* can be downloaded from major app stores of Open source OS<sup>5</sup>

\*This number is the sum total of all the apps available on Google Play Store, Amazon Appstore and BlackBerry World. The number does not account for double counting of applications that may be present in multiple stores.

### Societal Benefits

- **Job creation** – A total of 6.7 lakh jobs<sup>8</sup> have been created due to production of mobile phones in India. Out of these-

Number of direct jobs created due to manufacturing/ of open source mobile OS based handsets since 2014 <sup>8</sup>	<b>1.38 Lakhs</b>
Number of indirect jobs created due to manufacturing/ of open source mobile OS based handsets since 2014 <sup>8</sup>	<b>4.15 Lakhs</b>

- **Increased GDP per capita**<sup>9</sup> – Growing penetration of smartphones has made online services like mobile banking, shared economy services, e-commerce etc. more accessible for consumers. It has led to greater value addition from manufacturers and app developers as well as a robust sales and marketing ecosystem thereby contributing to economic growth

Cumulative increase in GDP Per Capita over the last five years	<b>1.4%</b>
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handsets with better compatibility with local languages with respect to messaging, curated content, voice assistant etc.

Currently, mobile handsets support message readability in all 22 official languages and input text in three languages.

The modifiable stack of open OS is a key factor enabling the integration of local language capabilities in smartphones.

Furthermore, as mobile internet users in smaller cities and rural India increase, the role of indigenous languages in smartphones and mobile apps is expected to gain more significance.

Growing penetration of smartphones has made online services more accessible for consumers. According to a research conducted by IAMAI, nearly 77% of urban users and 92% of rural

users consider mobile as the primary device to access the Internet. The report stated that mobile now represents two out of three minutes spent online. This has helped Indian internet companies widen their reach. Most of the entrants in the startup unicorn club like Ola, Paytm, Flipkart etc. have been able to leverage this reach successfully.

It has also led to the proliferation of a host of allied activities such as sales & distribution, mobile centric marketing, e-commerce, digital payment gateways etc. All these activities are having a cumulative positive impact on the overall economy.

All this growth has been made possible largely due to advent of open source mobile OS. It has widened the effective market available for businesses and created the right circumstances

### Smartphone Proliferation Leading to Increased Business Activities in the country

1



- The proliferation of smartphones combined with favourable government policies has led to the establishment of manufacturing/ assembly units
- A host of allied manufacturing units producing batteries, chargers, phone covers, earphones etc.

Direct

Indirect

- Smartphone adoption has enabled the development of an entire value chain around it
- This includes transportation services, distributors, retailers, sales force and associated mobile repair/ accessory outlets

2



3



Induced

- Smartphones have become the primary mode of internet connectivity for a large portion of India's population. This has led to a considerable induced impact on business spanning across various verticals. For example:
  - Companies are investing heavily in brand communication via smartphones making it easier for brands to establish themselves
  - Increase in digital literacy and comfort with online payments has led to the proliferation of digital payment gateways and wallets
  - Online shopping has shifted the trend from e-commerce to m-commerce with many brands like Ola/ Uber being available only on phones

for an entrepreneurial population to assert its agency and independence.

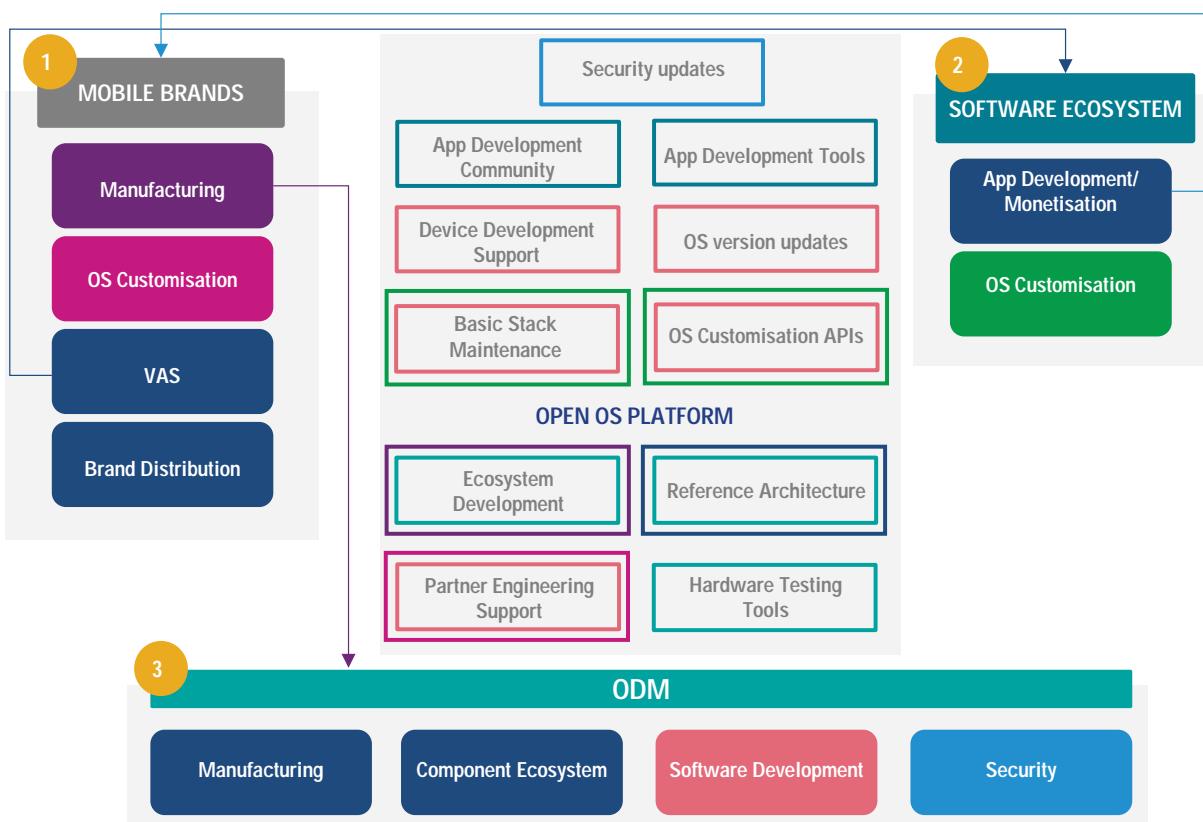
Open source mobile OS thrives on collaborative growth. The foundation of the ecosystem established around open OS lies in many-to-many interactions that enable all stakeholders to deliver value to the end customer.

The open OS platform interacts with various stakeholders in this ecosystem to provide support (engineering and development), updates (version and security), reference architecture, test hardware compatibility as well as promote

device development. These interactions foster and enrich the ecosystem, leading to further advancements. It also maintains the basic stack and is central to the evolution of the ecosystem.

The next decade is expected to give rise to plethora of industries based on open-source concepts, such as information sharing and joint innovation. An intuitive network of connected devices is emerging as the next big wave. This has begun to impact diverse sectors such as healthcare, education, government and financial services.

**Figure 1 :The interactions in an open source ecosystem**



Source: KPMG Analysis

1,2 & 3 in the figure are the stakeholder ecosystems (apart from consumers) interacting with the central operating system's platform. Each box within the open OS platform area in the figure, represents an activity carried out by the management of the said platform. Each of the three stakeholder ecosystems further comprise of components that interact with a) each other – represented by arrows; b) an activity being carried out by the management of the OS – represented by the colored boxes around each activity. The colour of the outline of the boxes in the center correspond to the colours of the component/sub-component in the ecosystem that the activity interacts with.

**Figure 2 : Alignment of open OS ecosystem with key national priorities**

### Make in India



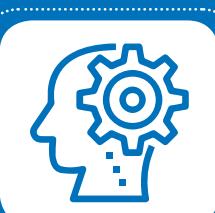
- In 2017-18, **82%** of the mobile phones were manufactured domestically<sup>11</sup>
- 120 million units of smartphones were manufactured domestically in 2017<sup>11</sup>; this is expected to grow at a **CAGR of 48.4%** between 2017 and 2025<sup>12</sup>
- Manufacturing units for mobile handsets & allied industries have increased from **3 in 2014 to 268 in 2018**<sup>11</sup>
- There were 115 mobile device related allied manufacturing setups\* operating in India in 2017-18<sup>11</sup>

### Digital India



- On the back of increased affordability of open OS for mobile phones, smartphone penetration increased from **0.3% in 2009-10**<sup>13</sup> to **26% in 2017-18**<sup>14</sup>
- Smartphones are bridging the urban rural digital divide; there were **109 million smartphone** users in rural India in 2017<sup>15</sup>
- The rural population is gaining easier access to agriculture related information, better healthcare and education through apps such as Microlekha, Srijan, OpAsha, etc. This is bringing them one step closer towards inclusion<sup>16</sup>

### Skill India



- The advent of the digital era and increasing prevalence of smartphones has created new job opportunities, leading to the need for upskilling and re-skilling the existing work force in India
- NSDC has undertaken several initiatives to equip the talent pool with the required skill set for the smartphone driven digital era<sup>17</sup>
- In November 2017, Google announced a new scholarship program aimed at training **1.3 lakh app developers** and students across India
- As of end of 2017, more than **1,80,000 students** have completed courses developed by Google
- GSMA and its partners have launched the Mobile Internet Skills Training Toolkit (MISTT) to reduce the digital skills barrier in India<sup>18</sup>

### Startup India



- There were over 5,000 tech start ups in India by the end of 2017; ~60% of these start-ups provide B2C services, primarily via mobile apps<sup>19</sup>
- Many Indian startups like Ola, Paytm, have been valued at more than a billion dollars (joining the coveted unicorn club) by leveraging the expanding smartphone user base
- According to a survey by the Global Accelerator Learning Initiative (GALI), India has around 259 startup incubators and accelerators
- ShellE4, Target, SAP, Microsoft, Qualcomm, Cisco, Google, Bosch, Intel, GE Healthcare, Intuit are some of the MNCs operating startup accelerators in India
- GoI has also been actively involved in driving this wave of incubation – NITI Aayog, MeitY, MSME, state governments have all launched initiatives aimed at promoting startups

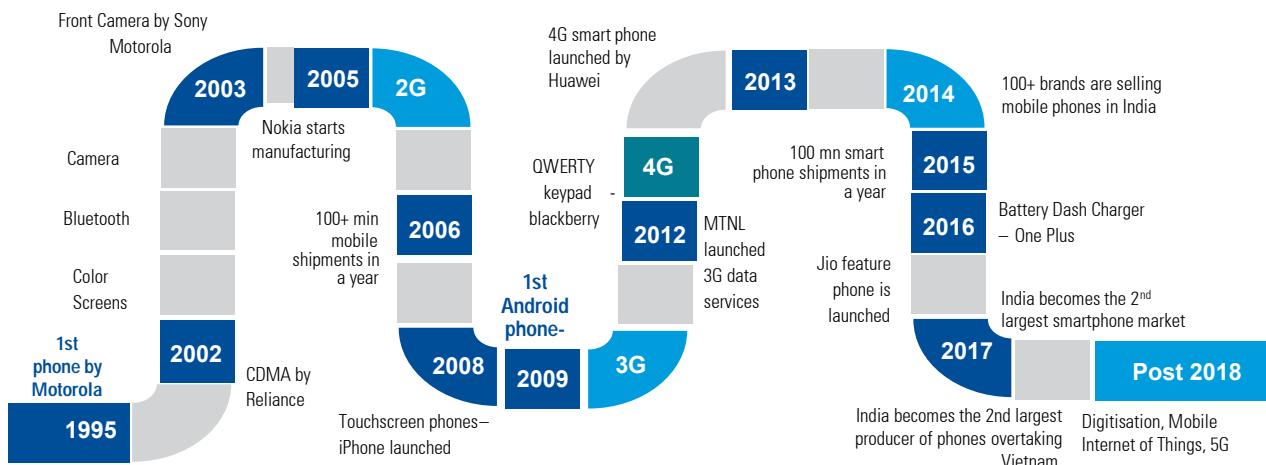
\*These are not unique factories but a split of the total number of units operational (342) in 268 unique factories

Source: 11. ICEA; 12. Frost and Sullivan; 13. Research Gate; 14. Emarketer; 15. TRAI; 16. Yourstory; 17. Google; 18. National Skills Network; 19. NASSCOM

# Mobile Devices Market Overview



**Figure 3 : Journey of Mobile Phones in India**



Source: KPMG Research & Analysis

## Evolution of Mobile phones in India

July 1995 saw the first cellphone service being launched in India. By 1998, the telecom network had expanded, cellphones had become more popular, and call rates considerably less expensive. These events collectively marked a turning point in the Indian mobile phone journey.

Total tele-density in India has increased from 1.94% in 1998 to 92.8% as of March, 2018<sup>1</sup>. This increase has aided the evolution of an entire ecosystem pivoted around mobile phones. This comprises of not just telecom operators and OEMs/ODMs, but also chip set designers, software designers and application developers.

Although India had predominantly been a feature phone market driven by ‘value for money’ customers, the introduction of feature rich open source OS phones by international brands in 2009 and local brands in 2010, allowed smartphones to gain traction in the Indian market.

Indigenous brands such as Micromax, Karbonn, Lava, etc. particularly helped in this regard by incorporating functionalities to better suit local needs and preferences at affordable price points. These included India specific product features such as dual sim compatibility, longer battery life, on-device music capability etc., which further propelled smartphone adoption in India.

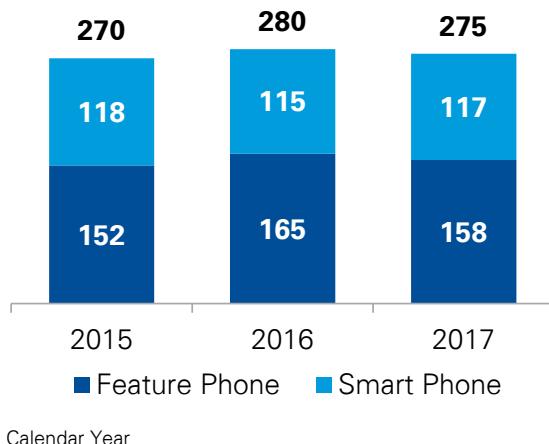
Between 2014 and 2017, the Indian smartphone market grew at a CAGR of 37% in value, i.e. from INR 54,900 crore to INR 1,43,000 crore<sup>2</sup>. In 2017, India overtook USA to become the second largest mobile phone market (in terms of units) after China<sup>3</sup>. It also continues to hold its position as the biggest feature phone market globally<sup>4</sup>. The country has maintained its position as one of the fastest growing smartphone markets and is amongst the top 20 fastest growing markets for smartphones<sup>4</sup> around the globe.

Source: 1: TRAI; 2. ICEA ; 3. Canalys; 4. IDC

The smartphone market witnessed a healthy 14% annual growth in 2017<sup>4</sup>. The feature phone market also witnessed a positive growth in the same year, after recording a decline for three consecutive years. This was largely driven by the traction gained by the nominally priced Jio phones launched towards the end of 2016.

Jio phone is a feature phone with some smart capabilities as it provides limited internet connectivity, online entertainment services, digital payment support as well as access to certain high usage applications like Facebook and WhatsApp to its users. Launched at a price point of INR 1500, it is aimed at reaching more price sensitive customers who cannot afford entry level smartphones. However, Jio phone differs from a smartphone which typically offers full-fledged internet connectivity, touch screen capability, QWERTY keypad and access to third party apps downloadable via an app store.

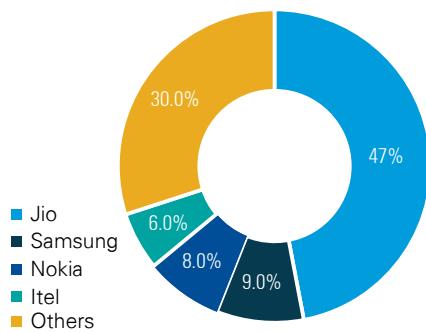
**Figure 4 : Mobile Phone Sales India (in Million units)<sup>4</sup>**



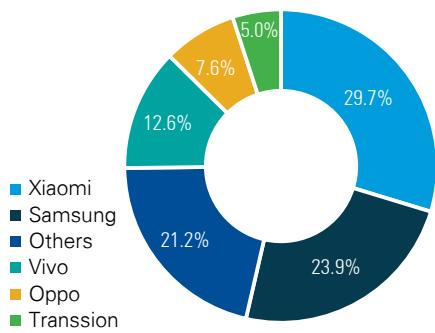
The last three-four years have witnessed a sharp increase in the number of applications available to smartphone users. These span across various verticals and functions and have made handheld

**Figure 5 : Player wise share of Smartphone & Feature phone<sup>5</sup>**

**Feature Phone Market Share % Q2 2018**



**Smartphone Market Share % Q2 2018**

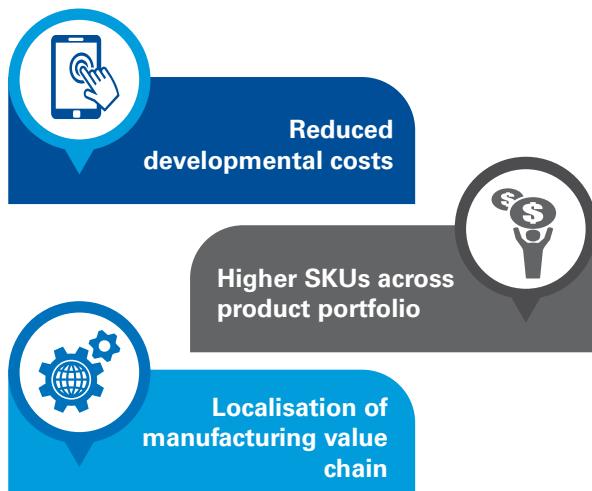


- Feature phone refers to a basic mobile phone with limited computing capabilities
- Supported by multiple OS (including open OS) and can run proprietary firmware, with third-party software support through a platform like Java ME
- Some high end feature phones now have limited internet capabilities with certain pre-loaded applications
- Some feature phones now have access to app stores (eg KaiOS) that enable users to download apps

- Smartphone refers to a mobile phone that has advanced functions similar to a personal computer and has a comprehensive operating system running the device
- These computing functions include ability to install and run downloaded apps, email, web browsing, etc.

devices an integral part of the consumer's daily life. Consumers are now looking for enhanced experience, seamless end-to-end connectivity, longer battery life and efficient data utilisation at affordable prices. Phones with larger screen sizes are making a comeback as more and more consumers access content on their phones. Embellishments in terms of wearables and phone accessories is also an upcoming trend amongst today's consumers.

The ASP of mobile phones has declined by ~16% from INR 14,000 in 2009 to reach INR 11,800 in 2017-18<sup>6</sup>. Some of the reasons for this are:



Declining ASP coupled with increased import duties on mobile components provides an incentive for OEMs to manufacture locally in India, thus promoting the 'Make in India' initiative.

## Manufacturing Landscape

Mobile phone manufacturing has been prevalent in India since 2005. However, with the launch of 'Make in India' program in September 2014 by Government of India and implementation of necessary policy reforms (raising excise duty differential between domestic and imported phones), domestic manufacturing of mobile

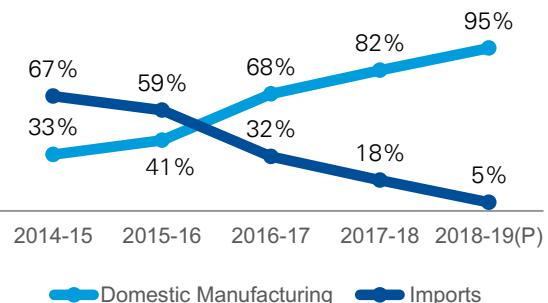
phones has expanded. Associated central and state-led incentive schemes have further complemented this expansion. As a result many domestic as well as international brands have ramped up their manufacturing capabilities in India.

The Make in India initiative is encouraging OEMs to manufacture domestically, by providing them a differential duty advantage. Local manufacturing is providing OEMs more control over the manufacturing process, quality and customisation of features. The number of manufacturing facilities have increased from 3 in 2014 to 268 in 2018<sup>6</sup>, with major players like Samsung, Xiaomi etc. investing heavily to manufacture in India.

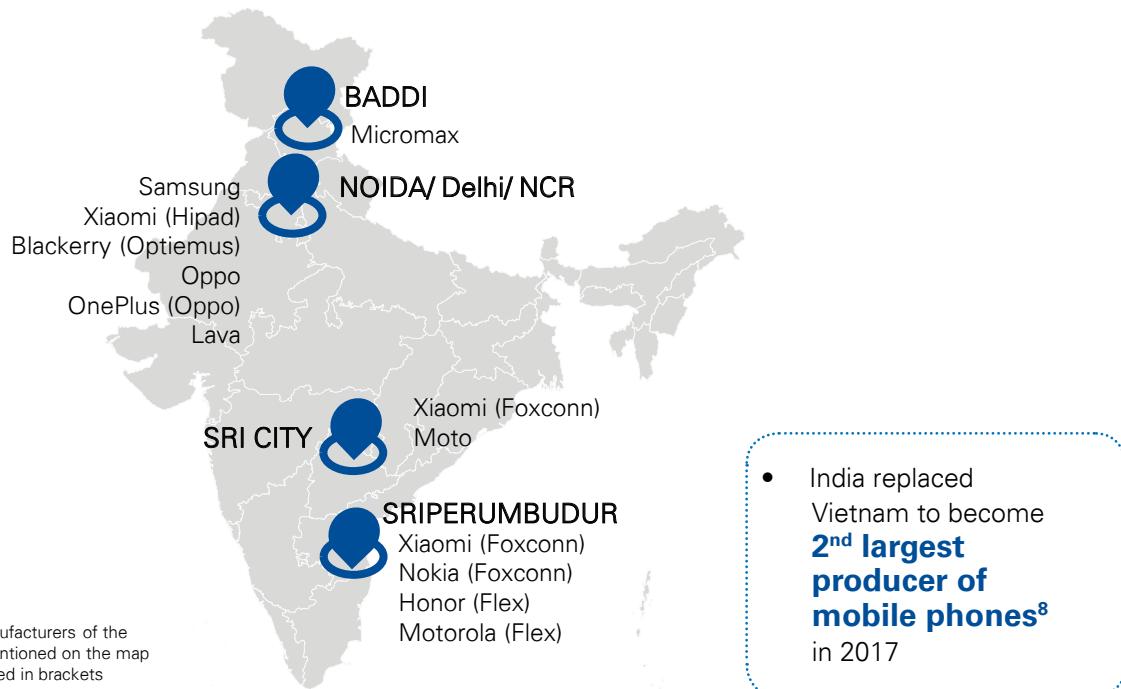
From a volume perspective, 2016 was a pivotal year for India as the share of domestic manufacturing surpassed that of imports in terms of the total retail sales of mobile phones sold. It is estimated that by 2019, close to 95%<sup>6</sup> of mobile phones will be manufactured domestically.

Mobile manufacturing sector suffers from a host of problems, including stringent labor laws, poor infrastructure and an inefficient supply chain. These factors are hindering the growth of this sector and leading to sub-optimal profit levels for local manufacturers. The Government aims to tackle some of these hindrances by implementing the Phased Manufacturing Program (PMP). With the implementation and

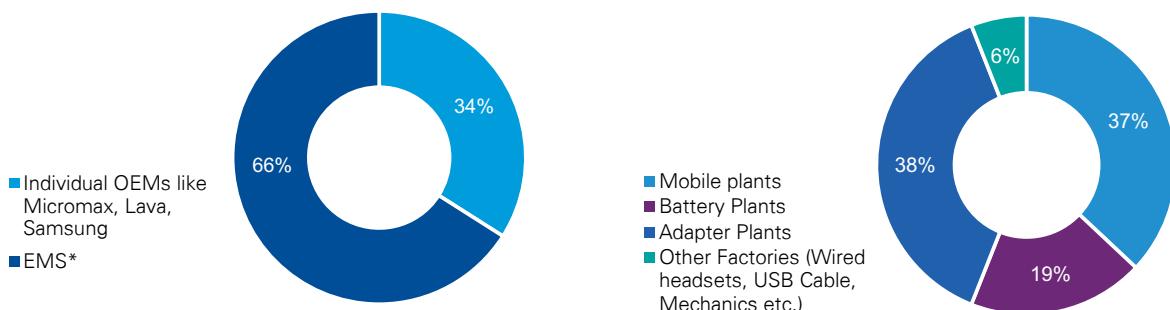
**Figure 6 : Indian Mobile Phone Market (% contribution to volume)<sup>6,7</sup>**



**Figure 7 : Manufacturing Landscape in India in 2017**



**Split of Manufacturing Units (2017-18)**



Source: Counterpoint

\* EMS (electronics manufacturing service) is a term for a contract manufacturer in the electronics field that not only makes products for OEMs but also offers assistance with a wide array of value-added services like support with design, design for manufacture etc.

Source: ICEA

\* The split represented in the graph is based on the activities carried out by the plants. Example - some plants manufacturing mobiles, battery and adapters will be included in all three heads.

- In 2017-18, 225 million<sup>8</sup> handsets were assembled and/or manufactured in India
- Individual OEMs operate close to 1/3<sup>rd</sup> of manufacturing facilities in India, with EMSes operating the remaining 2/3<sup>rd</sup><sup>9</sup>
- In 2018-19, India is expected to produce approximately 290 million units of mobile handsets<sup>8</sup>

Source: 8. ICEA; 9. Counterpoint

success of various phases of this plan, India is on the path to have a robust indigenous mobile manufacturing ecosystem. Introduction of duty arbitrage under PMP is incentivising Indian and foreign brands to gradually move manufacturing to India.

### Connected Devices Ecosystem

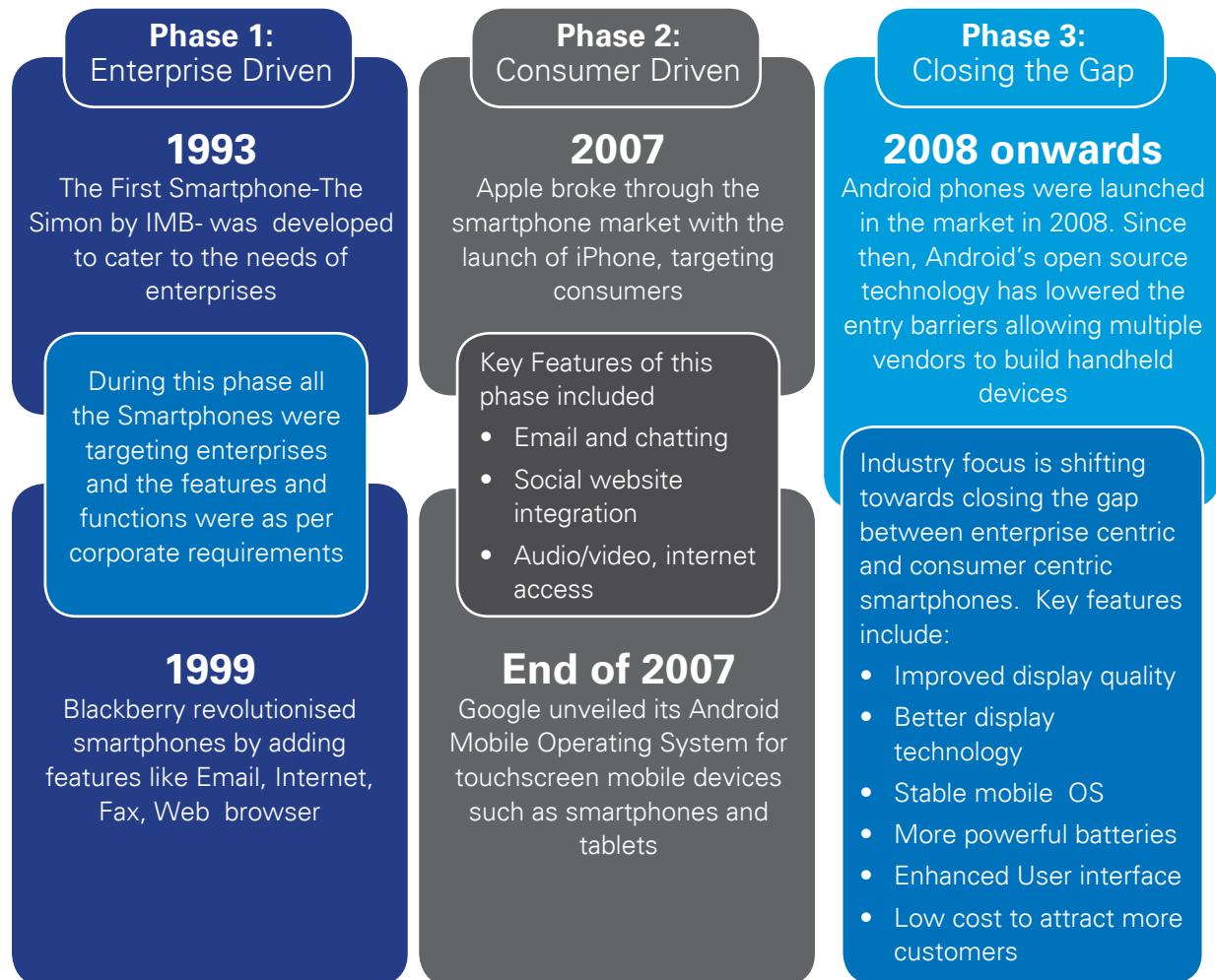
Smartphones have become an integral part of life, making the scenario of not being constantly connected to the internet a thing of the past for most people. The consumers' increasing need to stay connected is paving the way for a highly intuitive ecosystem of connected devices.

Meanwhile, hardware improvements are increasing the capability of devices. Technological innovations like machine learning and blockchain,

coupled with the proliferation of data available, are enabling devices to become smarter. This technology driven ecosystem is increasingly penetrating every aspect of life. Smart devices which include smartwatches, wearables, connected speakers etc. are changing the way millions of Indians interact, do business, and stay connected to each other and the world.

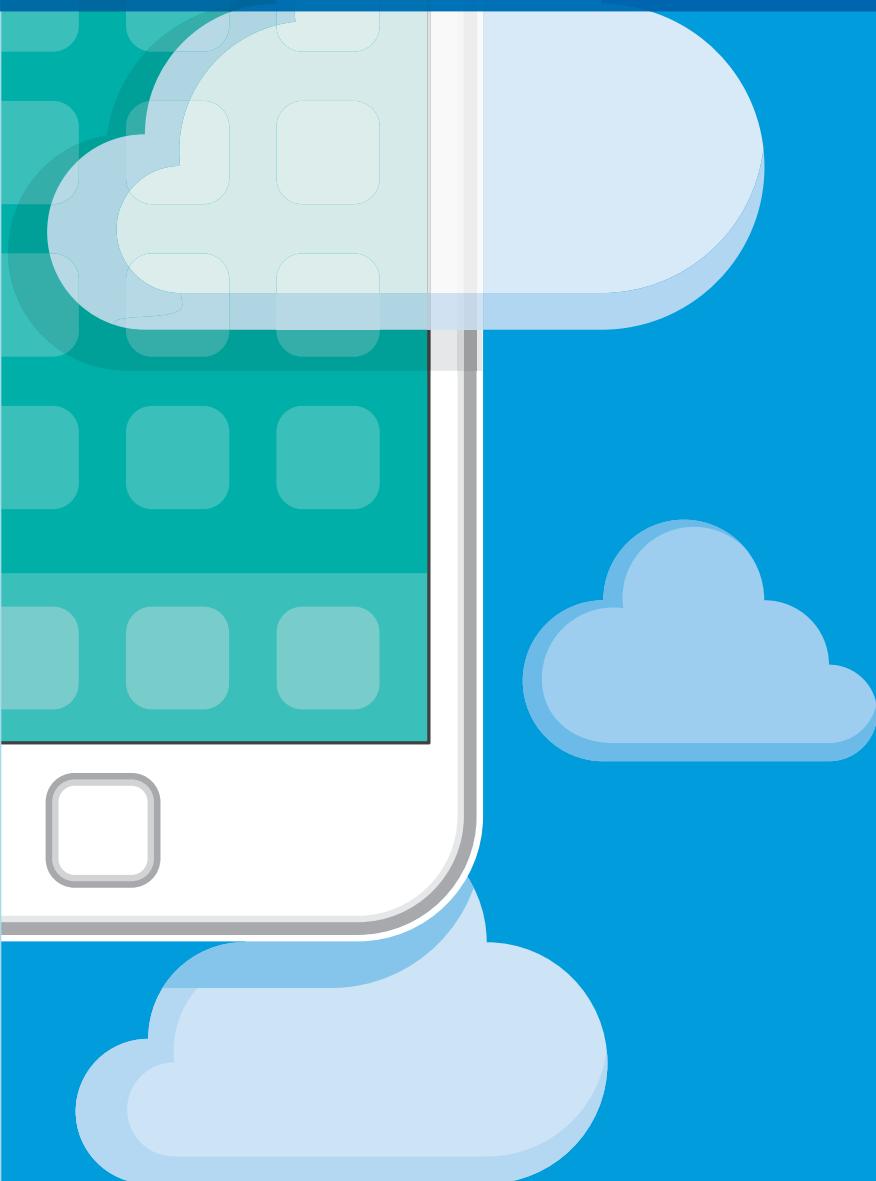
The growing connected devices ecosystem is underscoring the importance of the underlying software used to run them; the software is not only central to how users interact with the devices but also how these devices interact with each other. Open source software, like Android OS, therefore is playing a key role in this ecosystem development by standardising the platform that these connected devices interact on.

### The Three Phases of Smartphone Evolution

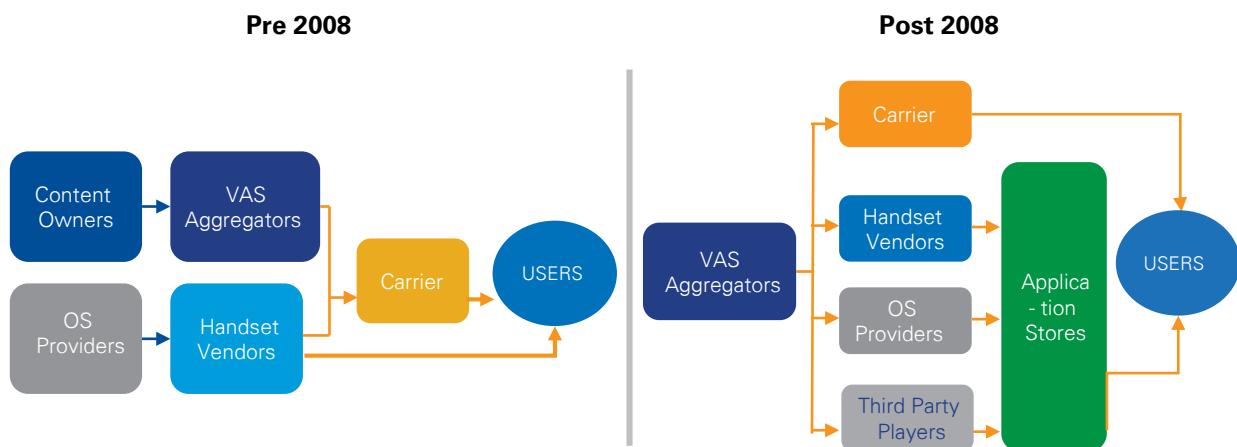


\*OEM are the producers and designers of mobile phones for their own brand and an ODM are the companies carrying out production for another brand

# Significance of Operating System in device ecosystem



**Figure 8 :The changing mobile phone value chain**



Source: Industry Reports, KPMG Analysis

### Value Chain of Handheld devices & role of Mobile Operating System

Since its inception in 1970s, the mobile handset has undergone many phases of evolution. This has largely been driven by major changes in hardware, network technology and innovations in the mobile operating system.

Mobile OS is the primary interface between the user and his/her device, and is thus the cornerstone determining user experience. It therefore plays a vital role in both customer acquisition and retention for handset players. An OEM's choice of mobile OS not only lays the foundation for its product and marketing strategy, but also determines the amount of control that it can exercise on the software.

Before the rise of open source operating systems, handset vendors and carriers possessed maximum control over the mobile handset value chain. They decided the OS that would run on their handsets, the content that was accessible as well as the applications available to the user.

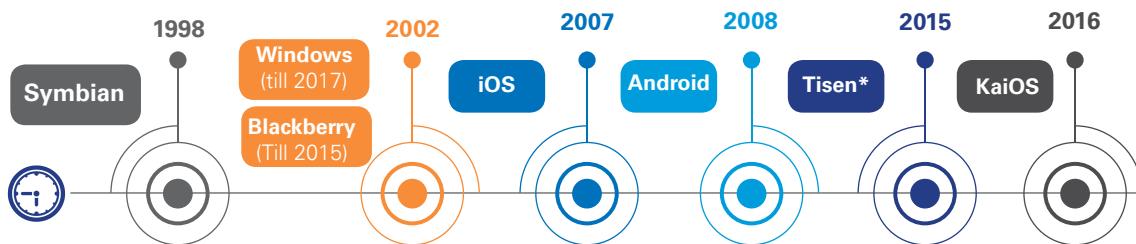
With the emergence of open source mobile operating systems, this control has now been distributed evenly across the value chain. Due

to the change in the role and control exercised by each player, the business models have undergone a radical shift. The stakeholders are now focusing on evolving their respective products.

### Evolution of Mobile OS

Before 2008, all mobile carriers developed 'vertically integrated walled gardens' of services, devices and applications. They invested in proprietary technologies and generated revenue by exploiting intellectual property rights. They imposed walls around their content, where the only apps and ringtones available for download were those from the carrier's app store. Although they provided Wireless Application Protocol (WAP) browsers, the pages were restricted to the operator's portal. Since most mobile operating systems at the time were closed and proprietary (including proprietary forks of Symbian, an OS used by multiple OEMs), there was no easy way to onboard a range of apps like GPS navigation, games etc. onto any device. The problem with this approach to business lay in its inability to capture value from crowd sourced innovation.

**Figure 9 : Timeline of some key Mobile OSes**



\*Only a few smartphone models were launched. This OS is still used in connected devices.

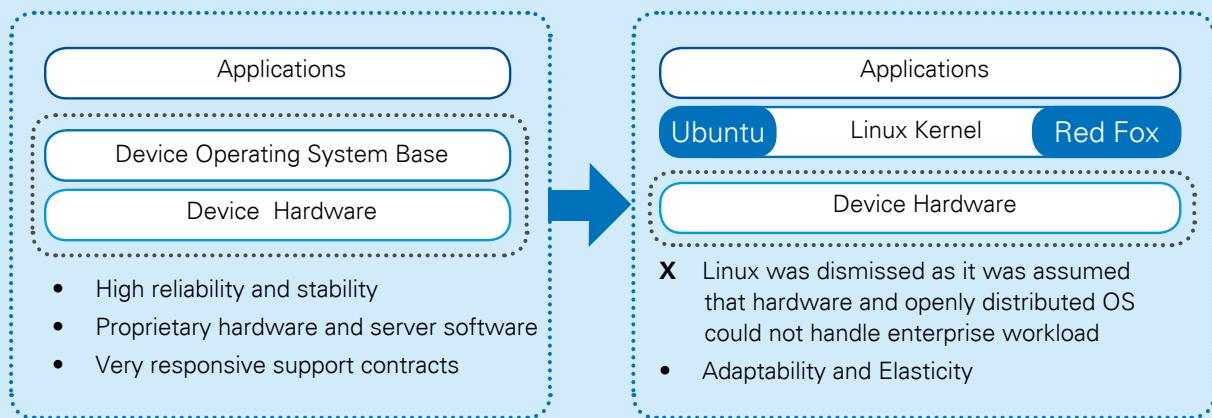
Source: KPMG Analysis

A free and open source movement started with the launch of Linux operating system and eventually led to the development of Android. The launch of Android open source platform (AOSP) in 2007 turned the tide away from walled garden software, ushering in an era of collaborative growth. It helped leverage the power of distributed innovation in sourcing

new ideas and expertise from a community of developers by making the OS available free of cost. This led to rapid evolution of the middleware layer, thereby freeing application vendors from the hassle of building apps from scratch. Reduced developmental costs due to a faster pace of innovation helped achieve cost effectiveness for businesses.

### The evolution of Open Source – The LINUX story

The history of open source software movement dates back to the evolution of Linux which was preceded by heavily guarded vertically integrated walled garden of hardware and software/ operating systems. Linux kernel was developed and distributed with the aim of opening the gates for innovation and collaboration.



Operating systems, traditionally tied to hardware, were making money from companies that relied on the stability of their core servers. Linux, however, adopted a decentralised developmental approach. It was developed as a kernel and the remainder of the operating system was developed around it by its vendors – Red Hat, Ubuntu etc. Linux has carried the open source story with it, serving as an icebreaker for thousands of other open source projects that would have failed to gain legitimacy on their own.

The evolution of an open source mobile operating system benefits all the stakeholders. Businesses achieve greater opportunity for monetisation and profitability while developers leverage collaborative growth to deliver value to consumers, who are spoilt for choice. Fragmentation of the operating system's code is one of the biggest challenges arising as a result

of an open source OS. As the basic stack is open, it is difficult to have a homogenous design with respect to both hardware and software. Managing security also becomes a concern in such an environment. Thus, the most crucial decision to make for the open OS administrator is to determine how much of the stack should be kept open.

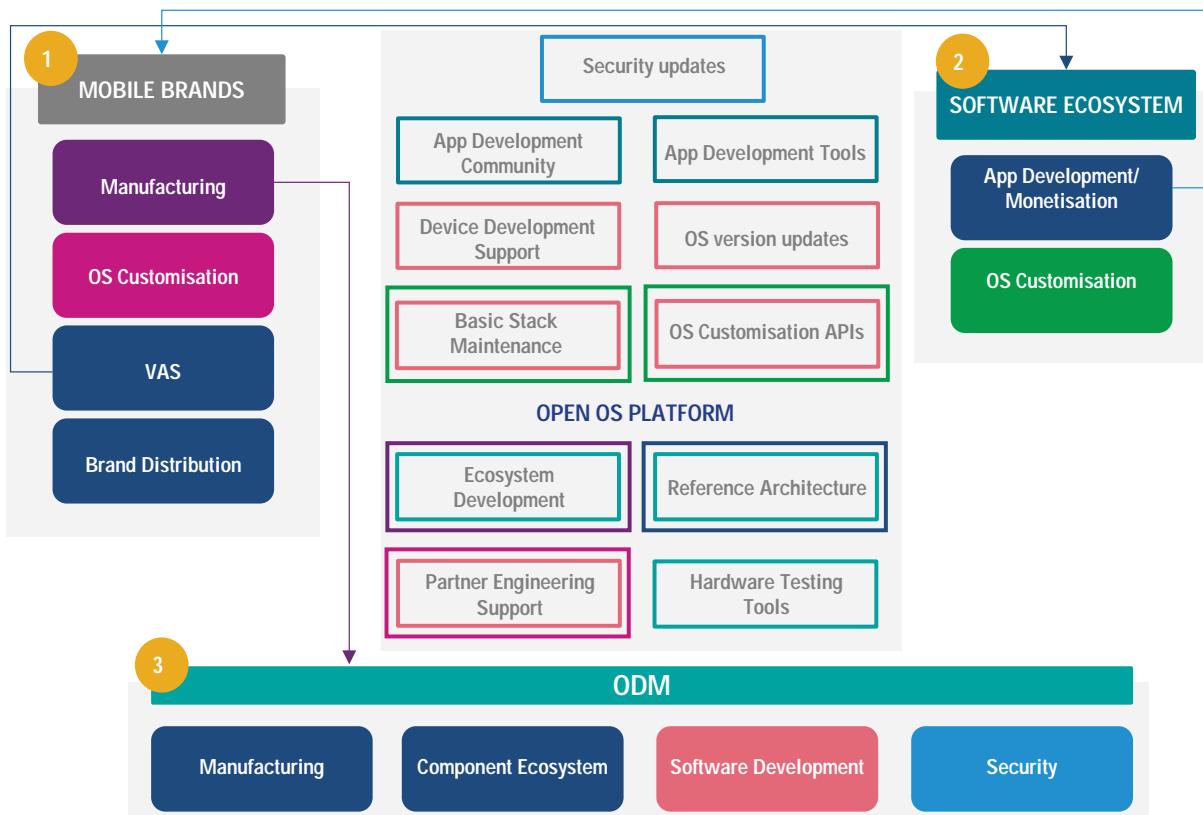
## Emergence of a Collaborative Ecosystem

The advent of open source operating system has promoted collaborative growth, giving rise to an entire ecosystem. This ecosystem comprises mobile brands, OEMs, ODMs and software developers who constantly interact with each other. The manufacturers interact with ODMs for updated hardware capabilities. The value added service providers interact with the software development ecosystem to figure out what additional functionalities can be offered on the handset. The software ecosystem relies on the mobile brands for its monetisation.

The open OS platform interacts with various stakeholders in this ecosystem to provide support (engineering and development), updates (version and security), reference architecture, test hardware compatibility as well as promote device development. It also maintains the basic stack and is central to the evolution of the ecosystem.

Android is the most prevalent open source operating system in the market today. It is free of cost and is available for download without any riders.

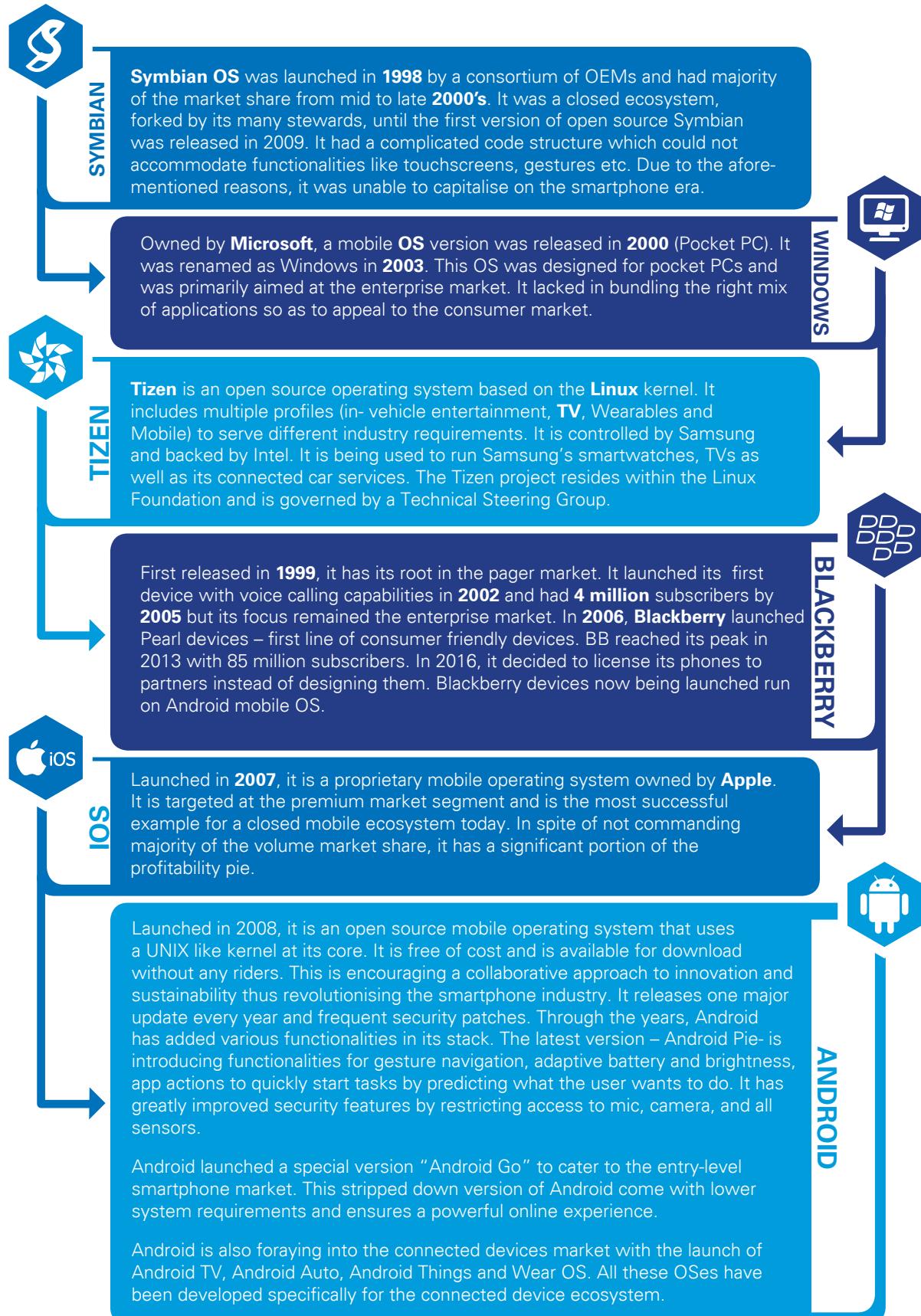
**Figure 10 :The interactions in an open source ecosystem**



Source: KPMG Analysis

1,2 & 3 in the figure are the stakeholder ecosystems (apart from consumers) interacting with the central operating system's platform. Each box within the open OS platform area in the figure, represents an activity carried out by the management of the said platform. Each of the three stakeholder ecosystems further comprise of components that interact with a) each other – represented by arrows; b) an activity being carried out by the management of the OS – represented by the colored boxes around each activity. The colour of the outline of the boxes in the center correspond to the colours of the component/sub-component in the ecosystem that the activity interacts with.

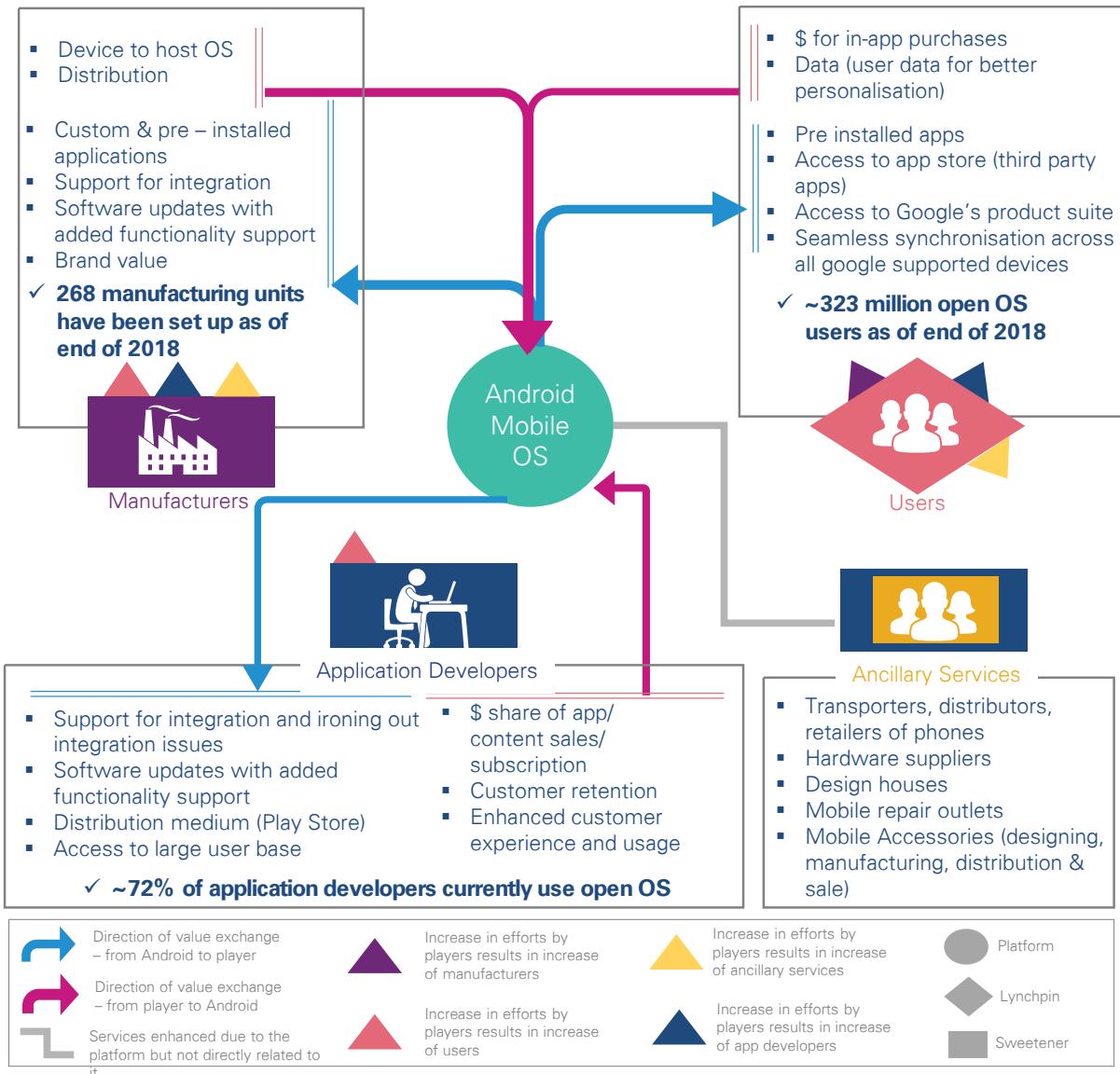
# Overview of some Key OSes



# Platform Business Model Map of Android Mobile OS

As an operating system at the center of an open ecosystem, Android mobile OS is a platform providing value to multiple stakeholders, enhancing the overall network benefits. Some of these benefits and value have been summarized below:

## Platform Business Model Map



- The Platform Business Model Map is an analytical and visualisation tool designed to identify all the critical parties in a multi-sided platform. It analyses where value creation and exchanges take place with the platform business and amongst the different stakeholders.
- A spike represents every other customer that is attracted by the player to the platform
- A sweetener provides no monetary value to the platform, but does provide value to other parties
- Lynchpin is the player that dictates the most power and attracts more customers than any other

Source: KPMG Analysis

# Customisation of Android by different brands

Android is a highly customisable operating system. Many OEMs create a “skin” to run on top of the Android operating system. This skin alters many aspects of the phone’s user interface (UI), from the menu design to the home screen shortcuts. Some changes are more aesthetic in nature while others go much deeper into the operating system.

**As of 2017, 72% of smartphone brands in India are customising Android OS<sup>10</sup>**

## Why OEMs Customise Android

### Differentiation



### User Retention



### Additional Services



### Push the envelope



## Some examples of customisations made by OEMs

### APPLICATIONS

Add OEM & carrier-branded pre-installed non-removable versions of apps - calendar apps, contacts apps, notes apps, and even the phone dialer.

E.g.. Samsung’s Health app, Xiaomi’s skin MIUI loads its own application in place of Google apps; OnePlus’s OxygenOS adds a unique text message app in place of Google’s standard app.



### DESIGN



Add custom icons, animations, fonts, HD wallpapers.

E.g. OnePlus gives users the ability to customise the color scheme of their devices in Oxygen OS. Some OEMs, like Xiaomi’s MIUI, offer full theme stores.

Blackberry is making changes to the Android kernel to provide the most secured version of Android.

### SETTINGS

Move the settings options around or even completely reformat the Settings app.

E.g. Samsung adds many of its own settings to its devices that sometimes supersede Android’s stock settings



### ADDITIONAL SERVICES



Add services like cloud services, “out of the box” features, integrated or supplemental security layers.

E.g. OnePlus’s Oxygen OS has an App locker that lets the user assign fingerprint entry into certain apps they want to keep private even if their phone screen is unlocked.

### NOTIFICATIONS

Change the way notifications come up on the screen.

Eg. Huawei skin’s (Emotion UI - EMUI) notification shade hides lock screen notifications once the user drops the shade, Xiaomi redesigns the drop-down notification bar in its MIUI.



## Open OS: Facilitating Complementary Innovations Beyond Handsets

As the ecosystem around open source mobile operating system develops, it is promoting an array of complimentary innovations. This is resulting in an increase in the number of application developers as well as giving rise to a host of connected devices, making IoT a conceivable reality.

### Application Developers

By achieving broad dissemination (of compatible devices), Android proved an attractive opportunity for developers to pursue. The ecosystem encourages innovative application development and leads to the formation of a community of developers who support each other. India is the second largest developer ecosystem in the world and is estimated to overtake the US by 2021<sup>11</sup>.

Mobile app design and development are essential components to almost every single business and individual today. The open ecosystem is thus furthering the era of technology startups in India. These startups span across verticals and functions ranging from game development to those leveraging artificial intelligence in

order to provide utility to the consumer. This proliferation of applications in the mobile universe is enhancing consumer experience, elevating it beyond the hardware specification of the device. The biggest boon for complimentary innovations has been the advent of curated app stores like Apple's "App Store" and Google's "Play Store". They have democratised the distribution of innovations to the consumers.

### Internet of Things (IoT)

The advent of open source OS is rapidly paving the way for more innovative IoT devices by forging greater uniformity, standardisation and the consequent decoupling of information from a particular physical device to include a host of such connected devices. The next decade is expected to give rise to a plethora of industries based on open-source concepts, such as information sharing and joint innovation. An intuitive network of connected devices is emerging as the next big wave. This has begun to impact diverse sectors, such as healthcare, education, transportation, government and financial services.

### Some Facts about the Indian App Industry



Source: App Annie 2017 Retrospective Report

### Some Facts about the IoT Industry

- Connected home device shipments are expected to grow at a CAGR of 67% over the next five years, faster than smartphones or tablets, and shipments are expected to cross 1.8 billion units by 2019<sup>12</sup>
- The global market for IoT in 2020 will be worth USD 373 billion in terms of revenue, with USD 194 billion and USD 179 billion stemming from hardware and software respectively<sup>13</sup> - India will account for at least USD 15 billion of this total revenue forecast<sup>13</sup>
- There were 60 million connected devices in India in 2017 – estimated to reach 1.9 billion units by 2020<sup>13</sup>
- Wearables constitute a major proportion of the connected device market - India's wearables market size touched USD 157 million in 2017<sup>14</sup>

Source: 11. Google; 12. BI Intelligence; 13. NASSCOM; 14. IDC

# Android OS moving beyond handsets

As technology advances, gadgets and wearables are enhancing the interconnected utility for mobile users. Machine-to-machine interactions are increasing as IoT connects our lives into one giant web of devices. This presents a new wave of opportunities for business to capitalise upon.



- Launched in 2014 as a successor to Google TV
- Most of the Android TV functions run on proprietary software not found on AOSP eg. Google First Time Install Wizard, GMS etc. It has to be licensed from Google
- As of May 2018, Android TV has 3,600 apps and games
- MyBox Technologies is working in collaboration with Google to develop Android TV based hybrid set-up boxes for the Indian masses
- A JBL Link Bar was released in May, 2018. This is a soundbar powered by Android TV with Google Assistant integrated
- Some of the brands that have launched Android TVs are Haier, Hisense, Nvidia, Philips, Sony, TCL, Westinghouse etc.



- Launched in 2014 as a voice-enabled platform for cars
- Android Auto is the platform for bringing mobile operating system to the car - essentially mirrors one's phone — with a special on-screen interface designed for the car to bring home screens, maps, music, communication, voice and applications on to the display in the car
- Mahindra & Mahindra, Maruti and Tata have tied up with Google to provide Android Auto based infotainment systems in its cars
- From May 2018, Android Auto is being directly built into the head units of Volvo
- By 2022, Android Auto is expected to be the exclusive in-dash operating system for millions of cars from the Renault-Nissan-Mitsubishi Alliance – they estimate to sell 14 million vehicles in 2022

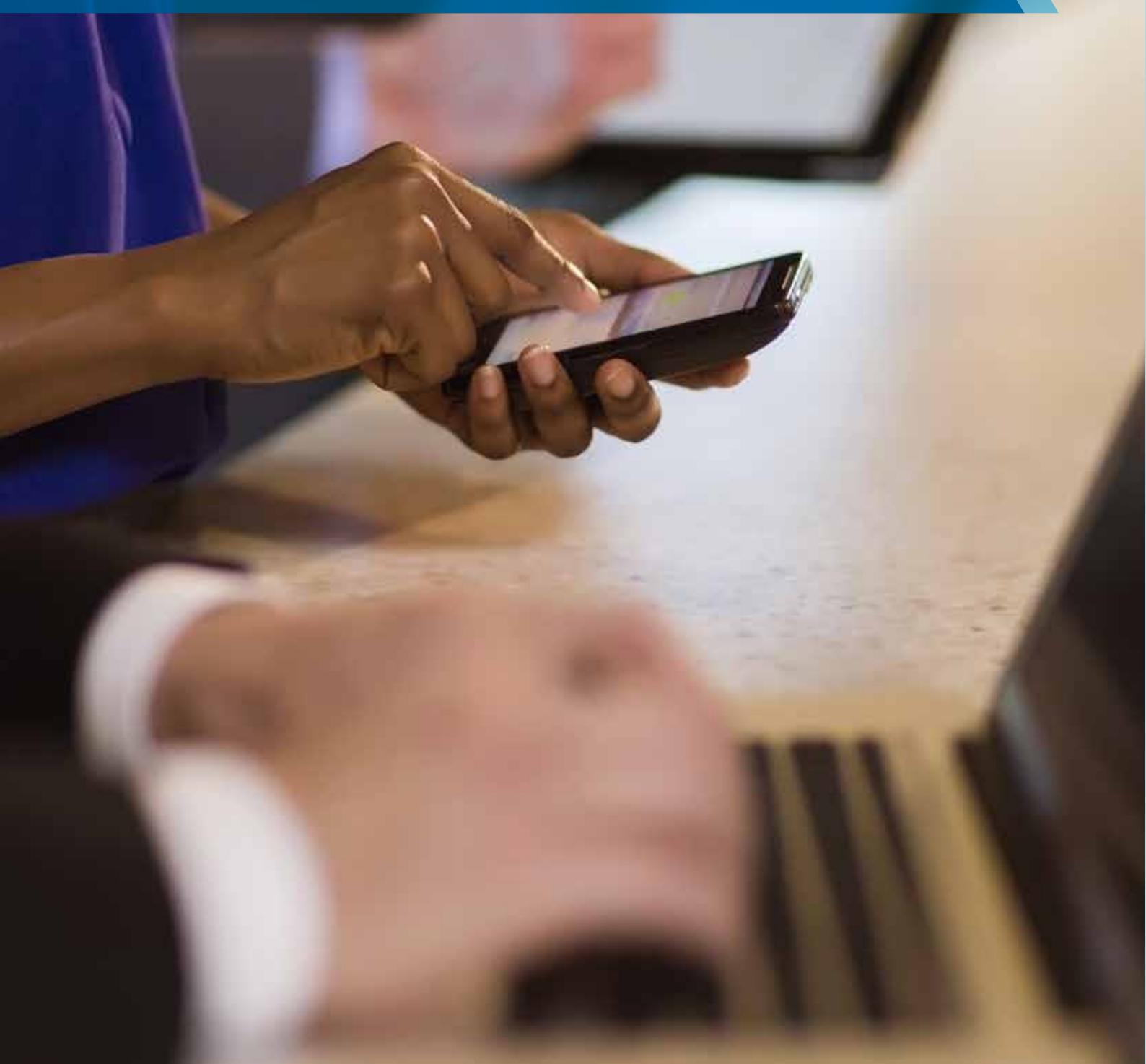


- Originally launched as Brillo in 2015 – rebranded as Android Things in 2016
- Stripped down version of Android OS designed to power light-weight devices eg. smart displays of kitchen appliances, connected speakers, smart thermostats etc.
- Works in the background, allowing smart devices to handle their own tasks as opposed to servers doing the processing
- Enables companies to ship IoT hardware more easily as Android Things uses the same developer tools as standard Android
- The first devices include speakers from LG and iHome, as well as smart displays from LG, Lenovo, and JBL



- Originally launched as Android Wear in 2014 – rebranded as Wear OS in 2018
- Stripped down version of Android OS designed for wearable devices and smartwatches
- Some of the key features include smart suggestions through Google Assistant with voice (if device has a built-in speaker or is connected via bluetooth), enabling control of smart devices at home with the Wear OS watch, better compatibility with non-Android devices
- Some brands using Wear OS are: Casio, Diesel, Emporio Armani, Fossil, Guess, Misfit, Michael Kors, Polar, Skagen, TAG Heuer

# Impact Assessment of Open OS Ecosystem



## Impact of Open OS Ecosystem

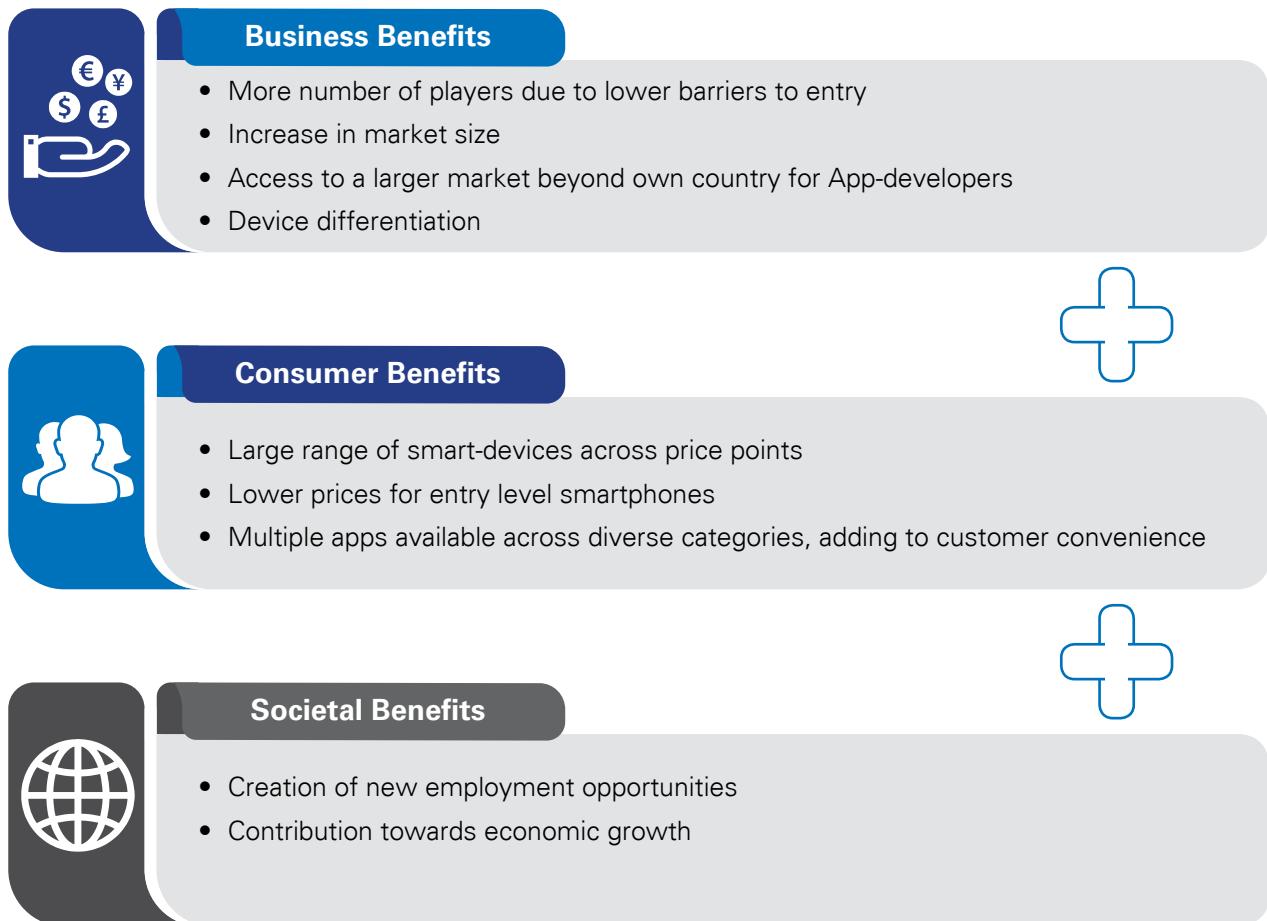
Over the last decade, the country saw the rise of a new trend that has encompassed day-to-day lives of Indian consumers. Development of a free open source OS available for download without any riders was a major driving force behind rising smartphone penetration, signaling the beginning of a digital boom in India. The impact of open OS can be categorised into three broad areas: Business, Consumer and Societal benefits.

The digital ecosystem is creating new business opportunities for players across the value chain by expanding the overall market. By achieving broad dissemination (of compatible devices), open OS has proved an attractive opportunity for developers to pursue.

Consumers are being introduced to a new way of connecting to the world. The resulting digital roadway is providing them with a large variety of apps useful in various aspects of life. Additionally, this new way of life comes with increased affordability and convenience for the consumers.

Open OS ecosystem is aiding the expansion of manufacturing landscape in the country by lowering the barriers to entry for OEMs and enhancing consumers' appetite for smart devices. It is also contributing to economic growth by creating new employment opportunities.

**Figure 11: Impact of Open OS Ecosystem**



Source: Industry Reports, KPMG Analysis

## Business Benefits

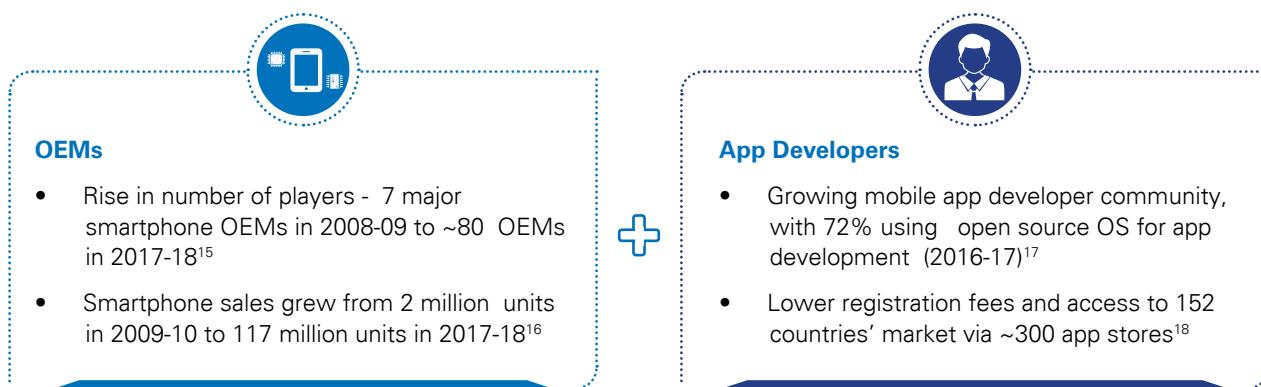
Emergence of open-source OS has positively impacted various industry players in the value chain, with OEMs and app development businesses being the primary beneficiaries. Reduction in developmental costs with respect to the time and resources needed along with simplification of future maintenance are the major benefits for OEMs. App developers are experiencing lower developmental costs and have access to a global audience thanks to the improved app distribution framework.

## OEMs

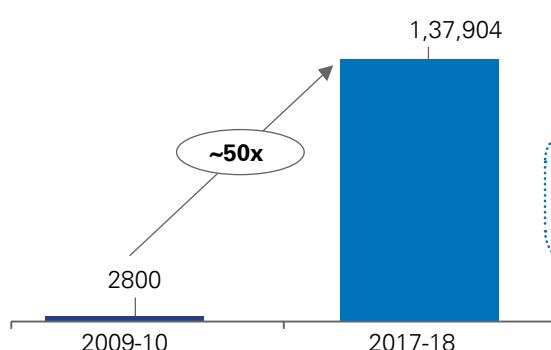
At the start of the OS revolution, there were 7 key OEMs selling smartphones in India as part of their product portfolio. By 2018, this number grew to ~80<sup>15</sup>. With a few exceptions, most of these OEMs predominantly have open OS-based smartphones in their portfolios.

The introduction of Android stack layer, has standardised the base on which OEMs, ODMs and app developers can work to easily develop their products. This standardised base has led to the elimination of high fragmentation costs. The absence of such a base might have led to a different scenario with considerably lesser number of players operating in the market.

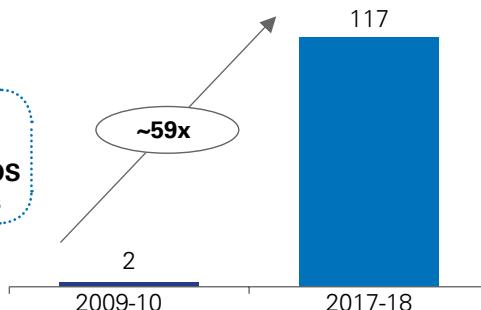
**Figure 12: Business Benefits of Open OS**



**Figure 13 a: Smartphone Value  
(in INR Crore)**



**Figure 13 b: Smartphone Volume sold  
(in Million units)**



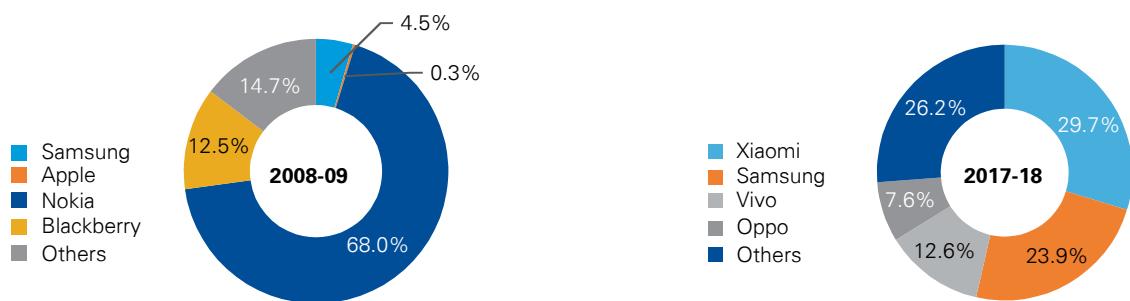
Source: 15. Bureau of Indian Standards; 16. ICEA; 17. India Mobile Talent Report by Belong.co; 18. Google Play Console Support, Business of Apps

Many global OEMs have identified India as one of the focal markets for smartphones. The rapidly increasing smartphone penetration in the country has led to a proportional increase in revenues for the OEMs.

Along with reduction in developmental efforts, open source OS community provides periodic updates of the reference architecture to the OEMs. This translates to lower maintenance requirements.

Lower costs for development and maintenance resulted in increased margins making the smartphone market lucrative. Thus over the past decade, many new OEMs have entered the space. These currently account for majority of the market share- 11 entrants now comprise ~75% of the smartphone units sold by the major players<sup>19</sup>.

**Figure 14: Market Share of Smartphone Units Sold**



Source: Euromonitor, KPMG Analysis

**Figure 15: Enterprise Cases for Android**



Many businesses are customizing the Android kernel to drive efficiency in their work flows. Some of the examples are mentioned below:



Food ordering mechanisms in some restaurants now uses customized versions of Android -

- Replace the use of paper and pen to digital devices to place orders
- The system synchronizes with a server computer in the kitchen order data being directly displayed on the LCD screen
- This reduces the level of errors that occur in the kitchen as well as streamlines the operations



Manufacturing industry is extensively using customized versions of Android to

- Measure Asset Performance
- Track Inventory
- Improve Inspection Process
- Manage Internal Equipment Service & Repair with Preventive Maintenance Schedules
- Support Dealers with a Streamlined Service Process

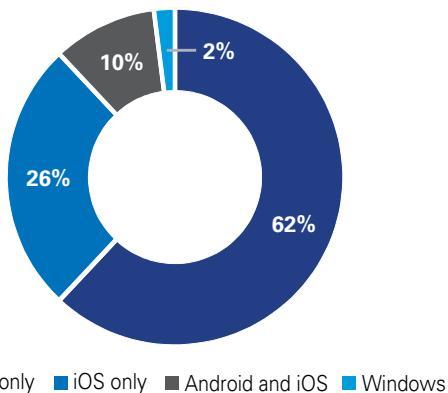
Source: 19. Euromonitor

## App Developers

Through open OS based developments with safeguards against fragmentation, the app-development community get access to consumer markets all around the world. They can now target more than 1 billion users worldwide. Through open OS based app distribution platforms, app-developers can reach consumers in 152 countries. Apart from Google play, they can reach out to consumers through approximately 300 other third party app stores as well<sup>20</sup>.

Access to such a large market for the app-developers means more demand for their products across various geographies resulting in increased monetisation opportunities.

**Figure 16: App-developer talent Pool Distribution (2016-17)**



Source: India Mobile Talent Report by Belong.co

Wider market reach, lower registration fees, better development support and relaxed norms for placing the app on the stores has led to more developers using the open source OS stack to develop their mobile applications.

As of 2017-18, 72% of estimated 1 million mobile app developers were using open OS as a base for their product development<sup>21</sup>.

App-developers have to pay a registration fee for placing their apps on a smartphone app store. While Android open source OS charges a one-time fee of USD 25 from the developer, the corresponding recurring fee charged by a closed mobile OS is USD 99 per annum<sup>22</sup>. This implies considerable savings for the app-developers who intend to place their app on the open source OS for an extended period; further there is no limit to the number of apps that they can introduce over a period of time.

The standardised open source OS base layer has increased the ease with which app developers can develop their products. Furthermore, there is no longer a need to replicate apps for different platforms. This allows them to focus on coming up with the right product rather than getting entangled in complex product designing technicalities.

There is a considerable differential in terms of time taken to port an app on an open OS versus that taken on a closed OS. It takes 1-2 hours to launch an app on an open source OS app-store whereas it takes 4-5 days to do so on a closed OS<sup>22</sup>.

These benefits have resulted in majority of the app-developing community using Android OS.

Google has made an active effort to promote quality apps in the past three-four years. They have set-up a dedicated BD team as part of their 'Developer Outreach Program'. Under this program, app developers are provided full support by Google, not only till the time the app goes fully live, but also post that.

Source: 20. Google Play Console Support, Business of Apps; 21. Press Releases, India Mobile Report by Belong.com 2017; 22. Industry Interactions by KPMG in India

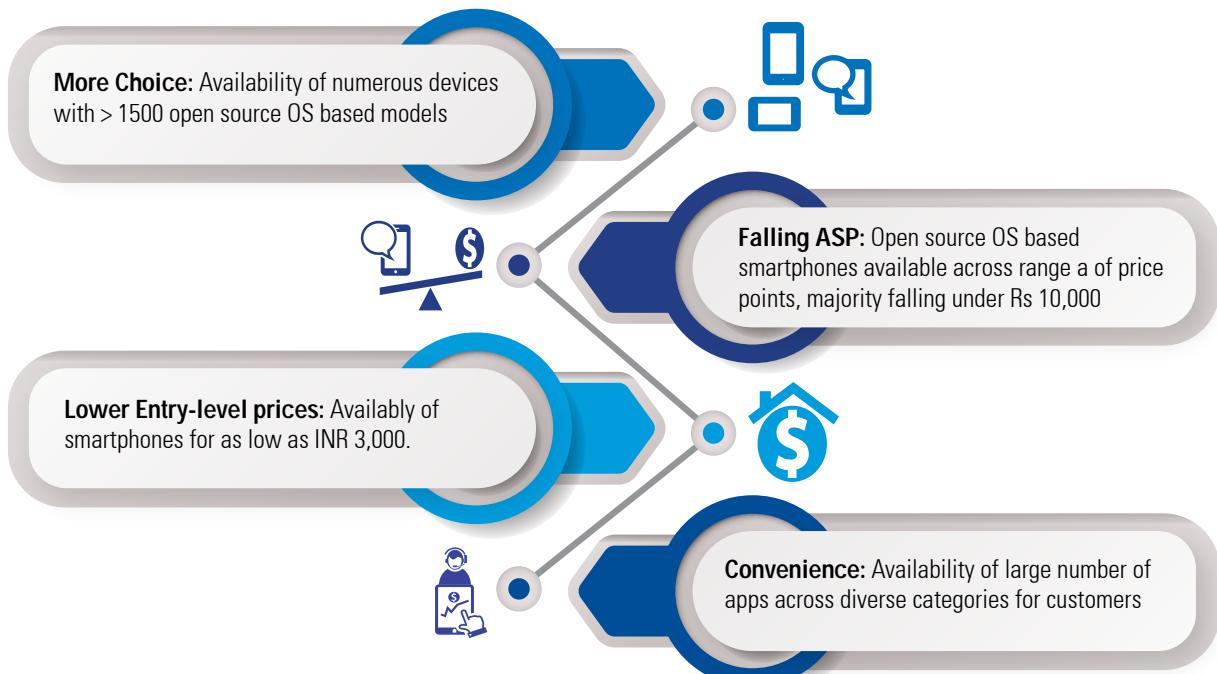
## Consumer Benefits

Apart from business benefits, the open OS ecosystem has resulted in many consumer benefits in a digitally connected society. With the entry of multiple players in the market, Indian consumers have access to a huge variety of smartphones to choose from. Adding to this, the sharp drop in the costs associated with open OS are passed on to the consumers, leading to increased affordability.

Simultaneously, a large number of multi-feature apps have emerged across diverse categories, adding to customer convenience and enhancing user experience.

A decade ago, mobile was just a device to make/receive calls and exchange text messages. Today, a standard mobile can support a range of features varying from messaging, internet access, wireless communications in the short range (Bluetooth, Wi-Fi) to business applications, photography, gaming and videography. With intensifying competition in the smartphone market, players are continuously experimenting with novel technologies to pack phones with an ever increasing array of impressive features.

**Figure 17: Consumer Benefits of Open OS**



Source: Euromonitor, KPMG Analysis

## Affordability of Smart Phones

With each passing year, smartphone screens are being amplified to higher resolutions, cameras are being improved to higher pixel densities, internal storage capabilities are getting enhanced while processing power is fast approaching that of PCs and laptops.

Apart from their utility, smartphones have become a style statement for today's generation. Manufacturers are paying close attention to details in order to come up with sleeker appearances. The smartphone revolution has already integrated almost all the features that were once done by other digital gadgets (including computers and cameras) into today's mobile phones.

The availability of an array of choices in smartphones can be attributed to the consistency of the OS code across these devices.

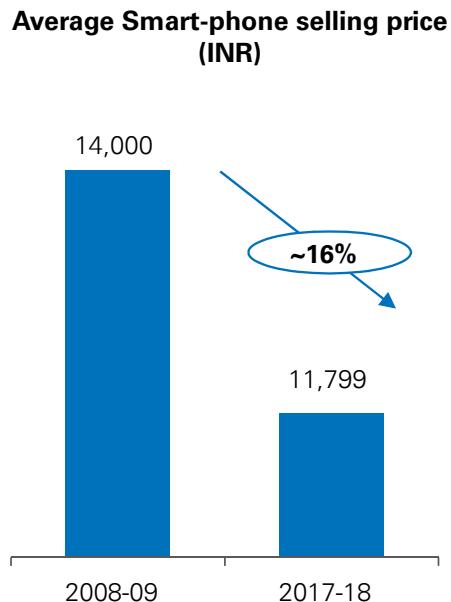
This has shifted the focus of OEMs towards catering to different consumer segments by experimenting with new features instead of individually developing complex OSes.

In 2010, the cost of an entry level basic smartphone was as high as INR 12,000. Today an entry level smartphone is available at INR 1,400 and comes loaded with multimedia features such as messaging, social media, video entertainment, etc<sup>23</sup>.

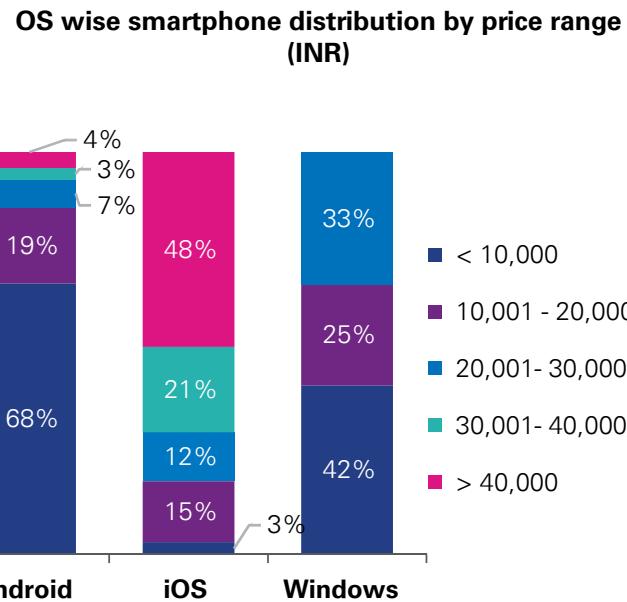
Furthermore, the country has witnessed a consistent fall in average retail selling price of smart-phones over the past decade. Lower development cost has enabled more OEMs to manufacture smartphones and leverage the economies of scale which in turn is resulting in lower priced phones being more readily available.

Amongst available Android based smartphone models, ~70% lie in the sub INR 10,000 category<sup>24</sup>.

**Figure 18: Smartphone Prices**



Source: ICEA, KPMG Analysis



Source: Pricebaba.com, KPMG Analysis

Source: 23. Press Release, KPMG Analysis; 24. Pricebaba.com, KPMG Analysis

## Access to a large variety of Apps

Since its advent, the open source OS has reached all corners of the globe. This opportunity was well-perceived by the app-development community and thus the demand for good-quality apps has been well supplemented by developers.

An extensive universe of apps is available for Android consumers and this is one of the major reasons why consumers prefer Android based smartphones. Google's app-store, called 'Play Store', gives consumers access to millions of free apps.

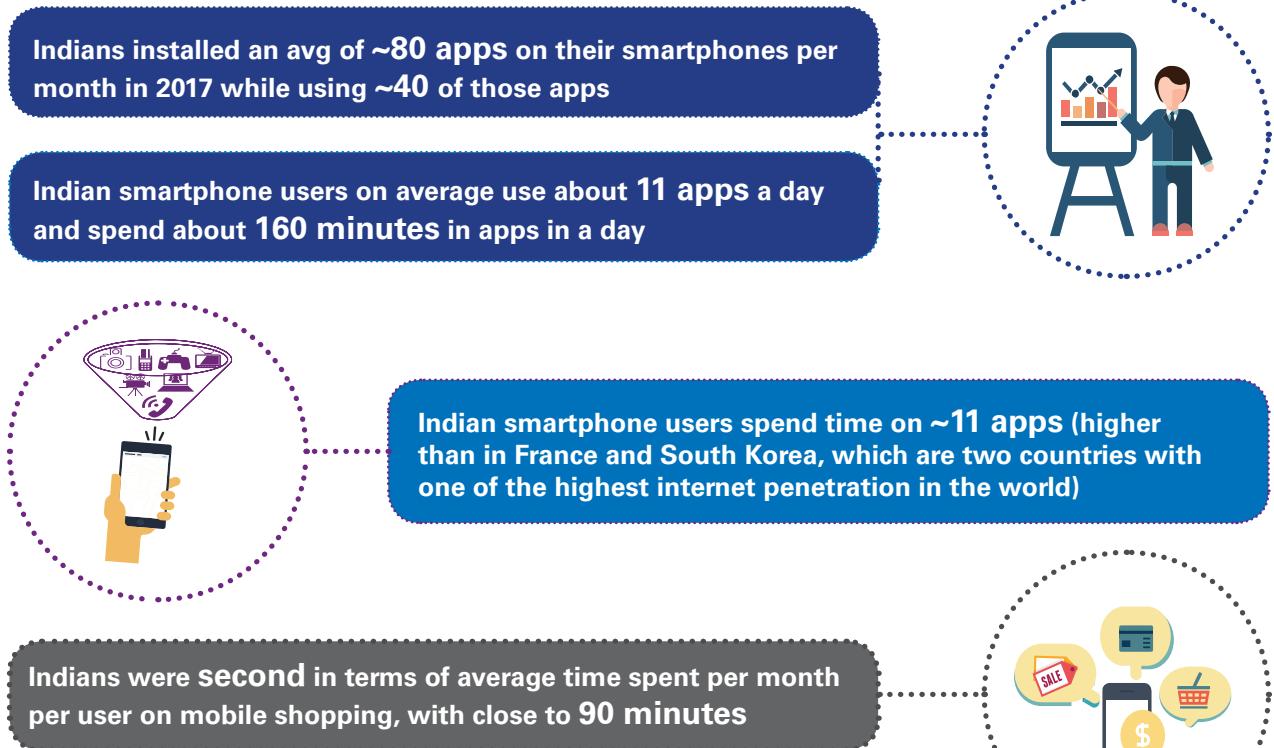
Google also provides a suite of in-built apps under 'Google Mobile Services'. These include basic apps such as Google Search, Gmail, Calendar, internet browser, etc. OEMs are issued licenses to make this suite available on their handsets. This, however is only done after ensuring its compatibility with their devices. The readily available suite of apps has enhanced customer convenience.

In Q1 2016, Indian consumers spent 2.5 times more time on apps as compared to that in Q1 2014<sup>25</sup>. Indian smartphone users spent ~119 minutes on apps in a day in Q1 of 2015. This went up marginally to about 122 minutes in Q1 2016. The time spent by Indian smartphone users on apps in a day in Q1 2017, has significantly risen to 160 minutes in a day<sup>25</sup>.

The trend of video streaming apps has also been on the rise, with a sharp growth in revenue. The period between 2016 and 2015 saw 600% rise in total time spent on top 10 video streaming apps<sup>25</sup>. This indicates that the Indian consumer is taking full advantage of the app universe.

With the expansion of the app-development community, developers are trying their best to give consumers access to better features and provide them with more than just utility services. As a result, consumers now have an array of best in class apps in varied categories to choose from.

**Figure 19: Some Facts about App Usage in India**



Source: App Annie 2017 Retrospective Report

Source: 25. AppAnnie Retrospective report 2017

## Societal Benefits

Open source OS is contributing to socio-economic benefits as well. Increasing smartphone penetration has contributed to job creation, with domestic manufacturing and app development being key contributors for employment generation. This is facilitating economic growth as well.

A boost in the operations of all players across the mobile phone ecosystem including OEMs, app-developers, telecom operators and other indirect actors involved at the point of sale throughout the country, has positively impacted the supply side of the economy.

**Figure 20: Societal Benefits Associated with Open OS**

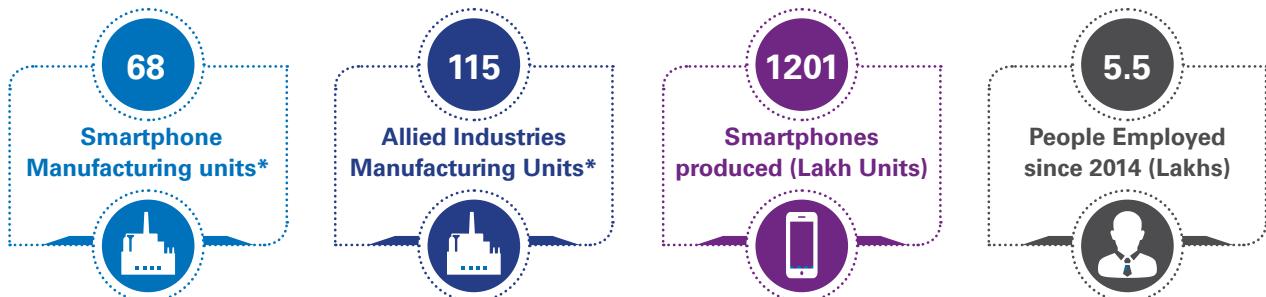


### Employment Generation

The proliferation of smartphones combined with the GoI's Phased Manufacturing Program and lower labor costs is driving OEMs to manufacture smartphones domestically. In 2017, 82%<sup>27</sup> of the

mobile phones were manufactured domestically. The smartphone manufacturing landscape has significantly contributed towards employment generation in the country.

**Figure 21: Contribution of Open OS ecosystem to device manufacturing (2017-18)**



Source: ICEA, KPMG Analysis

Smartphones are estimated to account for 54% of the total 225 million units of mobiles manufactured in India in 2017<sup>27</sup>. Assuming uniform distribution, this implies that at least 115 OEM and allied units\* are engaged in smartphone production, leading to creation

of 5.5 lakh jobs (out of 6.7 lakh total jobs due to production of mobile phones in India)<sup>27</sup>. The number of people employed in the manufacturing sector is expected to increase with India targeting to enhance proportion of localisation in manufacturing through Government intervention.

\*These are not unique factories but a split of the total number of units operational (342) in 268 unique factories

Due to proliferation of smartphones supported by the growing open OS ecosystem, the app-development community has also prospered. This is adding to the employment generation in the country. Due to lower cost of development as compared to that in other geographies such as America and Europe, the app development community is a major attraction for global organisations. There is a sizable freelancing pool of app developers based out of India.

### Economic Growth

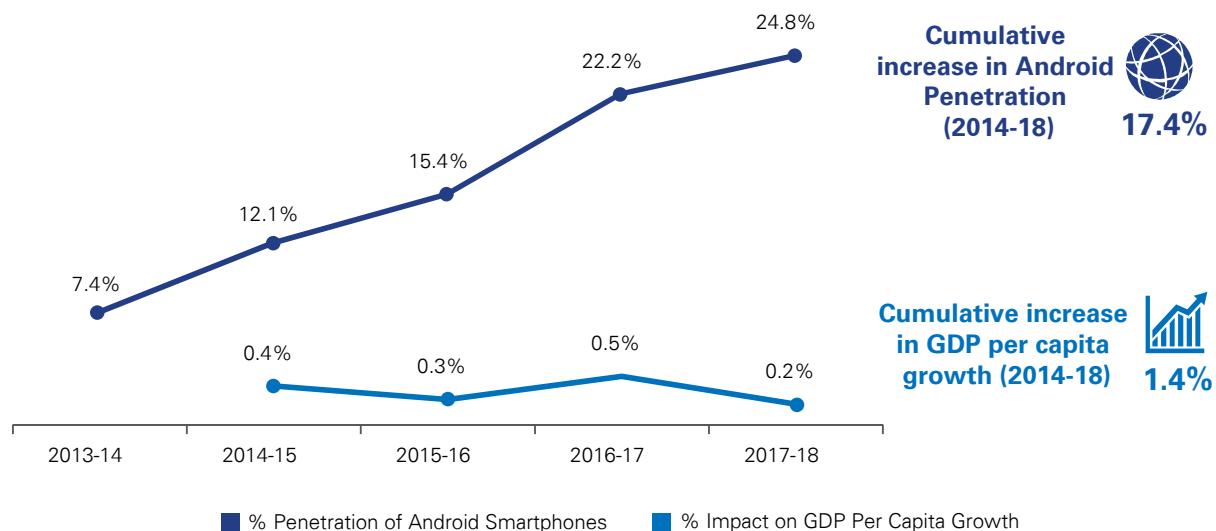
A study by World Bank indicates that with every 10% increase in mobile penetration, the GDP per capita growth increases by 0.8% for an emerging economy.

This is due to the cumulative positive impact to demand as well as supply side of the economy. The supply side is positively affected by greater value addition on part of manufacturers, app-developers and other players involved across

the value chain. Boost to mobile telephony has enhanced productivity and efficiency of the workforce by increasing ease of access to information, reduction in travel time and associated costs. This is leading to enhanced business productivity.



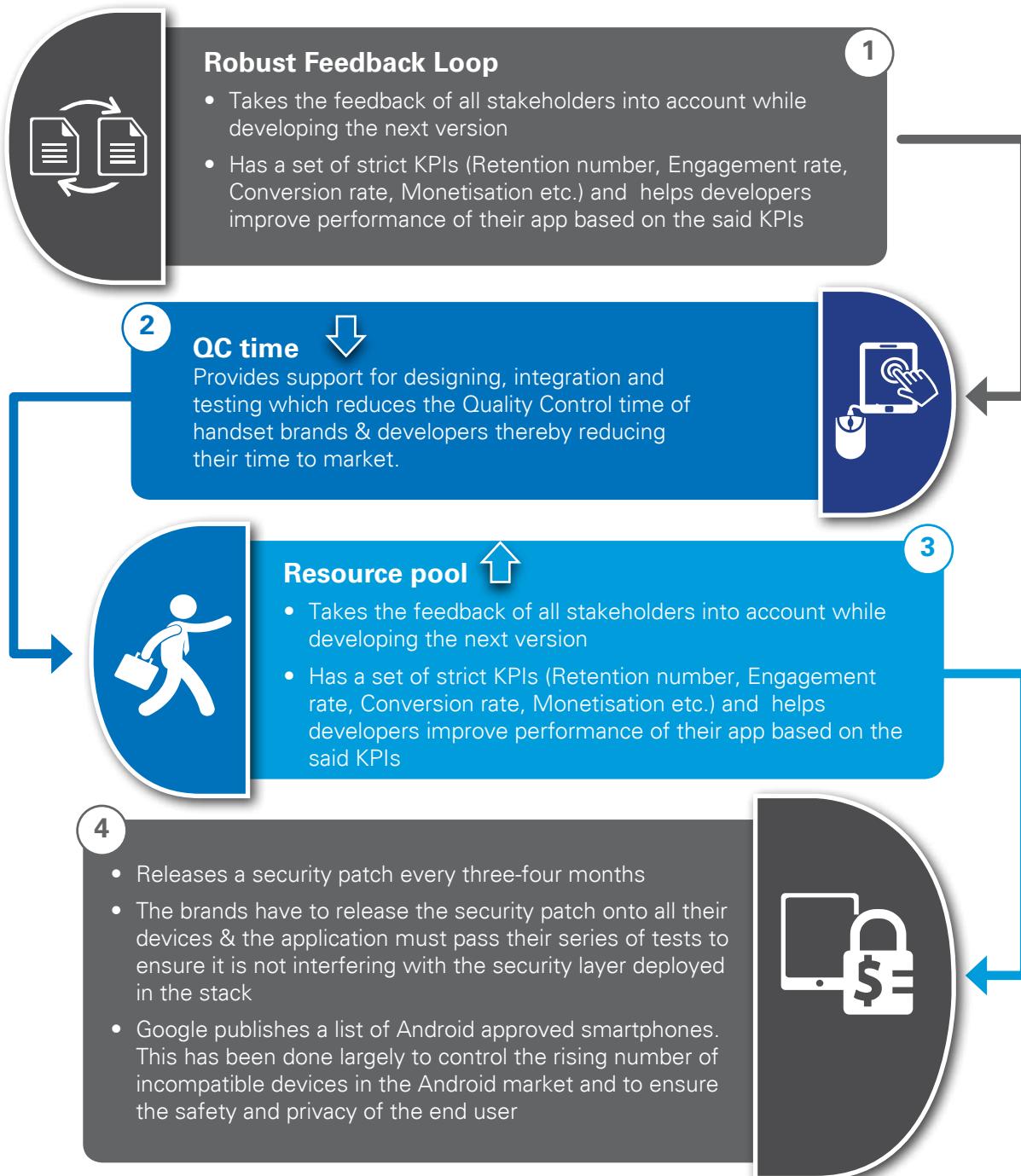
**Figure 22: Impact of Open OS Smartphone Penetration in last 5 years**



Source: World Bank Report, KPMG Analysis, Emarketer

# Benefits of using open OS for OEMs and developer community

Prior to 2008 all mobile carriers had developed their own 'vertically integrated walled gardens' of services, devices and applications. Android revolutionised this value chain by distributing the control amongst all stakeholders. Since the inception of Android, Google has taken many steps to continually evolve and maintain the ecosystem by promoting collaborative growth.



Source: Industry interactions by KPMG in India, KPMG Analysis

# Some examples of Success Stories from India

Emergence of the open OS ecosystem has presented unprecedented growth opportunities for Indian companies. Government of India is also leveraging the ecosystem to further its aim of Digital India by promoting mobile governance via apps.

1

## An Indian App Developer's foray into the Global Gaming App Market: NukeBox Technologies

- Mobile game development studio focusing on developing and publishing innovative, original and high-quality games for a global audience
- Decided to focus on producing its own games after working on ~ 200 games in a work-for-hire capacity - the idea for **Food Truck Chef** was conceived
  - Downloaded 4.7 million times in 100 days (recording USD1.3 million in revenue). The number of downloads was **~16 million** by Sept 2018
  - Became the No.1 Android casual game in 40 countries; chosen as "**Best of 2017**" and "**Awesome Game Made In India**" by the Google Play store
  - Made it to the **Top 100 Grossing Charts in more than 100 countries** on the App Store and Google Play

2

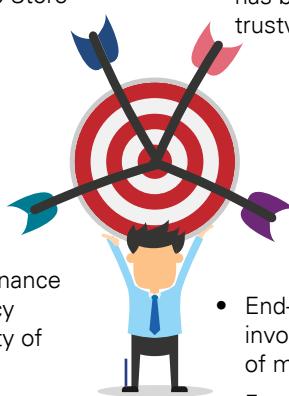
## Domestic brand achieving Manufacturing Excellence - Lava

- Launched in 2009, LAVA's topline and bottomline have witnessed a CAGR of 90% since inception
- It crossed the USD1 billion mark in revenues in 2015-16 – has witnessed an overall smartphone sales growth of 248% over the last 5 years
- The share of smartphones in its domestic sales mix (value wise) has increased from 17% in 2012-13 to 57% during the first nine months of 2017-18
- Lava is now selling in some 14-15 countries of SAARC, Middle East and Africa. Exports are about 40 percent of business
- According to CyberMedia Research's (CMR) "Retail Sentiment Index 2018", the three key parameters for channel partners were sell-out schemes, timely payout and transparency in dealings - Domestic smartphone maker Lava has been ranked first by the Indian retailers on trustworthiness as well as timely payouts

3

## Leveraging Technology to Empower Citizens: Government of India

- Aiming to move from paper based governance to m-governance to increase transparency and efficiency by leveraging the popularity of smartphones and mobile internet
- Apps were first developed on the Android platform to avail cost benefits of open OS and make use of its high captive base
- UMANG app launched in Nov 2017 as a one stop shop for all the key government services - 7.8 million downloads; 90% are on Android based devices
- BHIM app launched in Dec 2016 to enable fast, secure, reliable cashless payments through mobile phones – over 33 million downloads; more than 90% are on Android based devices
- Other apps like IRCTC, mPassport seva, cVigil etc. have also been launched



4

## An Indian OEM manufacturing Blackberry Devices : Optiemus Infracom

- End-to-end telecom ecosystem company - involved in manufacturing, retail, and distribution of mobile handsets in India since 1997
- Formed a JV with Wistron in 2015, to set up telecom manufacturing facilities. Currently has 2 factories with 21 assembly lines employing 1600 people
- 100% of smartphones produced are Android phones
- Inked the **license to design, manufacture and distribute BB devices** (using secure Android versions) in the Indian subcontinent in Feb 2017

Source: KPMG Analysis, Industry Interactions by KPMG in India

Source: Industry interactions by KPMG in India, NPCI, Venturebeat



# Alignment of Open OS with key national priorities

Digital technology based smart devices (like smartphones & wearables) have emerged as catalysts for rapid economic growth and consumer empowerment all across the globe. Open source operating ecosystem is providing additional impetus to Government of India's key initiatives such as Make-in-India, Digital India, Startup India and Skill India. It has fostered the growth of a large ecosystem comprising consumers, manufacturers and developers.

### Make in India

Make in India is a major national program of the Government of India, designed to facilitate investment, foster innovation, enhance skill development, protect intellectual property and build best in class manufacturing infrastructure in the country. The primary objective of this initiative is to attract investments from all across the globe and strengthen India's manufacturing sector.

Open source operating system has enabled both EMSes and OEMs to optimise and

enhance product design to accommodate higher processing flexibility thereby streamlining the manufacturing process.

Thus, a host of domestic and international OEMs have made an entry into the Indian mobile phone market over the past five years. This has been facilitated by lower barriers to entry made possible by an open OS, and a growing demand for smartphones. Favorable government policies have also provided a positive push to the mobile phone manufacturing landscape in India.

In 2017, 82%<sup>28</sup> of mobile phones sold in India were manufactured domestically. This has been made possible largely due to the implementation of the Phased Manufacturing Program (PMP), under which differential import tariffs are being imposed on mobile phone components in stages. It is estimated that, with the increase in local manufacturing, India's production will exceed its domestic demand by 2020<sup>28</sup>. Along with promoting manufacturing in India for domestic consumption.

**Table: Current & Upcoming Investments in Mobile Manufacturing (INR Crore)**

Activity	Companies	Investment	Time Period
Product Assembly & Packaging	<ul style="list-style-type: none"> <li>• Gionee</li> <li>• Xiaomi</li> <li>• Videocon</li> <li>• Jivi Mobile</li> </ul>	INR 1,250 Crore	2016 – 2019
Board Processing, Product Assembly & Packaging	Lava	INR 2,615 Crore	2016 – 2022
Manufacturing of Display Fab	Foxconn	INR 34,000 Crore	2018 – Not Specified
Board Processing, Product Assembly & Packaging	Samsung	INR 5,000 Crore	2018 – 2020
Product Assembly & Packaging	Comio Intex	INR 1,150 Crore	2018 – 2019
R&D	iVoomi	INR 250 Crore	2018 - 2019

Source: KPMG Research, Frost and Sullivan

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Source: 28. ICEA

In FY17-18, PMP covered the domestic production of mechanical components, die cut parts, microphones and receivers, key pads and USB cables. In FY18-19, it will also include printed circuit board assemblies, camera modules and connectors.

PMP is incentivising local sourcing of components as well as setting up of SMT lines thus increasing domestic value addition in the mobile handset manufacturing value chain from 5% to 15%<sup>29</sup>.

This increase is due to the localisation of PCB assembly in addition to mobile phone assembly. It is estimated that due to the mobile components localisation as per PMP, domestic value addition will increase up to 45% in the next three to four years<sup>29</sup>.

The growing mobile ecosystem is also giving a push to manufacturing facilities for allied industries such as accessories, handset covers,

chargers, screen guards, etc. Manufacturing units for mobile handsets & allied industries have increased from 3 in 2014 to 268 in 2018<sup>30</sup>.

In 2017-18, 225 million handsets, including 120 smartphone units<sup>30</sup>, were assembled and/or manufactured in India.

The domestic manufacturing of smartphones is expected to grow at a CAGR of 48.4% between 2017 and 2025<sup>31</sup>. India is also expected to surpass China as the preferred destination for manufacturing of mobile handsets in the not-so-distant future.

India is expected to produce 520 million phones by the end of 2019 which would require about 170 SMT lines<sup>30</sup>. By 2025, it is expected that India will produce 1.2 billion phones. This translates into about 415 SMT lines<sup>30</sup>. From 2014, approximately 5.5 lakh<sup>30</sup> jobs have been created by virtue of smartphone manufacturing/ assembly in India. This is estimated to go up to 18-20 lakh jobs by 2025<sup>30</sup>.

**Figure 23 : Domestic Handset Production (2017-2018)**



- In 2018-19, a total of INR 1.65 lakh crore worth of handsets is estimated to be sold in India - approximately 30% growth<sup>30</sup>
- Estimated manufacturing of mobile phones in India by 2025 – 1,250 million handsets<sup>30</sup>

Source: ICEA, KPMG Analysis

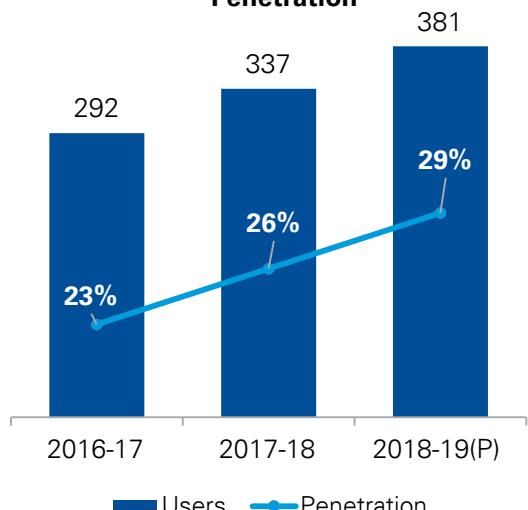
Source: 29. Industry interactions by KPMG in India; 30. ICEA; 31. Frost & Sullivan

## Digital India

Digital India was launched in July 2015 by Government of India to empower every citizen with access to digital services, knowledge and information. This campaign aims to connect rural areas with high-speed internet network and improve digital literacy across India. Smartphones have emerged as a convenient one-stop destination for every mode of communication that technology can put forward. These have thus played a key role in bringing India onto a digital platform, ensuring the campaign's last mile reach. Through its multiple offerings such as camera, calculator, fitness measurement, and more, it has become an intrinsic part of everyday life. On the back of open OS, Smartphone penetration increased from 0.3% in 2009-10<sup>32</sup> to 26% in 2017-18<sup>33</sup>.

Further, India is a linguistically diverse country with as many as 22 official languages and over 1600 spoken dialects<sup>34</sup>.

**Figure 24: Smartphone users (in million) & Penetration**



Source: Emarketer, Industry Interactions by KPMG in India

Majority of Indians use indigenous languages as their first language and this number is growing.

In line with this trend, the number of users accessing internet in local Indian language reached 234 million by the end of 2016, surpassing those that do so in English. This number has grown at a CAGR of 41% between 2011 and 2016<sup>34</sup>.

More and more people are consuming content in their own language. Growing smartphone penetration is also driving the demand for handsets having better compatibility with local languages with respect to messaging, curated content, voice assistant etc.

As per a GoI mandate, all mobile handsets sold in India will need to support message readability in all 22 official languages and input text in at least three languages- Hindi, English and one regional language<sup>35</sup>. This has come into effect from May 2018. Furthermore, as the number of mobile internet users in smaller cities and rural India increases, the role of indigenous languages in smartphones and mobile apps is expected to gain more significance.

The modifiable stack of open OS is a key factor enabling the integration of local language capabilities in smartphones. Smartphone vendors such as Micromax, Karbon, Intex, etc. have also partnered with Indus OS- an Android stack based regional OS player- to cater to regional language speakers. E.g. LAVA produced ~30 lakh open OS smartphones with indigenous capabilities in Q2 2018, supporting 22 official languages<sup>35</sup>.

Smartphones are also bridging the rural urban divide. By enabling access to previously unavailable information and remote facilities, smartphones are emerging as an instrument for empowerment in rural India.

Source: 32. Research Gate; 33. Emarketer; 34. KPMG-Google Report- Indian Languages-Defining India's Internet 2017; 35. ICEA

As the urban market gradually reaches saturation, rural geographies are increasingly becoming more important for brands for ensuring growth and traction. Owing to increased adoption and better affordability, 2017 recorded 109 million smartphone users in rural India<sup>36</sup>. Rural India is estimated to account for 60%<sup>37</sup> of the new mobile subscriber growth in 2018.

With entry level prices for smartphones as low as INR 1,400, residents of tier II, tier III cities and villages can afford devices packed with features for communication, social media and entertainment.

With data connectivity spreading to remote areas in India, smartphones are providing access to essential services such as healthcare, agricultural tools, financial services and education thus furthering GoI's objective of digital inclusion.

Through apps such as Microlekha (a microfinance lending platform), Srijan (a platform for providing information about crops), OpAsha (a TB detection App), etc., the rural population has gained convenient access to smart agriculture tools as well as better healthcare facilities, bringing them closer towards inclusion<sup>38</sup>.



### Smartphones: Fostering inclusion by bridging the Rural-Urban divide

AGRICULTURE	Current State	Potential Useful Services	Benefits/ Use Cases
 <ul style="list-style-type: none"> <li>• Studies indicate that <b>weather parameters have up to 67%</b> impact on variance in crop production</li> <li>• <b>47% of Indian farm land still relies on monsoon rains</b>, leaving farmers vulnerable to unpredictable or changing weather patterns</li> </ul>	<b>Current State</b> <ul style="list-style-type: none"> <li>• Studies indicate that <b>weather parameters have up to 67%</b> impact on variance in crop production</li> <li>• <b>47% of Indian farm land still relies on monsoon rains</b>, leaving farmers vulnerable to unpredictable or changing weather patterns</li> </ul>	<b>Potential Useful Services</b> <ul style="list-style-type: none"> <li>• Crop Insurance</li> <li>• Digitisation of Land Records</li> <li>• Access to Financial Services</li> <li>• Information on agricultural policies</li> </ul>	<b>Benefits/ Use Cases</b> <ul style="list-style-type: none"> <li>• <b>Product:</b> Launched in 2007, RML Farmer – Krishi Mitr a.k.a. Farmbee- provides <b>information service covering farming advice, weather forecasts and market prices</b></li> <li>• <b>Impact:</b> Average 5-15% increase in income for farmers using RML services</li> <li>• <b>Coverage:</b> RML covers more than 70% of the farming population across 17 Indian states</li> </ul>

Source: Journal of Climatology & Weather Forecasting 2017, Vodafone Connect Farmers Report 2015

## Smartphones: Fostering inclusion by bridging the rural urban divide

BANKING	Current State	Potential Useful Services	Benefits/ Use Cases
	<ul style="list-style-type: none"> <li>Only ~1/3 of India's rural population has a bank account and <b>only 8% have taken a formal loan</b></li> <li>For a population of approximately 1.3 billion, there are only <b>1,55,000 bank branches and 2,00,000 ATM i.e. millions</b> of people in India have limited access to banking services</li> </ul>	<ul style="list-style-type: none"> <li>Banking services closer to home</li> <li>Information related to loans and insurance</li> <li>Easily accessible financial products and services</li> </ul>	<ul style="list-style-type: none"> <li><b>Product:</b> Launched in 2010, <b>MoneyOnMobile</b> offers facilities for money transfer, MOM ATM, MOM Cart, DTH recharge and Bill payments through their app or SMS based services in rural India</li> <li><b>Impact:</b> As of July 2018, MOM is facilitating monthly transactions of approx. <b>INR 7 Crore</b> through its network</li> </ul>

Source: Inc42.com-MoneyonMobile putting its on underserved rural India

HEALTHCARE	Current State	Potential Useful Services	Benefits/ Use Cases
	<ul style="list-style-type: none"> <li>India has the highest number of <b>TB patients</b></li> <li><b>In 2016, 2.79 million of new TB incidences were reported i.e. 211 cases per 100,000 population</b></li> <li><b>It is estimated that 40% of the Indian population is infected with TB bacteria</b></li> </ul>	<ul style="list-style-type: none"> <li>Remote tele-consultations</li> <li>Health-related information through mobile phones/ village kiosks</li> </ul>	<ul style="list-style-type: none"> <li><b>Product:</b> Launched in 2013, <b>OpAsha app identifies and diagnoses TB in a patient</b></li> <li>The app asks the user a set of questions based on which a health worker enters contact details of the suspected TB patient</li> <li><b>Impact:</b> The app has successfully identified more than <b>7000 TB patients in multiple locations</b></li> </ul>

Source: Ruralmarketing.com

EDUCATION	Current State	Potential Useful Services	Benefits/ Use Cases
	<ul style="list-style-type: none"> <li>Teacher pupil ratio for secondary sections i.e. IX-X, stands at <b>1:27</b> and average annual drop-out rate for the same sections is <b>17.86%</b></li> <li>Limited availability of <b>quality education and uncertainty of employment</b> after completion of formal education are key factors for high drop-out rates</li> </ul>	<ul style="list-style-type: none"> <li>Remote tuitions</li> <li>Vocational training courses</li> <li>Skill development and placement assistance</li> </ul>	<ul style="list-style-type: none"> <li><b>Product:</b> BYJU'S is a learning for school students. The app offers comprehensive learning programs in Mathematics and Science for students between classes 4<sup>th</sup>-12<sup>th</sup></li> <li><b>Impact:</b> <b>16 million registered students</b> on its platform. Students are attracted to online education on account of affordability and flexibility with respect to commencement dates and study schedules</li> </ul>

Source: KPMG Report-Online Education in India in 2021, 2017

## Skill India

The pervasiveness of technology in today's world has created new job opportunities, leading to the need for upskilling and re-skilling the existing work force in India. With digital transformation and emergence of new age technologies like AR/VR, AI, etc., the technological skill gap is increasing. The number of mobile application developers is on the rise but the requirement for trained smartphone application designers is outpacing the resource talent pool.

According to National Skill Development Corporation, India is likely to have an incremental requirement of 24.4 crore<sup>39</sup> skilled people by 2022 in high growth sectors. Mobile application development is one of the focus sectors here. NSDC has launched specific courses in collaboration with Google, to improve the mobile app ecosystem.

In addition, GSMA and its partners have launched the Mobile Internet Skills Training Toolkit (MISTT) to reduce the digital skills barrier in India<sup>40</sup>.

For the Indian economy, the key challenge now is training new talent as well as helping the current talent pool to stay relevant. To overcome this challenge, the National Digital Communications Policy 2018 aims to train 1 million workers in new age skills.

## Startup India

The vision of Digital India is driving the start-up ecosystem of the country to the next level. With mobile internet penetration reaching 59% and 18%<sup>41</sup> in urban and rural areas respectively, the market for technology based startups has increased manifold in the past decade.

With over 1000 tech startups being registered in 2017, the total number of tech startups has reached 5000 over the last five years<sup>42</sup>, making India the world's third-largest startup ecosystem<sup>42</sup>. ~60% of these start-ups provide B2C services, primarily via mobile apps. With a growth of 167%, the funding of entire Indian startup ecosystem (led by unicorns) amounted to USD 6.4 Billion in H1-2017<sup>42</sup>.

According to a survey by the Global Accelerator Learning Initiative (GALI), India has around 259 startup incubators and accelerators. ShellE4, Target, SAP, Microsoft, Qualcomm, Cisco, Google, Bosch, Intel, GE Healthcare, Intuit are some of the MNCs operating startup accelerators in India. GoI has also been actively involved in driving this wave of incubation – NITI Aayog, MeitY, MSME, state governments have all launched initiatives aimed at promoting startups.

## Democratising Tech Learning



In November 2017, Google announced a new scholarship program aimed at training 1.3 lakh developers and students across India.



They aim to fund 1,00,000 and 30,000 scholarships on technology learning platform Pluralsight and educational institution Udacity, respectively.



This innovative program is designed around Android developers, Mobile web developers, Cloud architects and Data engineers.



From 2016-17, Google has engaged over half a million students and developers across India through more than 200 programs and initiatives, all designed to help them improve their development skills.



As of end of 2017, 327,000 Udacity students have already completed courses developed by Google on in-demand topics such as Mobile and Web development, Machine Learning, AR/VR, Artificial Intelligence and Cloud Platforms.

Source: Industry Reports, Google, Pluralsight

Source: 39. NSDC; 40. National Skills Network; 41. Internet and Mobile Association of India; 42. NASSCOM

# Conclusion

Open source mobile operating system has significantly contributed to India's technological transformation by ushering in an era of affordable smartphones. It has fostered the development of an ecosystem around mobile phones, positively impacting businesses, consumers and the society.

It has lowered barriers of entry for OEMs as well as helped streamline the manufacturing process through increased standardisation. OEMs can thus exploit economies of scale, enabling them to deliver phones packed with features at considerably lower price points. Consumers are being able to derive more utility not only through these features but also from apps available on smartphones. The increased appetite for apps is fostering the growth of a healthy app development environment and a startup ecosystem which in turn is spurring development of new skill-set in the country.

India is witnessing the development of a robust handset manufacturing landscape that has

emerged due to proliferation of smartphones, strengthened by GoI's initiatives like the Phased Manufacturing Program (PMP).

With increased device penetration, India is upwardly traversing the digital adoption curve giving rise to a host of connected devices ranging from wearables to connected televisions and smart speakers.

Open OS is playing a pivotal role in connecting India over a digital platform. For a large portion of the Indian population, internet-enabled smartphones are their first personal computer, music player, TV screen, camera etc.

The positive impact of the open operating system on businesses, consumers and society can be further enhanced through favorable policy interventions and by encouraging greater contributions from all the stakeholders involved, in order to unleash the full potential of the rapidly evolving and growing ecosystem.

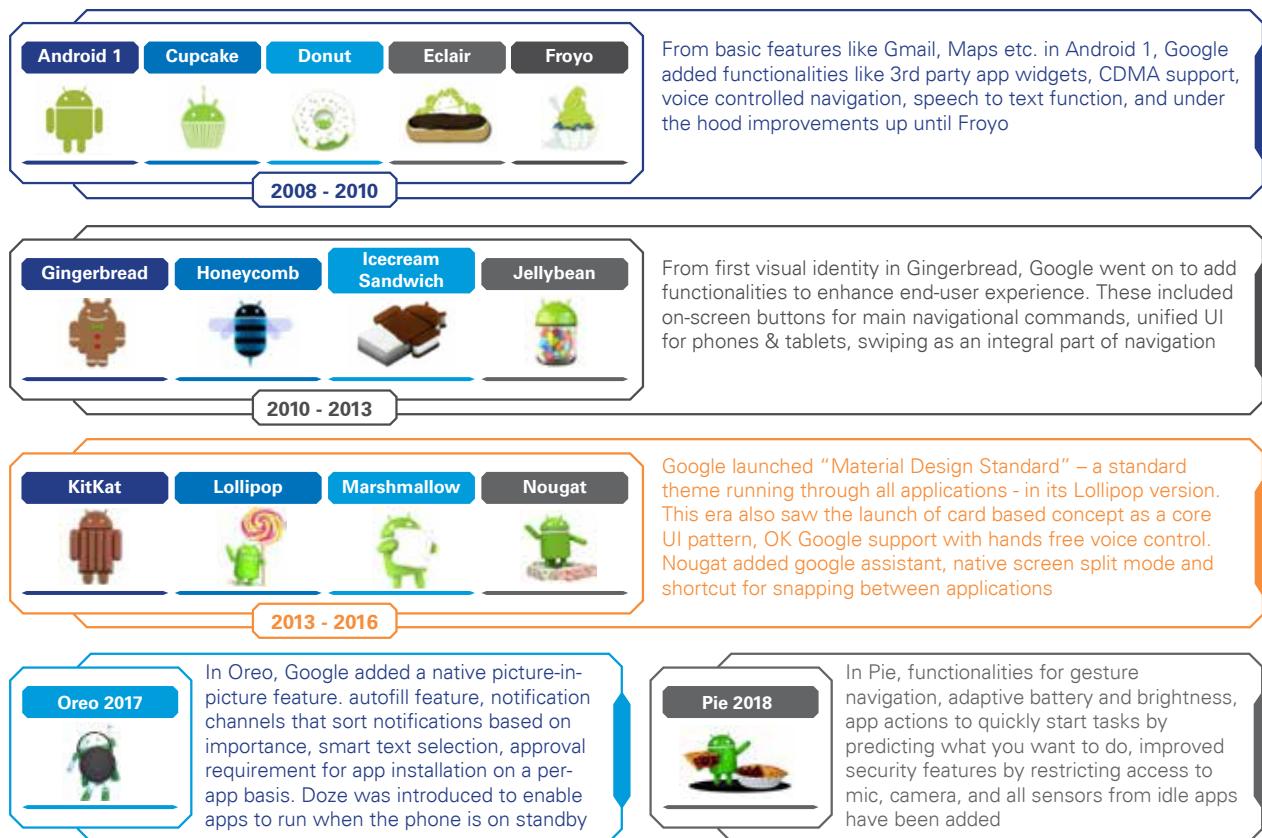


# Android - The most prevalent open OS

Android 1.0 was launched in 2008 and its latest version Android Pie has been launched in 2018. Through the years, Android has added various functionalities in its stack, furthering innovation as well as end user experience. In December 2017, a stripped down version, Android Oreo Go, was launched for entry level smart phones with memories as low as 512 MB. It also has access to a special version of Google Play Store.

Google has taken many steps to ensure security and timely updates. They have recently started publishing a list of Android approved smart phone vendors who now have to ensure that all their devices in the market get proper and timely updates. This has been done largely to control the rising fragmentation in the Android market and to ensure the safety and privacy of the end user.

## Evolution of Android



## Prevalence of Android

~86% of smartphones in use globally are Android based

~66% of tablets in use globally are Android based – 794 million

In the U.S., 48.3% of all active smartphones are Android based – 125 million

In India, 96% of all active smartphones are Android based – 323 million

China is the #1 market for Android based smartphones with ~731 million active users

Top 5 Chinese brands (OPPO, Huawei, Xiaomi, Vivo and Lenovo) account for ~40% of all Android based smartphones in use globally

\*These are not unique factories but a split of the total number of units operational (342) in 268 unique factories

# Glossary

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3G	3 <sup>rd</sup> Generation	MeitY	Ministry of Electronics and Information Technology
4G	4 <sup>th</sup> Generation	MIUI	Mi User Interface
AOSP	Android Open Source Project	MNC	Multi National Corporate
API	Application Program Interface	MoM	Money on Mobile
AR	Augmented Reality	MSME	Micro, Small & Medium Enterprises
ASP	Average Selling Price	NASSCOM	National Association of Software and Services Companies
ATM	Automated Teller Machine	NITI	National Institute for Transforming India
B2C	Business to Consumer	NSDC	National Skill Development Corporation
BB	Blackberry	ODM	Original Device Manufacturer
BD	Business Development	OEM	Original Equipment Manufacturer
CAGR	Compound Annual Growth Rate	OS	Operating System
CCTV	Closed Circuit Television	PC	Personal Computer
CDMA	Code Division Multiple Access	PCB	Printed Circuit Board
DTH	Direct to Home	PMP	Phased Manufacturing Program
EMUI	Emotional User Interface	QC	Quality Control
EMS	Electronics Manufacturing Service	R&D	Research and Development
FY	Financial Year	RML	Reuters Market Light
GDP	Gross Domestic Product	SAARC	South Asian Association for Regional Cooperation
GMS	Google Mobile Services	SMS	Short Message Service
GoI	Government of India	SMT	Surface Mount Technology
GPS	Global Positioning System	TB	Tubercolusis
HD	High Definition	TV	Television
IAMAI	Internet and Mobile Association of India	UBS	Universal Serial Bus
INR	Indian Rupee	UI	User Interface
iOS	iPhone Operating System	USD	United States Dollar
IoT	Internet of Things	VR	Virtual Reality
JV	Joint Venture	WAP	Wireless Application Protocol
KPI	Key Performance Indicator	YoY	Year on Year
MB	Megabyte		

# Appendix



# Methodology Applied for estimating Impact Assessment

Impact Assessment of Android Open Source OS has been categorised into three broad areas : Businesses, Consumers and Societal benefits. A mix of reliable third party data sources as well as inputs gathered via primary interactions with players in the ecosystem have been relied upon to estimate the same.

## Business Benefits

Business benefits refers to the gains realized by handset OEMs & allied sector on account of usage and proliferation of open OS. For the purpose of estimation, Handset OEMs and Application Developers have been considered as the two key stakeholders.

**OEMs** – The main benefit is lower barriers to entry on account of reduced developmental and maintenance costs. This has enabled more OEMs to enter the Indian market.

The output has been depicted in terms of increase in volume of smartphones (in million units) sold from 2009-10 to 2017-18. The respective change in terms of value (in INR Crore) of smartphones sold has also been depicted.

**Application Developers** – The benefits to application developers are access to large market, lower registration fees and ease of development (due to basic stack being available for development).

This has been depicted by the differential of registration fees charged by various OS

ecosystems, the increase in number of application developers and their distribution with respect to the platform they choose to develop on.

**Table 1: Inputs and sources for calculating business benefits to OEMs**

Impact	Metric	Source
Increase in retail revenue generated by major OEMs b/w 2009 - 2018	Volume sold by major OEMs (million units)	ICEA
	Value of smartphones sold by major OEMs (INR Crore)	ICEA
	ASP (Total retail sales Value/ Volume) (INR)	ICEA

**Table 2: Inputs and sources for calculating business benefits to Application Developers**

Impact	Metric	Source
Registration fee	Fee charged by Android and iOS	Primary Interactions with industry players
App developer talent pool by platform	Talent distribution (% split by developmental platform)	India Mobile Talent Report by Belong.co

## Consumer Benefits

Consumer benefits refers to the gains realized by the consumers on account of proliferation of smartphones and entry of more OEMs in the Indian market.

The benefits to consumers are increased affordability, more choices of handsets available across price points and access to a large variety of applications.

This has been calculated as per the table below:

**Table 3: Inputs and sources for calculating Consumer benefits**

Impact	Metric	Source
Increased affordability (2009-2018)	ASP (Total retail sales Value/ Volume) (INR)	ICEA
	Price of entry level smartphones	Press Release
	OS wise smartphone distribution by price range (INR)	Pricebaba (product research platform)
Access to large variety of apps	Number of apps available on closed and open source based app distribution platforms	App Stores list 2018 – Business of Apps

## Societal Benefits

Societal benefits refer to the gains realized by the Indian society due to increased proliferation of smartphones. Employment generation and economic growth have been considered as the two key impact areas.

**Employment Generation** – Android has lured more OEMs in the market, thus creating employment (direct job creation). Employment creation has been estimated by using the percentage split of smartphone production

vs feature phone production to calculate the minimum number of jobs that smartphone manufacturing has created in India.

Application development is another employment opportunity supported by Android

**Economic Growth** - This impact is through the positive push to the supply side of the economy through the value addition by the manufacturers, app-developers and other players involved across the value chain.

**Table 4: Inputs and sources for calculating Societal benefits - Employment**

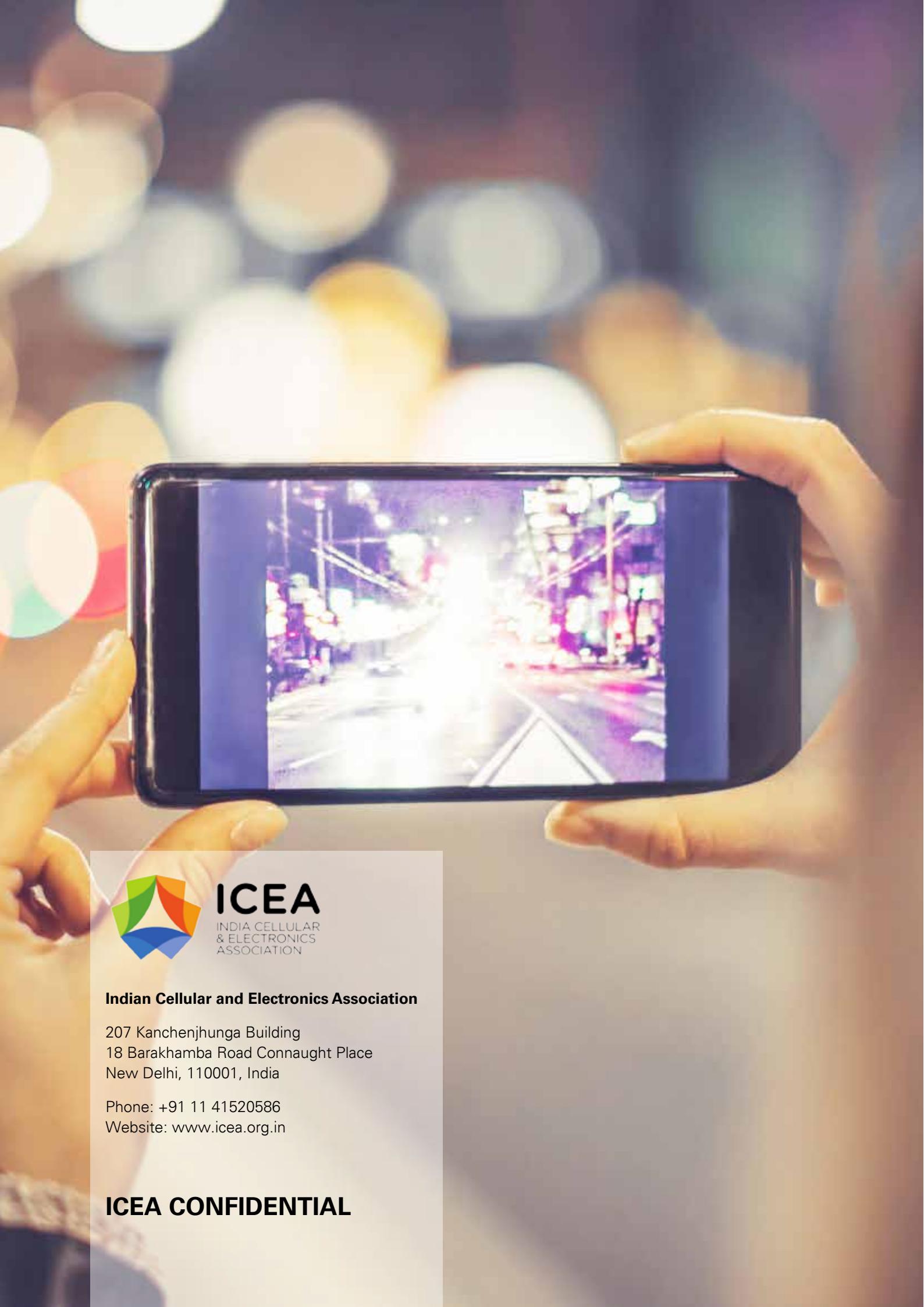
Impact	Levers for calculation of Impact	Calculation	Source
Manufacturing (Smartphones & Allied Industry) – Direct jobs	a. Number of jobs generated (in Lakhs) by mobile phone manufacturing units (Direct + Indirect)	(a * b) * c% * d	ICEA
	b. Ratio of direct to indirect jobs created		ICEA
	c. % smartphone production		ICEA
	d. Ratio of employment generation due to smartphone and feature phone		
Manufacturing (Smartphones & Allied Industry) – Indirect jobs	a. Ratio of direct to indirect jobs created	a*b	ICEA
	b. Total number of direct jobs created due to smart phones		Calculated as above
Number of allied units attributed to smartphones	a. Number of allied units	a*b%	ICEA
	b. % share of smartphones in domestic production		ICEA

**Table 5: Inputs and sources for calculating Societal benefits – Economic Growth**

Impact	Levers for calculation of Impact	Calculation	Source
Impact on GDP per capita growth	d. 10% increase in mobile penetration raises GDP per capita by 0.8% for low income countries	[c(2018) – c(2014)] * d%	World Bank report







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