TRAI

TELECOM REGULATORY AUTHORITY OF INDIA

सत्यमेव जयते

TELECOMMUNICATIONS IN SELECT COUNTRIES POLICIES - STATISTICS

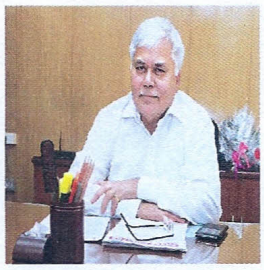
Telecom Regulatory Authority of India

(IS/ISO 9001-2008 Certified Organisation)

TELECOMMUNICATIONS IN SELECT COUNTRIES

POLICIES-STATISTICS

PREFACE



Today Telecommunication services are playing a pivotal role in the basic operations of society in business, government and at inter personal level. In fact, communication among people is the essence of what distinguishes an organization, community, or society from a collection of individuals. Communication through cell phone calling, web browsing to instant messaging has become increasingly integrated into how we work, play and live. Telecommunications Sector has emerged as a highly vibrant and dynamic sector of the India economy over the last few years. Robust policy framework promotes investment, innovation and competition in the Telecom Sector.

The telecommunication industry has grown by leaps and bounds worldwide, in past years. The growth has been not only in terms of increased revenue but also in terms of its reach to more subscribers, improved technology and varied usage. To assist in understanding trends and developments that have taken place globally in telecommunication sector i.e. its policies and practices. Telecom Regulatory Authority of India (TRAI) has made an attempt by putting together compilation of data related to various aspects of the telecommunication industry for select few countries. These include telecom indicators and practices covering telecom growth and penetration, quality of service performance, spectrum management and financial performance of selected telecommunication companies in these countries for the period of four years ending 2016. This compilation is based on information & statistics from various sources available for the period and is an in-house exercise. I must acknowledge the tireless efforts put in by the TRAI's Finance and Economic Analysis (F&EA) team led by Shri S.K. Mishra, Principal Advisor (Finance and Economic Analysis) and valuable inputs from NSL and QoS division of TRAI.

All out efforts have been made to present the compilation in a readable and easy to understand format so that it finds interest not only among the different segments of telecommunication industry but also among the public at large. We hope that the compilation will be of use to stakeholders and would serve as a good reference document.

(R.S. SHARMA)
CHAIRMAN

New Delhi
Date: 5th November, 2018

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TABLE OF CONTENTS

INTRODUCTION

The compilation is presented in four chapters:

Chapter-I : This chapter contains the information and statistics on key telecom indicators related to Subscribers, Tele-density, etc. in select twenty three countries including India for the last four years ending December 2016.

Chapter-II: This chapter covers the quality of telecom services across the twenty three countries.

Chapter-III: This chapter covers the practices followed by thirteen countries for spectrum management.

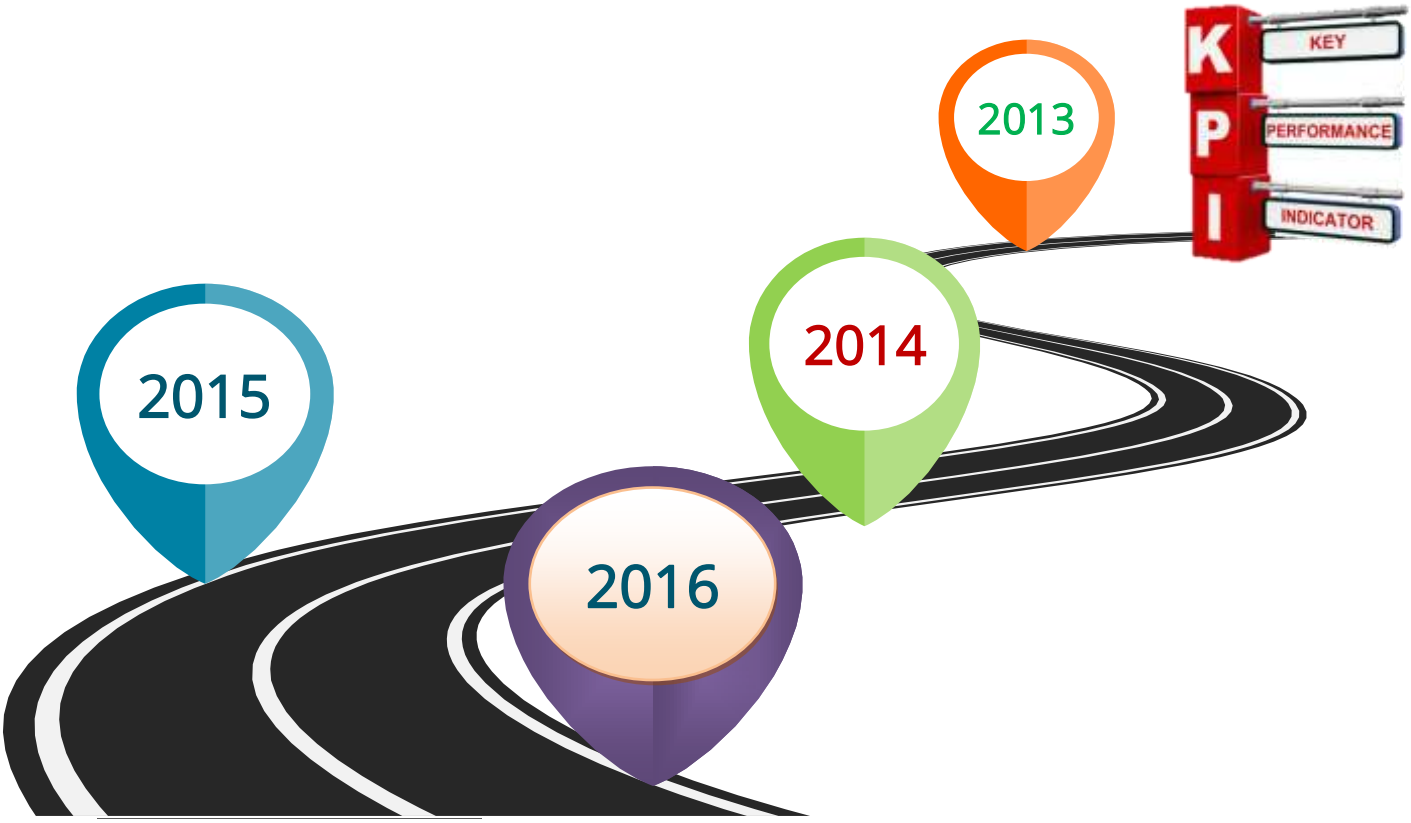
Chapter-IV : This chapter contains the financials results of twenty five leading telecom companies for the last four years (including two Indian telecom companies viz. Bharti Airtel Limited and Idea Cellular Limited) operating in the selected twenty three countries. The annual financial results of these companies represent the group financials i.e. results on consolidated basis, which include operations in their country of incorporation as well as in other countries through subsidiary companies/joint ventures.

CHAPTER – 1

KEY PERFORMANCE INDICATORS

This Chapter highlights the trends over the past four years, till 2016 of key performance indicators at global level, such as number of subscribers, tele-density, Information and Communication Development Index (IDI) etc. and also for the twenty three selected countries[1]. This analysis has been carried out based on published data for the four years period, ending 2016. The study covers the mobile services, fixed line services and internet services of telecom service sector. The chapter is divided into four segments namely:

1. Mobile Services
2. Fixed Line Services
3. Internet Services
4. Information and Communication Technology Development Index (IDI)



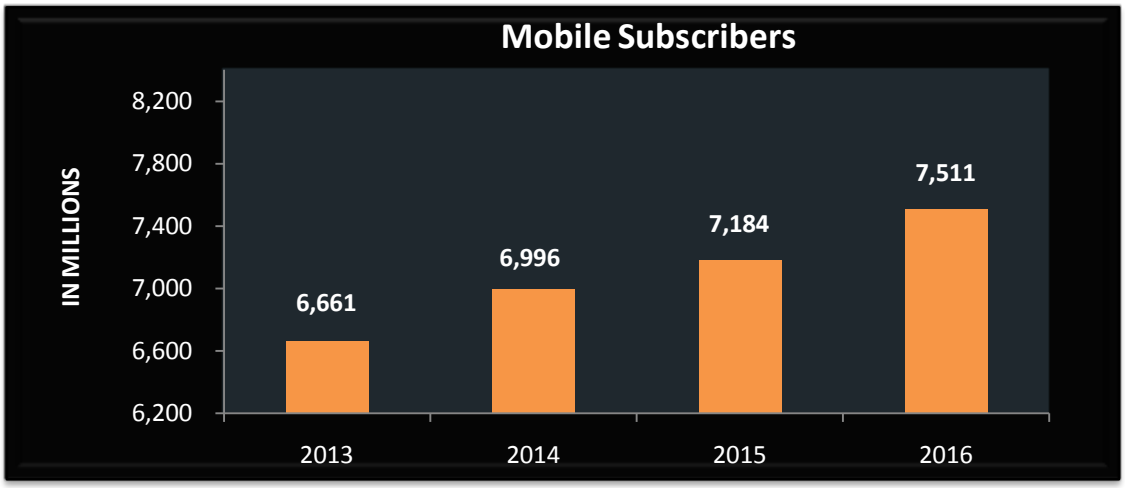
[1] Australia, Brazil, Canada, China Egypt, France, Germany, India, Indonesia, Italy, Japan, Korea Republic, Malaysia, Mexico, New Zealand, Nigeria, Pakistan, Philippines, Russia, South Africa, Turkey, UK and USA

1.1 MOBILE SERVICES

1.1.1 The Global Trend

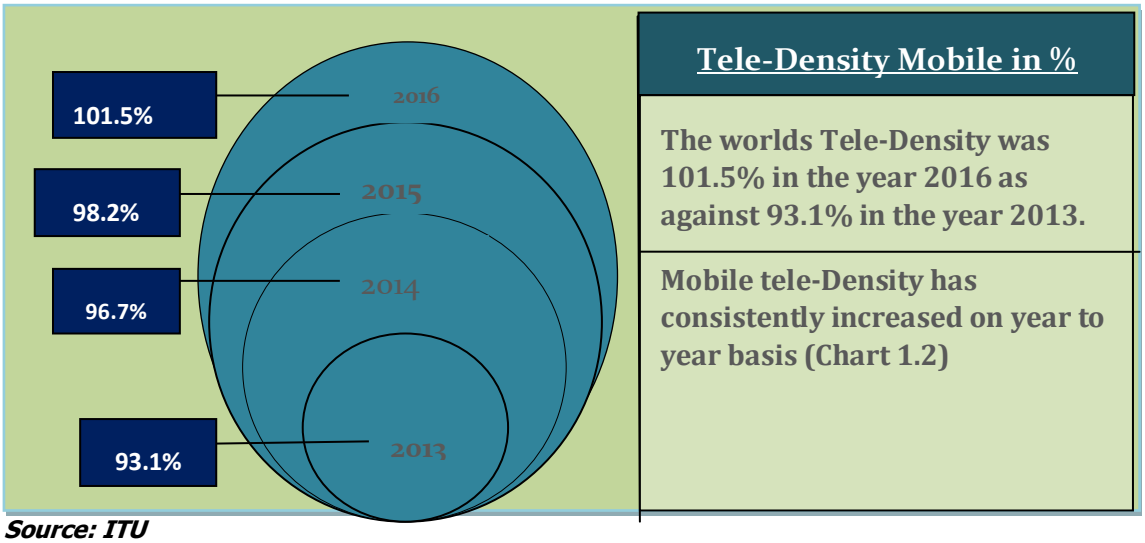
The mobile subscribers[2] base has grown consistently on a year-to-year basis and reached 7,511 million in 2016 though the growth rate has shown both decreasing and increasing trend. Growth rate was 5.02%, 2.69% and 4.56% in 2014, 2015 and 2016 respectively. In comparison to 2013, mobile subscribers have increased by 12.76% in 2016. Over four years, it has increased with CAGR[3] of 6.19%. The details of world's mobile subscribers for four years ended 2016 are given below in Chart 1.1

Chart 1.1



Source: ITU

Chart 1.2



Source: ITU

[2] Mobile Subscribers mean mobile, cellular and wireless subscribers
[3] CAGR refers to Compounded Annual Growth Rate

1.1.2 Country Wise Trend

1.1.2.1 Mobile Subscribers

In terms of mobile subscribers, an increasing trend has been observed in most of the countries. The following chart 1.3 shows the number of mobile subscribers in twenty-three selected countries during the last four years ended 2016.

Chart 1.3

Mobile Subscribers (in Millions)

Country	2013	2014	2015	2016
China	1,229.1	1,286.1	1,292.0	1,364.9
India	886.3	944.0	1,010.9	1,127.4
United States	310.7	355.5	382.3	416.7
Indonesia	313.2	325.6	338.9	385.6
Brazil	271.1	280.7	257.8	244.1
Russian Federation	218.3	221.0	227.3	231.4
Japan	147.9	155.1	160.5	164.3
Nigeria	127.2	139.0	150.8	154.3
Pakistan	127.7	135.8	125.9	136.5
Philippines	102.8	111.3	117.8	113.0
Mexico	106.7	104.9	107.7	111.7
Germany	100.0	99.5	96.4	94.4
Egypt	99.7	95.3	94.0	97.8
Italy	96.9	89.9	87.7	86.0
South Africa	76.9	79.3	88.0	76.7
United Kingdom	78.7	78.5	79.3	78.5
Turkey	69.7	71.9	73.6	75.1
France	63.3	65.4	66.7	67.6
Korea (Rep.)	54.7	57.3	58.9	61.3
Malaysia	43.0	44.9	44.1	43.9
Canada	28.4	28.8	29.8	30.5
Australia	24.9	25.1	25.8	26.6
New Zealand	4.8	5.1	5.6	5.8

Source: ITU & TRAI

Country wise Mobile subscribers for the last four years along with growth trends is tabulated inAnnexure1.1

- China had the highest number of subscribers in the world with 1364.93 million in 2016 followed by India with 1127.37 million subscribers. New Zealand had the least number of mobile subscribers with 5.80 million.

- The number of mobile subscribers has shown an increasing trend worldwide in 2016 except in Brazil, Germany, Italy, Malaysia, Philippines, South Africa, United Kingdom.
- In absolute terms, India topped the table with growth of 116.48 million mobile subscribers in 2016 followed by China with 72.94 million and Indonesia with 46.62 million. In 2015 also, India had the highest absolute growth of mobile subscribers with 66.88 million, followed by USA and Indonesia with 26.80 million and 13.36 million mobile subscribers respectively.
- World's average mobile subscribers' growth rate was 2.22% in 2016. Thirteen countries (USA, Pakistan, Nigeria, New Zealand, Mexico, Korea (Rep), Japan, Indonesia, Egypt, China, Canada, Australia, India) had a growth rate greater than 2.22%.
- In the year 2016, Indonesia topped with 13.76% mobile subscriber growth rate followed by India with 11.52% and United States with 8.99%.
- Brazil recorded the highest negative growth of 8.16% in 2015 whereas South Africa witnessed the highest negative growth of 12.89% in 2016.
- The following chart shows categorization of selected 23 countries based on number of mobile subscribers.

Chart 1.4

1.1.2.2 Mobile Tele-Density

The following chart reflects the Mobile tele-density in 23 selected countries during the past four years ended December 2016.

Chart 1.5

Mobile Density (%)

Country	2013	2014	2015	2016
Russia	152.8	155.1	160.0	163.3
South Africa	145.6	149.2	164.5	142.4
Italy	158.8	147.2	143.4	140.4
Malaysia	144.7	148.8	143.9	141.2
Indonesia	125.4	128.8	132.6	149.1
Brazil	135.3	139.0	126.6	118.9
Japan	116.3	122.2	126.5	129.8
UK	124.6	123.6	124.1	122.3
Germany	120.9	120.4	116.7	114.5
Korea (Rep.)	111.0	115.7	118.5	122.7
New Zealand	105.8	112.1	121.8	125.0
Egypt	121.5	114.3	111.0	113.7
USA	97.1	110.2	117.6	127.2
Philippines	104.5	111.2	115.8	109.2
Australia	106.8	106.1	107.7	109.6
France	98.5	101.2	102.6	103.5
Turkey	93.0	94.8	96.0	96.9
China	88.7	92.3	92.2	96.9
Mexico	87.3	84.8	86.0	88.2
Canada	80.6	81.0	83.0	84.1
Nigeria	73.3	77.8	82.2	81.8
India	71.7	75.4	79.8	88.0
Pakistan	70.1	73.3	66.9	71.4

Source: ITU&TRAI

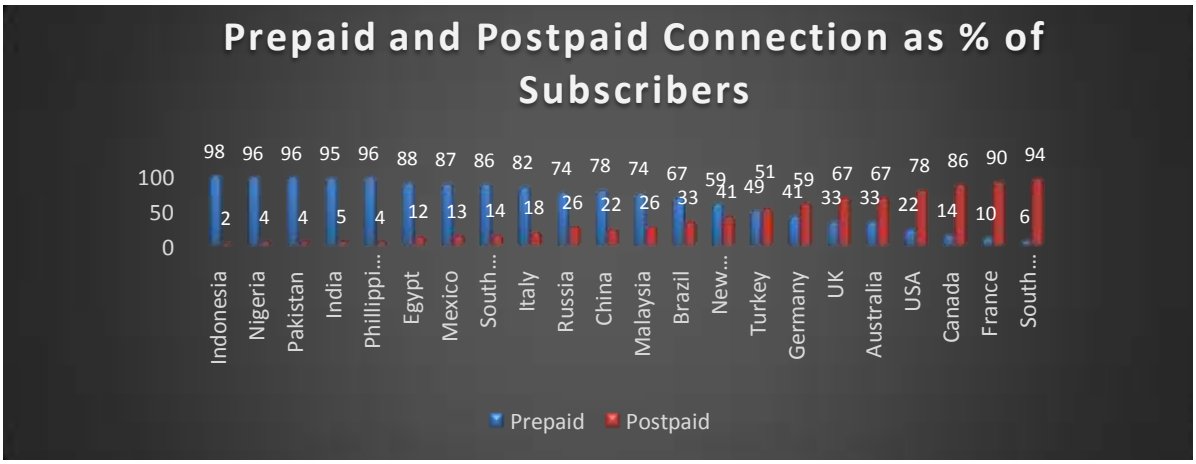
Country wise Mobile tele density for the last four years is tabulated in Annexure 1.2

- Russia had recorded the highest mobile tele-density of 163.26% in 2016, followed by Indonesia of 149.13% and South Africa of 142.38%. India's mobile tele-density was 88% in 2016.
- In 2015, South Africa had the highest mobile tele-density of 164.51% followed by Russia with 159.95%. India's mobile tele-density was 79.82% in 2015.
- Sixteen countries had recorded the mobile tele-density more than 100% in 2016.

1.1.2.3 Prepaid and Postpaid Connections as Percentage of Subscribers

Following chart presents the percentage share of prepaid and postpaid mobile subscribers[4] in total mobile subscribers.

Chart 1.6

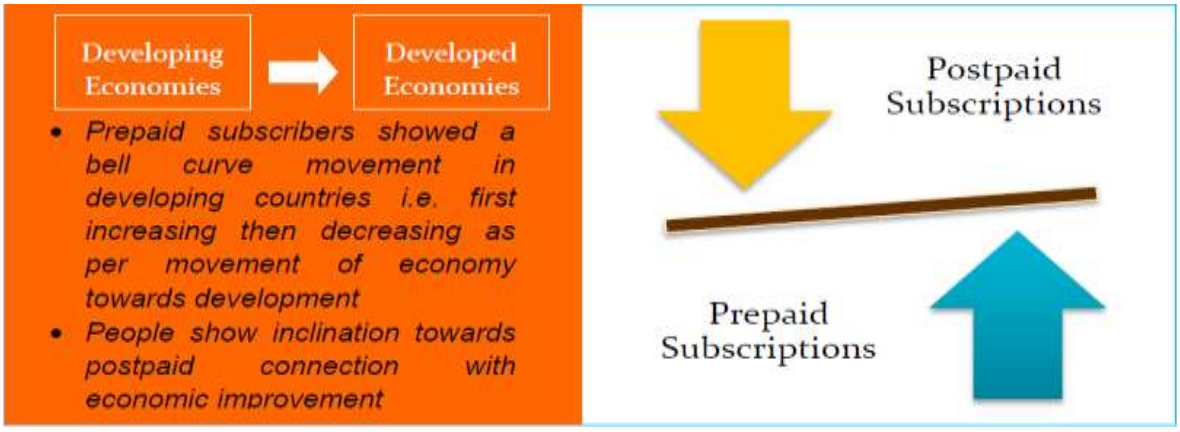


Source: GSMA Intelligence

- South Korea, France and Canada topped the list of post-paid connections with more than 85% postpaid subscribers.
- Indonesia, Nigeria, Pakistan, India and Philippines were having highest percentage of prepaid subscribers. All these have more than 90% prepaid subscribers. Indonesia had the highest percentage of prepaid connections at 98%.
- It is evident from the figures that subscribers in developing and emerging economies have inclination towards availing prepaid services. In most developing countries more than 90% of mobile subscribers had prepaid connections in the year ended 2016. On the other hand, in most of the developed countries, mobile subscribers preferred postpaid connection (Italy being an exception to this categorization having 82% prepaid connections in December 2016).

[4]Note: Information on Japan is not available for the year ended December, 2016.

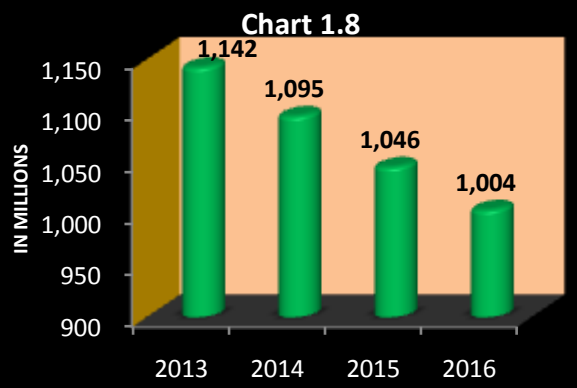
Chart 1.7



1.2 FIXED LINE SUBSCRIBERS

1.2.1 The Global Trend

FIXED LINE SUBSCRIBERS

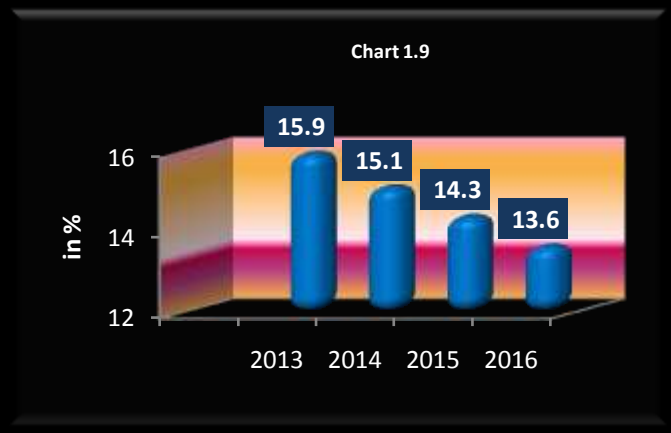


The chart represents world's fixed line subscribers for 4 years ended December 2016.

Fixed line connections have been declining consistently. It has dropped to 1,004 million in year 2016 from 1142 million in 2013. It had declined by 4.51% and 3.99% in year 2015 and 2016 respectively.

Source: ITU

FIXED LINE TELE-DENSITY



The chart represents world's fixed line tele-density for 4 years ended December 2016.

The fixed line tele-density has been declining consistently.

Tele-density of fixed line had dropped down to 13.6% in the year 2016 from 15.9% in 2013.

Source: ITU

1.2.2 Country Wise

1.2.2.1 Fixed Lines Subscribers

The number of fixed line subscribers have decreased in general in most of the countries in the year 2016 as can be seen from the following Chart.

Chart 1.10

Fixed Line Subscribers (in Million)

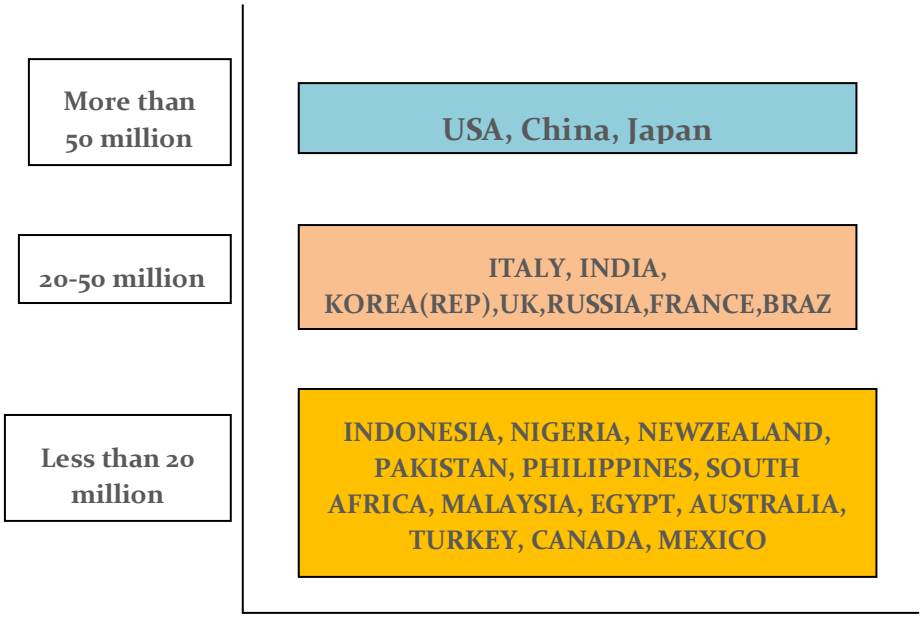
Country	2013	2014	2015	2016
China	267.0	249.4	231.0	206.6
USA	133.2	128.5	124.8	121.5
Japan	64.0	63.6	63.7	64.0
Germany	48.7	47.0	45.4	44.3
Brazil	45.0	44.1	43.7	41.8
France	39.1	38.8	38.9	39.0
Russia	40.5	38.2	35.6	32.3
UK	33.4	33.2	33.2	33.5
Korea (Rep.)	30.3	29.5	28.9	28.0
India	28.9	27.0	25.5	24.4
Italy	21.1	20.6	20.2	20.3
Indonesia	30.7	26.2	10.4	10.4
Mexico	18.6	18.6	19.3	19.6
Canada	16.9	16.4	15.6	15.0
Turkey	13.6	12.5	11.5	11.1
Australia	10.4	9.2	8.5	8.2
Egypt	6.8	6.3	6.2	6.1
Malaysia	4.5	4.4	4.5	4.5
Pakistan	6.4	4.9	3.0	3.1
South Africa	3.9	3.6	4.1	3.6
Philippines	3.1	3.1	3.2	3.8
New Zealand	1.9	1.9	1.9	1.8
Nigeria	0.4	0.2	0.2	0.2

Source: ITU &TRAI

Country wise fixed line subscribers for the last four years ended 2016 along with growth trends are tabulated in Annexure 1.3.

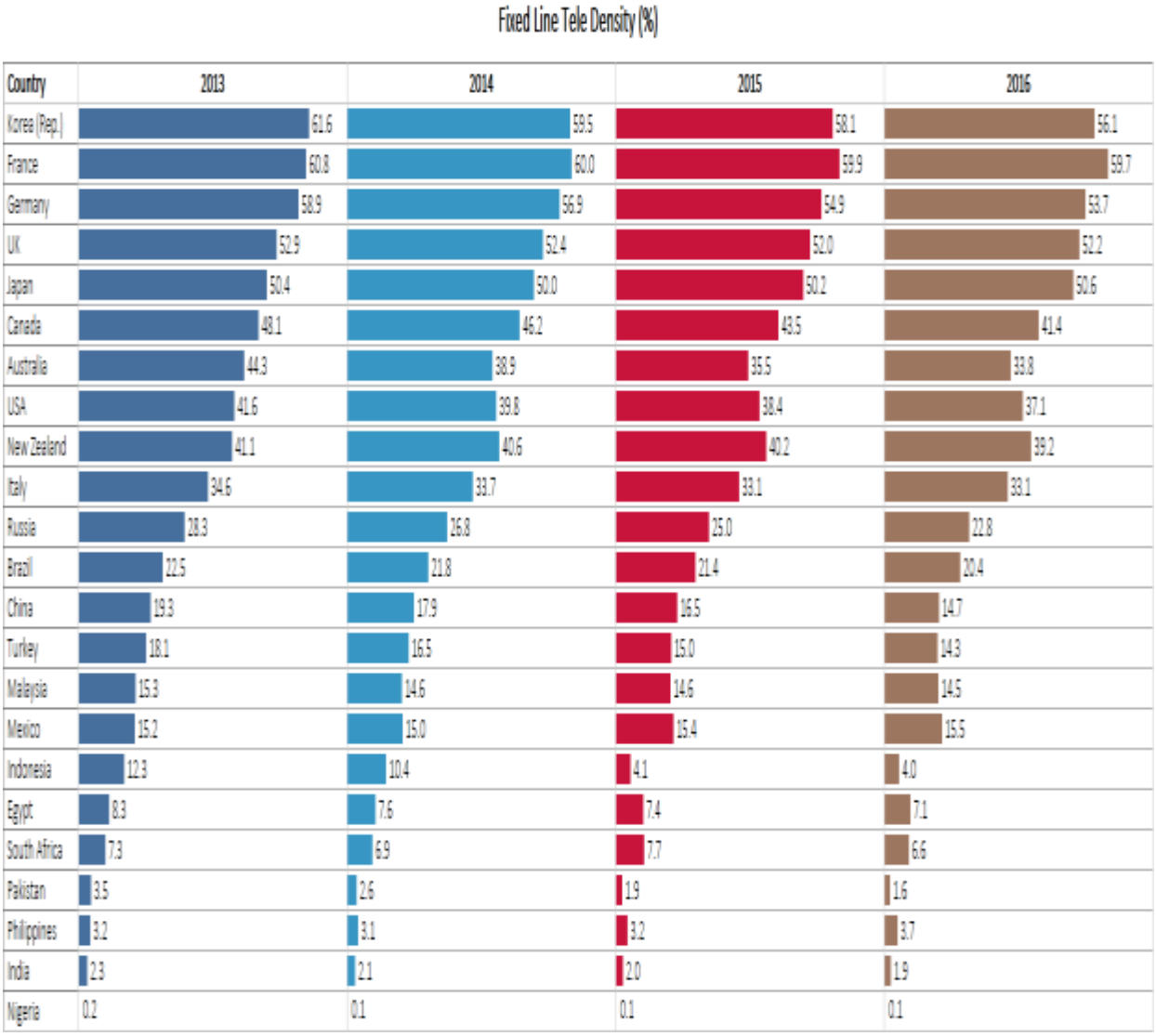
- China had the highest number of fixed line subscribers in all the four years followed by USA, Japan, Germany, and Brazil. China had 206.62 million fixed line subscribers in 2016, 231 million in 2015 and 249.43 million in 2014.
- Nigeria had the least fixed line subscribers at 0.15 million in 2016.
- India had recorded 24.4 million fixed line subscribers at the end of 2016.
- In 2016, Philippines had recorded the highest growth of 18.80% in fixed line subscribers. Only ten other countries (Nigeria, Mexico, UK, France and Japan, Malaysia, Pakistan, Philippines, Italy, South Africa) had recorded growth in fixed line subscribers in four years' period.
- The highest negative growth (decline) of 19.85% was recorded in Nigeria followed by South Africa with negative growth (decline) of 13.82% in 2016.
- Twelve countries (Egypt, Australia, Turkey, Canada, Indonesia, India, Korea (Rep), Russia, Brazil, Germany, USA and China) witnessed negative growth (decline) in 2015 as well as in 2016. Japan, France, Malaysia, Mexico and Philippines are the only countries, which had recorded growth in fixed line subscribers in 2015 and 2016. The remaining countries had witnessed mixed trends.
- The following chart shows categorization of selected 23 countries based on the number of fixed-line subscribers.

Chart 1.11



1.2.2.2 Fixed Line Tele-Density

Chart 1.12



Country	2013	2014	2015	2016
Korea (Rep.)	61.6	59.5	58.1	56.1
France	60.8	60.0	59.9	59.7
Germany	58.9	56.9	54.9	53.7
UK	52.9	52.4	52.0	52.2
Japan	50.4	50.0	50.2	50.6
Canada	48.1	46.2	43.5	41.4
Australia	44.3	38.9	35.5	33.8
USA	41.6	39.8	38.4	37.1
New Zealand	41.1	40.6	40.2	39.2
Italy	34.6	33.7	33.1	33.1
Russia	28.3	26.8	25.0	22.8
Brazil	22.5	21.8	21.4	20.4
China	19.3	17.9	16.5	14.7
Turkey	18.1	16.5	15.0	14.3
Malaysia	15.3	14.6	14.6	14.5
Mexico	15.2	15.0	15.4	15.5
Indonesia	12.3	10.4	4.1	4.0
Egypt	8.3	7.6	7.4	7.1
South Africa	7.3	6.9	7.7	6.6
Pakistan	3.5	2.6	1.9	1.6
Philippines	3.2	3.1	3.2	3.7
India	2.3	2.1	2.0	1.9
Nigeria	0.2	0.1	0.1	0.1

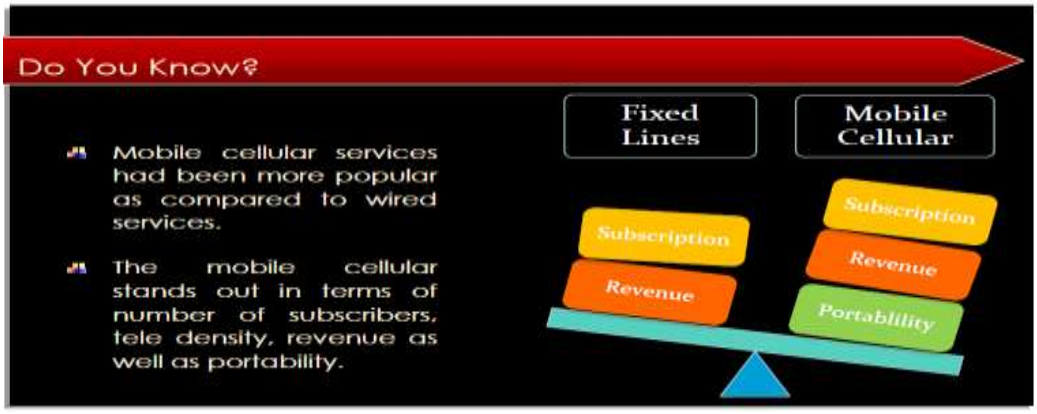
Source: ITU&TRAI

Country wise fixed line tele density for the last four years ended along with changes are tabulated in Annexure 1.4.

- France had the highest fixed line tele-density of 59.72% in the year ended December 2016, followed by Korea (Rep.) (56.10%), Germany (53.74%) and UK (52.20%).
- Nigeria had the lowest fixed line tele-density amongst the 23 countries in all the four years with 0.08 % in 2016, 0.10% in 2015, 0.10% in 2014 and 0.21% in 2013.

- India, Pakistan and Philippines had fixed line tele-density lower than 5% in all the four years. India had recorded fixed line tele-density of 1.90% in 2016.
- Japan, Mexico and Philippines are the only countries, which had recorded increase in fixed line tele-density in 2015 as well as in 2016.
- Following chart shows a comparison of mobile services and fixed line services.

Chart 1.13



1.3 INTERNET SERVICES

The world's internet subscribers have been constantly increasing since past four years ended 2016 (Chart 1.14).

1.3.1 The Global Trend

The internet subscribers have increased to 3500 million in 2016. There was an increment of 9.42% in internet users in 2015 and 9.14% in 2016. The CAGR was 14.71%.

Chart 1.14

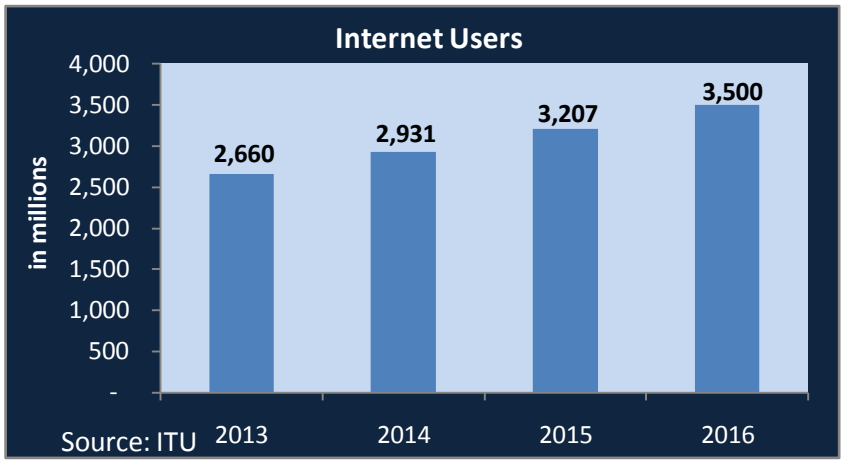
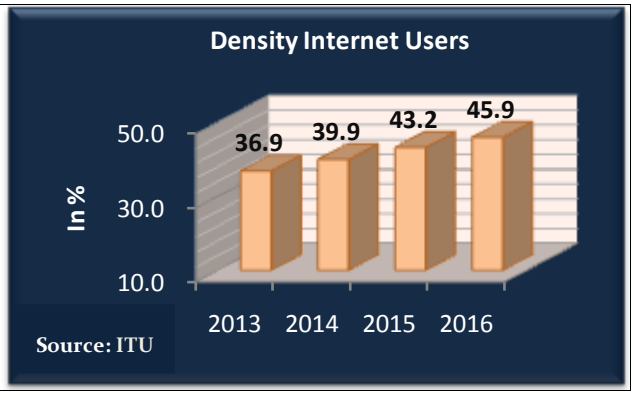


Chart 1.15

Internet User Density

The internet user density has increased consistently on year to year basis and reached to 45.9% in year 2016 as compared to 36.9% in 2013.



1.3.2 Country wise Trend

Broadband subscribers in the 23 countries are shown in following chart for four years ended 2016.

Chart 1.16

Fixed Broadband Subscriptions (in Millions)

Country	2013	2014	2015	2016
China	188.9	200.5	277.0	322.6
USA	96.0	100.2	102.2	106.1
Japan	36.9	37.8	38.9	39.8
Germany	28.6	29.6	30.7	31.4
France	24.9	26.0	26.9	27.7
Russia	23.7	25.0	26.9	27.6
UK	23.0	23.7	24.7	25.2
Brazil	21.4	23.6	24.9	26.6
Korea (Rep.)	18.7	19.2	20.0	20.6
India	14.9	15.8	16.5	18.1
Italy	14.0	14.4	14.9	15.6
Mexico	12.7	13.0	14.8	16.0
Canada	12.1	12.6	13.0	13.5
Turkey	8.9	8.9	9.5	10.5
Australia	6.0	6.5	6.8	7.4
Philippines	2.6	2.9	4.9	5.6
Indonesia	3.3	3.4	4.0	4.9
Egypt	2.7	3.1	3.8	4.5
Malaysia	2.9	3.1	3.1	2.7
Pakistan	1.6	2.0	1.8	1.6
South Africa	1.6	1.7	1.4	1.5
New Zealand	1.3	1.4	1.5	1.5
Nigeria	0.0	0.0	0.0	0.0

Source: ITU & TRAI

Country wise fixed broadband subscribers for the last four years along with growth trends are tabulated in Annexure 1.5

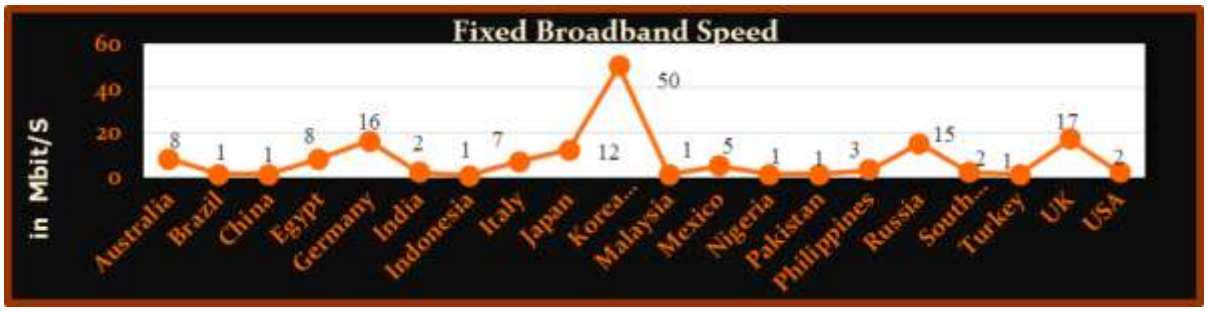
- China had the highest number of subscribers in all four years ended 2016. At the end of 2016, China was having 322.59 million fixed broadband subscribers, followed by USA with 106.07 million and Japan with 39.84 million subscribers.
- Nigeria had the least number of subscribers with 0.02 million in 2016 followed by New Zealand with 1.50 million subscribers.
- India had recorded 18.14 million fixed broadband subscribers in 2016.
- Fixed broadband connections had been increasing in almost all the selected countries in 2016 except in Pakistan and Malaysia.
- In absolute terms, China had recorded maximum growth in fixed broadband subscribers in 2016 with 45.54 millions followed by USA with 3.88 millions. In 2015 also, China had recorded the highest growth with 76.56 millions followed by USA with 2.00 millions fixed broadband subscribers.
- In 2016, Nigeria, Indonesia and Egypt were the top three countries in terms of broadband subscribers with growth of 38.01%, 22.77% and 16.56% respectively. India ranked at seventh place with growth of 13.45% in 2016.
- Twenty one countries (including India) had recorded growth in fixed broadband subscribers in 2016 and twenty countries (including India) had recorded growth in fixed broadband subscribers in 2015.

1.3.3 Broadband Speed

The broadband speed in Mb per second[5] is given in the chart for the year ended 2014. On an average, most of the countries had fixed broadband speed ranging between 1Mbps to 5 Mbps. South Korea had the highest fixed broadband speed of 50 Mbps followed by UK (17 Mbps) and Germany (16 Mbps).

[5]Fixed-broadband speed, in Mbit/s refers to the advertised maximum theoretical download speed and not speeds guaranteed to users associated with a fixed broadband Internet monthly subscription. Data for Canada, France and New Zealand were not available.

Chart 1.17



Source: ITU

1.3.4 Percentage of Mobile Users Using Internet

A rise in percentage of individuals using internet was recorded in all of the countries in the year 2016 as can be seen from the following Chart.

Chart 1.18

Percentage of Mobile Users Using Internet

Country	2013	2014	2015	2016
UK	89.84	91.61	92.00	94.78
Japan	88.22	89.11	91.06	92.00
Canada	85.80	87.12	88.47	89.84
Korea (Rep.)	84.77	87.56	89.65	92.72
Germany	84.17	86.19	87.59	89.65
Australia	83.45	84.00	84.56	88.14
New Zealand	82.78	85.50	88.22	88.47
France	80.92	83.75	84.69	85.62
USA	71.40	73.00	74.55	76.18
Russia	67.97	70.52	73.41	76.41
Italy	58.46	55.64	58.14	61.32
Malaysia	57.06	63.67	71.06	78.79
Brazil	51.04	54.55	58.33	59.68
Philippines	48.10	49.60	53.70	55.50
South Africa	46.50	49.00	51.92	54.00
Turkey	46.15	51.04	53.74	58.35
China	45.80	47.90	50.30	53.20
Mexico	43.46	44.39	57.43	59.54
Egypt	29.40	33.89	37.82	39.21
Nigeria	19.10	21.00	24.50	25.67
India	15.10	18.00	26.00	30.56
Indonesia	14.94	17.14	21.98	25.37
Pakistan	10.90	12.00	14.00	15.51

Source: ITU

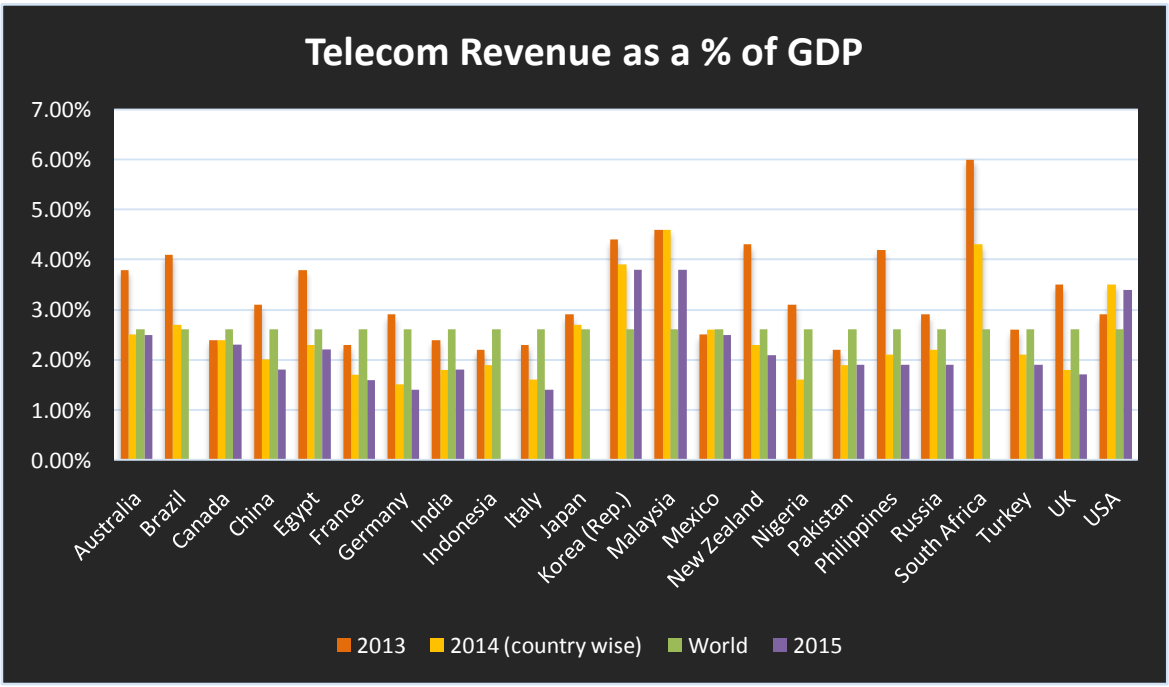
Country wise Percentage of users using Internet for the last four years ended 2016 are tabulated in Annexure 1.6

- UK had the highest percentage of individuals using internet at 94.78% followed by Korea (Rep.) at 92.72% in 2016, whereas Pakistan had the least percentage of individuals using internet at 15.51%. In India, 30.56% individuals were using internet in 2016.
- In 2016, in eight countries (UK, Japan, Canada, Germany, New Zealand, Australia, Korea (Rep.) and France), more than 80% of individuals were using internet.
- In 2016, percentage of users using internet had grown on year-to- year basis in all the countries.
- Malaysia had recorded the highest growth (7.73%) of internet users in 2016. In 2015, Mexico had recorded the highest growth (13.04%) of internet users.

1.4 TELECOM REVENUE AS PERCENTAGE OF GDP

Following chart represents contribution of telecommunication revenue towards GDP for the year ended 2015.

Chart 1.19



Source: World Bank

Country wise telecommunication revenue as % of GDP for the year 2014 and 2015 are tabulated in Annexure 1.7 (Data for Brazil, Indonesia, Japan, Nigeria and South Africa were not available for year 2015)

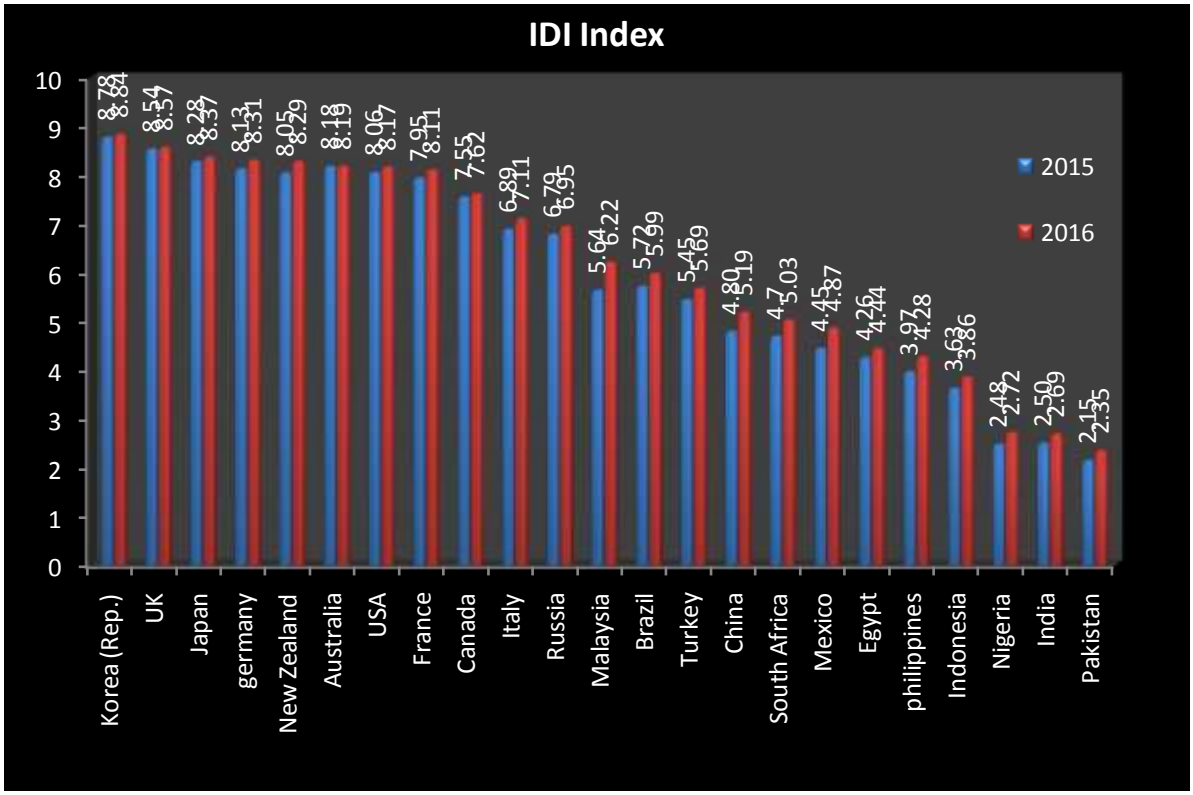
- World's telecom revenue as percentage of world's GDP was about 2.6%. Only three countries namely Korea (Rep.), Malaysia, and USA had exceeded the average mark.

- Korea (Rep.) and Malaysia had the highest telecom revenue as % of GDP i.e. 3.80%, while it was the least in Germany and Italy with 1.40%. Indian telecom service revenue contributed to 1.97% to GDP in 2016-17.

1.5 INFORMATION AND COMMUNICATION DEVELOPMENT INDEX (IDI)

The ICT Development Index (IDI) is a composite index that combines eleven indicators into one benchmark measure. It is used to monitor and compare developments in information and communication technology (ICT) across countries. IDI is computed through three sub-indices namely, Access sub-index (5 indicators), Use sub-index (3 indicators) and Skills sub-index (3 indicators). The following chart indicates the IDI of selected 23 countries in 2015 and 2016.

Chart 1.20



Source: ITU

Country wise IDI for 2015 and 2016 years are tabulated in Annexure 1.8

- Korea (Rep.) had recorded the highest IDI in 2016 as well as in 2015 followed by UK in both the years.
- Indian IDI increased from 2.50 in 2015 to 2.69 in 2016. Only Pakistan had low IDI than India in 2016.
- IDI of all countries had witnessed improvement in 2016 as compared to 2015 indicating overall improvement in information and communication technology.

CHAPTER – 2

TELECOM QUALITY OF SERVICE IN SELECTED COUNTRIES

2.1 Meaning and Need of Quality of Service

Quality of Service as defined[6] "in the context of customer/user, by the attributes or criteria which are considered to be essential in the use of service; and in the context of service provider, by parameters which contribute towards the end-to-end performance of the service, this end-to-end performance reflecting customer's requirements."

Customer is a part and parcel of the process that provides the service in the telecommunication industry. So, it becomes all the more important for a service provider to concentrate on the various dimensions of service quality from the customers' perspective. Measurement of QoS parameters helps customers to make informed choices. With the rapidly changing technologies, customer needs and increased customer awareness, it becomes imperative to review the Quality of Service parameters for mobile communication.

Quantitative perception about QoS helps in understanding the state of the market which further expedites the process of improving the quality of services rendered by the operator in the presence of competition.

The main goal of the telecom industry is to make people well connected and measurement of QoS parameters and thereafter analyzing various ways to improve it will certainly pave the way for achieving this mission.

There are broadly two approaches for regulating the Quality of services of a telecom network.

The first approach is based on the power of publicity and level of competition existing in the telecom industry. This may be termed as "*Encouragement Approach"* since the encouragement to boost the quality of services comes from competition among various incumbent players.

The second Approach which may be employed may be the "Enforcement approach" wherein a set of QoS parameters and benchmarks are defined which the service

[6]Quality of Service in Telecommunication by A.P. Oodan et. Al.

providers need to comply with. Standards may be set at the individual level as well as the aggregate level for penalties to be imposed on no-compliance.

2.2 Quality of Services in selected Countries

This chapter attempts to assess the level of functional service quality in various countries in accordance with the regulators' benchmarks. The performance indicators for telecom services related to Quality of Service reported by various countries including Australia, Brazil, Canada, Egypt, France, Germany, India, Indonesia, Italy, Malaysia, New Zealand, Nigeria, Pakistan, South Africa, Turkey, United Kingdom, United States of America and others are given below.

1. Australia[7]

The Quality of Service in Australia is essentially measured in terms of Customer Service Guarantee (CSG) Standards. The CSG Standard sets minimum service standards for Consumer Service Providers (CSPs) in installing and repairing standard telephone services and meeting appointments for residential and small business customers. A Consumer Service Provider (CSP) is exempt from complying with a performance standard for a service if the CSP supplies a customer with more than five services. If a CSP fails to meet the minimum performance standards, compensation may be payable to the customer.

In addition, formal CSG performance benchmarks are established by the Telecommunications (Customer Service Guarantee – Retail Performance Benchmarks) Instrument (No. 1) 2011 and apply to the qualifying carriage service providers.

The CSG performance benchmarks are set at 90 per cent for:

- new connections in urban, major rural, minor rural and remote areas (national)
- in-place connections in all areas (national)

[7]https://www.acma.gov.au/-/media/Research-and-Analysis/Report/pdf/Communications-report-2016-17-pdf.pdf?la=en

- fault rectifications in urban, rural and remote areas (national)
- Appointment -keeping in all areas (national).

If a CSP fails to meet a CSG performance benchmark, the ACMA may take compliance action, including the option to issue the CSP with an infringement notice in certain circumstances.

As on 30 June 2017, there were 6.22 million services subject to the CSG Standard, compared to 6.11 million at 30 June 2016—a decline of 1.8 per cent (Table 2.1). This decline may have resulted from the growth in the number of consumers without a fixed-line telephone service in the home and consumers using voice services provided by VoIP. QCSPs are those that have 100,000 CSG services or more, as at the last day of the preceding financial year. For 2016–17, the QCSPs were Telstra, Optus, iiNet and Dodo.

Table 2.1 Services subject to the CSG Standard by provider

	2012	2013	2014	2015	2016	2017
iiNet	493	418	443	473	427*	391
Optus	913	850	799	808	977	1,079
iPrimus	103	101	95	49	57	42
Telstra	5,608	5,314	5,038	4,757	4,361	4,489
Dodo	n/a	n/a	159	249	283	223
Total	**7,117**	**6,683**	**6,534**	**6,336**	**6,105**	**6,224**

n/a=not applicable. n/p=not provided.

**TPG acquired iiNet in September 2015.*

Note: Numbers may not add up due to rounding

Source: CSP data.

Table 2.2 sets out the CSG Standard time frames within which service providers must connect telephone services and complete fault repairs. The CSG Standard time frames vary according to the location of the customer and, in the case of connections, whether infrastructure is readily available and whether there is an existing in-place connection.

Table 2.2 CSG Standard time frames (working days)

Community	In-place connection	New service connection		Fault repair
		Close to infrastructure	Not close to infrastructure	
Urban	2	5	20	1
Major rural	2	10	20	2
Minor rural	2	15	20	2
Remote	2	15	20	3

Note: 'Urban' is defined as communities with 10,000 or more people, 'major rural' is defined as communities with between 2,500 and 10,000 people, 'minor rural' is defined as communities with a population greater than 2,500 but less than 10,000 people, 'minor rural' is defined as communities with a population greater than 200 but not more than 2,500 people, 'remote' is defined as communities with up to 200 people. These are defined in the Telecommunications (Customer Service Guarantee – retail Performance Benchmarks) Instrument (No. 1) 2011.

Source: CSG Standard.

Connections

Table 2.3 shows CSP performance in 2016–17 in meeting CSG Standard time frames for new service connections and for in-place service connections. Any compliance action for non-compliance with annual performance benchmarks is considered by the ACMA after the reporting period.

A 'new service connection' is the connection of a standard telephone service to premises where there is the need for additional work to be completed (for example, cabling) before a service can be connected. This excludes in-place service connections where there has been a previous working CSG service that is available for reconnection or reactivation by the CSP.

Table 2.3 Percentage and number of new service and in-place connections provided within CSG Standard time frames, 2016–17

		New service*				In-place service*
		Urban areas	Major rural areas	Minor rural areas	Remote areas	All areas
iiNet	%	95.6	98.7	98.5	100.0	94.8
	No.	37,109	3,517	1,659	46	16,553
Optus	%	98.0	99.4	99.4	NQCSP	n/a
	No.	304,374	3,160	1,246	NQCSP	n/a
Dodo	%	100.0	100.0	100.0	NQCSP	100.0
	No.	18,090	1,359	985	NQCSP	58,309
Telstra	%	94.4	95.0	94.1	92.6	96.6
	No.	223,538	23,062	11,517	622	199,817

*NQCSP=Not a qualifying CSP (QCSP); n/a=not applicable; *Service connections*

Note 1: Commencing in 2012–13, QCSPs were required to record the number of requests that were not complied with within the applicable performance time frames and to identify if the CSP's failure to do so was wholly or partly attributable to one or more acts or omissions by another CSP.

Note 2: Location-specific thresholds are met if a QCSP supplied 10,000 or more CSG services in urban areas, 1,000 or more CSG services in major rural areas, 1,000 or more CSG services in minor rural areas, 500 or more CSG services in remote areas.

Source: CSP data.

Appointments & Fault Repairs

Table 2.4 shows CSP performance in 2016–17 in meeting the CSG Standard for fault repair time frames and appointment-keeping.

Table 2.4 Percentage and number of faults repaired within CSG Standard time frames and appointment-keeping performance, 2016–17

		Fault repairs			Appointments*
		Urban areas	Rural areas	Remote areas	All areas
iiNet	%	98.3	97.8	100.0	100.0
	No.	48,953	8,918	43	36,545
Optus	%	96.2	95.8	NQCSP	99.2
	No.	151,391	1,169	NQCSP	202,050
Dodo	%	100.0	100.0	NQCSP	100.0
	No.	46,986	11,667	NQCSP	137,461
Telstra	%	93.3	92.1	92.5	96.2
	No.	385,547	128,627	2,229	488,122

*NQCSP=Not a qualifying CSP (QCSP); *New service connections and fault repairs.*

Note 1: Commencing in 2012–13, QCSPs were required to record the number of requests that were not complied with within the applicable performance time frames and to identify if the CSP's failure to do so was wholly or partly attributable to one or more acts or omissions by another CSP.

Note 2: Location-specific thresholds are met if a QCSP supplied 10,000 or more CSG services in urban areas, 1,000 or more CSG services in rural areas, 500 or more CSG services in remote areas.

Source: CSP data.

Table 2.5 shows the number of new service and in-place connections, fault repairs and appointments for iiNet, Optus, iPrimus, Telstra and Dodo over the previous two financial years (2015–16 and 2016–17). Most notably, the number of in-place connections by iiNet more than halved (57 per cent) in the year to June 2017. iiNet advised this decline reflects a technology shift away from in-place connections to full utilisation of Enhanced Vacant Unbundled Local Loop (eVULL).

Prior to November 2015, iiNet was not fully utilising the eVULL process and, as such, all naked connections before the said date were connected as in-place connections and then transferred to ULL. Currently, all naked connections are being connected directly via the eVULL process. This shift has driven the declining trend of in-place connection requests evident in the data.

Table 2.5 Number of new service connections, in-place connections and fault repairs requested at the national level and appointment-keeping performance, 2015–16 and 2016–17.

	iiNet		Optus		Dodo		Telstra	
	2015–16	2016–17	2015–16	2016–17	2015–16	2016–17	2015–16	2016–17
New service connections	66,181	44,119	271,436	315,318	27,444	20,460	347,657	274,013
In-place connections	40,325	17,465	n/a	n/a	87,778	58,309	267,258	206,904
Fault repairs	66,644	58,976	168,403	158,562	83,642	58,692	602,492	555,429
Appointments†	45,240	36,545	225,249	203,613	106,186	137,461	476,419	507,329

n/a=not applicable.

† New service connections and fault repair.

Source: CSP data.

CSG Standard payments

As a result of failing to meet CSG Standard time frames during 2016–17, CSPs made compensation payments to customers as shown in Table 2.6.

Table 2.6 Volume and value of compensation payments made by CSPs to customers, 2015–16 and 2016–17.

	2015–16		2016–17	
	Volume	$ (million)	Volume	$ (million)
iiNet	18,434	1.22	11,964	1.11
Optus	32,093	4.88	27,625	4.10
iPrimus	1,678	0.09	2,692	0.12
Telstra	153,310	9.29	198,514	14.58
Dodo	16,038	0.69	13,934	0.91
Total	**221,553**	**16.17**	**254,729**	**20.82**

Note: Numbers may not add up due to rounding.

Source: CSP data.

Compensation payments totalled $20.80 million for 2016–17, compared to $16.17 million during 2015–16—an increase of 29 per cent.

2. Brazil[8]

Quality - Mobile Telephony

Anatel monitors the quality of the Personal Mobile Service (SMP), the Mobile Telephony, through operational indicators. The 14 indicators defined in the Quality Management Regulation (RGQ-SMP), demonstrate the performance of providers with more than 50 thousand accesses in four aspects: user reaction, network, data connection and service.

Each indicator has an associated goal that corresponds to the minimum performance established for the adequate quality of service in each geographic area defined in the regulation.

Table 2.7: Indicators defined in the Quality Management Regulation (RGQ-SMP)

GROUP OF INDICATOR	MNEMONIC	INDICATOR	DESCRIPTION	META IN FORCE	APPLICABILITY OF THE GOAL
USER REACTION	**SMP1**	Claims Fee	Complaints received from the operator by total accesses in operation	**≤ 1%**	Numbering Area (popular DDD)
	SMP2	Anatel Complaint Rate	Complaints received at Anatel on the total carrier	**≤ 2%**	Numbering Area (popular DDD)
NETWORK - VOICE	**SMP3**	Call Completion Rate for the Telephone Answering Center	Attendance of the calls destined to the Service Center of the provider, in each Period of Greater Movement	**≥ 95%**	Numbering Area (popular DDD)
	SMP4	Completion Rate (of calls)	Summoned calls completed from total attempts, in each Period of Greater	**≥ 67%**	Numbering Area (popular DDD)

[8] http://www.anatel.gov.br/dados/controle-de-qualidade/controle-telefonia-movel

			Movement		
	SMP5	Traffic Channel Allocation Rate	Access to the voice channels of the total number of attempts, in each Period of Greater Movement	**≥ 95%**	Numbering Area (popular DDD)
	SMP6	Text Message Delivery Rate	Text messages delivered to the user within 60 sec	**≥ 95%**	Numbering Area (popular DDD)
	SMP7	Connection Drop Rate	Connection drops of the total number of completed calls in each Period of Greater Movement	**<2%**	Numbering Area (popular DDD)
DATA CONNECTION	**SMP8**	Data Connection Rate	Established connections of the total data connection attempts, from 10h - 22h	**≥ 98%**	Federative unit
	SMP9	Data Connection Drop Rate	Connection drops from total data connections established, from 10:00 a.m. to 10:00 p.m.	**<5%**	Federative unit
	SMP10	Contracted Instant Transmission Rate Guarantee	Represents the speed measured at each measurement. It must reach at least 40% of the contracted transmission rate in 95% of the measurements carried out,	**≥ 95%**	Federative unit

			from 10h - 22h		
	SMP11	Average Contracted Transmission Fee Guarantee	Represents the average of all measurements performed on the operator's network. It should reach at least the percentage described to the right of the contracted transmission rate in the measurements carried out, from 10h - 22h	**≥ 80%**	Federative unit
ATTENDANCE	**SMP12**	Attendant Attendance Rate in Self-Service Systems	Calls answered by operators up to 20 sec	**≥ 90%**	Numbering Area (popular DDD)
	SMP13	User Response Rate	Replies to service requests or requests for information received within 5 business days	**≥ 95%**	Numbering Area (popular DDD)
	SMP14	Customer Service Fee	Face-to-face calls made up to 30 minutes	**≥ 95%**	Numbering Area (popular DDD)

Considering the valid indicators of all the providers monitored during the year 2017, the percentage of meeting the goals of the service reached 69.8%. This result was slightly higher than in the years of 2013 (68.8%), 2014 (68.8%), 2015 (68.5%) and 2016 (69.6%).

Comparing the performance of the providers, Datora Mobile proportionally presented the highest percentage of goals met, with 91.4% of a total of 672 valid indicators referring to the geographic area where it is in actual operation, followed by Claro (75, 4% of 11,678), Vivo (72.9% of 11,679), Porto Seguro Conecta (72.6% of 828), Nextel (72.5% of 8,852), Algar Telecom (72,1% of 1,275), Tim (66.0% of 11,413), Oi (62.3% of 11,647) and Sercomtel (58.2% of 194).

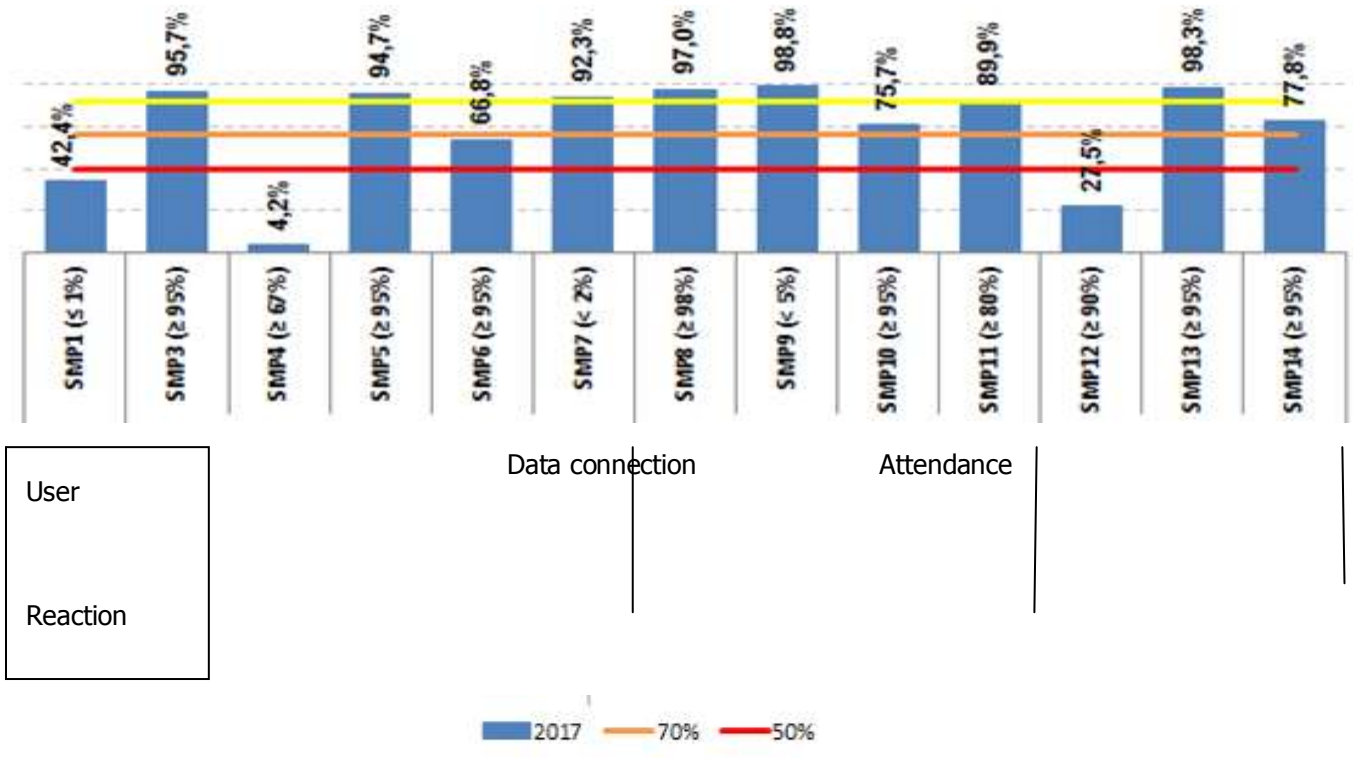
The providers Datora Mobile and Porto Seguro Conecta are mobile telephony providers (SMP), authorized by means of Virtual Network (whose model of rendering is known in the world as Mobile Virtual Network Operator - MVNO). Providers of this type do not have their own radiofrequency and network, thus, to provide the service they use these resources from other providers.

The indicators with the lowest percentage of goals achieved during this year were SMP4 - Call completion rate (4.2%), SMP12 - Self-service attendant attendance rate (27.5%) and SMP1 - Rate of Claims (42.4%).

Chart: 2.1

Achievement of Targets by Indicator

(Jan-Dec. 2017)



3. Canada[9]

The Canadian Radio-television and Telecommunications Commission (CRTC) is a public organisation in Canada with mandate as a regulatory agency for broadcasting and telecommunications. According to Telecom Regulatory Policy CRTC (Canada Radio-television and Telecommunication Commission) 2009-304:-

The Commission directed the ILECs (Incumbent Local Exchange Carriers) to continue reporting on an interim basis the results of the following retail QoS indicators for non-forborne areas:

- indicator 1.2 – Installation Appointments Met for urban, rural, and community areas (indicator 1.2);[2]
- indicator 2.1 – Out-of-Service Trouble Reports Cleared (within 24 hours for urban and rural and within 5 working days for "remote") for urban, rural, and community areas (indicator 2.1); and
- indicator 2.2 – Repair Appointments Met for urban, rural, and community areas (indicator 2.2)

Table 2.8[10]

Indicator	Standard
1.2A Installation Appointments Met – Urban	90% or more
1.2B Installation Appointments Met – Rural	90% or more
1.2C Installation Appointments Met – Community*	90% or more
2.1A Out-of-Service Trouble Reports Cleared within 24 Hours – Urban	80% or more
2.1B Out-of-Service Trouble Reports Cleared within 48 Hours – Rural	80% or more
2.1C Out-of-Service Trouble Reports Cleared "Remote" within 5 Working Days – Community*	90% or more
2.2A Repair Appointments Met – Urban	90% or more
2.2B Repair Appointments Met – Rural	90% or more
2.2C Repair Appointments Met – Community*	90% or more
*Community-level reporting applies only to Northwestel.	

[9] http://crtc.gc.ca/recherche-search/default.aspx?_ga=1.65631726.1731485000.1471859452&n=e&q=retail+quality+of+service&s=date&statistics_id=bbb1a920-6552-4fc0-bde8-bb819dda7286

[10] http://www.crtc.gc.ca/eng/archive/2009/2009-304.htm#a3

Retail QoS summary for various service providers of Canada is given below:-

MTS Retail QoS Summary for 2nd Quarter 2017

Table 2.8

Telco	Indicator	Group	Standard	Apr 2017	May 2017	Jun 2017
MTS	1.2B	Rural	90% or more	98.7%	97.4%	97.8%
MTS	2.1B	Rural	80% or more	91.4%	82.2%	84.9%
MTS	2.2B	Rural	90% or more	92.9%	93.8%	91.4%

TELUS (TCC) Retail QoS Summary for Jan-Sep 2017

Table 2.9

Telco	Indic	Group	Standard	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17
TCC	1.2A	Urban	90% or more	90%	93%	100%	93%	95%	80%
TCC	1.2B	Rural	90% or more	94%	94%	92	91%	94%	94%
TCC	2.1A	Urban	80% or more	92%	100%	94%	92%	93%	93%
TCC	2.1B	Rural	80% or more	90%	93%	91%	92%	94%	94%
TCC	2.2A	Urban	90% or more	98%	97%	97%	96%	92%	100%
TCC	2.2B	Rural	90% or more	92%	91%	91%	92%	92%	93%

BELL Canada Retail QoS Summary for Jan-June 2017

Table 2.10

Telco	Indic	Group	Standard	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17
Bell Canada	1.2A	Urban	90% or more	N/A	N/A	N/A	N/A	N/A	N/A
Bell	1.2B	Rural	90% or	94	96	95	96	96	97

Canada			more						
Bell Canada	2.1A	Urban	80% or more	N/A	N/A	N/A	N/A	N/A	N/A
Bell Canada	2.1B	Rural	80% or more	72	73	73	78	78	82
Bell Canada	2.2A	Urban	90% or more	N/A	N/A	N/A	N/A	N/A	N/A
Bell Canada	2.2B	Rural	90% or more	93	92	93	94	95	95

Saskatchewan Telecommunications (SaskTel) - Retail QoS Indicators Summary for 2nd Quarter 2017

Table 2.11

Telco	Indicator	Group	Standard	April	May	June
SaskTel	1.2A Installation Appointment Met	Urban	90% or more	100	100	100
SaskTel	1.2B Installation Appointment Met	Rural	90% or more	100	100	100
SaskTel	2.1A Out-of-Service Trouble Reports Cleared within 24 Hours	Urban	80% or more	90	85	83
SaskTel	2.1B Out-of-Service Trouble Reports Cleared within 48 Hours	Rural	80% or more	80	80	81
SaskTel	2.2A Repair Appointments Met	Urban	90% or more	94	94	98
SaskTel	2.2B Repair Appointments Met	Rural	90% or more	96	97	97

Northwestel Inc- Retail QoS Indicators Summary for 2nd Quarter 2017

Table 2.12

Telco	Indicator	Description	Group	Standard	Apr 17	May -17	Jun -17
Northwestel	1.2B	Inst App Met	Rural	90% or more	92	93	94
Northwestel	2.1B	oos<48hrs	Rural	80% or more	96	94	93
Northwestel	2.1C	oos<5 bus days	Remote	90% or more	94	93	91
Northwestel	2.2B	Repair App Met	Rural	90% or more	93	93	93

4. EGYPT[11]

The National Telecom Regulatory Authority of Egypt (NTRA) has the power and authority to monitor and measure the Quality of Service (QoS) provided by the three mobile operators in Egypt (Orange, Vodafone and Etisalat). NTRA is responsible for laying down the standards of QoS to be provided by mobile operators, ensuring the QoS and conducting periodical drive test surveys to protect interest of the consumers of wireless networks in Egypt.

Major QoS indicators were measured during drive test although the available NTRA QoS monitoring tools can measure other KPI's .These major KPI's give clear image on the performance of the three mobile operators for Voice and Data Services. We will be comparing different regions of Egypt with respect to voice services. The voice services compared are explained below:

- **Call Block Rate:** The percentage of unsuccessful call setup attempts to the total number of call attempts in a specified time period. Threshold value is 2 %
- **Dropped call Rate:** The percentage of calls being dropped or interrupted without the subscriber's permission after successful call establishment to the total number of successfully established attempts. Threshold value for dropped call rate is = 2 %

The following section compares the aforementioned Voice KPIs in various regions of Egypt.

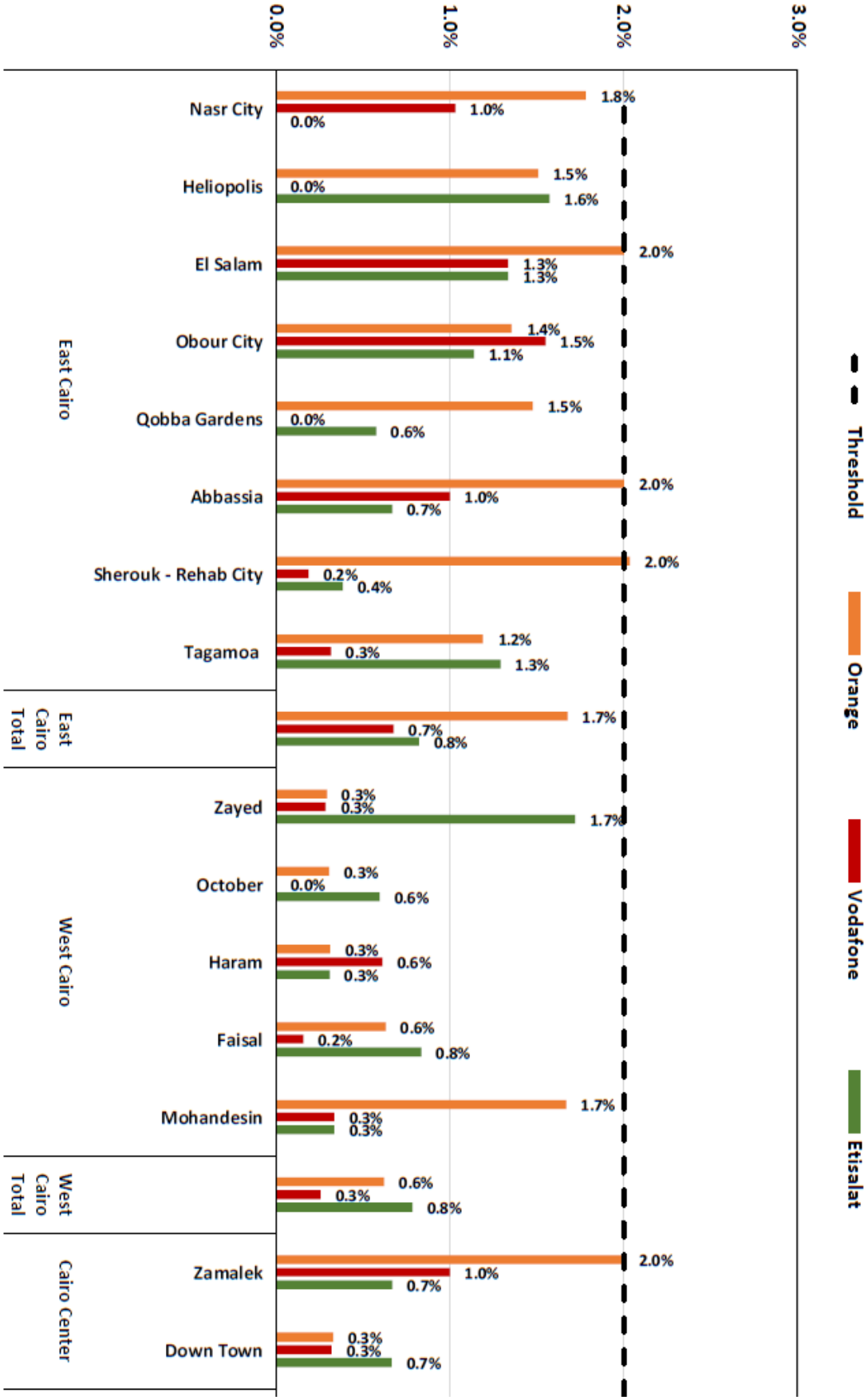
A. CAIRO

Call Block Rate (May 2017): This graph below shows network performance in terms of CALL BLOCK RATE for the mobile operators in Cairo Region divided to five main Sub regions and each Sub region is divided to

[11] http://www.tra.gov.eg/en/industry/quality-of-service/Pages/Quality-of-Services-Reports.aspx

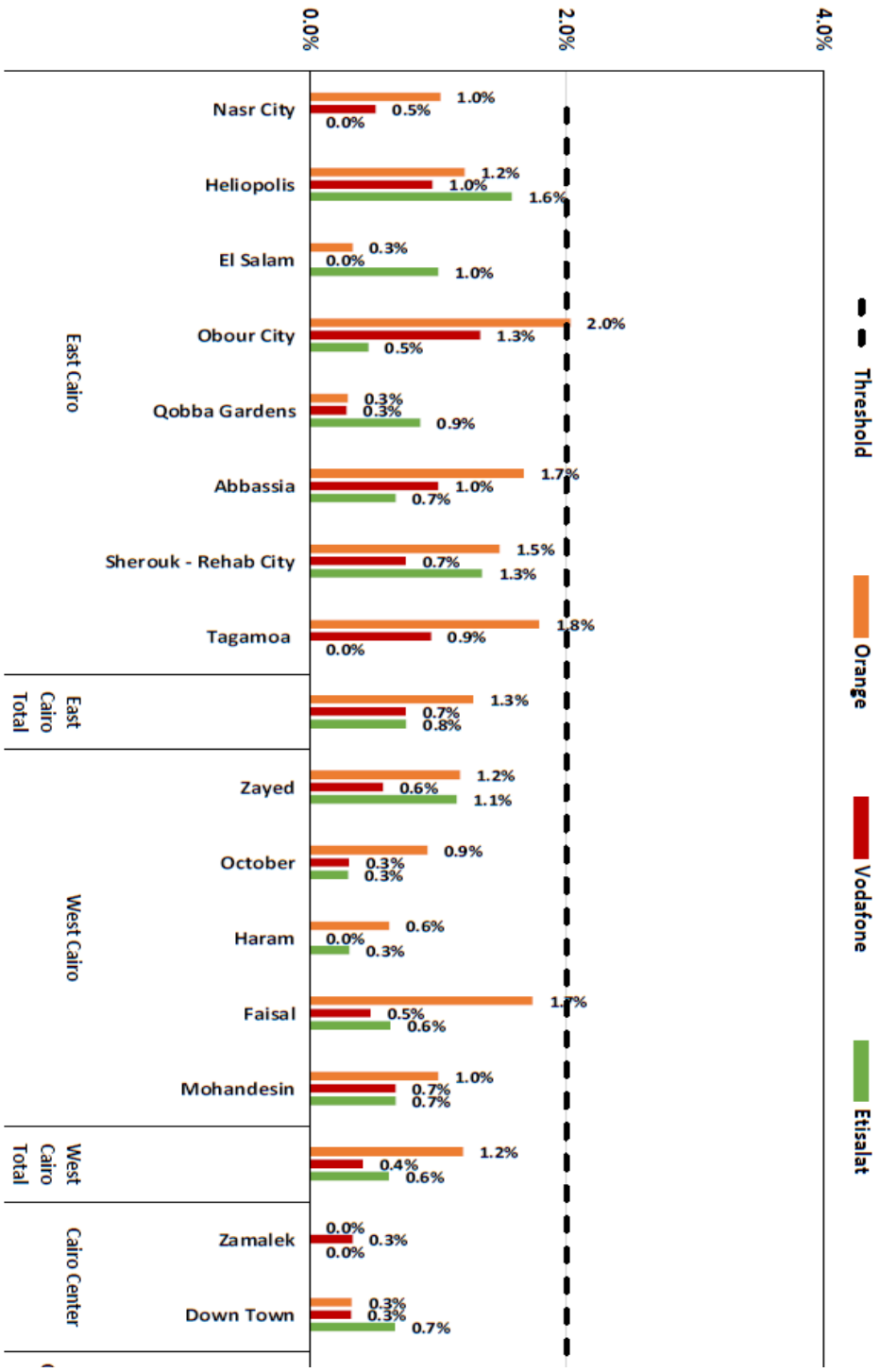
main Cities represented by the bar charts.(Threshold According to the license = 2% represented by the dashed line)

Chart 2.2



Call Drop Rate (May 2017): This graph below shows network performance in terms of CALL DROP RATE for the mobile operators in Cairo Region divided to five main Sub regions and each Sub region is divided to main Cities represented by the bar charts.(Threshold According to the license = 2% represented by the dashed line)

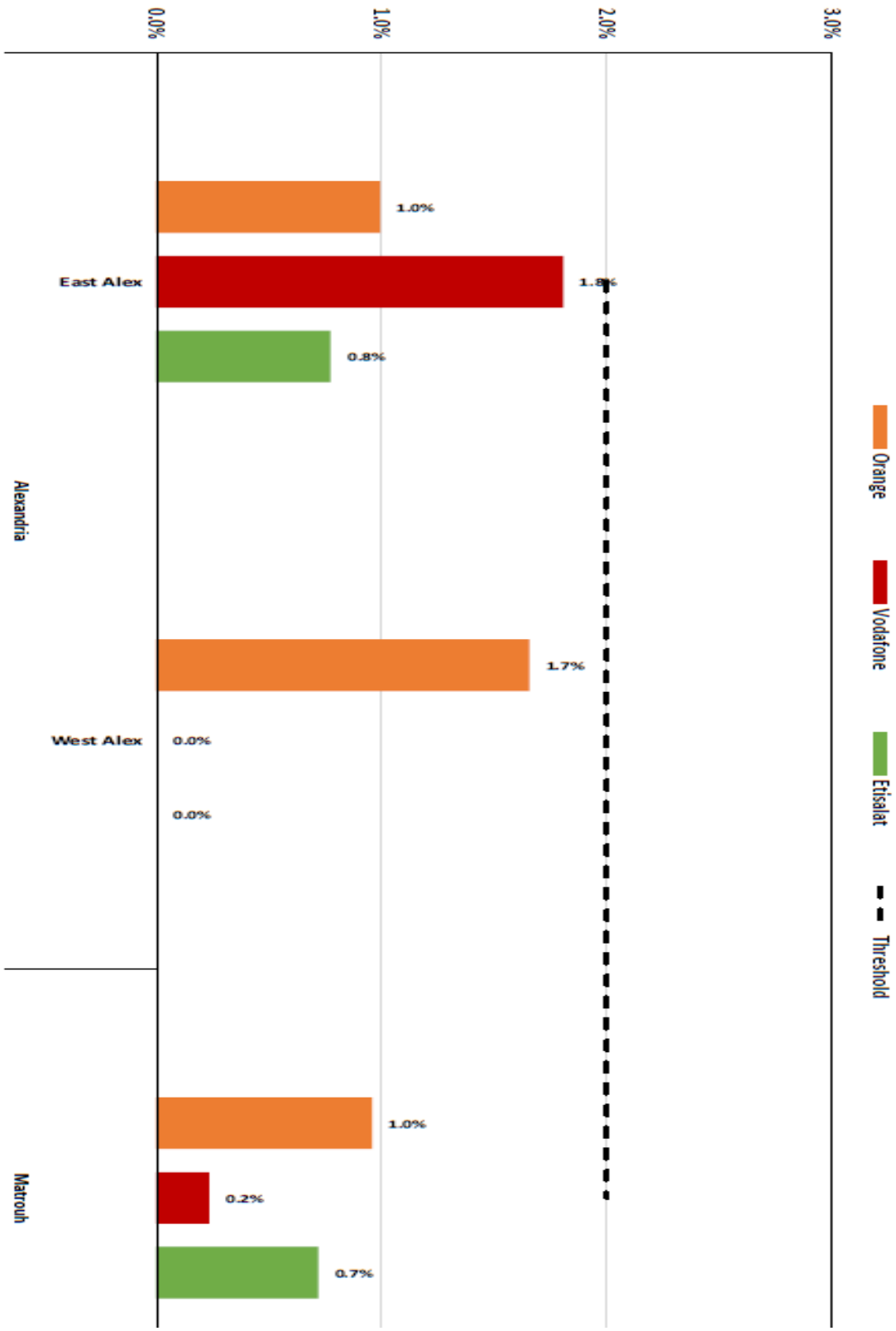
Chart 2.3



B. ALEX

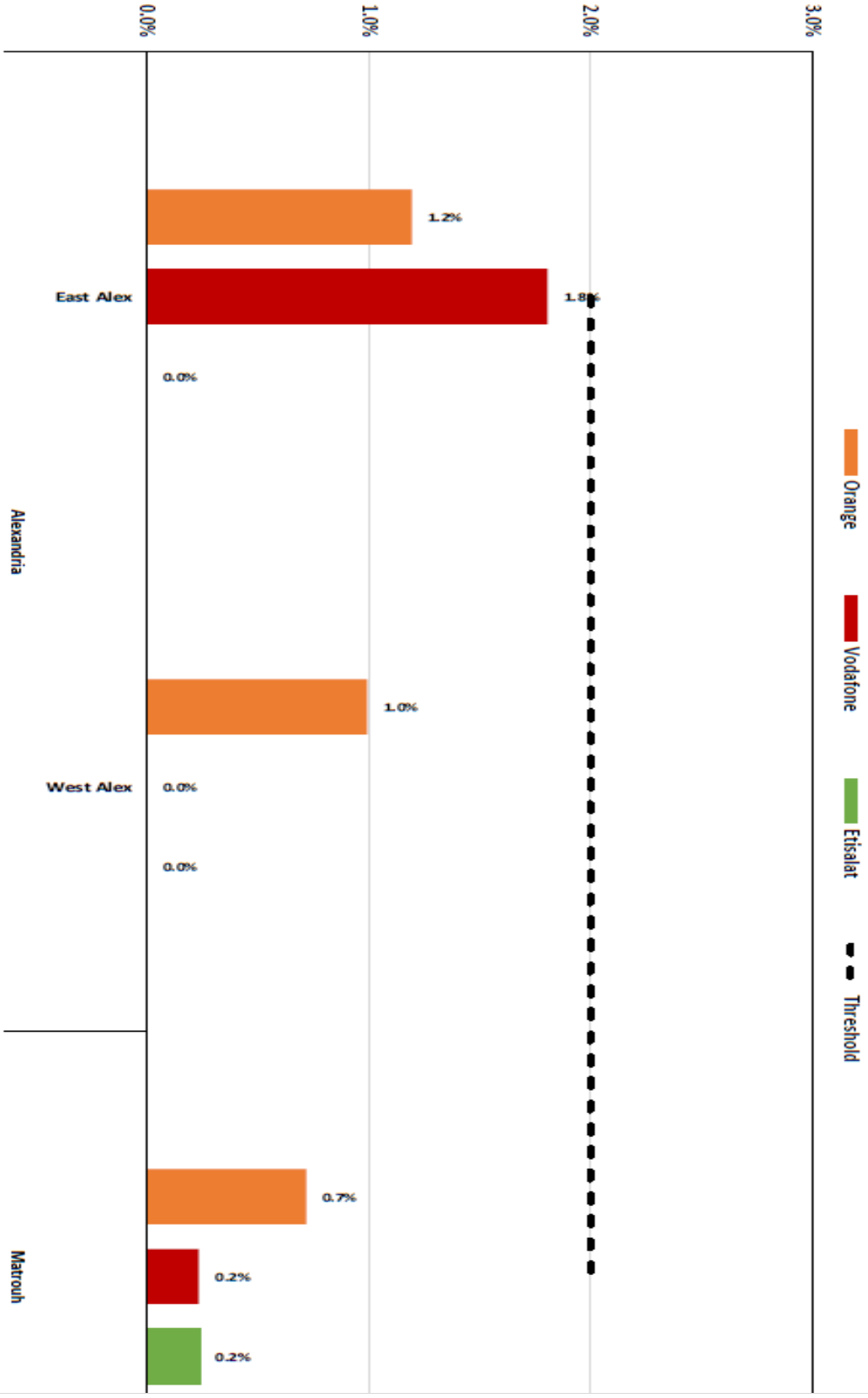
Call Block Rate (May 2017): This graph below shows network performance in terms of CALL BLOCK RATE for the mobile operators in Alex & Northern Coast Region represented by the bar charts.(Threshold According to the license = 2% represented by the dashed line)

Chart 2.4



Call drop rate (May 2017): This graph shows network performance in terms of **CALL DROP RATE** for the mobile operators in Alex & Northern Coast Region represented by the bar charts.(Threshold According to the license = 2% represented by the dashed line)

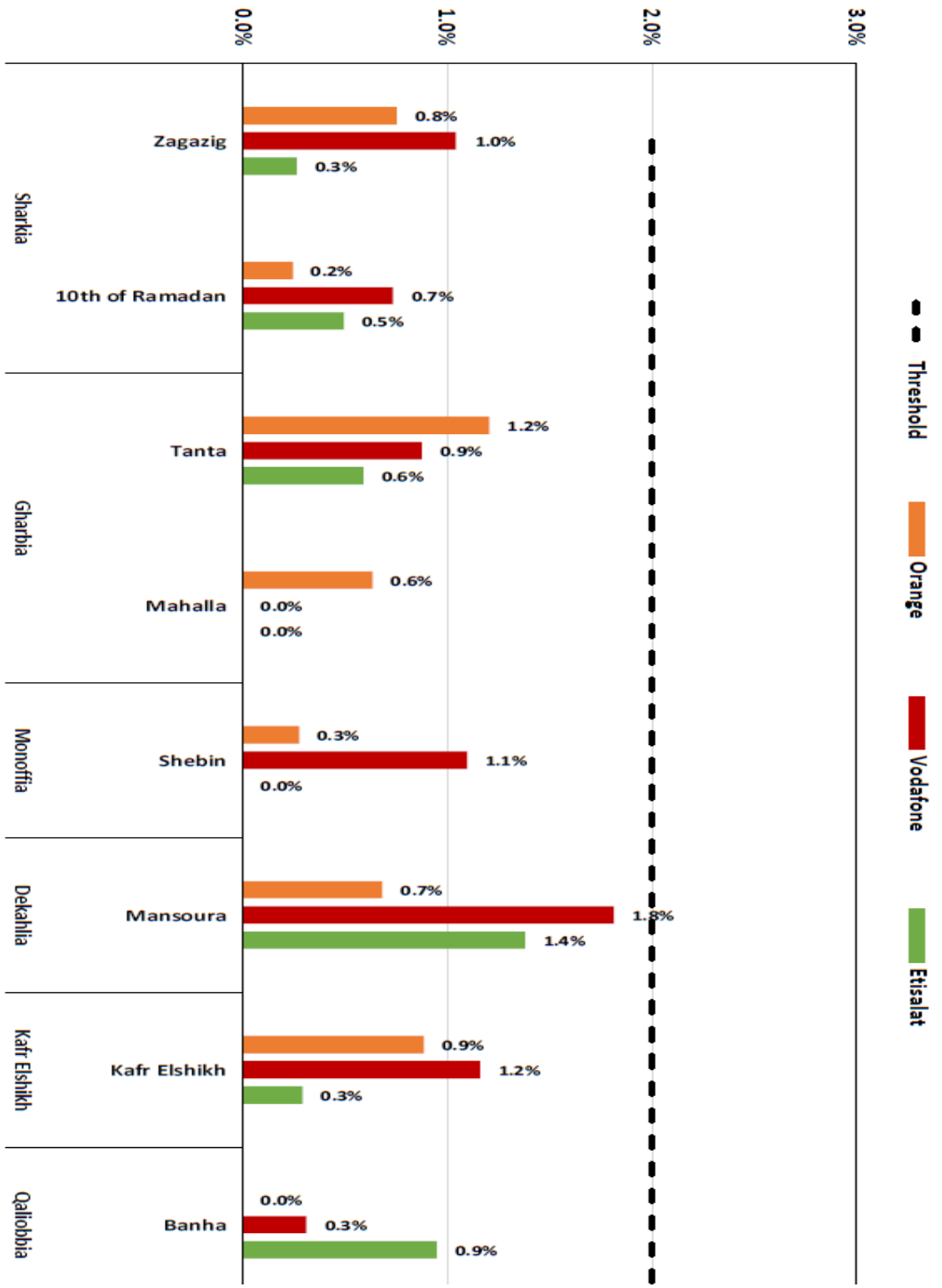
Chart 2.5



C. DELTA

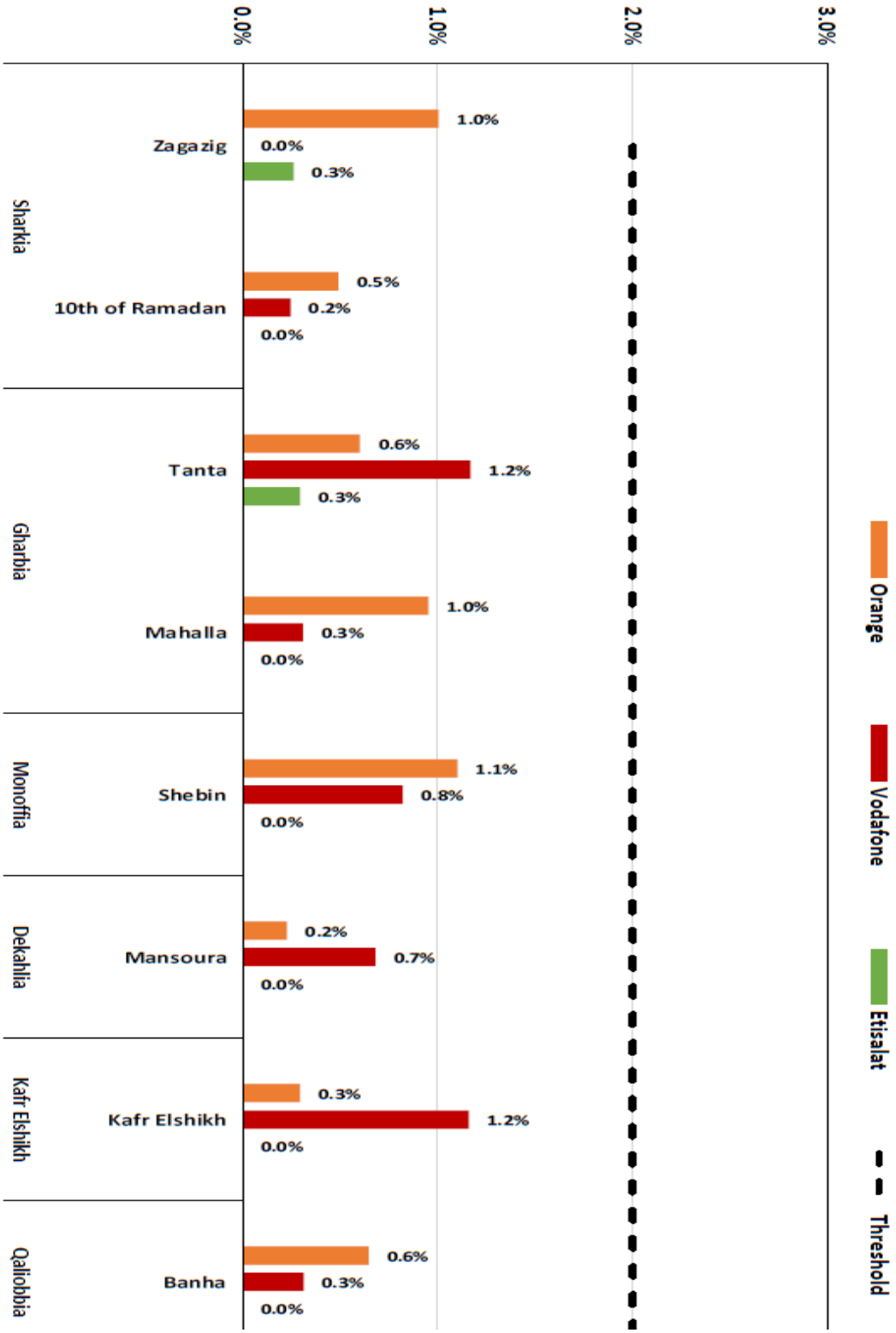
Call Block Rate (May 2017): This graph below shows network performance in terms of **CALL BLOCK RATE** for the mobile operators in Delta Region divided to eight main Sub regions and each Sub region is divided to main Cities represented by the bar charts.(Threshold According to the license = 2% represented by the dashed line)

Chart 2.6



Call Drop Rate (May 2017): This graph below shows network performance in terms of **CALL DROP RATE** for the mobile operators in Delta Region divided to eight main Sub regions and each Sub region is divided to main Cities represented by the bar charts.(Threshold According to the license = 2% represented by the dashed line)

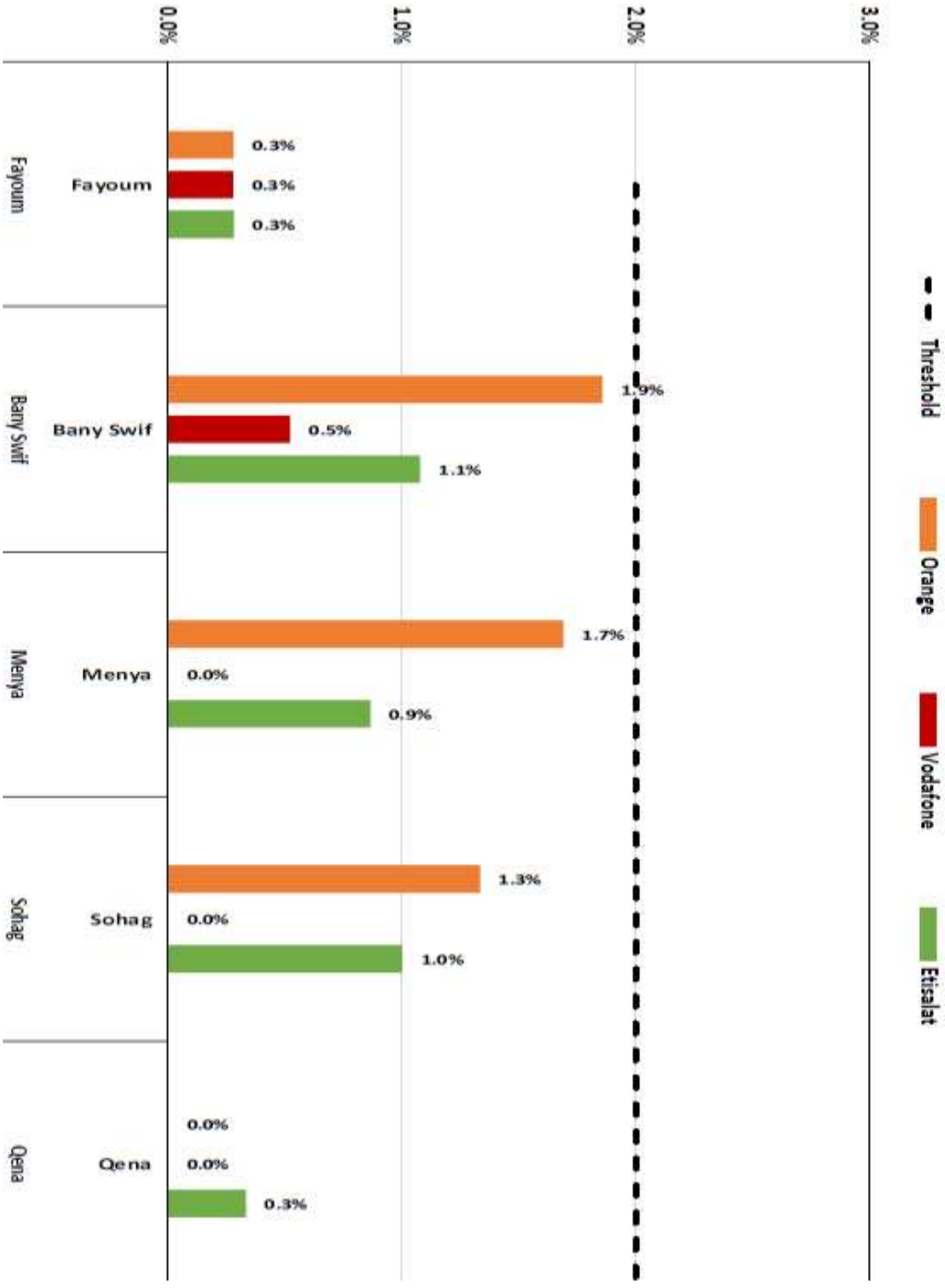
Chart 2.7



D. UPPER EGYPT REGION

Call Block Rate (May 2017): This graph below shows network performance in terms of **CALL BLOCK RATE** for the mobile operators in Upper Egypt Region divided to eight main Sub regions and each Sub region is divided to main Cities represented by the bar charts.(Threshold According to the license = 2% represented by the dashed line).

Chart 2.8



Call Drop rate (May 2017): This graph shows network performance in terms of **CALL DROP RATE** for the mobile operators in Upper Egypt Region divided to eight main Sub regions and each Sub region is divided to main Cities represented by the bar charts.(Threshold According to the license = 2% represented by the dashed line)

Chart 2.9

5. France[12]

There are five Service providers in France viz. Bouygues, Free, Numericable, Orange, SFR. Each provider uses various configuration access methods like Access to the decision xDSL or RTC, access plug to the optical fiber with coaxial termination or Access to fibre intake to the subscriber.

Summary of measures of quality of fixed telephony to the public

a.) Indicators related to access

A. Supply time for initial connection

i) Presentation

This indicator is the time measured in days, between the purchases of a subscription to a fixed electronic communications service. It incorporates the legal specificities related to each category of sale and depends on the strategy marketing of each operator. There is an incompressible withdrawal period in the case of doorstep selling, purchase on the internet or by phone lengthening of fact the connection time felt by the consumer. An operator that emphasizes sale store is able to significantly reduce connection times. The extent of this period is two cases depending on whether the line commissioning requires (or not) the intervention of a technician to the customer's home. The "lines with intervention" have generally a longer connection time than "lines without intervention" because including consideration of the availability of the customer to agree on the appointment as well Technical characteristics of the treatment process of this category of line.

Two measurement results are presented to provide an overview on time delivery connection:-

- The 50th percentile (also called median) is the time for distinguishing, below the Half of connections activated as quickly and beyond, half of the connections activated more slowly. This is the order of magnitude of the period in which applications Access is delivered on a line does not represent any particular problem;
- The 95th percentile is the time for distinguishing, below the 95% of connections activated soon and, beyond, the 5% of the connections activated more slowly. This is a period of the order of magnitude necessary to activate the difficult lines connected. The scope of measurement of this period is limited to requests from customers and not really activated takes to not consider requests that ultimately could not be met (non-eligibility issue art,

[12] https://www.arcep.fr/uploads/tx_gspublication/rapport-QoS-acces-services-fixes-S2-2016-avril2017.pdf

retraction of the client) by the operator. It should also be noted that supply changes and relocations involving guests staying at the same operator and maintaining the same access technology (xDSL, optical fiber to the home, fiber optic with coaxial termination PSTN) are not taken into account.

ii) Measurement results

Preliminary remarks:

- Concerning access to optical fibre with coaxial termination, Bouygues Telecom is a no 'Line without intervention ";

- Similarly for access to the optical fiber to the home, Free, Orange and SFR did not publish

"Line without intervention" since all the connections made today requires the intervention of a technician;

- Orange is the only operator to offer PSTN access

The histogram represents the full 50th percentile of connection time, that is to say the delay in below which are activated 50% of the faster connections. The shaded histogram represents the 95th percentile of connection time, that is to say the period below which are activated 95% of the faster connections.

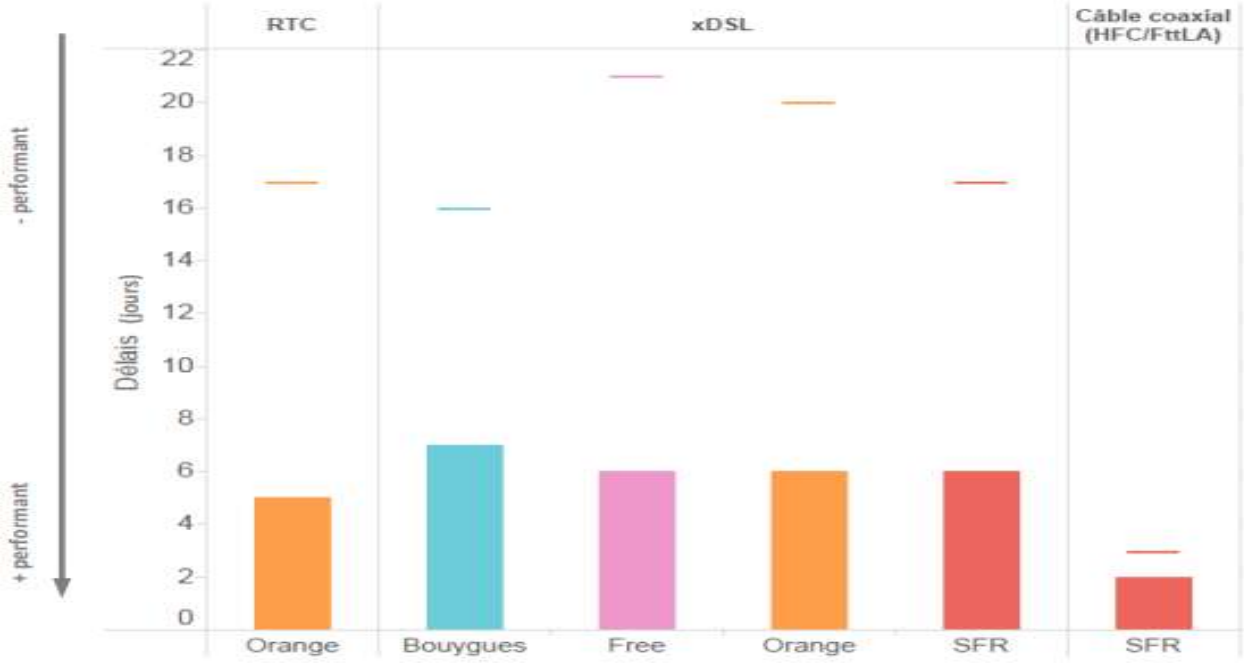


Chart 2.10: Connection time without Site intervention

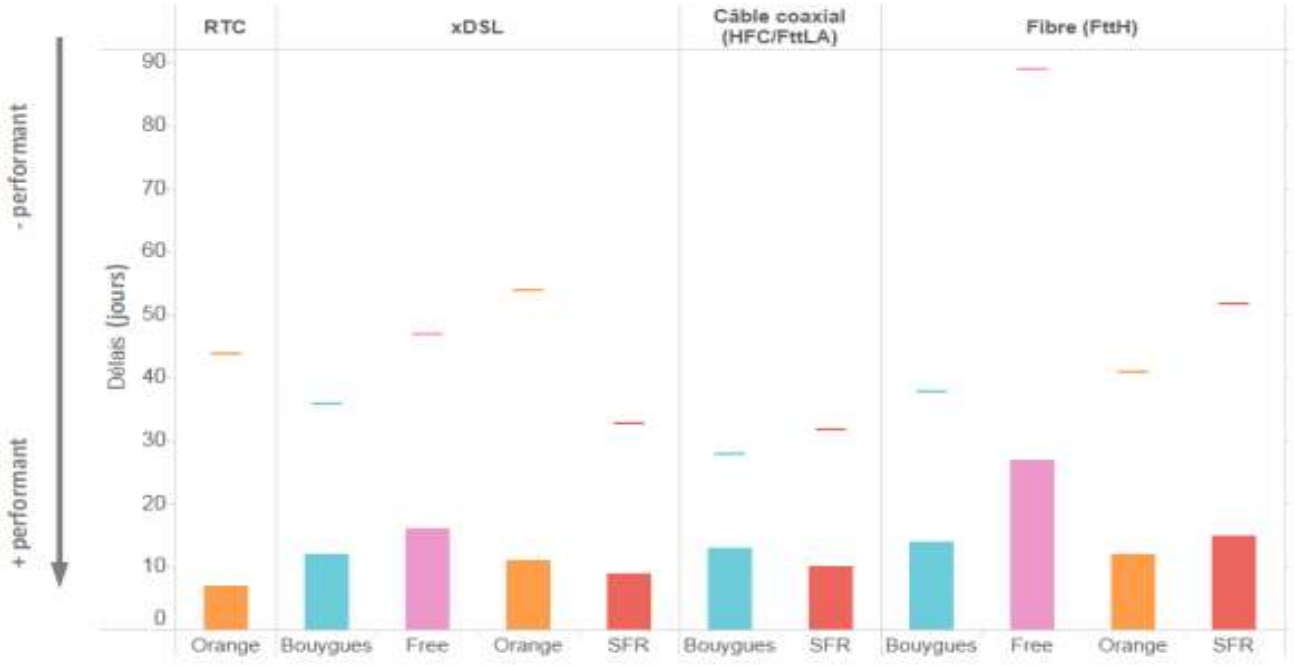


Chart 2.11: Connection time with on Site intervention

B. Failure rate reported by access line during the first 30 days and beyond the first 30 days

i) Presentation

A failure is defined as a complete failure of the main services provided on fixed networks (internet, TV and telephony for xDSL access, fiber to the home and fiber optical termination with coaxial; telephone for PSTN access). This indicator reports failures that subscribers to report their customer service operator and which are not resolved in of the call. The measures distinguish defects which occur on this side and beyond the first 30 days setting the service line. They are, in fact, significantly more numerous in early life line. When generic failures (affecting multiple clients), only end users who call customer service to report the failure is recognized. The box failures are included in the scope of the measure.

ii) Measurement Results

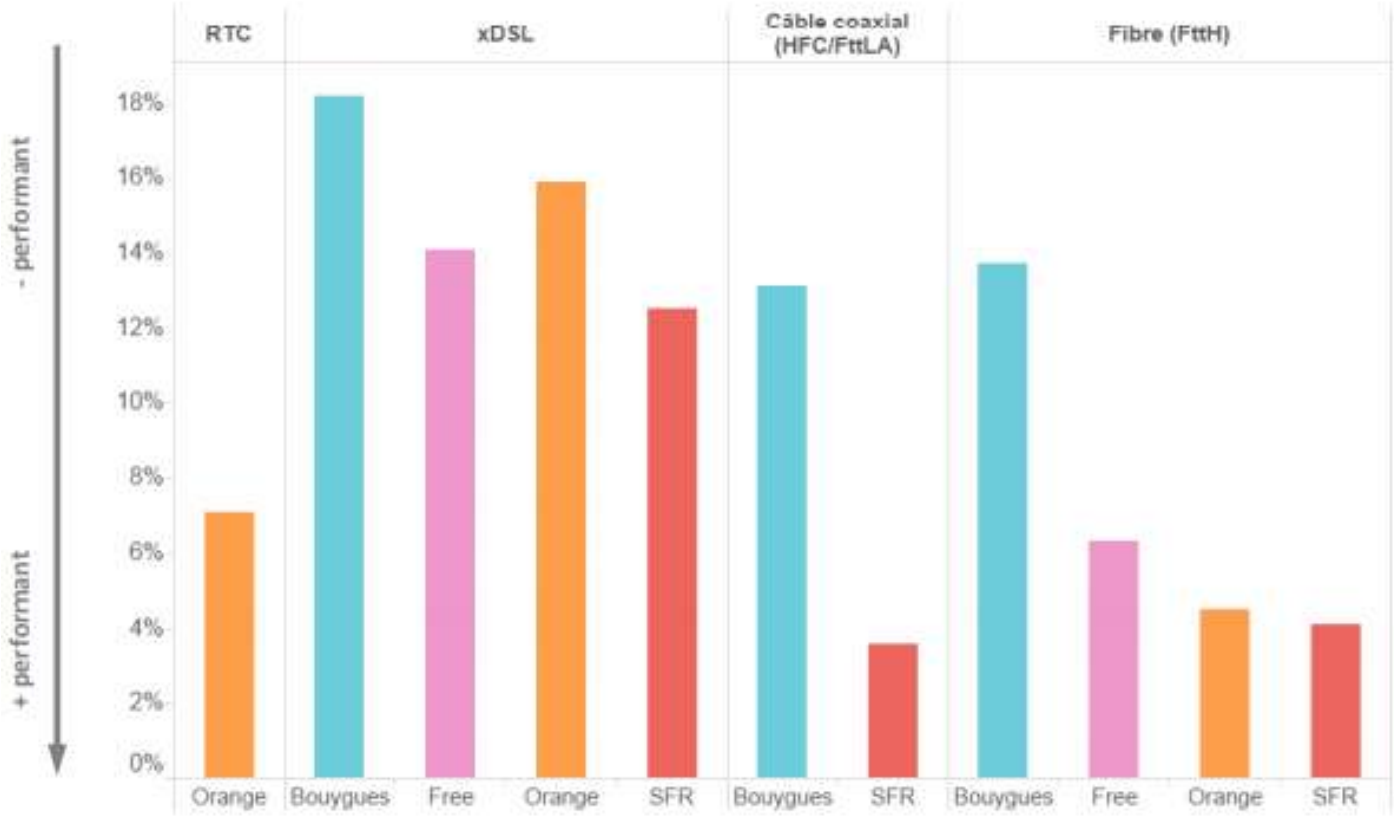


Chart 2.12: Failure rate during the first month after commissioning

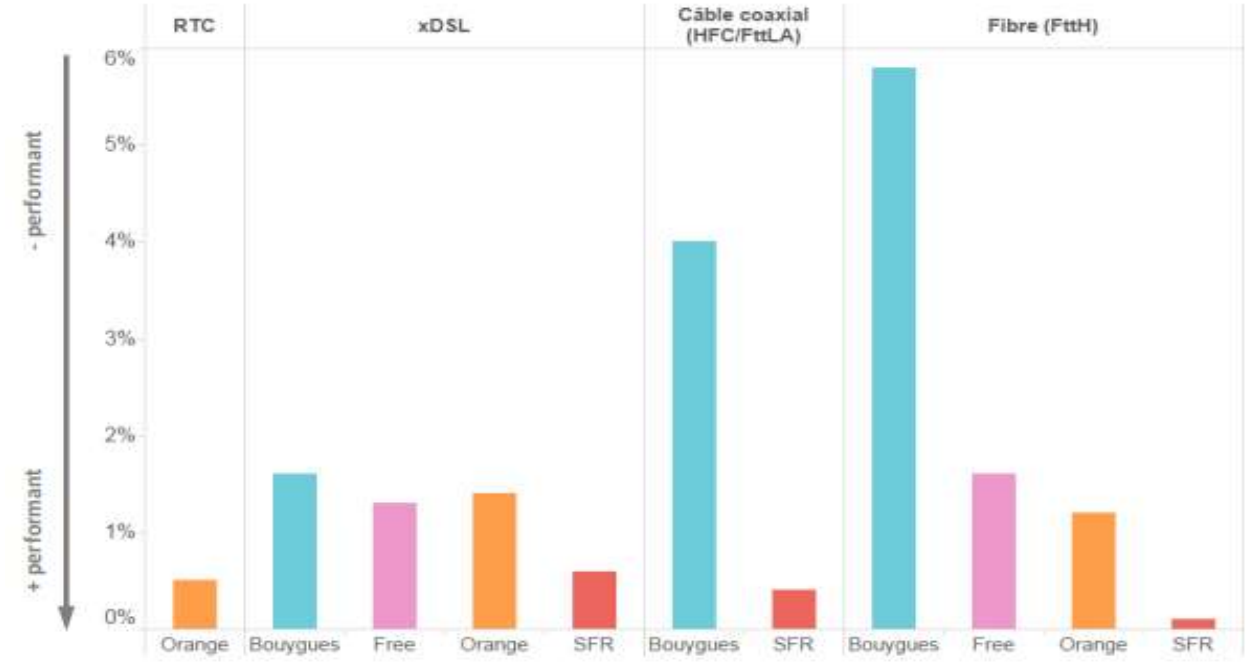


Chart 2.13: Reported failure rate monthly from the 2nd month after commissioning

C. Time to repair a failure

i) Presentation

Defining a retention failure to measure this indicator includes both failures that lead to service disruption and degradation of service (speed, pixilation, voice quality). The services selected for this measure are also larger as those for measuring the failure rate; these are the main services (internet, TV, telephone IP telephony or simply PSTN) as well as auxiliary services (email, VOD, e-mail). This indicator reflects the efficiency of the technical support to repair faults Technical reported by end users to the operator's customer service. The measures of this indicator differ, firstly, the time after which 95% of failures are repaired and, on the other hand, the percentage of failures repaired within 48 hours. Delays measured corresponds to the time between the date of notification of the failure and the when it is resolved. As such, deficiencies were not reported by.

ii) Measurement Results

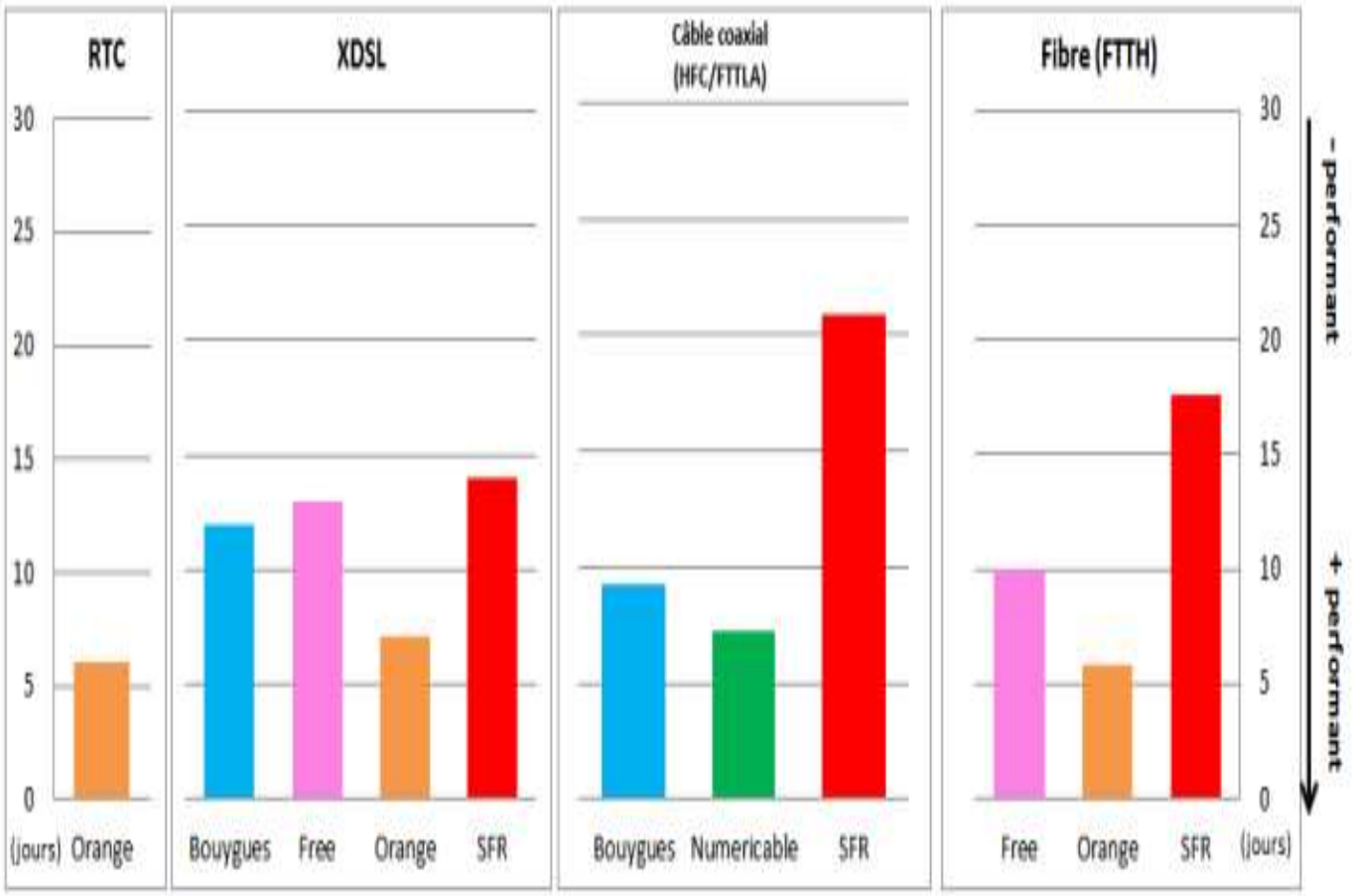


Chart 2.14: time after which 95% of failures are repaired

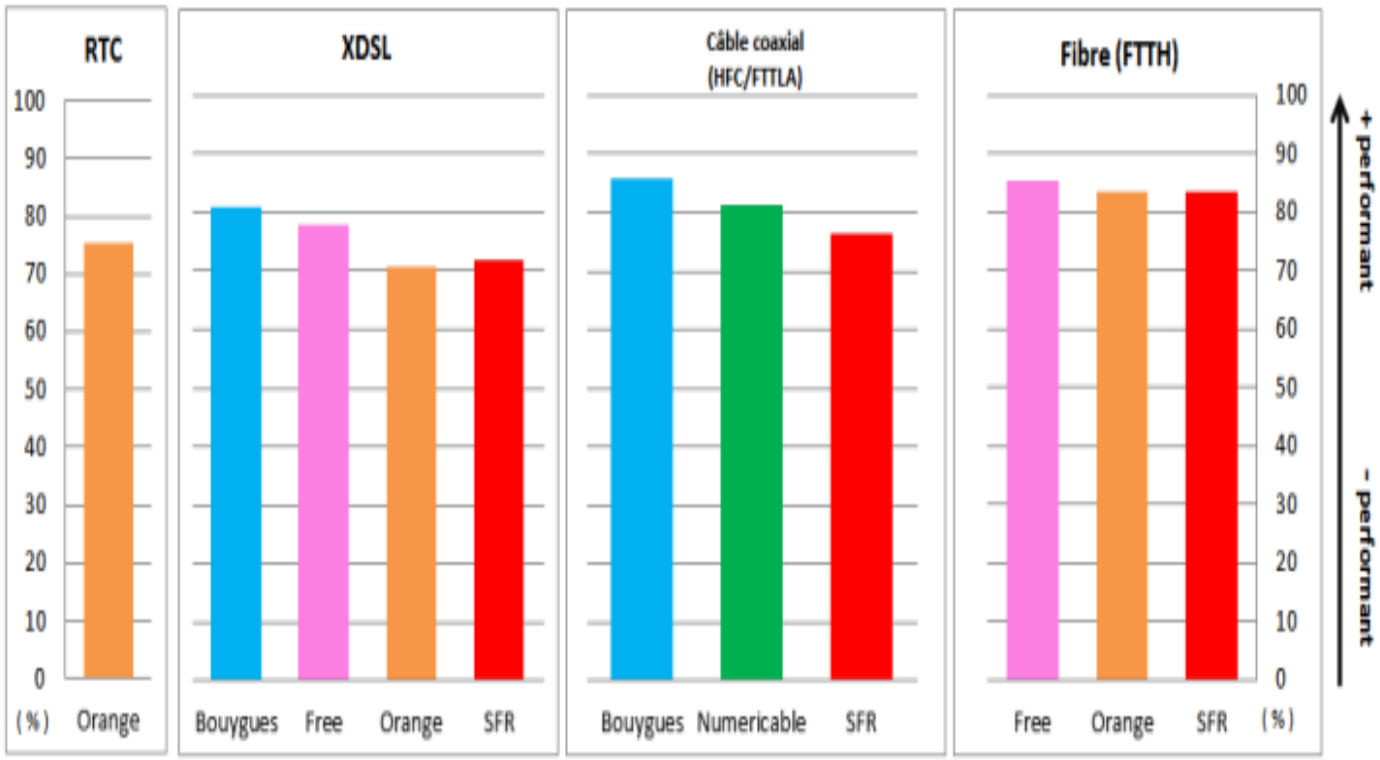


CHART 2.15: FAILURE RATE REPAIRED WITHIN 48 HOUR

D. RESPONSE TIME BY THE OPERATOR'S CUSTOMER SERVICES

i) Presentation

This indicator reflects the waiting time between the release of IVR and taking over by counsellor calls made to the technical assistance customer service the operator. Among these calls, only those related to technical reasons for which the client has been in connection with an account manager are recorded. Calls to business reason and lost calls before linking with a customer service are not included in the measurements.

ii) Measurement Results

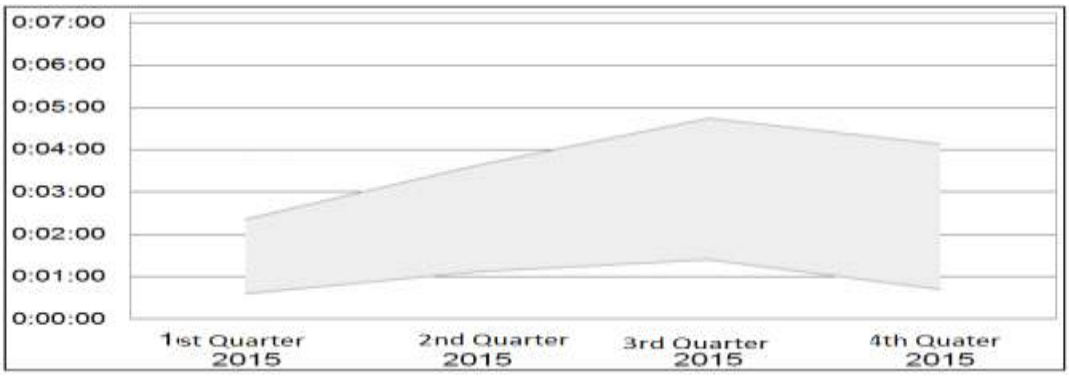


Chart 2.16: Change in the mean time won by a counsellor

E. Complaints about billing accuracy

i) Presentation

This indicator corresponds to complaints of erroneous bills (counted several calls times, inaccurate amounts,...) which have been the subject of a contact by the customer, irrespective of the mode of contact (email, call, mail), and have been regularized. This measure excludes contacts on the invoice legibility problems. The complaint rate measured is the number of complaints the criteria presented below above relative to the number of invoices issued on the observation period. The related adjustments to a service failure, commercial gestures, cashing incidents, errors corrected with the operator's initiative not being a customer contact are not taken into account in this indicator.

ii) Measurement results

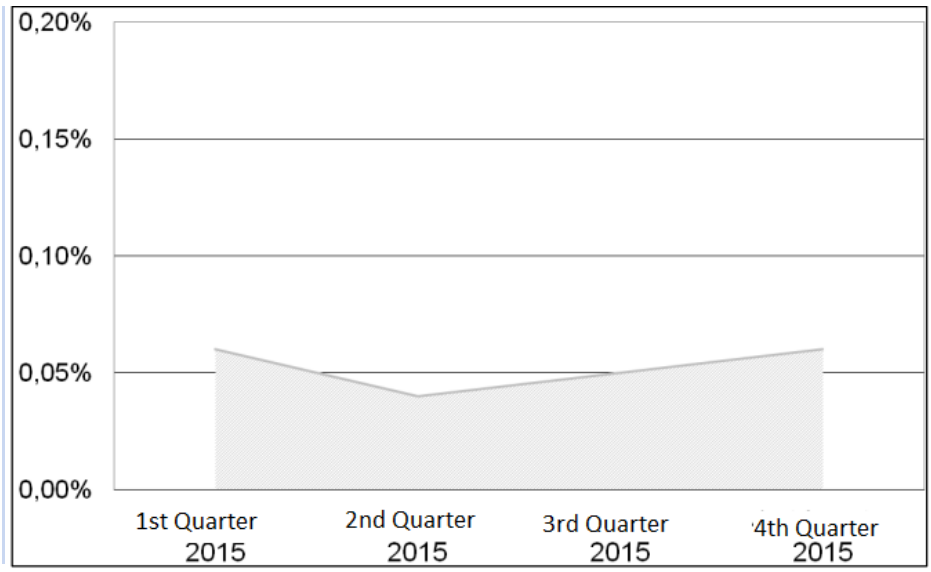


Chart 2.17: Evolution of the rate of complaints on billing accuracy

6. GERMANY[13]

The **Federal Network Agency** (German: *Bundesnetzagentur* is the German regulatory office for electricity, gas, telecommunications, post and railway markets.

[13]https://www.bundesnetzagentur.de/SharedDocs/Downloads/EN/BNetzA/PressSection/ReportsPublications/2016/2015AnnualReport.pdf?__blob=publicationFile&v=2

1. Enquiries and complaints: The Bundesnetzagentur's Consumer Advice service focuses on providing practical information for consumers and on the implementation and enforcement of customer rights in accordance with the German Telecommunications Act. In 2014 the Consumer Advice service received around 64,000 enquiries and complaints in connection with telecommunications.

The main subjects of enquiries and complaints concerning telecommunications were switching providers and relocation issues. Half of all enquiries received by the Consumer Advice service related to these topics. Many consumer enquiries also related to contractual matters, invoices issued by telecommunications providers, the provision of basic telephone services, and the allocation and administration of telephone numbers. This is shown in the following Chart.

Chart 2.18

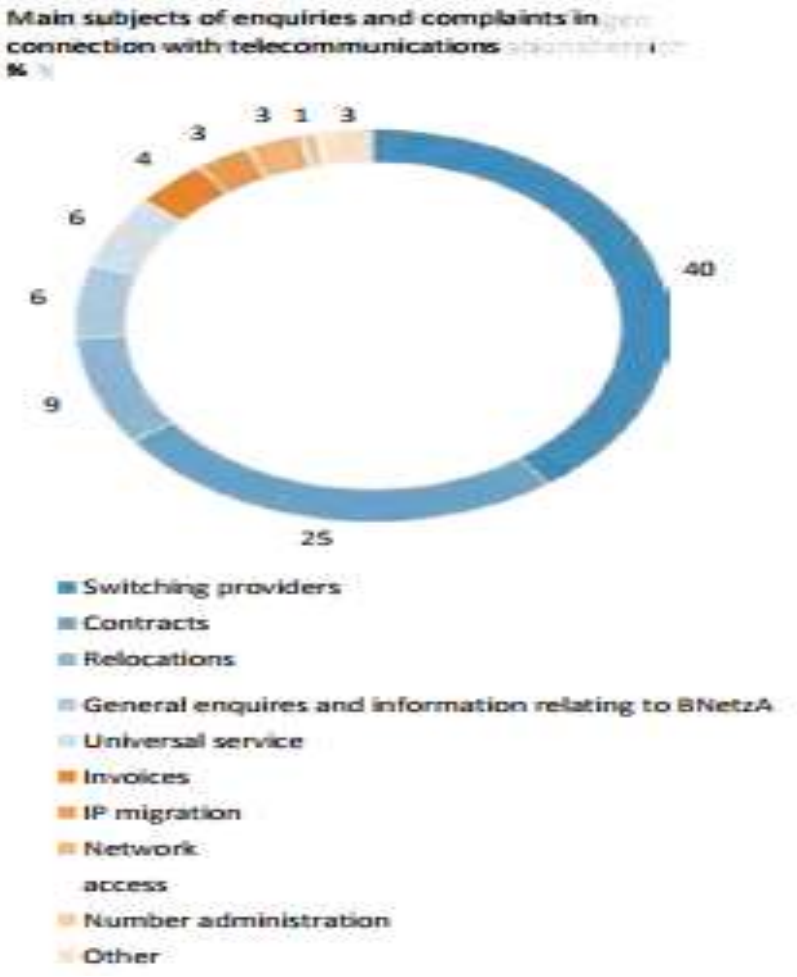


Chart 2.19

2. The Bundesnetzagentur conducted a study on the service quality of broadband access lines from 1 July 2013 and 31 December 2013.

The quality of Internet access service was evaluated by use of an integrated measuring concept that used a combination of two components:

1. A measurement platform (consisting of monitoring units at 26 sites throughout Germany and several server systems which served as, among other things, counter test points for the data measurements) conducted measurements in a fully-controlled measuring environment.

2. The (upload and download) data transfer rate of fixed Internet access services was however measured as part of the measurements conducted by end customers. For this, the Bundesnetzagentur invited end customers

between June and December to measure the data transfer rate of their Internet connection using special web-based software. The fundamental accuracy of the values obtained using the software application was monitored on an on-going basis by randomly comparing the values generated by the two methods. At total of 375,412 end-customer measurements were conducted for the 2013 study; of these measurements 153,216 valid individual measurements were included in the analysis.

As a first step, the study examined the parameters which decisively influence the quality of Internet access service for the end customer, namely

- the actual data transfer rate of the connection and
- the traffic management in the concentration network and core network.

The actual data transfer rate depends on the individual end customer's Internet access connection and was therefore measured by individual end customer software measurement via the website. By contrast, the traffic management is influenced by the network design and service profile settings of the provider and requires detailed measurements. Thus, these parameters where measured by use of the measurement platform. Traffic management aspects investigated are the temporal distribution of the actual data transfer rates, transfer times and the usability of standard applications.

As a second step, the study examined the question whether the data transfer rate changes when, in the case of bundled products consisting of Internet, VoIP and IPTV, other products are used at the same time as the Internet connection. To determine this specific test measurements were conducted on the measurement platform: The data transfer rate of the Internet connection was first ascertained and then compared with the data transfer rate that can be achieved when VoIP and/or IPTV are used at the same time that data is being transmitted.

Following this, the question was addressed how end users can be put in a position where they themselves can reliably check the performance of their

own broadband access. Selected technical methods for end-user measurements were compared with one another.

7. INDIA[14]

TYPE 1: Quality of Service Performance of Wireless Service Providers

Part 1: 2G Wireless Services

Table 2.13

S. No.	Parameters	Benchmark	
A	**Network Service Quality Parameters:**		
1	**Network Availability**		
(i)	Base Station Accumulated downtime (not available for service)	≤ 2%	On average basis over a period of one quarter
(ii)	Worst affected Base Station due to downtime	≤ 2%	On average basis over a period of one quarter
2	**Connection Establishment (Accessibility)**		
(i)	Call Set-up Success Rate and Session Establishment Success rate for Circuit Switch Voice or VoLTE as applicable (within licensee's own network)	≥ 95%	On average basis over a period of one quarter
(ii)	SDCCH/ Paging Chl. Congestion/ RRC Congestion	≤ 1%	On average basis over a period of one quarter

[14] http://www.trai.gov.in/sites/default/files/Performance_Indicator_Reports_28Sep2017.pdf

(iii)	TCH, RAB, E-RAB Congestion	≤ 2%	On average basis over a period of one quarter
3	**Connection Maintenance (Retain ability)**		
(i)	Network QoS DCR Spatial Distribution Measure [Network_Q_{SD}(90,90)]	≤ 2%	On percentile basis over a period of one quarter
(ii)	Network QoS DCR Temporal Distribution Measure [Network _Q_{TD}(90,90)]	≤ 3%	On percentile basis over a period of one quarter
(iii)	Connection with good voice quality, Circuit switched Voice Quality and Voice over LTE (VoLTE) quality	≥ 95%	On percentile basis over a period of one quarter
4	**Point of Interconnection (POI) Congestion (On individual POI)**	≤ 0.5%	On percentile basis over a period of one quarter
5	**Metering and Billing**		
(i)	Metering and billing credibility - post paid	≤ 0.1%	
(ii)	Metering and billing credibility - pre paid	≤ 0.1%	
(iii)	Resolution of billing/charging/ validity complaints	98% within 4 weeks	
		100% within 6 weeks	
(iv)	Period of applying credit/ waiver/ adjustment to customer's account from the date of resolution of complaints	within 1 week of resolution of complaint	
6	**Response time to the customer for assistance**		
(i)	Accessibility of call centre/ customer care	≥95%	
(ii)	%age of calls answered by the operators (voice to voice) within 90 seconds	≥ 95%	
7	**Termination / closure of service**		

(i)	%age requests for Termination / Closure of service complied within 7 days	100% within 7 days
(ii)	Time taken for refund of deposits after closures	100% within 60 days

Part II: 3G Wireless Services

Table 2.14

S. No.	Parameters	Benchmark	
A	**Network Service Quality Parameters:**		
1	**Network Availability**		
(i)	Base Station Accumulated downtime (not available for service)	≤ 2%	On average basis over a period of one quarter
(ii)	Worst affected Base Station due to downtime	≤ 2%	On average basis over a period of one quarter
2	**Connection Establishment (Accessibility)**		
(i)	Call Set-up Success Rate and Session Establishment Success rate for Circuit Switch Voice or VoLTE as applicable (within licensee's own network)	≥ 95%	On average basis over a period of one quarter
(ii)	SDCCH/ Paging Chl. Congestion/ RRC Congestion	≤ 1%	On average basis over a period of one quarter
(iii)	TCH, RAB, E-RAB Congestion	≤ 2%	On average basis over a period of one quarter

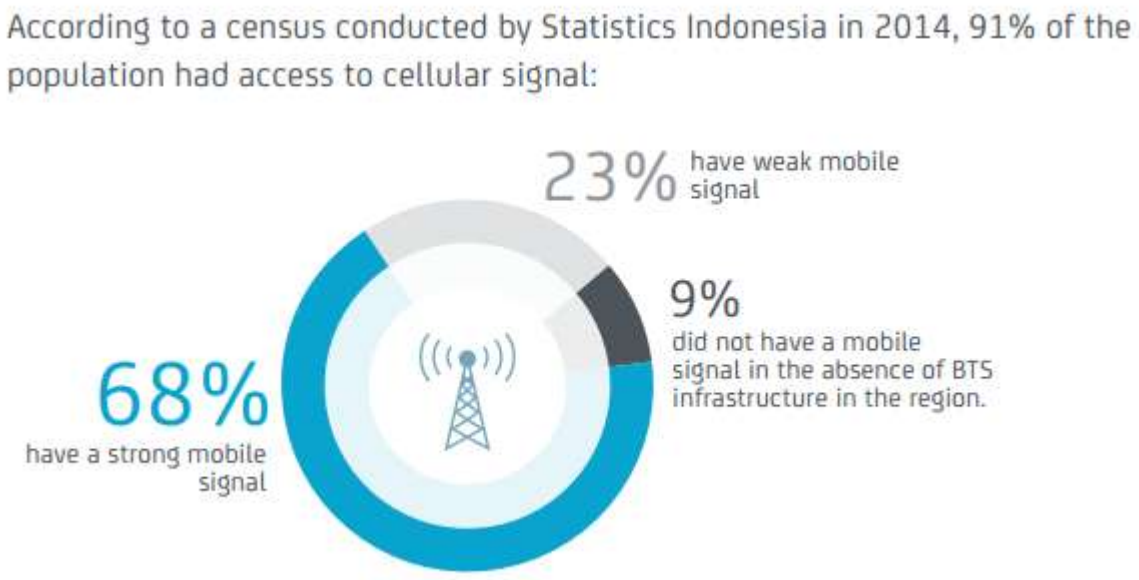
3	**Connection Maintenance (Retain ability)**		
(i)	Network QoS DCR Spatial Distribution Measure [Network_Q_{SD}(90,90)]	≤ 2%	On percentile basis over a period of one quarter
(ii)	Network QoS DCR Temporal Distribution Measure [Network _Q_{TD}(90,90)]	≤ 3%	On percentile basis over a period of one quarter
(iii)	Connection with good voice quality, Circuit switched Voice Quality and Voice over LTE (VoLTE) quality	≥ 95%	On percentile basis over a period of one quarter
4	**Point of Interconnection (POI) Congestion (On individual POI)**	≤ 0.5%	On percentile basis over a period of one quarter

8. INDONESIA[15]

Some useful statistics are given below:

a. <u>Signal coverage</u>

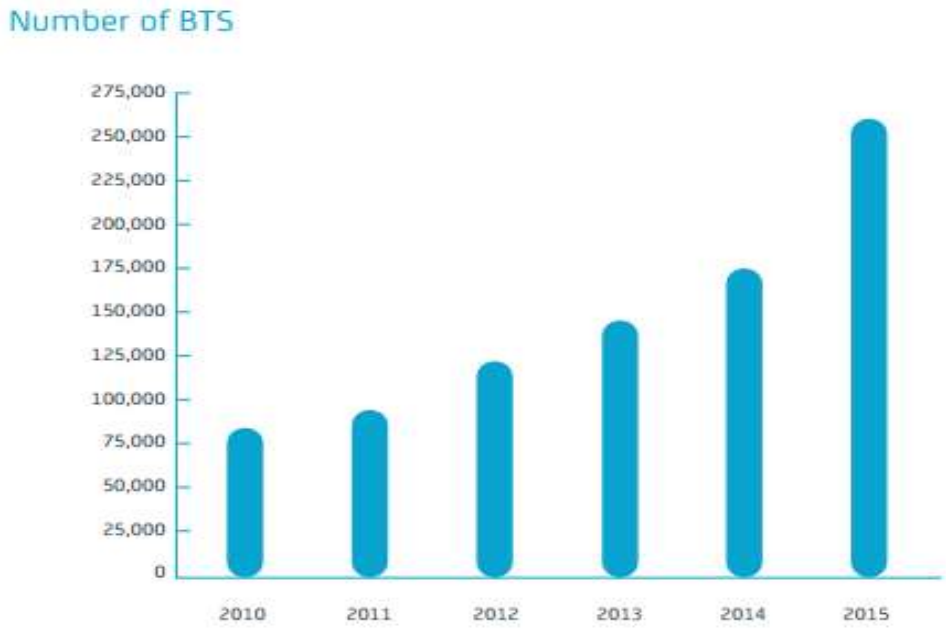
Chart 2.20



[15]http://www.atsi.or.id/wp-content/uploads/2016/02/A-Snapshot-of-the-Indonesian-Telecommunications-Industry-ATSI-2015.pdf

b. <u>Number of BTSs</u>

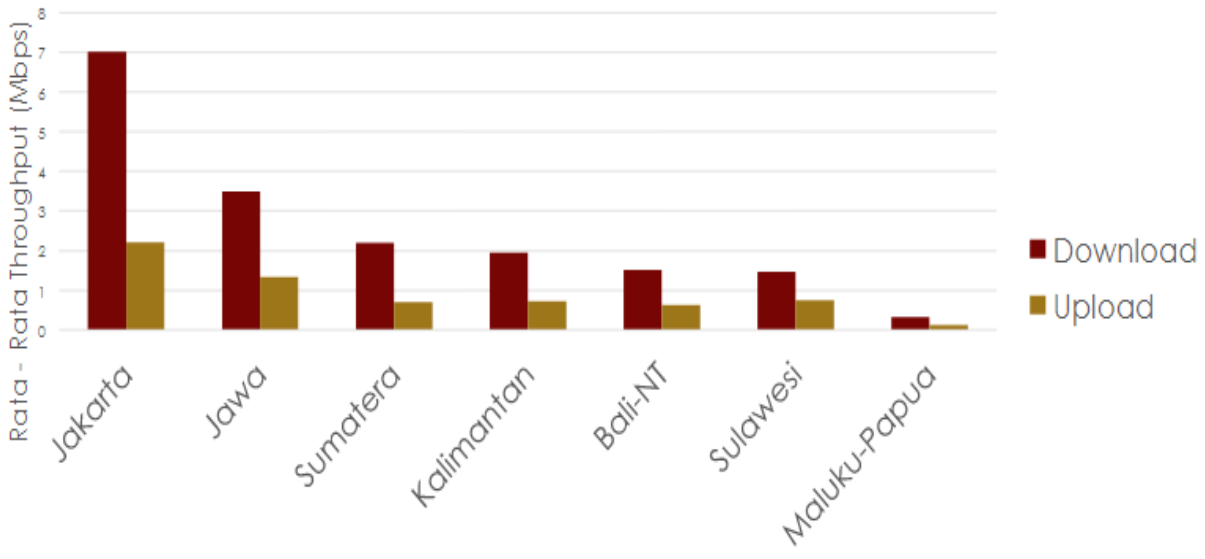
Chart 2.21



	2010	2011	2012	2013	2014	2015
Total BTS	82,457	98,042	124,003	147,795	176,332	257,429

<u>AVERAGE PERFORMANCE OF CELLULAR DATA NETWORK THROUGHPUT ACROSS INDONESIA</u>

Chart 2.22



9. ITALY

(i) M/s Telecom Italia Indicators[16]:

QOS for Mobile Customers

Table 2.15

Mobile Customers						
Indicator	Unit of measurement	Target 2015	Final results 2015	Target Status 2015 [*]	Target 2016 (1)	Target 2017
Activation time for voice service (pre-paid service) – Percentage of valid orders completed within the maximum period laid down in the contract	%	97	100	A	97	97
Activation time for voice service (post-paid service) – Percentage of valid orders completed within the maximum period laid down in the contract	%	97	100	A	97	97
Disputed charges – Ratio between the number of disputed charges in invoices received within the survey period and the number of invoices issued in the same period (post-paid service)	%	1.2	0.37	A	1.2	1.2
Disputed charges – Ratio between the number of disputed charges on pre-paid cards within the survey period and the average number of active SIM/USIM in the same period (pre-paid service)	%	1.2	0.30	A	1.2	1.2

[16] http://www.telecomitalia.com/tit/en/sustainability/performance-targets/telecom-italia-customers.html

QoS for Internet Customers

Table 2.16

Internet Customers						
Indicator	Unit of measurement	Target 2015	Final results 2015	Target Status 2015 [*]	Target 2016 (1)	Target 2017
Activation time for broadband Internet access services – Percentage of valid orders completed within the date agreed with the customer (active telephone lines)	%	95.0	97.6	A	95.0	95
Activation time for broadband Internet access services – Average time of supply (active telephone lines)	days	9	6	A	9	9
Activation time for broadband Internet access services – Percentage of valid orders completed within the date agreed with the customer (telephone lines transferred from another operator on which a broadband Internet access service was already in operation) (**)	%	//	//	//	//	95
Activation time for broadband Internet access services - Average supply time (telephone lines transferred from another operator on which a broadband Internet access service was already in operation) (**)	days	//	//	//	//	15
Broadband Internet access service faults - Ratio between the number of actual faults reported and the average number of broadband access lines (**)	%	//	//	//	//	12
Broadband Internet access service faults – Average repair time	hours	26	18	A	26	26
Broadband Internet access service faults – Percentage of completed repairs within the maximum period laid down in the contract (**)	%	//	//	//	//	92
Disputed charges – Ratio between the number of disputed charges in invoices regarding all Internet access services (received during the survey period) and the total number of invoices issued in the same period	%	1.40	0.42	A	1.40	1.4

QoS for IPTV Customers

Table 2.17

IPTV customers						
Indicator	Unit of measurement	Target 2015	Final results 2015	Target Status 2015 [*]	Target 2016 (1)	Target 2017
Disputed charges – Ratio between the number of disputed charges in invoices regarding the IPTV service (received during the survey period) and the total number of invoices containing charges regarding this service (issued during the same survey period)	%	1.0	0.45	A	No more revable service	No more revable service
Availability of IPTV service – Average unavailability of the service	hours/year	36	3	A	No more revable service	No more revable service

10. Malaysia[17]

The quality of standard[18] services is established to ensure that users are in satisfactory service levels that meet minimum and acceptable standards, as well as to protect and enhance the rights of users to obtain quality services. The quality of standard services also gives users clear and specific criteria through the services received or used can be measured.

Table 2.18

Service	QoS Items	Targets / Standards
PSTN	**Billing performance**	
	% of billing complaints in any one billing period	Shall not exceed 2% of the total number of bills issued in that billing period.
	Complaints resolved within 15 business days	90%
	Complaints resolved within 30 business days	95%
	Fulfillment of installation orders	
	Within 24 hours	80%
	Within 48 hours	90%
	Within 7 business days	100%
	General Customer Complaints	Should not exceed 50 complaints in a 12 month period.
	No of complaints per 1000 customer	
	Intra network call connection loss	Not more than 6% calls shall be lost calls

[17] https://www.mcmc.gov.my/skmmgovmy/media/General/pdf/2016-QoS-report-ver01022017.pdf
[18] https://www.skmm.gov.my/sectors/telco/quality-of-service

	Inter network call connection loss	Not more than 6% calls shall be lost calls
	Operator of Speed of Answer (emergency calls only)	
	Within 10 seconds	90%
	Within 20 seconds	100%
	Calls encounter busy signal	Less than 1% in any one busy hour
	Inter network post dialing delay	95% of attempted calls should take less than 13 seconds
	Intra network post dialing delay	95% of attempted calls should take less than 10 seconds
	Service Trouble Rate Report	
	No of service trouble reports for every 1000 lines	Should not exceed 500 reports for over a 12 month period
	Service trouble rate report over a 12 month period	Should not exceed 500 reports for 1000 lines
Service	**QoS Items**	**Targets / Standards**
Public Cellular Service	**Billing Performance**	
	% of billing complaints in any one billing period	Shall not exceed 2% of the total number of bills issued in that billing period.
	Resolved within 15 business days	90%

	Resolved within 30 business days	95%
	Endpoint Service Availability	Not less than 90% for both intra network and inter network call connection
	Dropped calls	Not more than 3% of intra network calls
	General Customer Complaints	Should not exceed 50 complaints in a 12 month period
	No of complaints per 1000 customer	
	Operator of Speed of Answer (emergency calls only)	
	Within 10 seconds	90%
	Within 20 seconds	100%
	Calls encounter busy signal	Less than 1% in any one busy hour
Service	**QoS Items**	**Targets / Standards**
Dial Up Internet Access Service	**Billing performance**	
	% of billing complaints in any one billing period	Shall not exceed 2% of the total number of bills issued in that billing period.
	Resolved within 15 business days	90%
	Resolved within 30 business days	95%
	Dial Up Internet Access Performance	

	No. of attempts for successful connection	A maximum of 3, with no more than 1 minute intervals between each of the attempts.
	Attempts made to access an IASP node within 40 seconds	95%
	Average file download time for a standard graphic or random text file of approximately 30 kilobytes	No more than 80% of modem line speed at least 95% of the time.
	General Customer Complaints	Should not exceed 50 complaints in a 12 month period
	No of complaints per 1000 customer	
Service	**QoS Items**	**Targets / Standards**
Content Applications Service	**Annual Service Availability**	No less than 99% over a 12 month period
	Billing performance	Shall not exceed 2% of the total number of bills issued in that
	% of billing complaints in any one billing period	billing period.
	Resolved within 15 business days	90%
	Resolved within 30 business days	95%
	General Customer Complaints	Should not exceed 50 complaints in a 12 month period
	No of complaints per 1000 customer	
Service	**QoS Items**	**Targets / Standards**
Public Payphone	**Service Availability**	90% shall have service availability

Service		at any one point
Service	**QoS Items**	**Targets / Standards**
Digital Leased Line Service	**Annual Service Availability**	
	Domestic Leased Line	No less than 99.90% over a 12 month period
	International Leased Line	No less than 99.80% over a 12 month period
	Fulfillment of installation orders	
	Within 2 weeks for Domestic Leased Line	90% fulfilled
	Within 4 weeks for International Digital Leased Line	90% fulfilled
	Within 3 weeks for Domestic Leased Line	100% fulfilled
	Within 5 weeks for International Leased Line	100% fulfilled
	Service Restoration Performance	
	Within 24 hours of receipt request	80% fulfilled
	Within 48 hours of receipt request	90% fulfilled
Service	**QoS Items**	**Targets / Standards**
Broadband Access Service	**Fulfillment of installation orders**	
	Within 24 hours from time and date requested by customer	80% fulfilled
	Within 48 hours from time and date requested by customer	90% fulfilled
	Within 7 days from time and date requested by customer	100% fulfilled

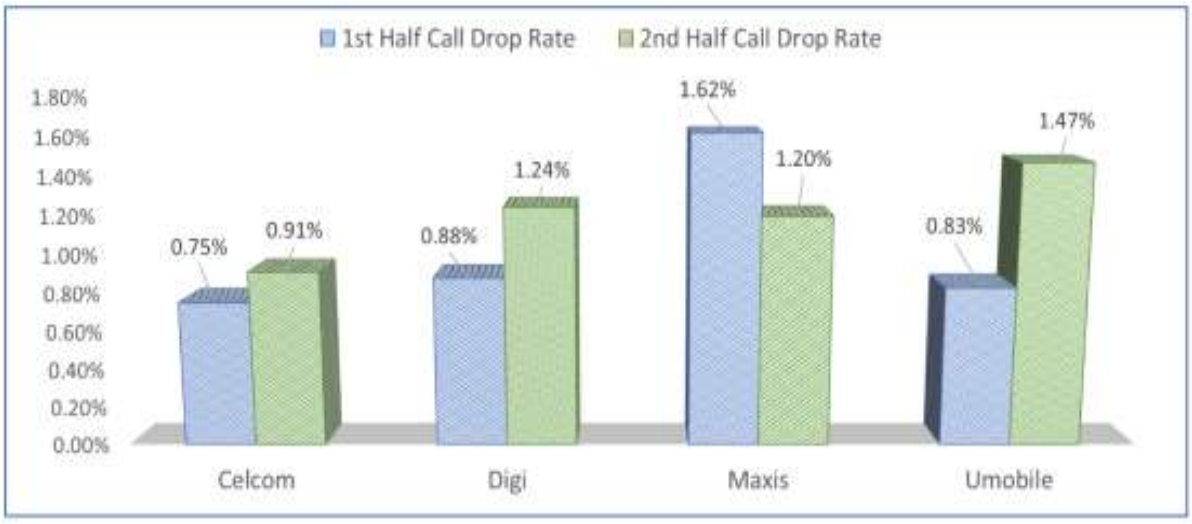
	Service Restoration Performance	
	Within 24 hours of receipt request	80% fulfilled
	Within 48 hours of receipt request	90% fulfilled
	Within 7 days of receipt request	100% fulfilled
	Billing Performance	
	% of billing complaints in any one billing period	Shall not exceed 2% of the total number of bills issued in that billing period
	Resolved within 15 business days	90%
	Resolved within 30 business days	95%
	General Customer Complaints	
	No of complaints per 1000 customer	Should not exceed 50 complaints
	Network Latency	
	Not more than 85ms	95% of the time
	Throughput or Bandwidth Utilization	
	Not less than 90% of subscribed level (both for uploading and downloading)	95% of the time during busy hours
	Packet Loss	Shall not exceed 1%
	Annual Service Availability	Shall be 99.99% for all users

Some useful statistics from 2016 report are given below:

The following charts show the performance of cellular service providers for dropped calls based on the assessments conducted by the Regional Office of MCMC for second half of 2016 nationwide and the performance of dropped calls rate at the Protocol Gateway throughout 2016 conducted by the Head Office of MCMC.

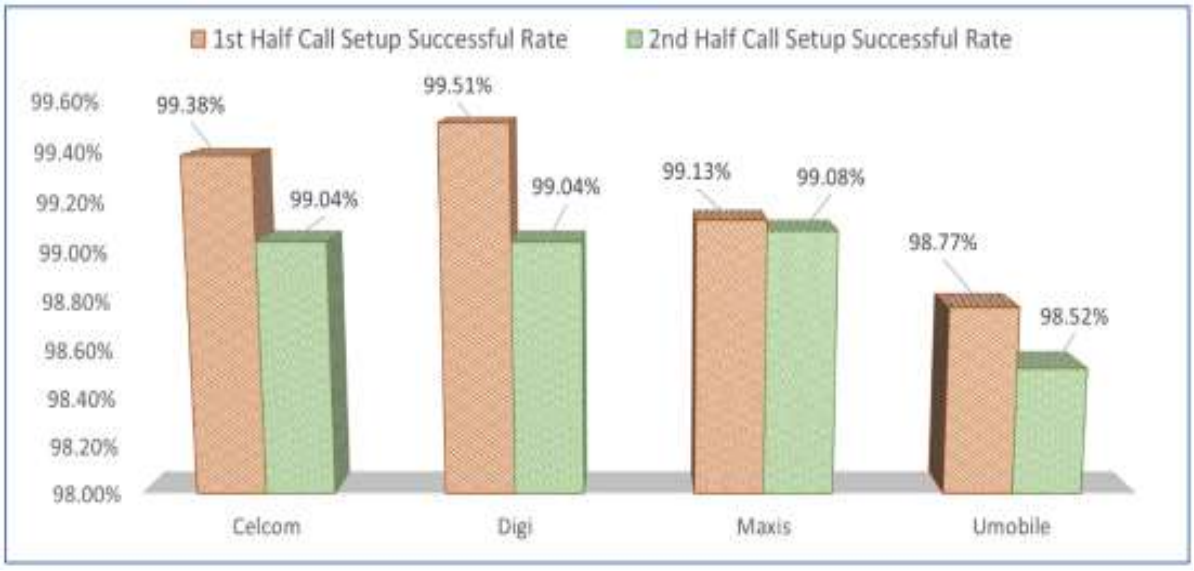
a. <u>Call drop rate: Half Yearly Performance (Nationalwide)</u>

Chart 2.23



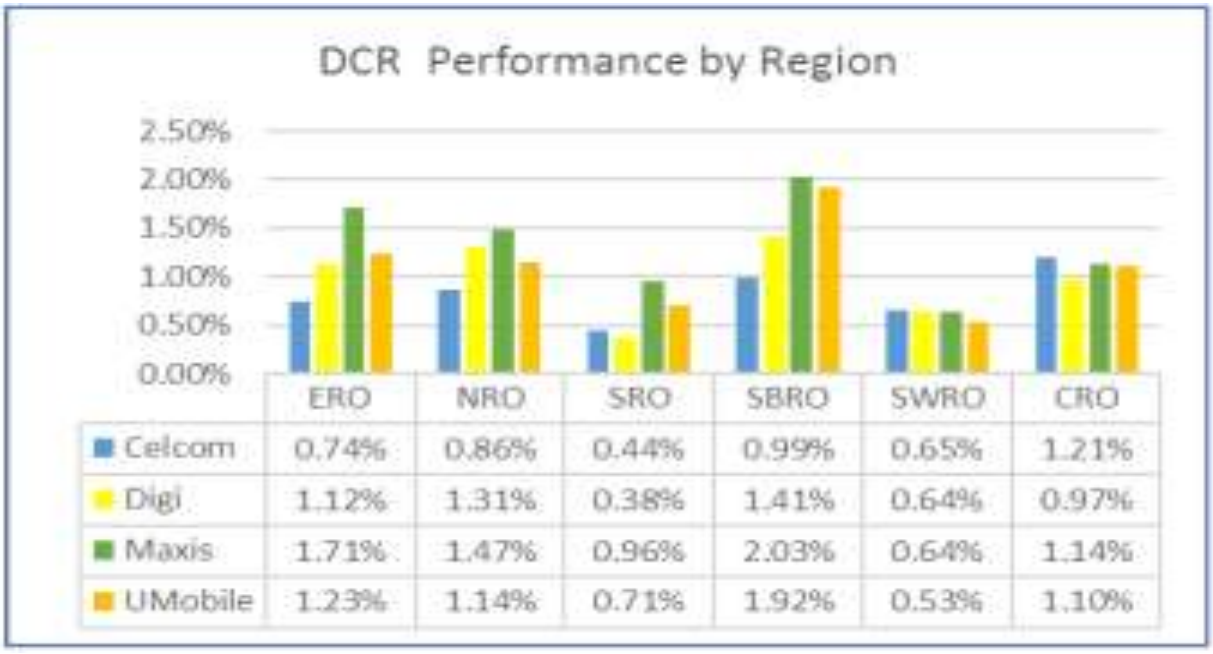
b. <u>Call Setup Success Rate :Half Yearly Performance (Nationalwide)</u>

Chart 2.24



c. Call drop rate :Region Wise

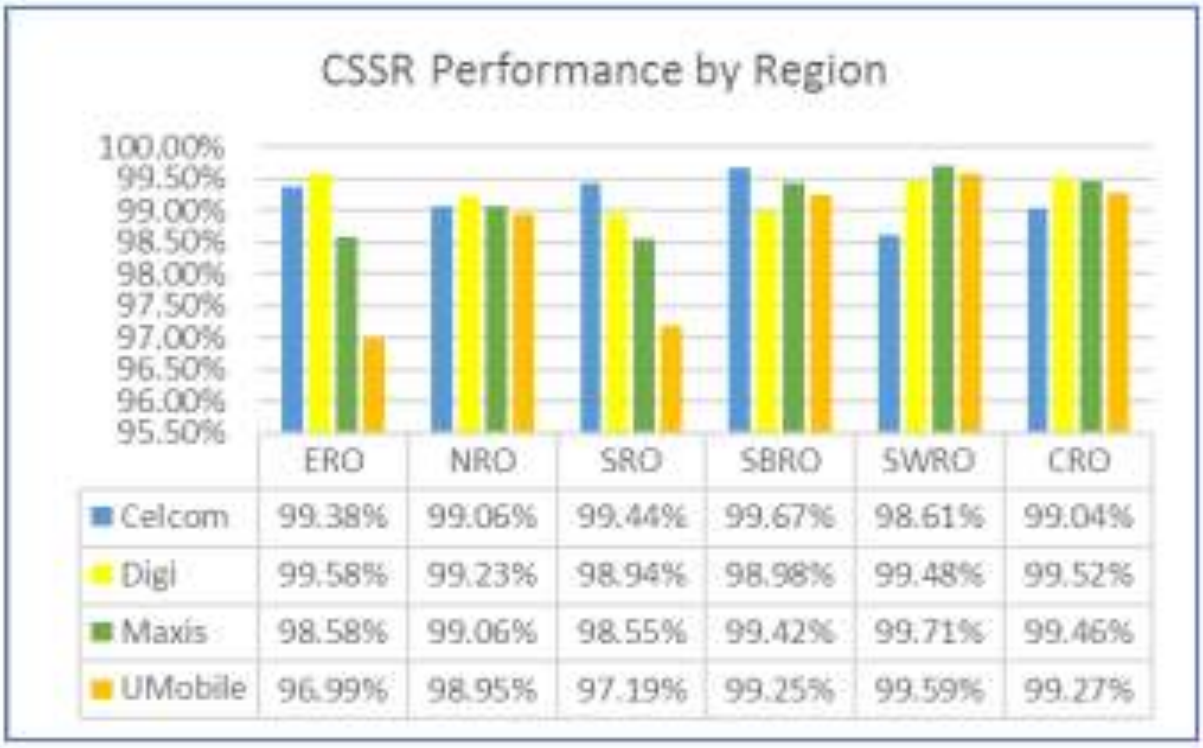
Chart 2.25



	ERO	NRO	SRO	SBRO	SWRO	CRO
Celcom	0.74%	0.86%	0.44%	0.99%	0.65%	1.21%
Digi	1.12%	1.31%	0.38%	1.41%	0.64%	0.97%
Maxis	1.71%	1.47%	0.96%	2.03%	0.64%	1.14%
UMobile	1.23%	1.14%	0.71%	1.92%	0.53%	1.10%

d. Call Setup Success Rate: Region Wise

Chart 2.26



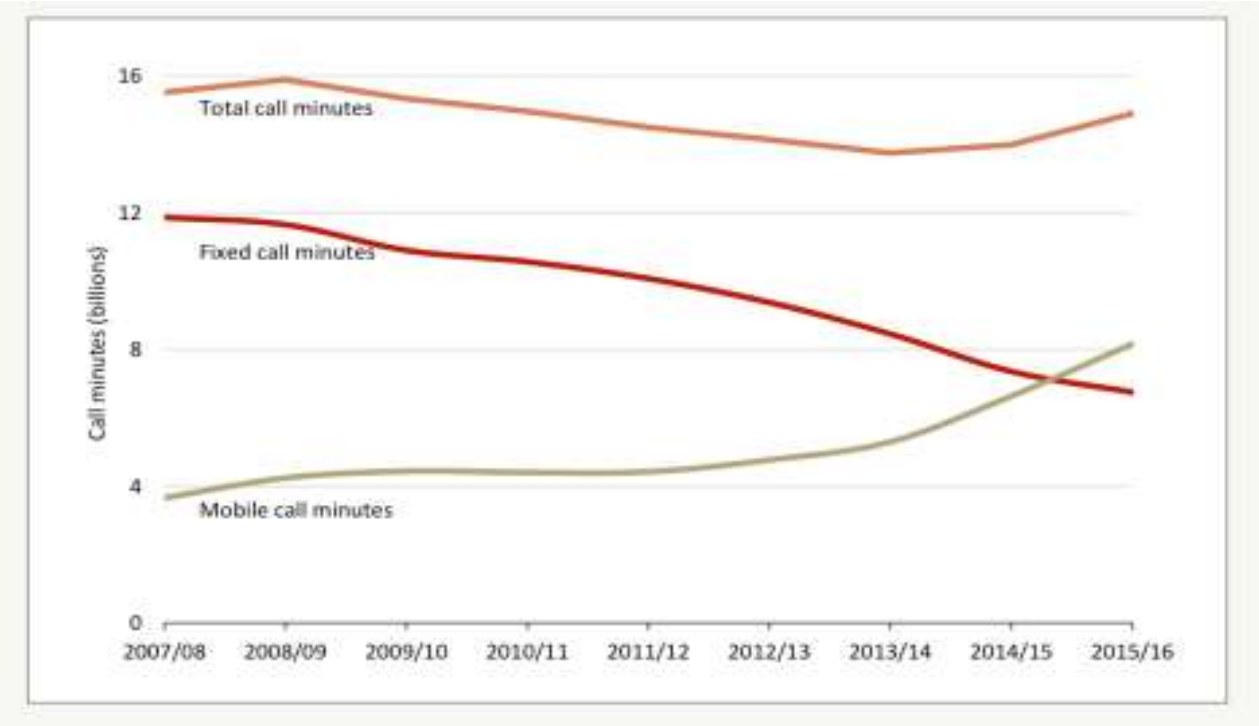
	ERO	NRO	SRO	SBRO	SWRO	CRO
Celcom	99.38%	99.06%	99.44%	99.67%	98.61%	99.04%
Digi	99.58%	99.23%	98.94%	98.98%	99.48%	99.52%
Maxis	98.58%	99.06%	98.55%	99.42%	99.71%	99.46%
UMobile	96.99%	98.95%	97.19%	99.25%	99.59%	99.27%

11. NEW ZEALAND[19]

A. Fixed Line, Mobile And Total Calling Minutes

The growth in mobile calling minutes accelerated in 2015, with mobile calling poised to overtake fixed calling in 2016. While fixed calling has continued to decline, the higher growth of mobile calling caused a rise in total calling on phones and mobiles, for the first time since 2009.

Chart 2.27

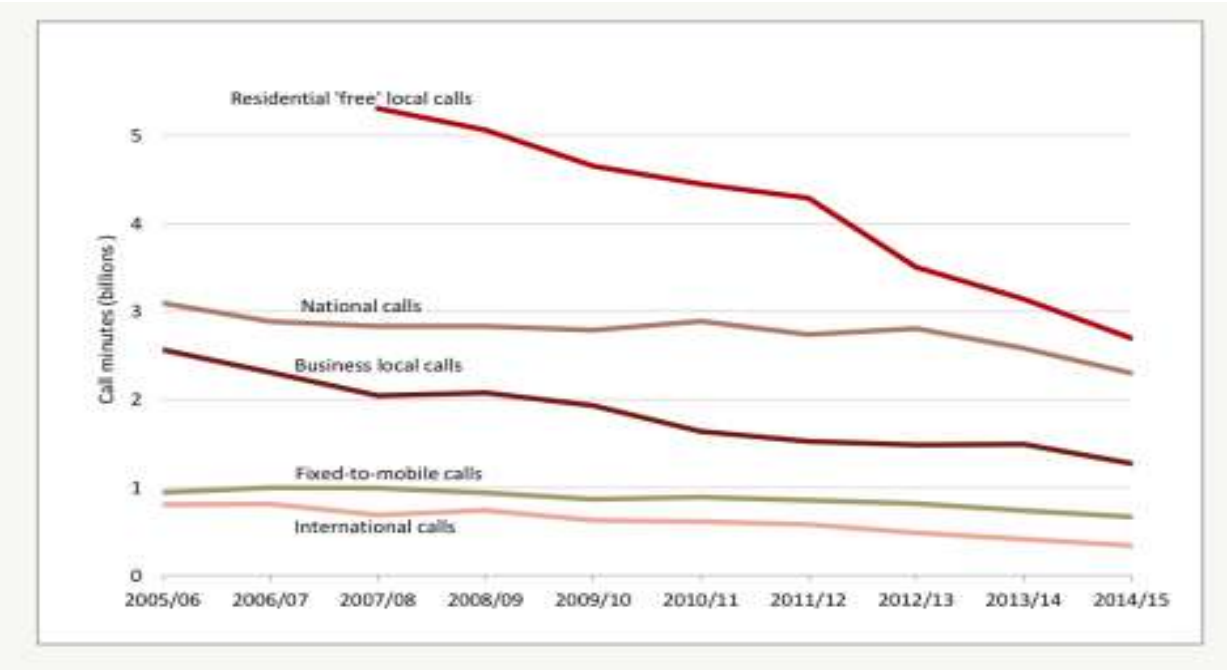


B. Fixed Line Retail Call Minutes By Call Type

Fixed line calling continues to decline. The severity of the decline depends on the type of calling. While all forms of fixed line calling declined in 2015, free residential local calling declined the most significantly.

[19] http://www.comcom.govt.nz/regulated-industries/telecommunications/monitoring-reports-and-studies/monitoring-reports/

Chart 2.28



e. ADSL Peak Hour Speed Variability

A measure of broadband quality is how much lower the peak hour speed is than the maximum speed for a sample of customers measured on a consistent basis. In heavily congested networks the peak hour speed can drop to under half the maximum speed. The chart below shows a general trend towards less slowing in the peak hour since 2012, but the rapid increase in data consumption after March 2015 appeared to contribute to a reversal of that trend for several months.

Chart 2.29

Source: TrueNet

12. NIGERIA[20]

QOS METRICS IN NIGERIA AS EXPLAINED HEREWITH:

The following are the metrics and their definitions for measuring Quality of Service (QoS).

- **Call Completion Rate**

The ratio of successfully completed calls to the total number of attempted calls (ITU-T E600/2.13). That is, the ratio of the number of completed call attempts to the total number of call attempts, at a given point of a network.

- **Note:** This ratio is typically expressed as either a percentage or a decimal fraction. It is the number of calls of specific duration successfully completed; measured per 100 calls.

- **Note:** A complete call is a call that is released by normal call clearing (i.e. Released Message "RL_M" and Released Complete Message "RLC_M" has been successfully exchanged in the signaling flow), be it during a ringing phase or conversation phase by either the caller or called party.

- **Answer Seizure Ratio (ASR)**
  The ratio of the number of successful calls over the total number of outgoing calls from a carrier's network (i.e. On a route or a Destination Point Code (DPC) basis, and during a specified time interval, the ratio of the number of seizures that result in an answer signal to the total number of seizures: ITU-T E600/2.14).
- **Note:** ASR is line seizures that are answered by person or device divided by total number of seizures.
- **Note:** Seizure is achieved after a successful "Call setup". It means seizing a trunk circuit for conversation or other network services. In GSM network, it refers to seizing a Traffic Channel (TCH) after a successful "Call setup".
- **Note:** A successful call is a call that is answered by a called party or machine (e.g., fax machine, answering machine, etc.).

- **Post Dialing Delay**
  In GSM network, is the average time between pressing send button (after pressing correct digits) and getting a ring back tone. This is also called "Call Setup Time" or time to connect a call.

- **Handover Success Rate (HOSR)**
  This is the ratio of the number of successfully completed handovers to the total number of initiated handovers. This ratio can be expressed as a percentage.

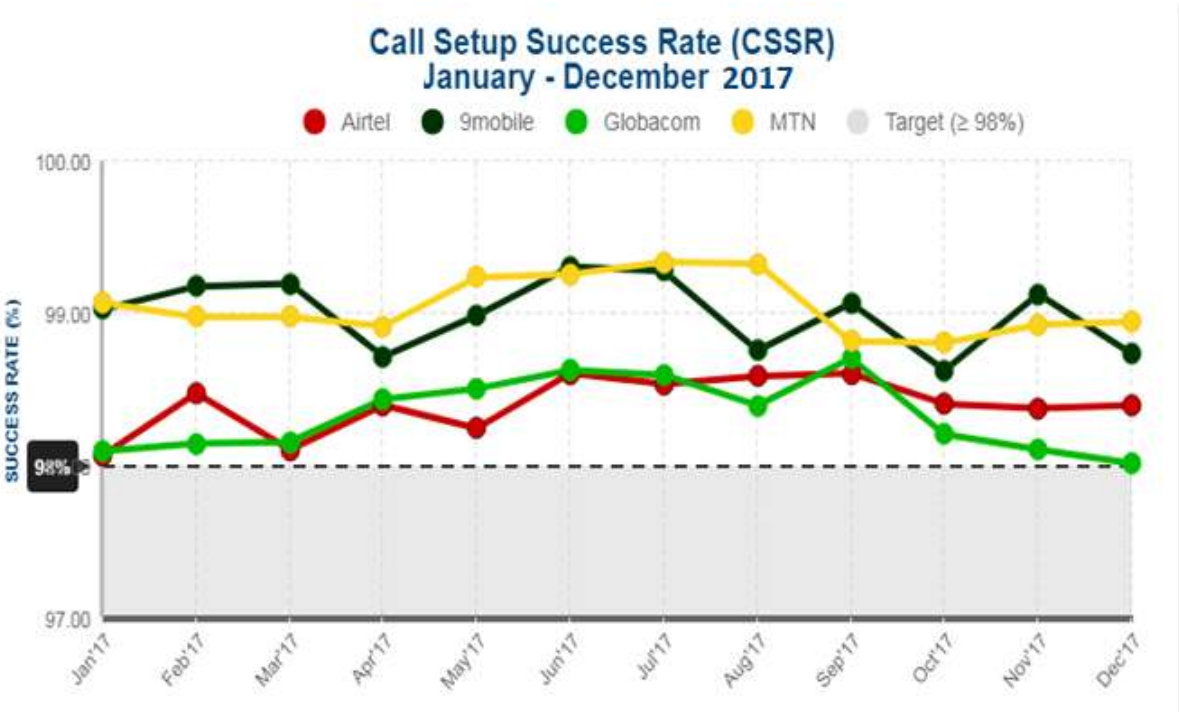
[20] https://www.ncc.gov.ng/23-spectrum-standards/technical-standards/quality-of-service-qos#measured-kpisfor-operators

- **Call Setup Success Rate**

Number of the unblocked call attempts divided by the total number of call attempts. Or (1 - Blocking Probability) x 100%

- **Note:** A call setup is an exchange of signalling information in the call process that leads to Traffic Channel (TCH) seizure

Chart 2.30[21]



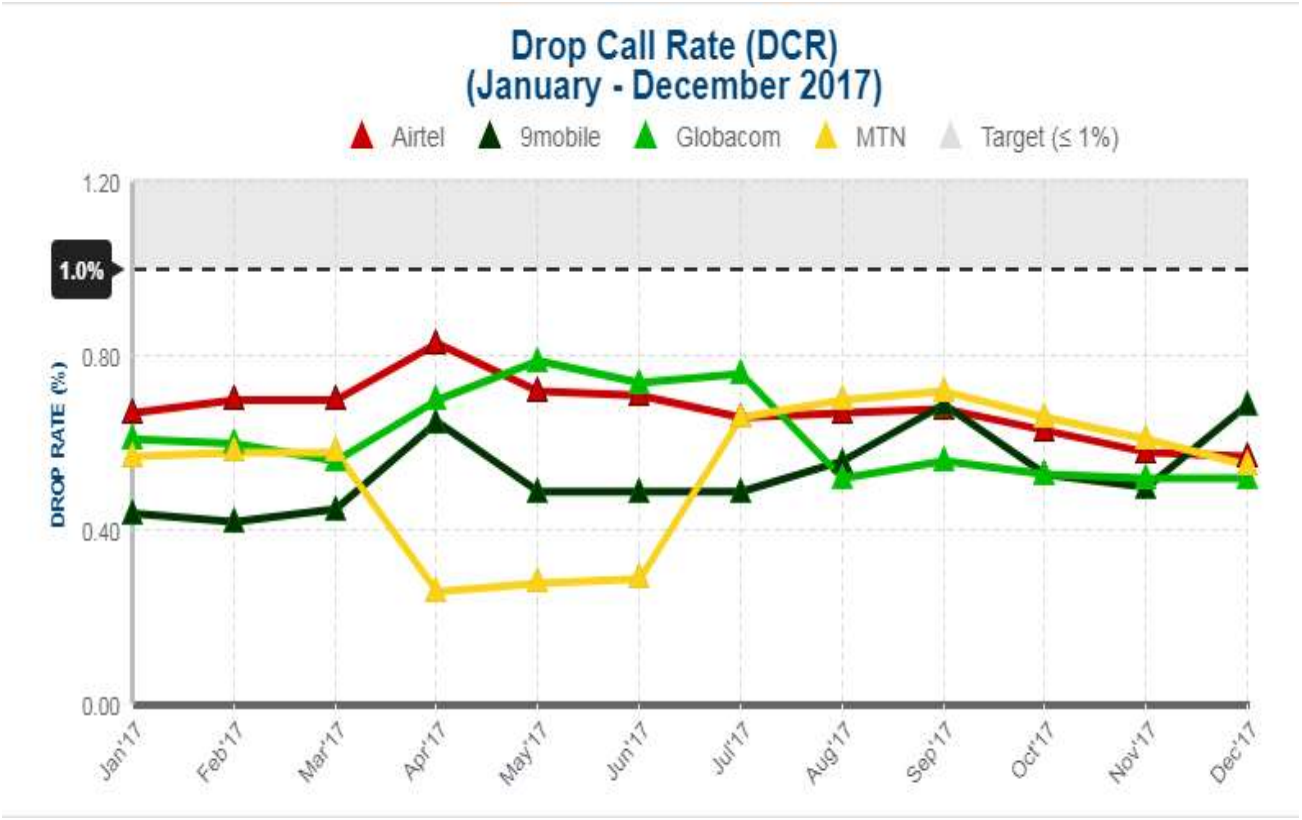
- **Call Drop Rate**

The Dropped Call Rate (sometimes called Call Drop Rate) is the number of dropped calls divided by the total number of call attempts. Or (1 - Call Completion Ratio) x 100%

- **Note:** A dropped call is a call that is prematurely terminated before being released normally by either the caller or called party (i.e., the call is dropped before the exchange of Released Message "RL_M" and Released Complete Message "RLC_M" in the signalling flow).

[21] https://www.ncc.gov.ng/23-spectrum-standards/technical-standards/quality-of-service-qos#latest

Chart 2.31[22]



The following technical Quality of Service (QoS) indicators for Mobile Services define the ***minimum*** QoS benchmarks for all GSM mobile operators' services licensed by the Nigerian Communications Commission.

Chart 2.32

		Internetwork			
Indicator	**Intranetwork**	**PLMN**	**PTO**	**PSTN**	**International**
Call Setup Success Rate (%)	= 90%				
Handover Success Rate (%)	= 90%				
Call Drop Rate (%)	= 2%				
Post Dialing Delay(s)	< 5 secs	< 10 secs	< 10 secs	< 10 secs	< 13 secs

- PLMN: Public Land Mobile Network
- PTO: Private Telephone Operators
- PSTN: Public Switched Telephone Network

[22] https://www.ncc.gov.ng/23-spectrum-standards/technical-standards/quality-of-service-qos#measured-kpisfor-operators

Chart 2.33

Transmission Impairment	Value
Bit Error Rate (BER) per Link	$= 1 \times 10^{-9}$
End-to-End Error Rate	$= 1 \times 10^{-6}$

Chart 2.34

Other Network Measures		Value
Voice Quality Impairment		< 2%
Answer Seizure Ratio (ASR)	Intranetwork	= 50%
	Internetwork	= 45%
Call Completion Rate (CCR) %		= 90%
Busy Hour BSC Traffic Channel (TCH) Congestion (%)		=10%
Minimum Data Encoding Rate		Half-Rate
Minimum Speech Encoding Rate		Half-Rate

Table: 2.19

SUMMARY OF GSM OPERATPORS KEY PERFORMANCE INDICATORS

JANUARY 2014

Operator	CSSR (%)	DCR (%)	SDCONG (%)	TCHCONG (%)
Airtel	96.99	0.84	0.40	0.79
Etisalat	99.20	0.55	0.10	0.27
MTN	96.85	1.21	0.17	0.55
GLO	96.89	1.19	0.58	0.79
Target	98	1	0.20	2

Table: 2.20

SUMMARY OF CDMA OPERATOR KEY PERFORMANCE INDICATORS

JANUARY 2014

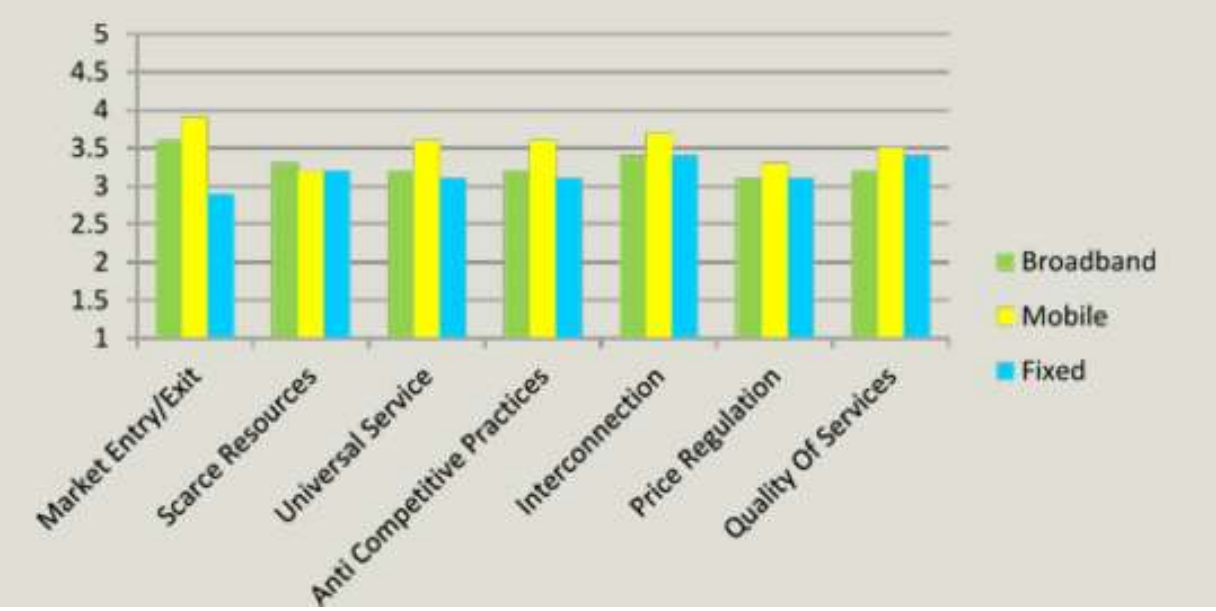
KPIs	CSSR	DCR	CCR	HOSR	TCH CONG
Target	≥ 98%	≤ 2%	≥ 96%	≥ 98%	≤ 2%
Visafone	98.71	0.61	98.11	99.44	0.15

13. PAKISTAN[23]

QoS is shown in the form of TRE score which is a tool to measure stakeholder perceptions about the effectiveness of the regulatory and policy environment, on a scale of 1 to 5 (1 being highly ineffective, 5 being highly effective, and 3 the mid-point for average performance). A comparison of the survey results for 2010 and 2011 indicates an improvement in quality of services.

a. TRE Score of Pakistan in various sectors of Telecom

Chart 2.35

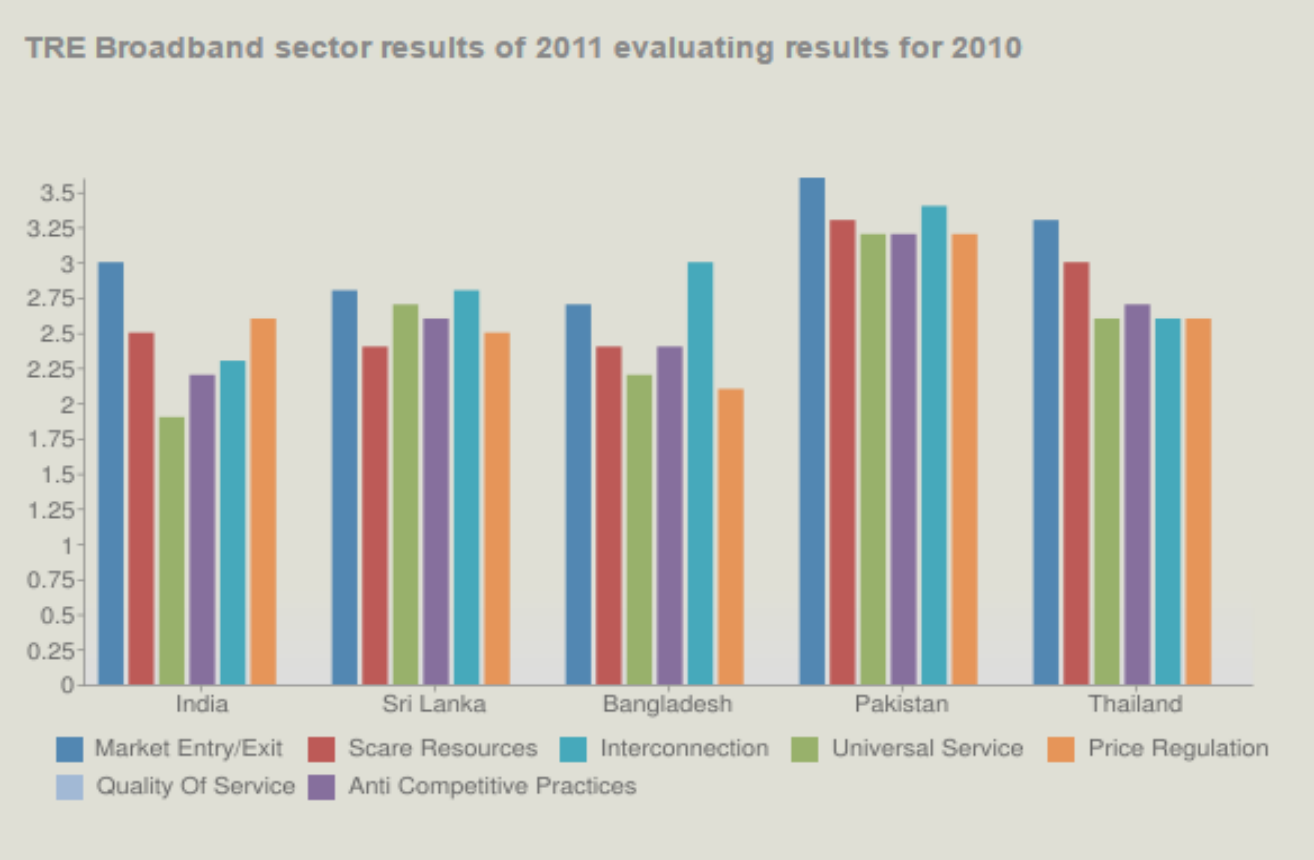


b. Comparison of TRE scores of various countries.

Overall it appears that Pakistan has achieved higher TRE results in the Broadband sector compared to India, Sri Lanka, Bangladesh and Thailand.

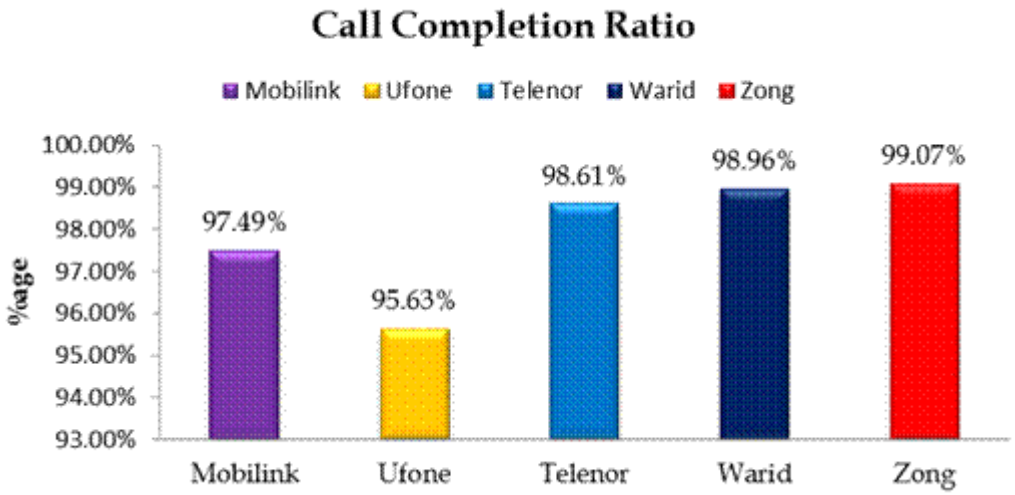
Chart 2.36

[23] http://broadbandasia.info/pakistan/



c. Call completion ratio(2016): Call drops[24]

Chart 2.37



[24] https://www.phoneworld.com.pk/cellular-mobile-operators-qos-survey-results-of-2016-pta-report/

14. SOUTH AFRICA[25]

DROP-CALL RATE: The measurements of dropped call rate is described by the ratio of successful originated calls that were found to drop, to the total number of successful originated calls that were correctly released. The formula to calculate DCR is shown below:

Drop Call Rate	
Successful Call Attempts	S
Drop Calls	D
DCR	D/S * 100

THE CALL SETUP SUCCESS RATE: The call setup success rate refers to the percentage of calls that are successfully set up and terminated as a percentage of the total call attempts. CSSR excludes dropped calls or calls that experience no network condition, low speech quality calls and calls with long set up time. The formula to calculate CSSR is shown below:

Call Success Rate	
Call Attempts	X
Call Success	Y
CSSR	(Y/X)*100

QUALITY OF SERVICE SUMMARY: MPUMALANGA PROVINCE FOR 2017/2018 QUARTER 1[26]

Chart 2.38

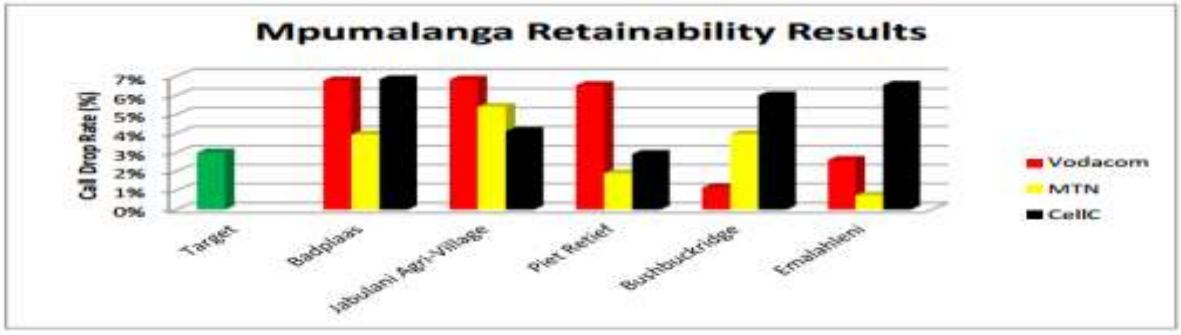


Figure : Mpumalanga Drop Call Rate (DCR)

[25] https://www.icasa.org.za/LegislationRegulations/EngineeringTechnology/QualityofService/tabid/546/Default.aspx

[26] https://www.icasa.org.za/Portals/0/Regulations/Engineering%20&%20Technology/QOSmp15.pdf

Chart 2.39

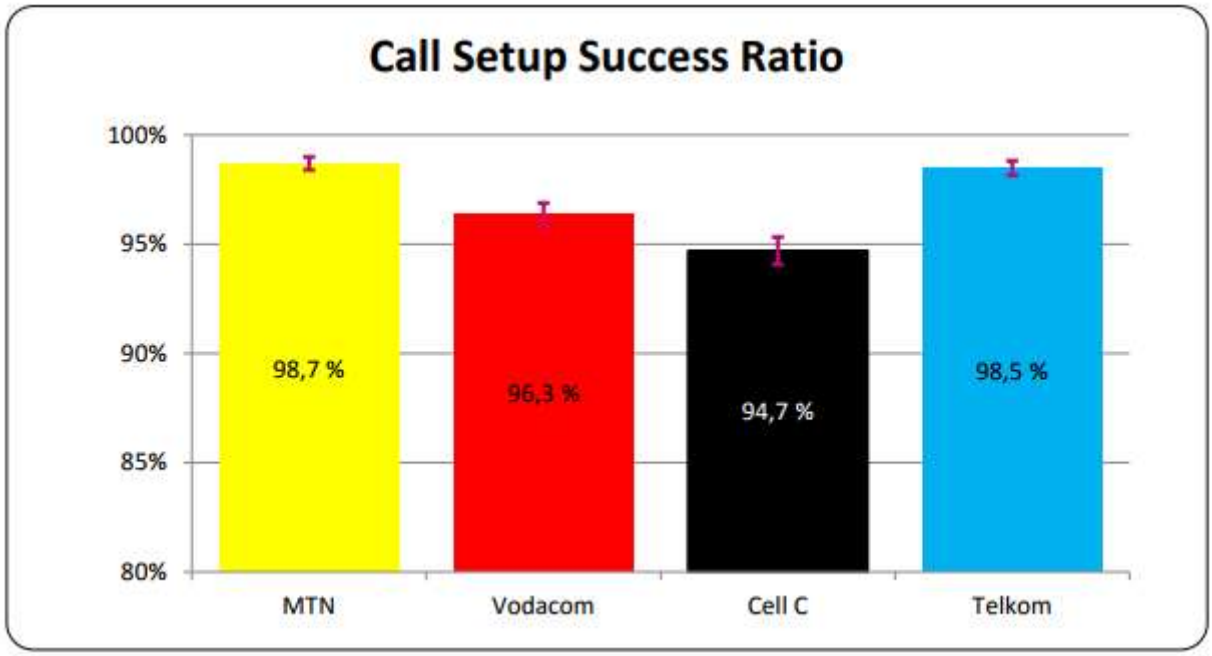
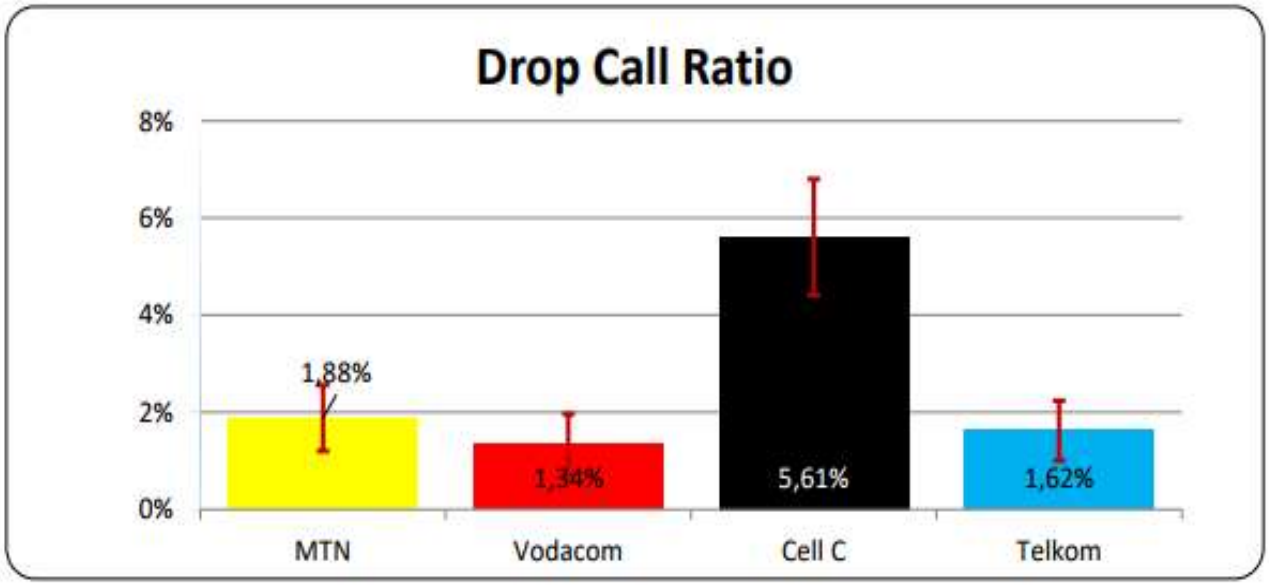
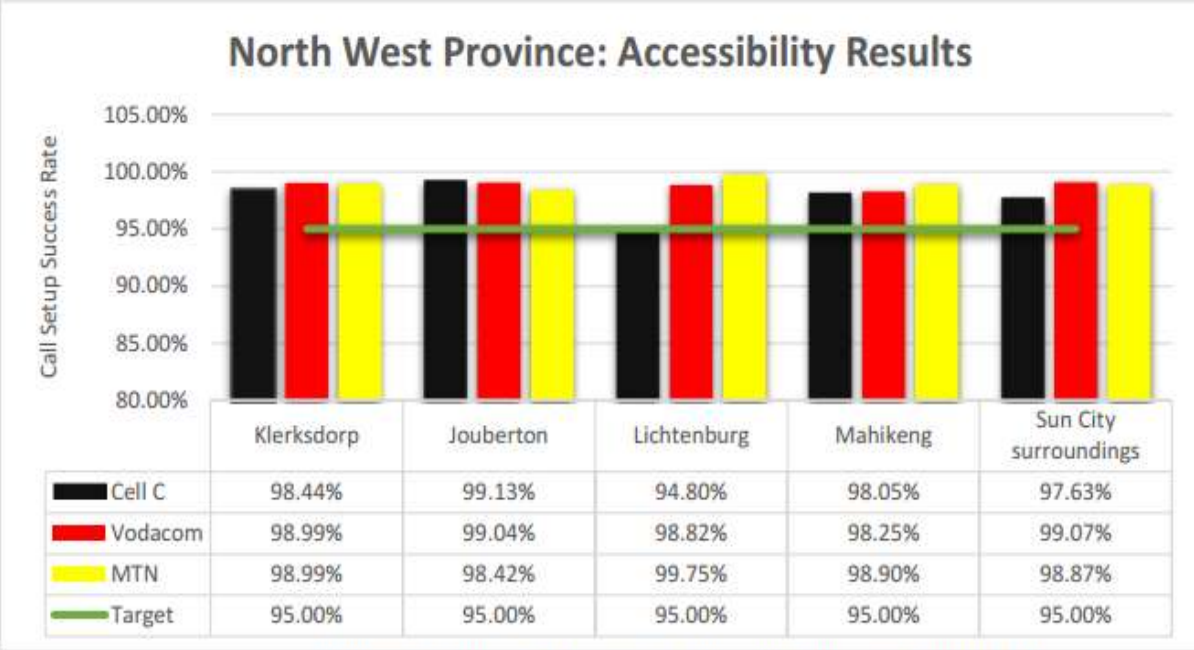


Chart 2.40



QUALITY OF SERVICE SUMMARY: NORTH WEST PROVINCE FOR 2016/2017 QUARTER 2[27]

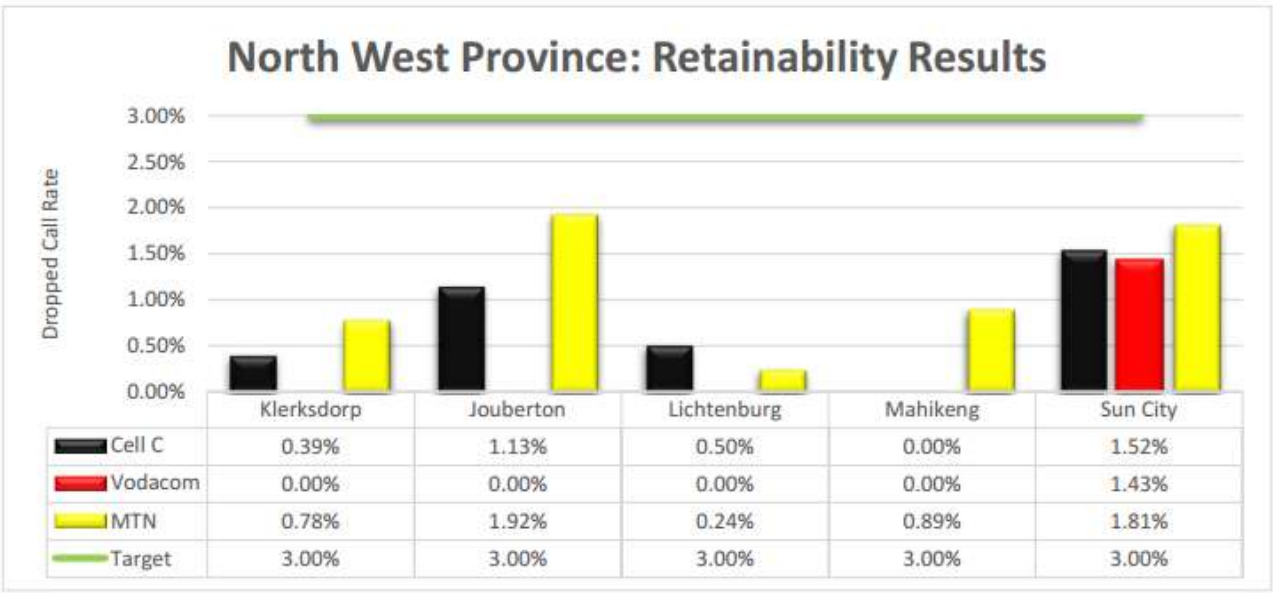
Chart 2.41



	Klerksdorp	Jouberton	Lichtenburg	Mahikeng	Sun City surroundings
Cell C	98.44%	99.13%	94.80%	98.05%	97.63%
Vodacom	98.99%	99.04%	98.82%	98.25%	99.07%
MTN	98.99%	98.42%	99.75%	98.90%	98.87%
Target	95.00%	95.00%	95.00%	95.00%	95.00%

Figure : North West Province Call Setup Success Rate (CSSR)

Chart 2.42



	Klerksdorp	Jouberton	Lichtenburg	Mahikeng	Sun City
Cell C	0.39%	1.13%	0.50%	0.00%	1.52%
Vodacom	0.00%	0.00%	0.00%	0.00%	1.43%
MTN	0.78%	1.92%	0.24%	0.89%	1.81%
Target	3.00%	3.00%	3.00%	3.00%	3.00%

Figure : North West Province - Drop Call Rate (DCR)

[27] https://www.icasa.org.za/Portals/0/Regulations/Engineering%20&%20Technology/QOSNorthWest15.pdf

Chart 2.43

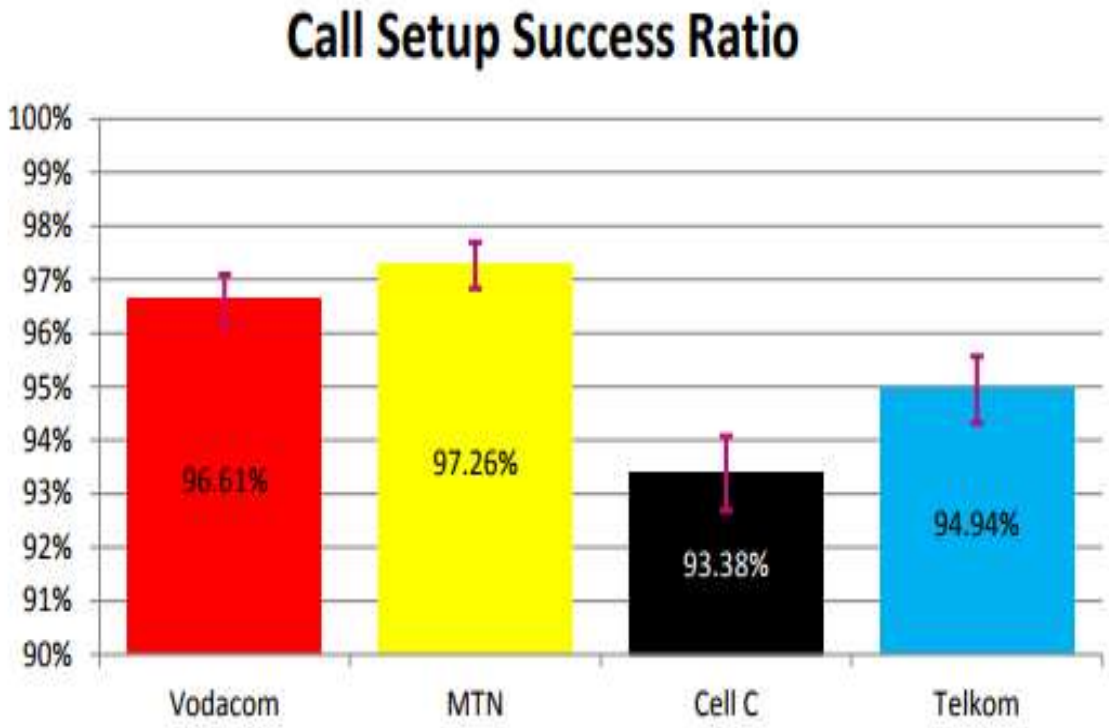
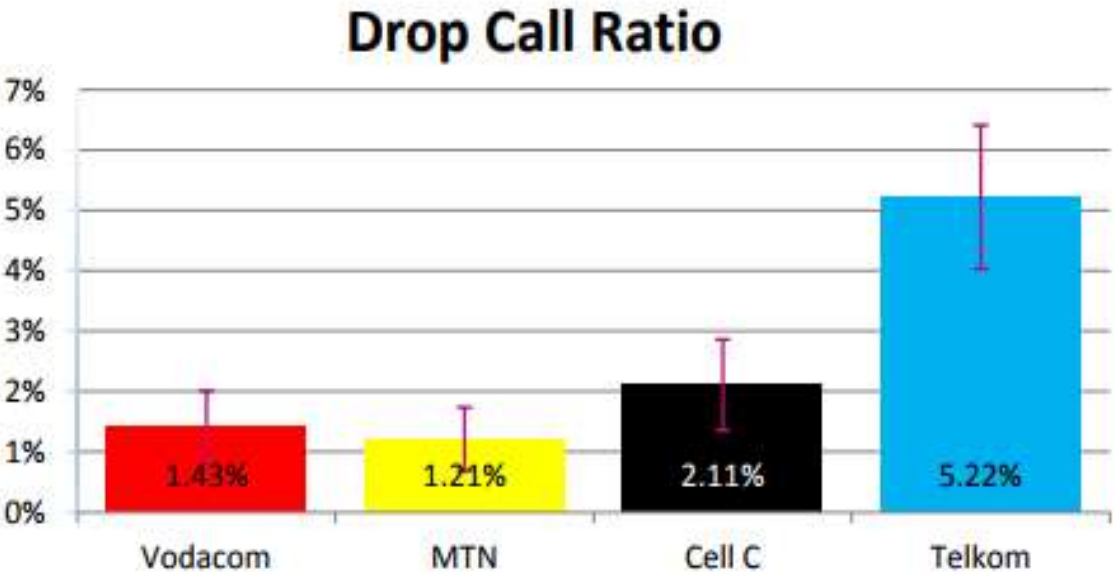


Chart 2.44

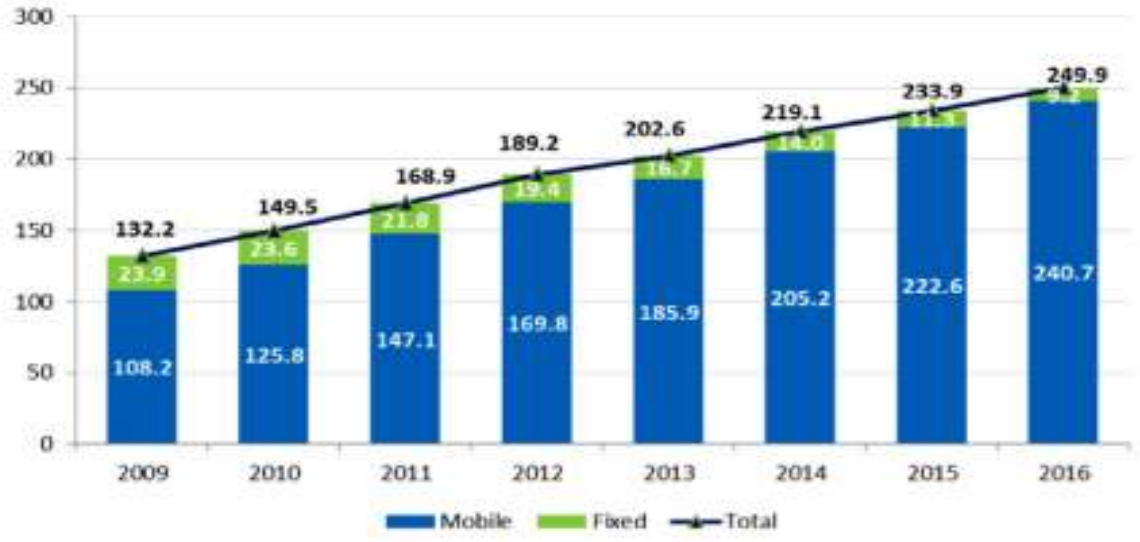


15. TURKEY[28]

The **Information and Communication Technologies Authority** (**ICTA**), is a national telecommunications regulatory and inspection authority of Turkey. The charts shown below show the trend in traffic volume (Both annually and quarterly), broadband connection speeds and consumer complaints.

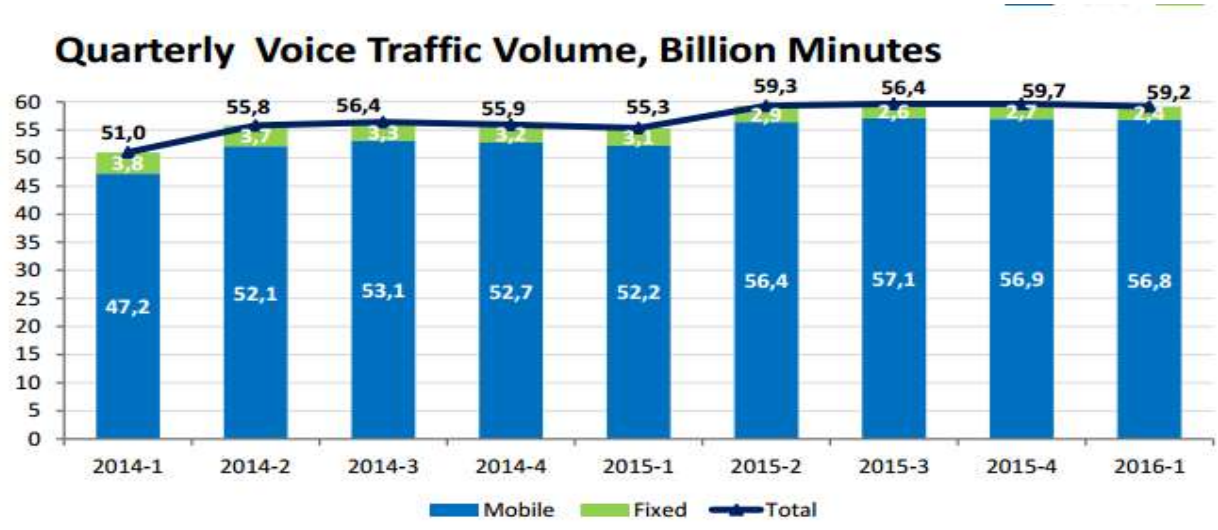
a. Annual Voice Traffic Volume

Chart 2.45



b. Quarterly voice traffic volume

Chart 2.46

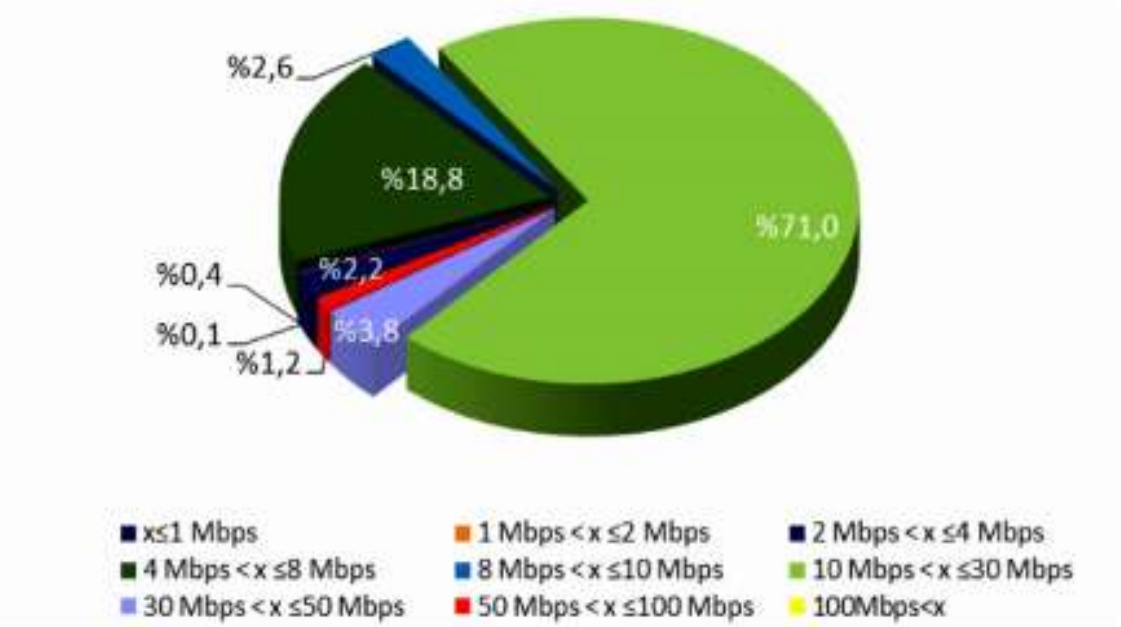


[28] http://www.btk.gov.tr/en-US/Pages/Market-Data

c. Broadband connection speed

The following graph shows connection speeds as of June, 2016.

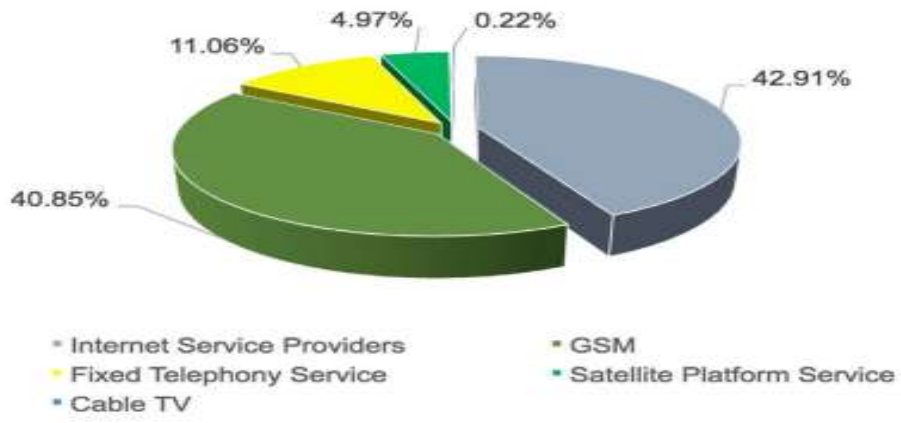
Chart 2.47



d. Consumer complaints

In 2016, 131.156 consumer complaints were received by ICTA. Number of complaints has increased by 38,26% compared with the previous year. Looking at the sectoral distribution of consumer complaints in 2016, most consumer complaints seem to have been received regarding Internet Service Providers and GSM services.

Chart 2.48



16. **UNITED KINGDOM** [29]

In June, 16 2017, Ofcom published its report on consumer mobile experience. It provides information on data service availability, and the performance of mobile voice and data services.

Key findings

Data service availability

- More than nine in ten mobile data downloads are successful for both 4G (95.6%) and 3G-only (92.4%) users.
- Almost seven in ten users (69%) are happy with their overall service, with 4G users more satisfied than 3G-only users (71% vs. 60%).
- When using apps, 4G consumers are connected to Wi-Fi 69% of the time. When 4G users are connected to a cellular network, 65% of time is spent on a 4G network, 30% on 3G and 5% on 2G.

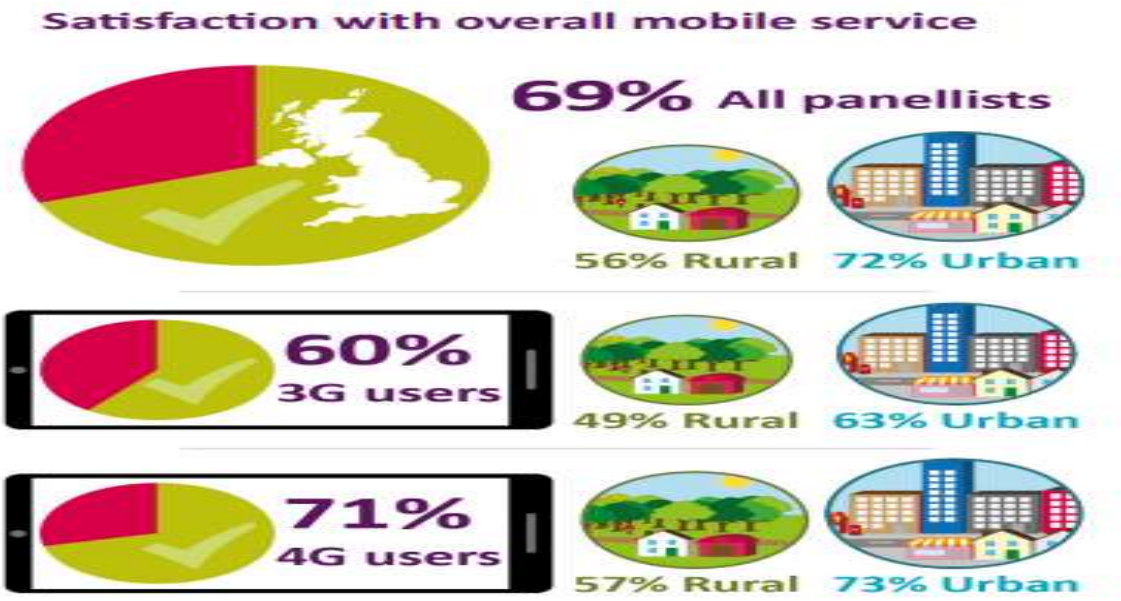
Data performance

- Connection speeds when using YouTube and Chrome are faster over 4G than 3G, with Wi-Fi providing higher average speeds than both mobile technologies.
- 4G networks are more responsive than 3G (48ms vs 64ms response time). Wi-Fi is even more responsive at 27ms.

Voice performance

- Once initiated, less than 1% of all calls are dropped due to loss of service.
- Nine in ten (90%) panellists say they are happy with the performance of their network when making a call.

Chart 2.49



[29] https://www.ofcom.org.uk/__data/assets/pdf_file/0005/103010/Consumer-mobile-experience.pdf

Chart 2.50

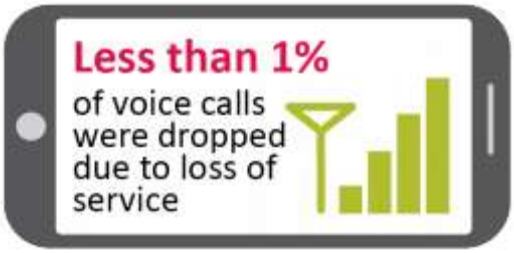
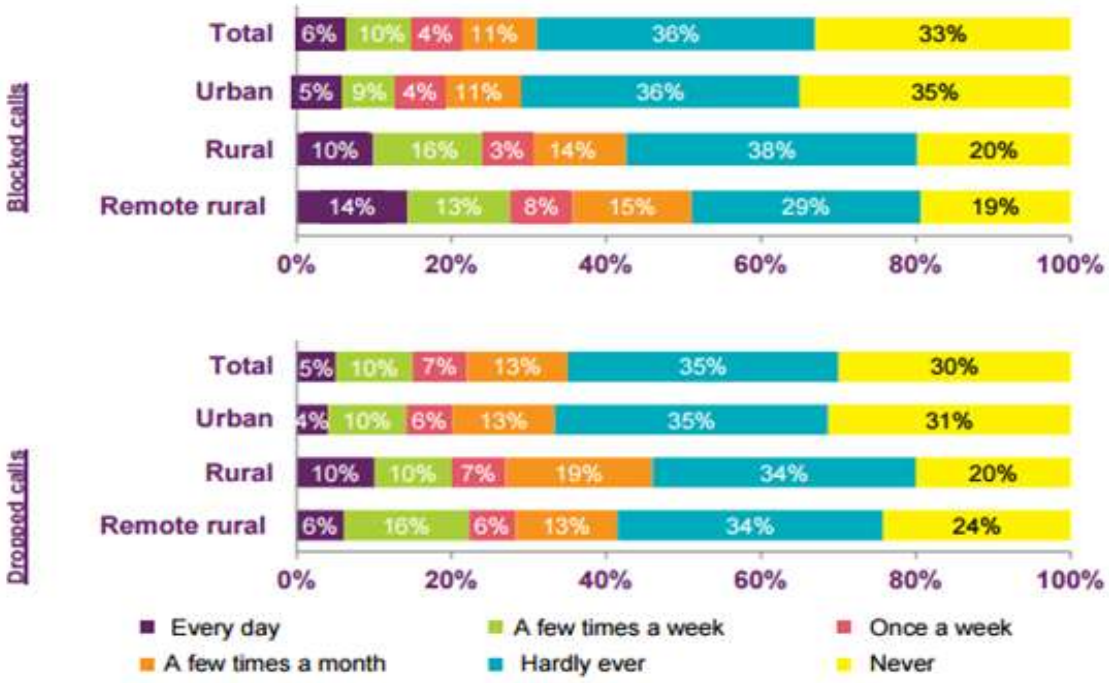


Chart 2.51

Figure Frequency of experiencing issues with voice services - UK, urban, rural and remote rural

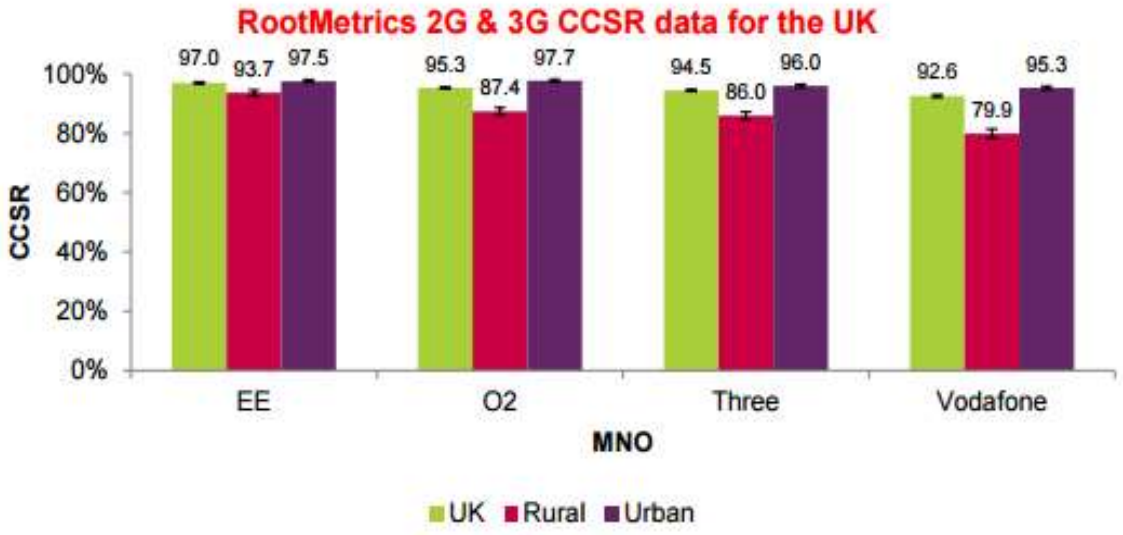


Source: Ipsos MORI, Ofcom Mobile Network Coverage Research, March 2014.
Unweighted base: all respondents (n=1,509), (urban n = 1,033, rural n= 366, remote rural n=110), weighted data.
Q43 How often, if at all, have you experienced any of the following when using your main mobile phone?

Call Completion Success Rate:

Chart 2.52

Figure RootMetrics 2G & 3G CCSR data for UK



Source: RootMetrics second half of 2013

17. USA[30]

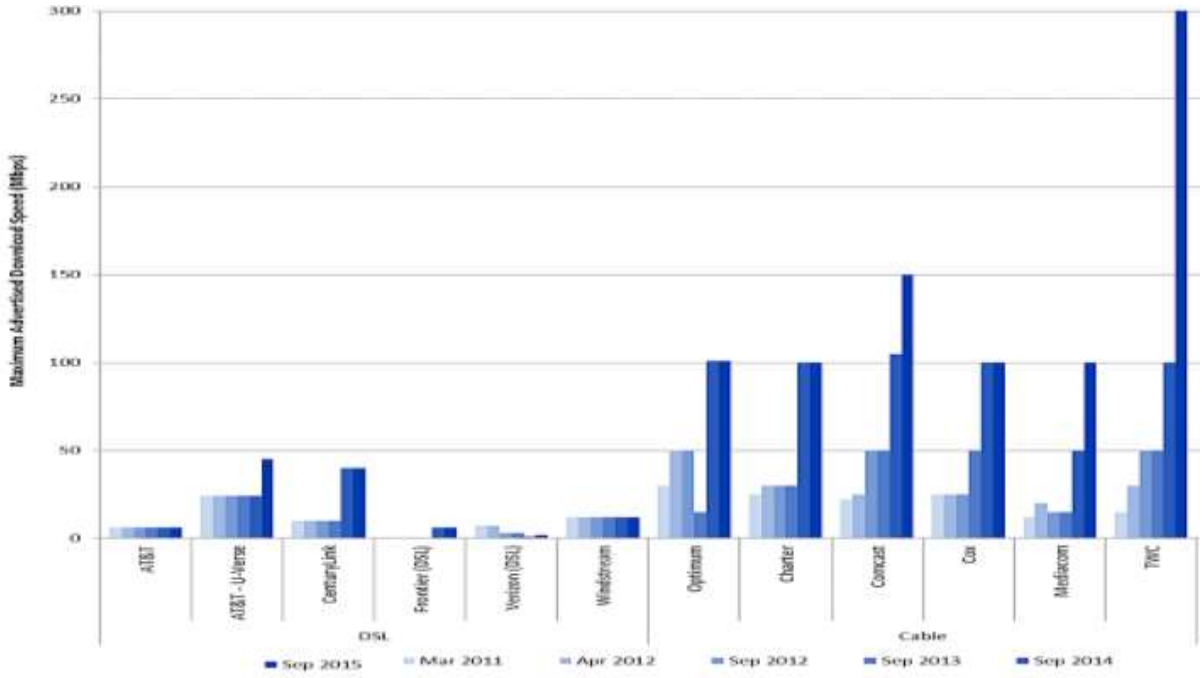
The 2016 Measuring Broadband America Fixed Broadband Report ("2016 Report") contains the most recent data collected from fixed Internet Service Providers (ISPs) as part of the Federal Communication Commission's (FCC) Measuring Broadband America program. This program measures the network performance delivered on selected service tiers to a representative sample set of the population. The thousands of volunteer sample panellists are drawn from subscribers of Internet Service Providers (ISPs) serving over 80% of the residential marketplace.

a. Download speed: Measures the download speed over a 5 second time interval, every 2 hours; the results are then averaged to determine the "actual download speed" for each panellist.

The actual download speeds ISP wise is shown in Chart 2.53.

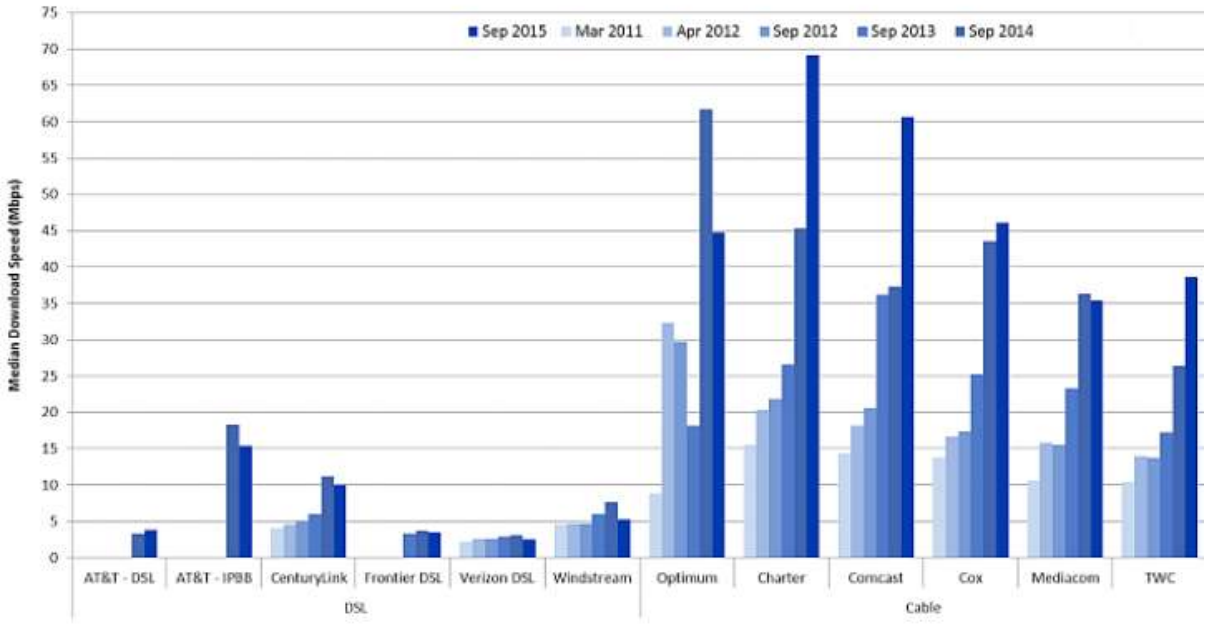
[30] https://www.fcc.gov/reports-research/reports/measuring-broadband-america/measuring-fixed-broadband-report-2016

Chart 2.53



The actual download speed technology wise is given in Chart 2.54.

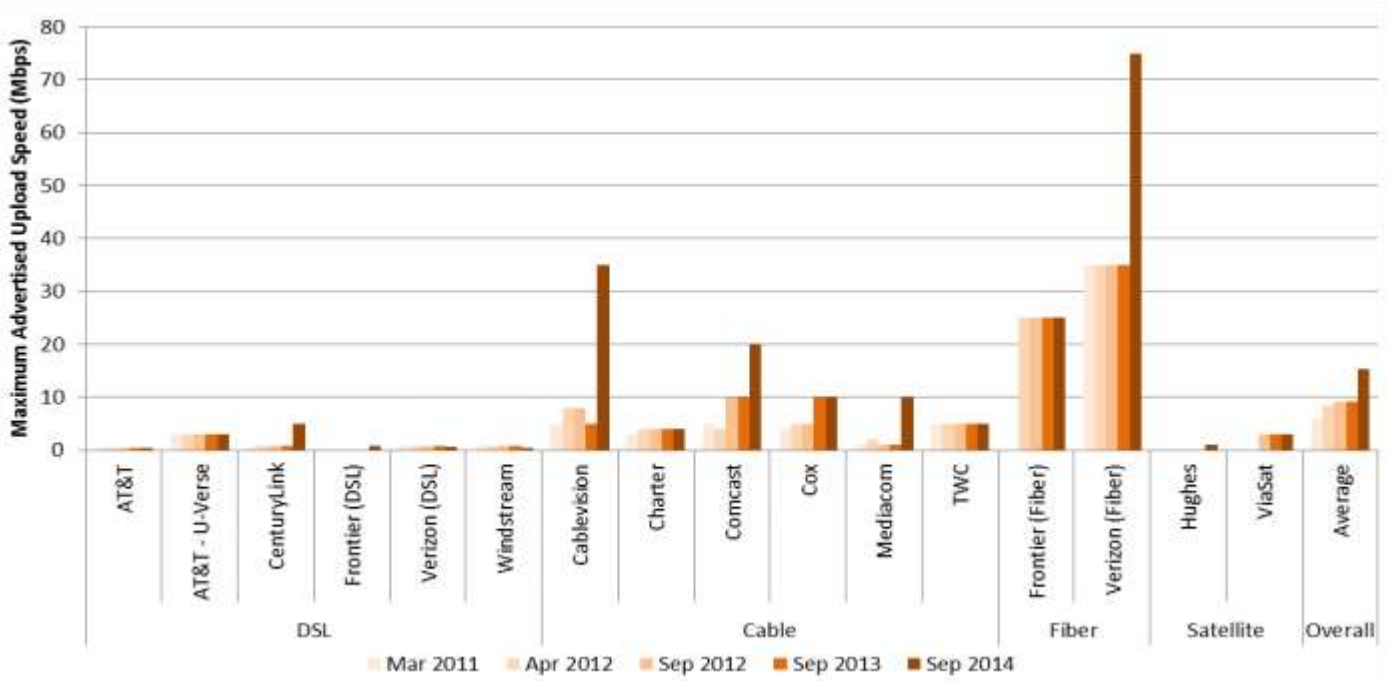
Chart 2.54



a. Upload speed: Measures the upload speed over a 5 second time interval, every 2 hours; the results are then averaged to determine the "actual upload speed" for each panellist.

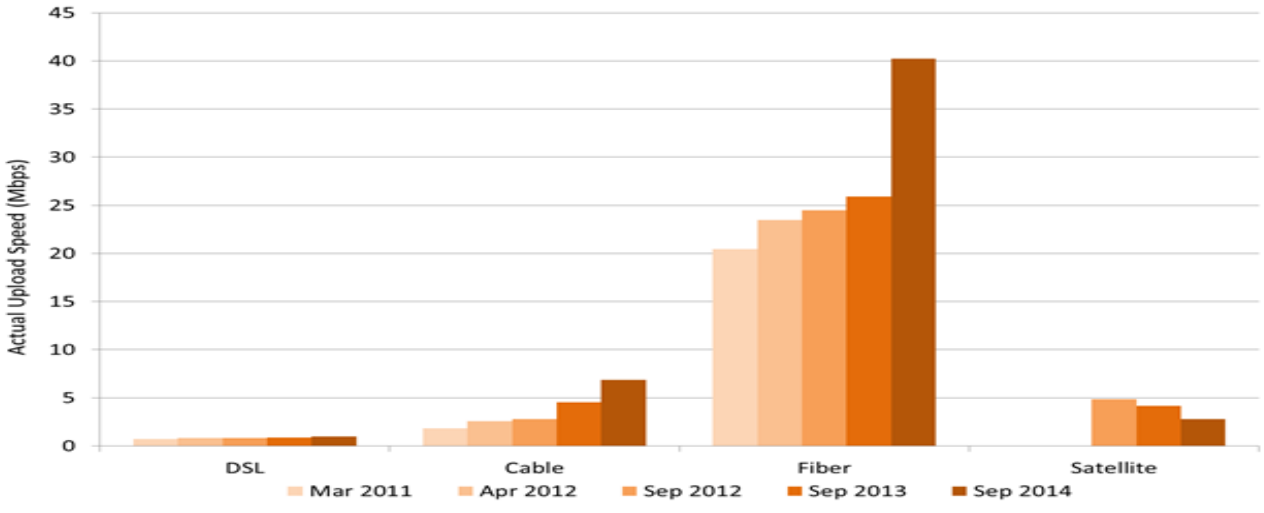
Chart 2.55 below displays the corresponding maximum advertised upload speeds. In particular, when DSL (Digital subscriber line) is used to provide broadband service, the maximum advertised upload speeds among the most popular service tiers has remained generally unchanged since 2011. In contrast, among cable-based broadband providers, the maximum advertised upload speeds among the most popular service tiers increased from 1-5 Mbps in March 2011 to 4-35 Mbps in September 2014.

Chart 2.55



The actual upload speed technology wise is given in Chart 2.56.

Chart 2.56

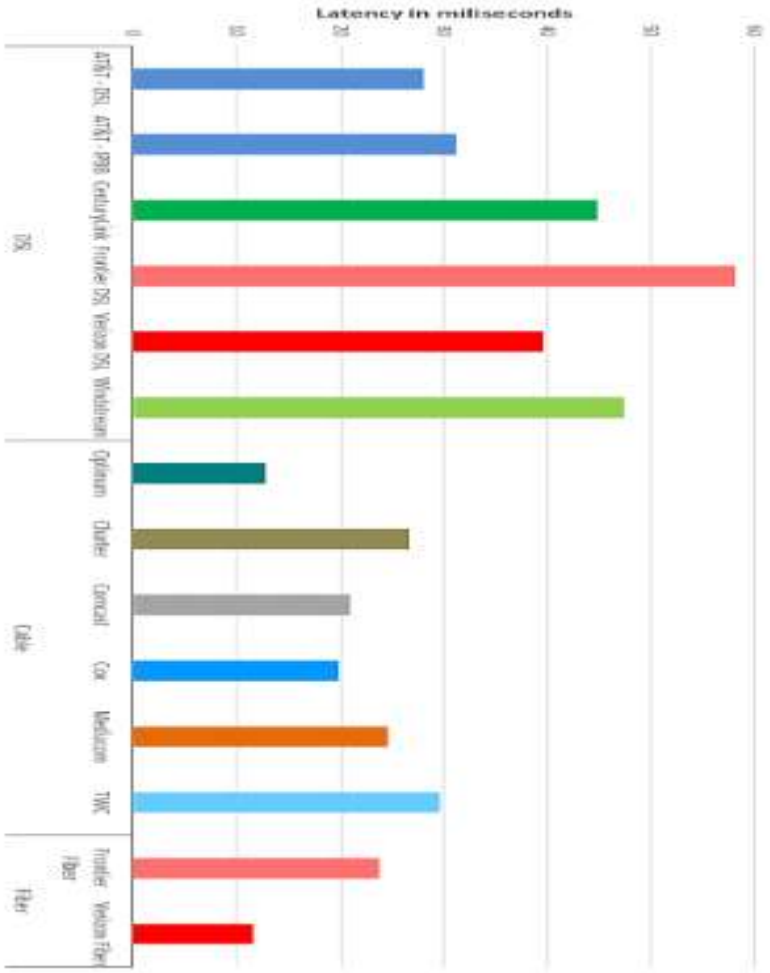


b. Latency: Latency is the time it takes for a data packet to travel from one point to another in a network. It increases with distance of the route between the source and destination and with any congestion on the route, and decreases as actual speed increases.

Chart 2.57 shows the average latency for each participating ISP. The data suggest that average latency is strongly influenced by the technology used by the ISP. In particular, satellite-based broadband service transmits packets to and from the consumer through a satellite. As a consequence, the distances of the paths used by satellite-based broadband services are much higher than those used by terrestrial technologies (DSL, cable, and fiber), and the average latencies of satellite-based broadband services (which range from 603 ms to 659 ms) are much higher than those for terrestrial-based broadband services (which range from 14 ms to 52 ms).

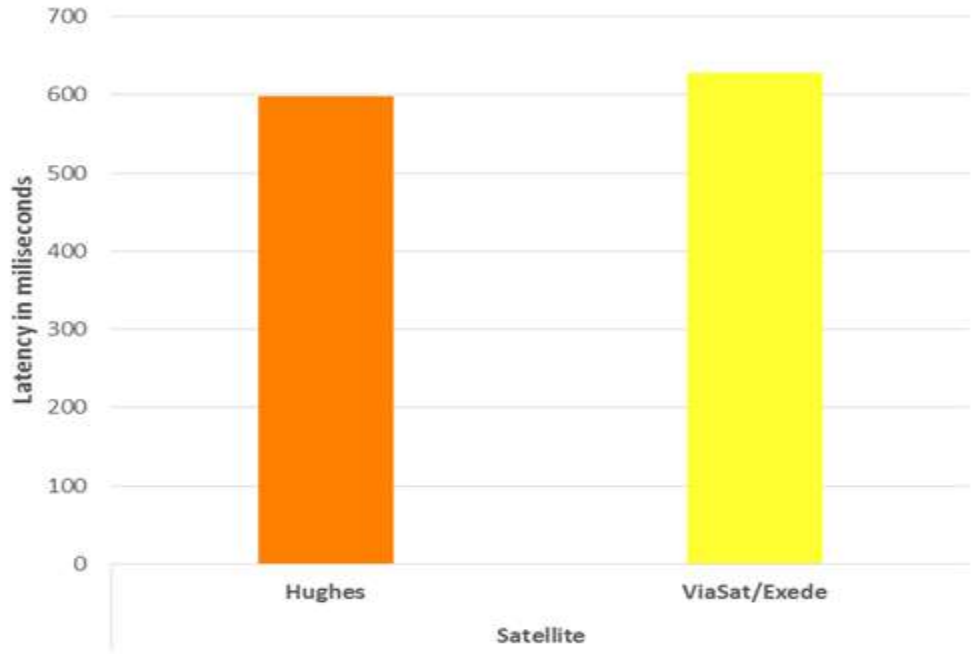
(i) Terrestrial ISPs

Chart 2.57



(ii) Satellite ISPs

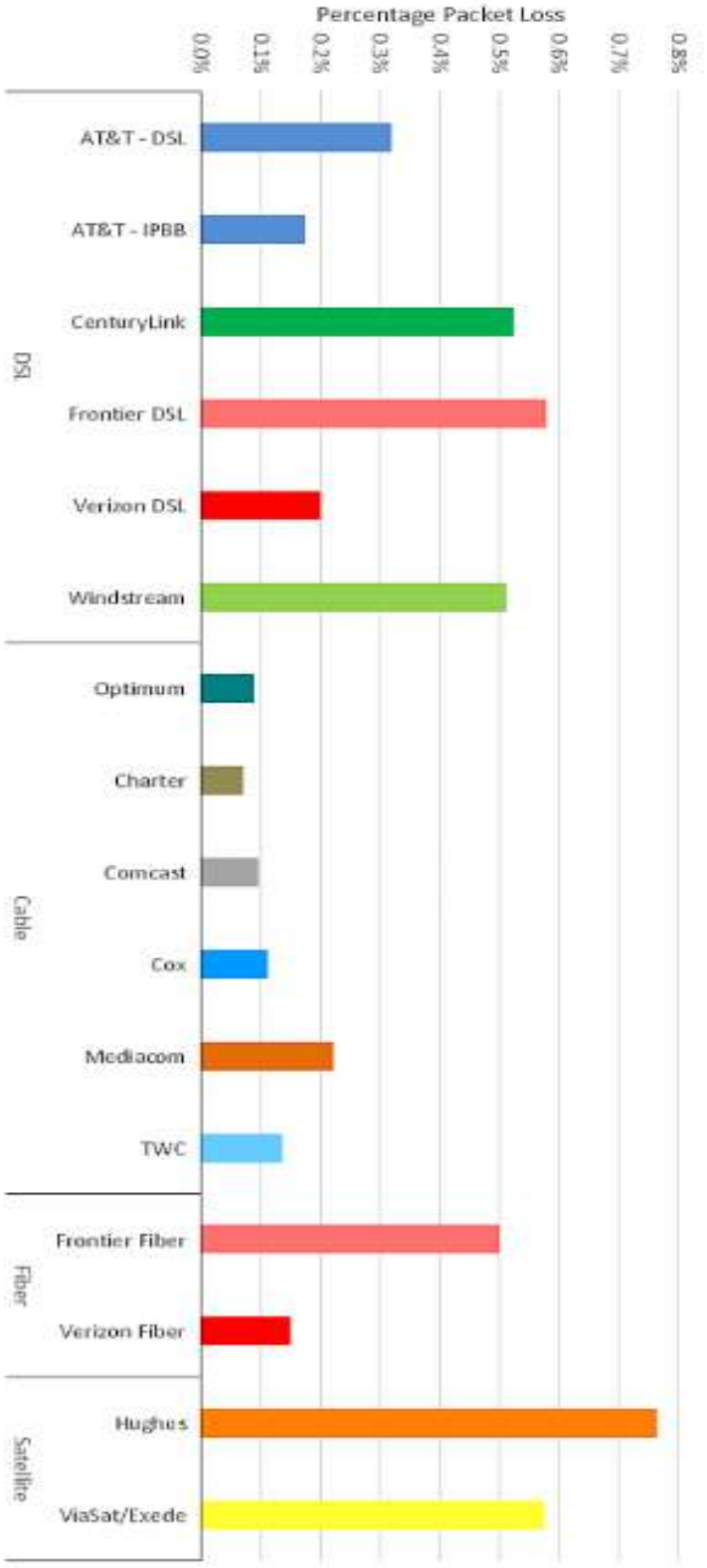
Chart 2.58



c. Packet Loss:

Packet loss is the percentage of packets that are sent by the source but not received by the destination. The most common reason that a packet is not received is that it encountered congestion along the route. A small amount of packet loss is expected, and indeed some Internet protocols use the packet loss to understand Internet congestion and to adjust the sending rate accordingly. Chart 2.59 shows the average packet loss for each participating ISP, grouped by technology.

Chart 2.59


Percentage Packet Loss
0.0%
0.1%
0.2%
0.3%
0.4%
0.5%
0.6%
0.7%
0.8%
DSL
AT&T - DSL
AT&T - IPBB
CenturyLink
Frontier DSL
Verizon DSL
Windstream
Cable
Optimum
Charter
Comcast
Cox
Mediacom
TWC
Fiber
Frontier Fiber
Verizon Fiber
Satellite
Hughes
ViaSat/Exede

18. RUSSIA/JAPAN/SOUTH KOREA/PHILIPPINES/MEXICO/CHINA

There are no specific benchmarks prescribed for Quality of Service (QoS) performance monitoring in Russia, Japan and South Korea. These countries are publishing the telecom subscription data on yearly basis. In Russia, however there is a system of Voluntary declaration of the Quality of Service offered by the operators certified by specialized agencies.

19. OMAN [31]

TRA is the regulatory body regulating the telecom sector in Oman.

Mobile voice performance was measured based on the following set of KPIs:

- **Call Setup Success Rate (CSSR)–** This indicator is used to measure the percentage of calls successfully established without facing blockage in the network as a ratio of the total number of call attempts made to access and establish a voice call. (to check network accessibility)

- **Call Drop Rate (CDR) –** This indicator is used to measure the percentage of calls dropped due to technical problems or coverage gaps in the service provider's network as a ratio of the total number of calls successfully established. (to check network retain-ability)

- **Call Success Rate (CSR) –** This indicator is used to measure the percentage of calls successfully established without facing blockage in the network as a ratio of the total number of call attempts made to access and establish a voice call and then successfully terminated from the user-end without being dropped or disconnected from the network side due to a technical irregularity. (to check service integrity)

[31] https://tra.gov.om/pdf/mobile-voice-2.pdf

Chart 2.60

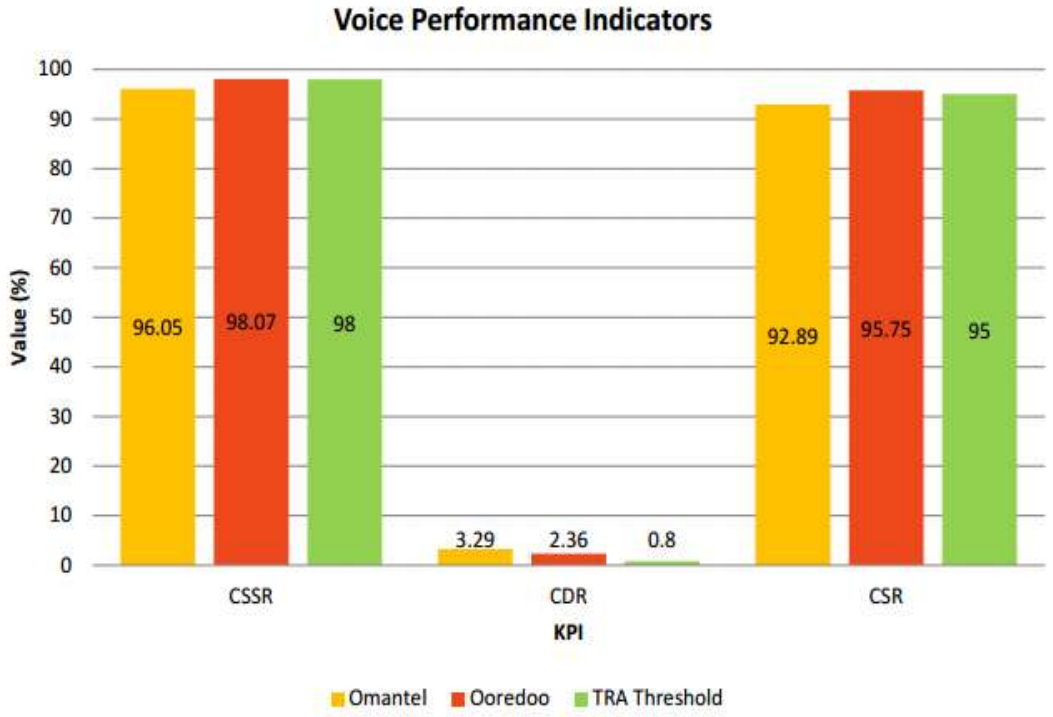


Chart 2.61

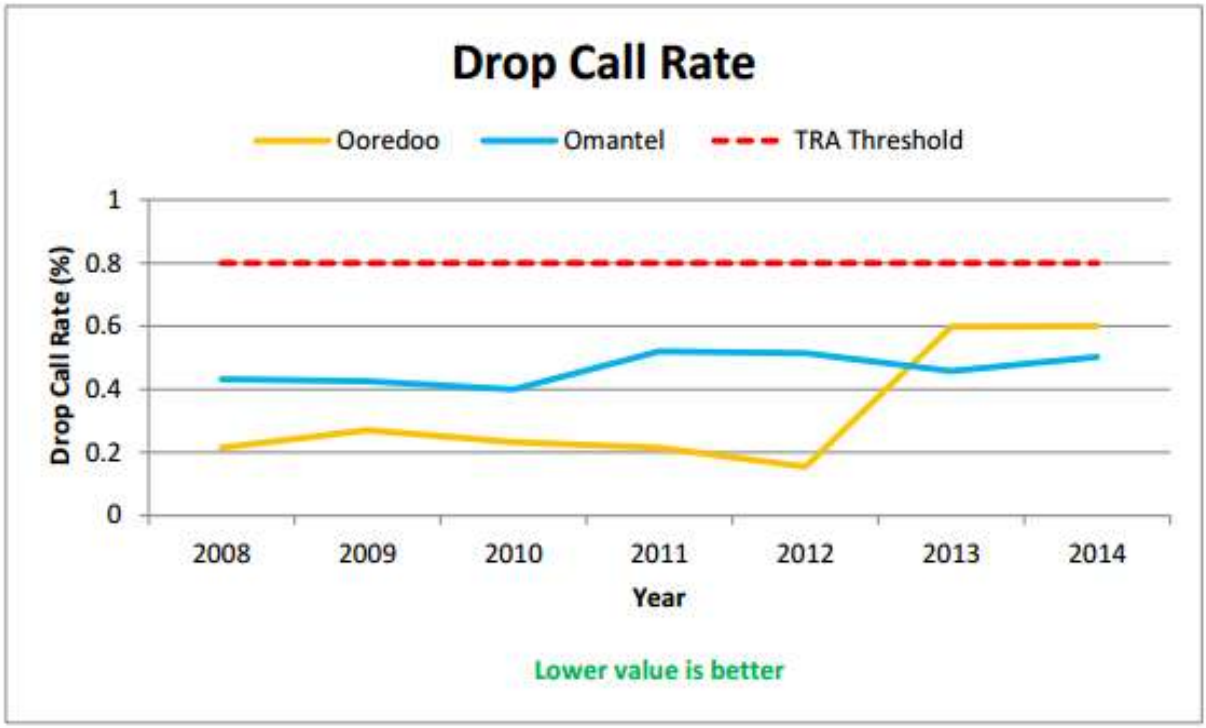


Chart 2.62

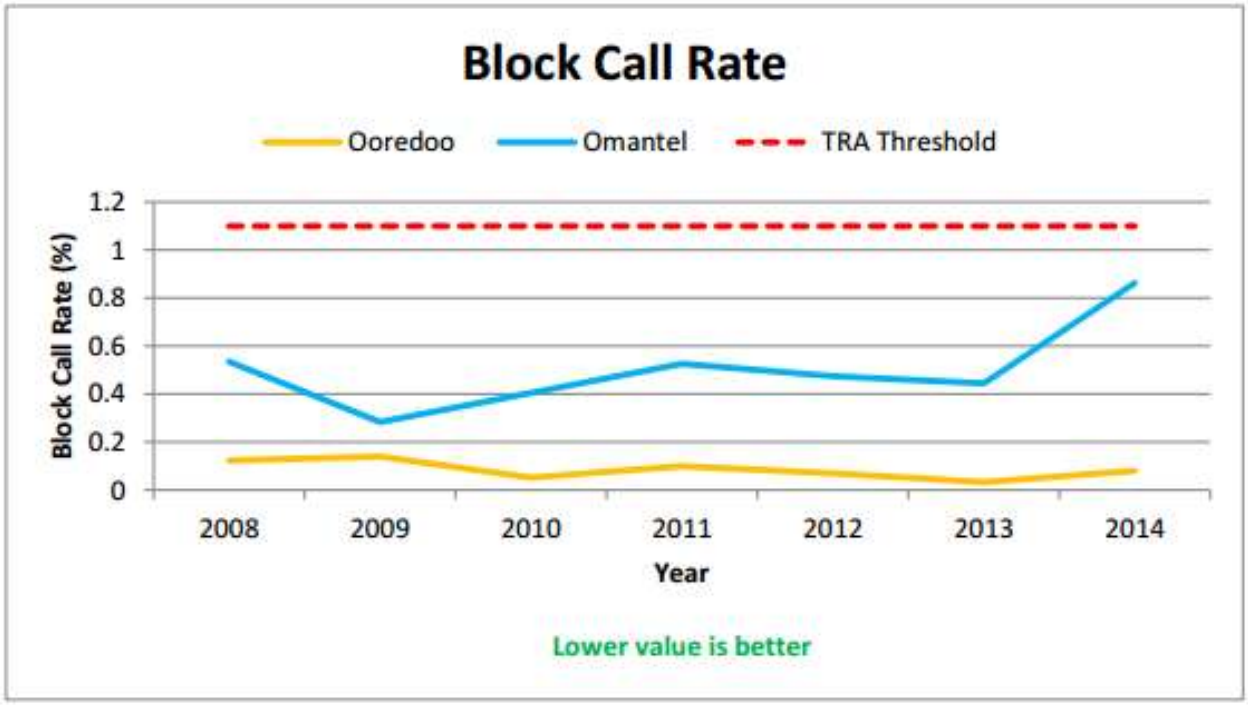


Chart 2.63

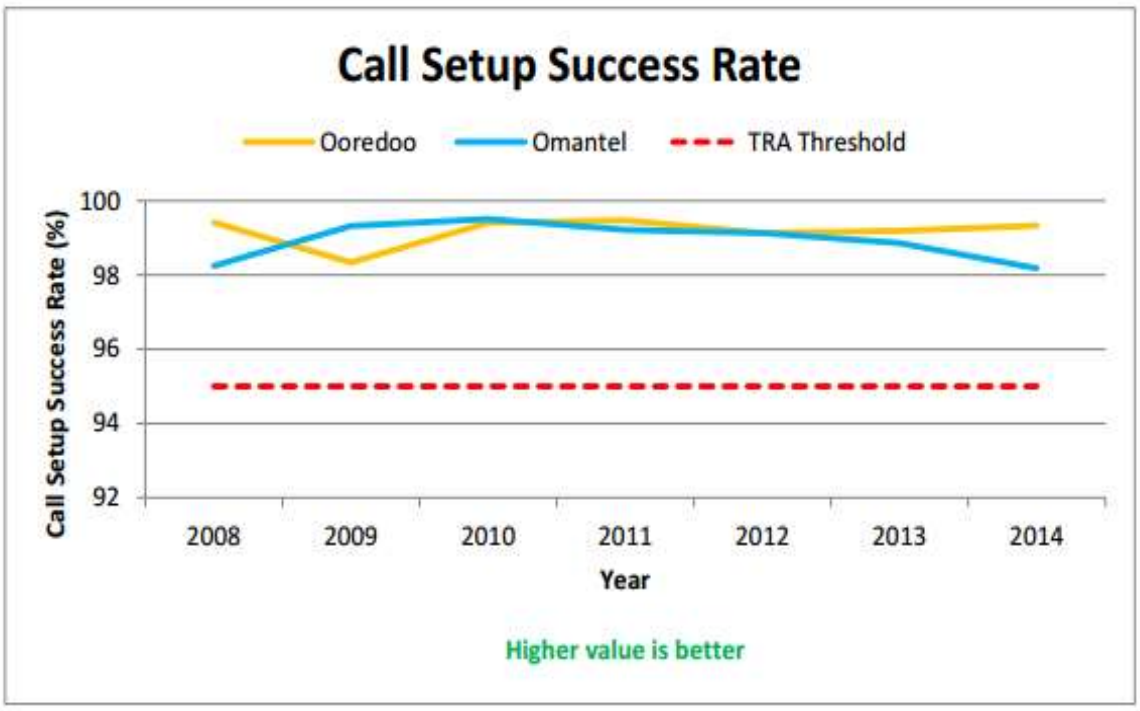
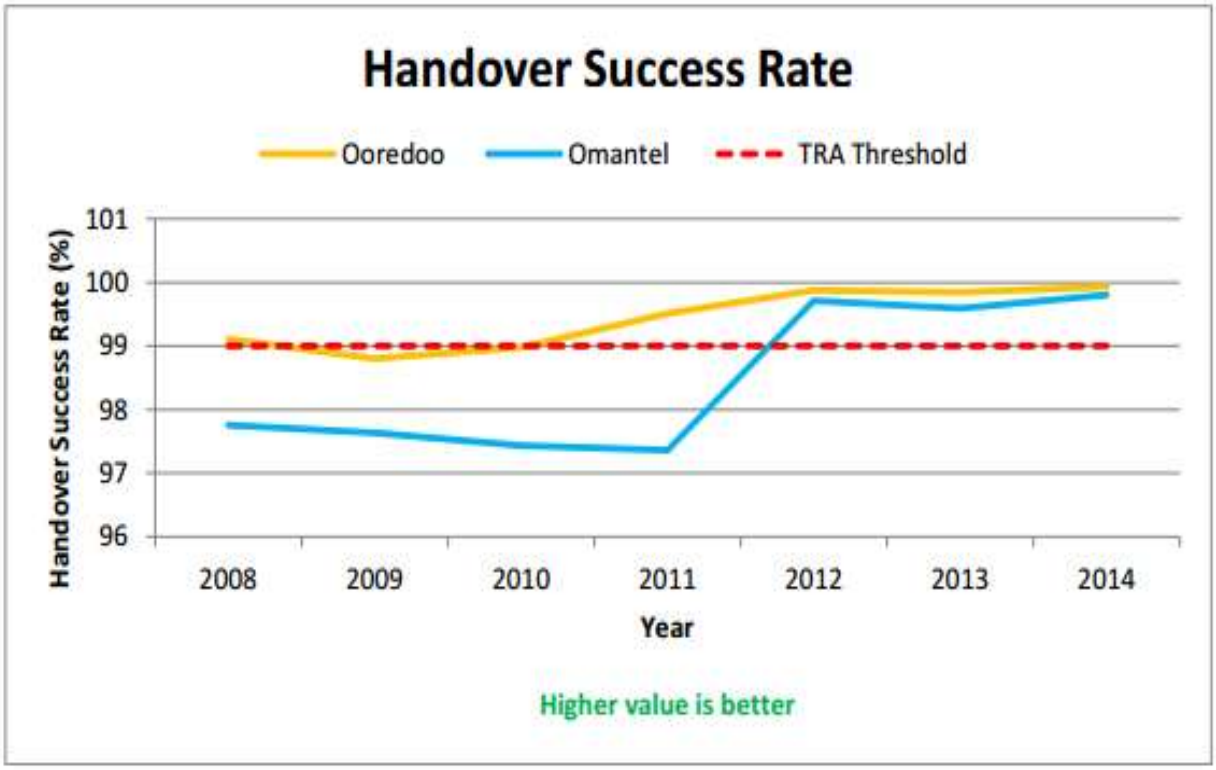


Chart 2.64



20. SINGAPORE

IMDA regulates the performance of key services offered by operators by setting Quality of Service (QoS) standards and requiring the operators to submit periodic reports of their service quality.

IMDA will consider all relevant factors such as (i) the extent of impact of the non-compliance; (ii) the cause of the non-compliance, (iii) the efforts taken by the service providers to meet the QoS standards; and/or (iv) any challenges faced by the service providers in meeting the QoS standards. Higher penalties may be imposed for (i) serious failures; and/or (ii) continuing or repeated breaches.

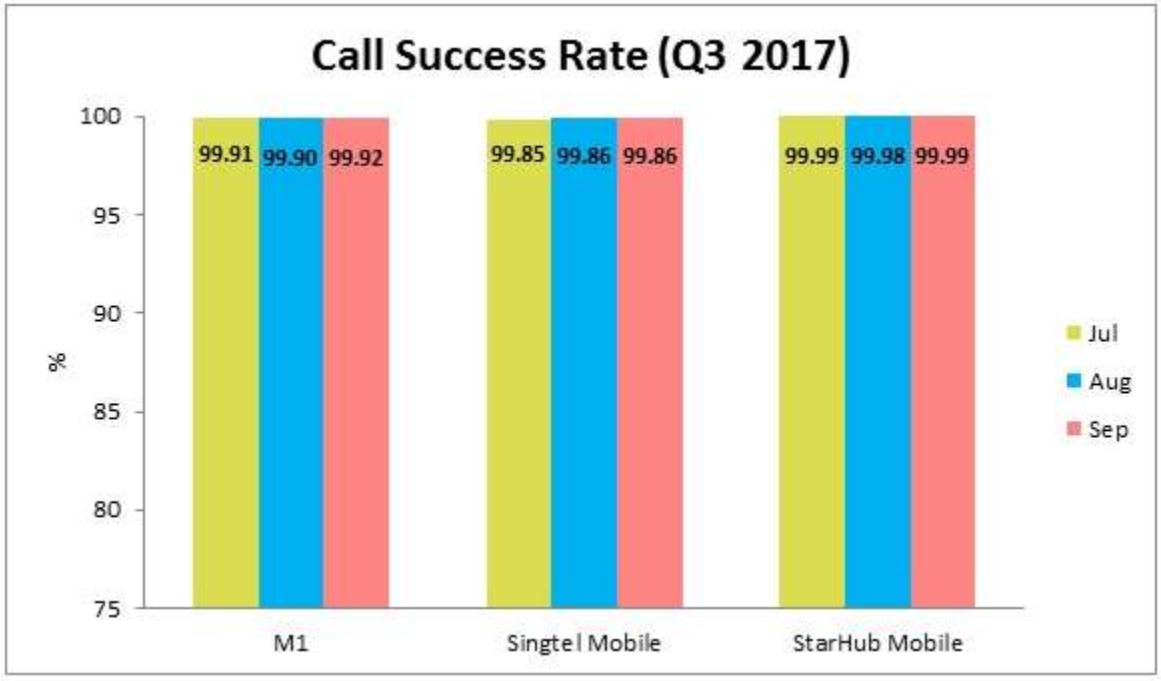
IMDA regularly reviews the QoS requirements to take into account industry and technology changes, as well as changes in consumer demand, to ensure that the requirements remain relevant.

1. 3G Services[32]:

Call Success Rate

This indicator measures the percentage of successful call attempts made on the 3G cellular network. A call attempt is deemed successful when the calling party (the individual who makes the call) gets connected to the called party (the individual who receives the call) or receives a busy tone. Under IDA's 3G PCMTS QoS framework, the mobile operators are required to achieve >99% success rate (average across all cell localities during busy hour).

Chart 2.65



CALL DROP RATE

This indicator measures the percentage of unintended disconnection of 3g mobile calls by the cellular network during a 100 second call. Under ida's 3g pcmts qos framework, mobile operators are required to achieve <1% drop call rate (average across the entire month).

[32] https://www.imda.gov.sg/regulations-licensing-and-consultations/licensing/licences/licence-for-the-sale-of-telecommunication-equipment/compliance-to-imda-standards/3g-services/jul-sep2017

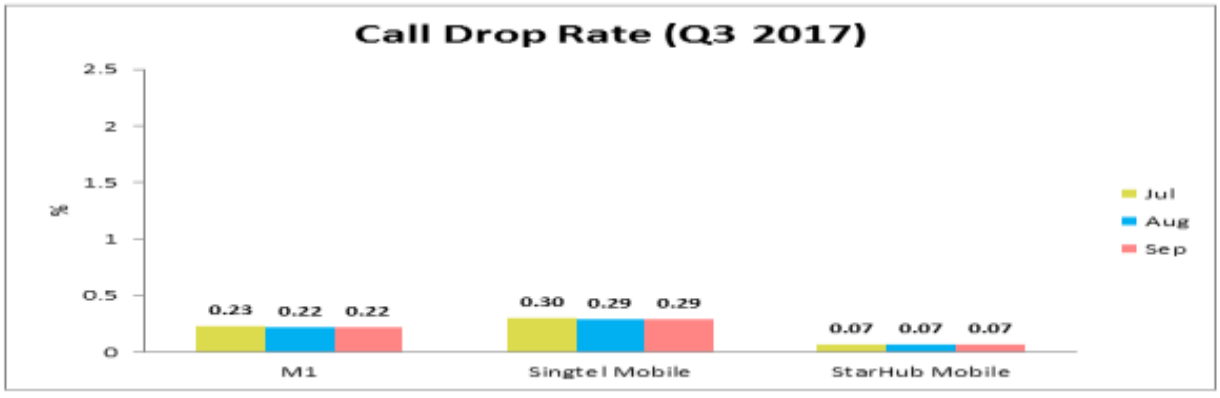
Table 2.21

(A)	Performance Indicators (for Compliance[1])	QoS Standards	With Effect From
(3)	**Drop call rate of PSTN and mobile originated calls ("Drop Call Rate")[12]**		
(a)	Average monthly drop call rate across the entire month[13]	<1%	1 April 2012
(b)	Average monthly drop call rate during busy hour[14]	<2%	
(c)	Average monthly drop call rate during hour with worst performance[15]	<2%	

Table 2.22

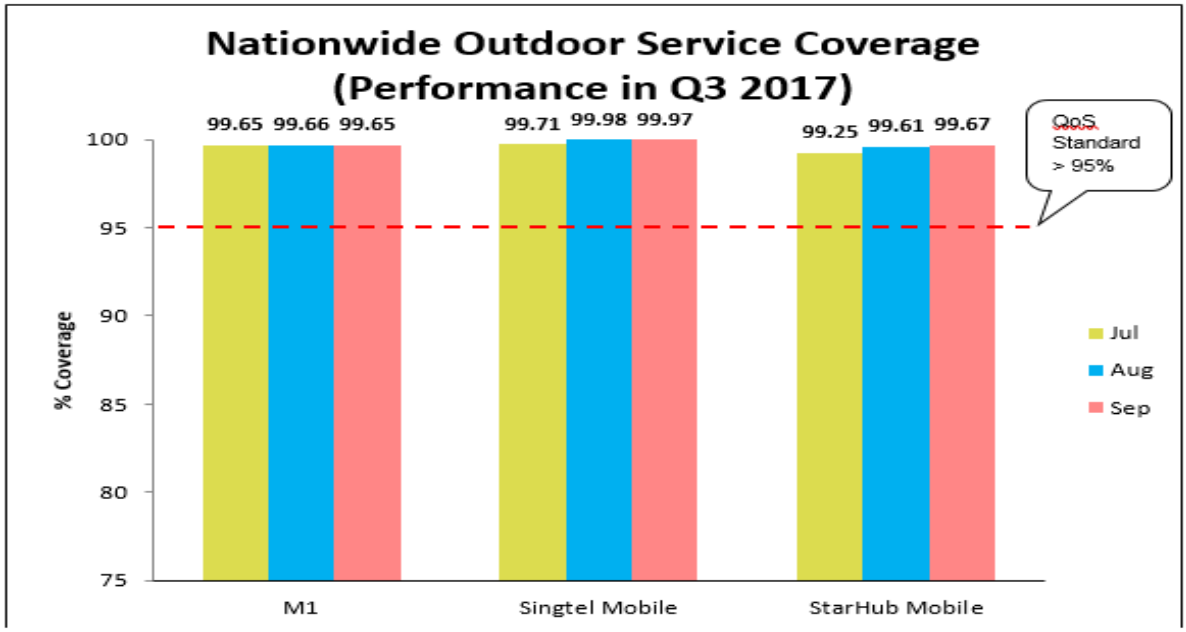
(B)	Performance Indicators (for Monitoring)	QoS standards
(1)	**Network Availability[16]**	For monitoring
	Base Stations (BS)	
	Mobile Switching Centre (MSC)	
(a)	Total outage time (hrs/min) in a month	
(b)	No. of day with >15min outage	
(c)	Worst outage time over 24hr period in a month	
(2)	**Network Congestion During Busy Hour[17]**	For monitoring
(a)	Total number of base stations/cells as at end period	
(b)	% of network congestion for the busiest cell during busy hour	
(c)	% of cells with >5% reduced GOS during busy hour	
(3)	**Average Call Set-up Time for[18]**	For monitoring
(a)	Land to mobile calls	
(b)	Mobile to land calls	
(c)	Mobile to mobile calls	
(4)	**Complaints on coverage per 1000 subscribers**	For monitoring

Chart 2.66



2. 4G Services[33]:

Chart 2.67



21. THAILAND[34]

The average result of the TRE survey in Thailand (2.8 out of 5) reveals mixed performance of the National Telecommunications Commission (NTC), the Thai telecom regulatory body. Higher TRE scores for market entry (3.1), tariff regulation (2.8) and quality of services (2.9) are interrelated. That is, the NTC has clearly adopted a liberal licensing regime that has led to increased competition in many markets, in particular, the broadband and the international internet gateway markets. New entrants into the broadband market are guaranteed access to the local loop or can request for a WiMAX license. Abolition of the monopoly over the international internet gateway (IIG) was a major boon to the industry. At the same time, its rather light-handed approach to tariffs regulation through the establishment of price ceilings that are mostly non-binding on operators, allow market mechanism to function without distortion.

[33] https://www.imda.gov.sg/regulations-licensing-and-consultations/licensing/licences/licence-for-the-sale-of-telecommunication-equipment/compliance-to-imda-standards/4g-services/jul-sep2017

[34] http://tdri.or.th/archives/download/publication/II0027.pdf

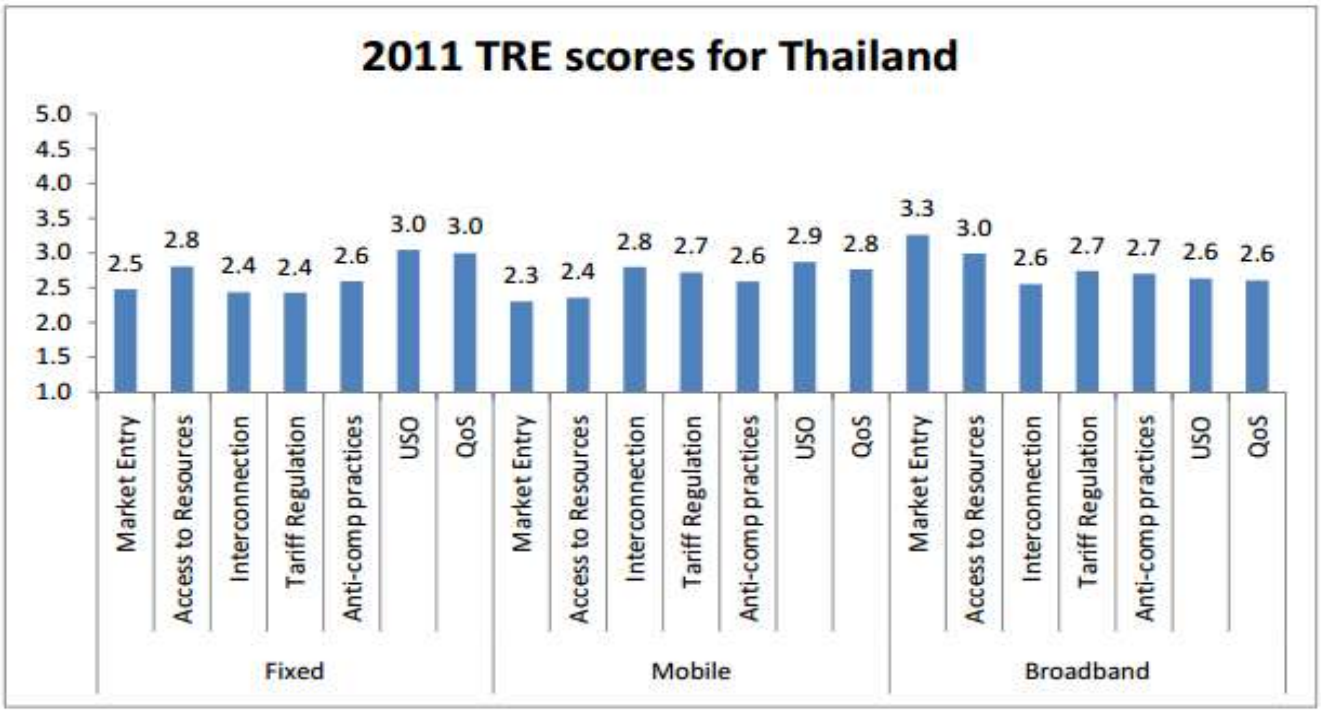


Chart 2.68

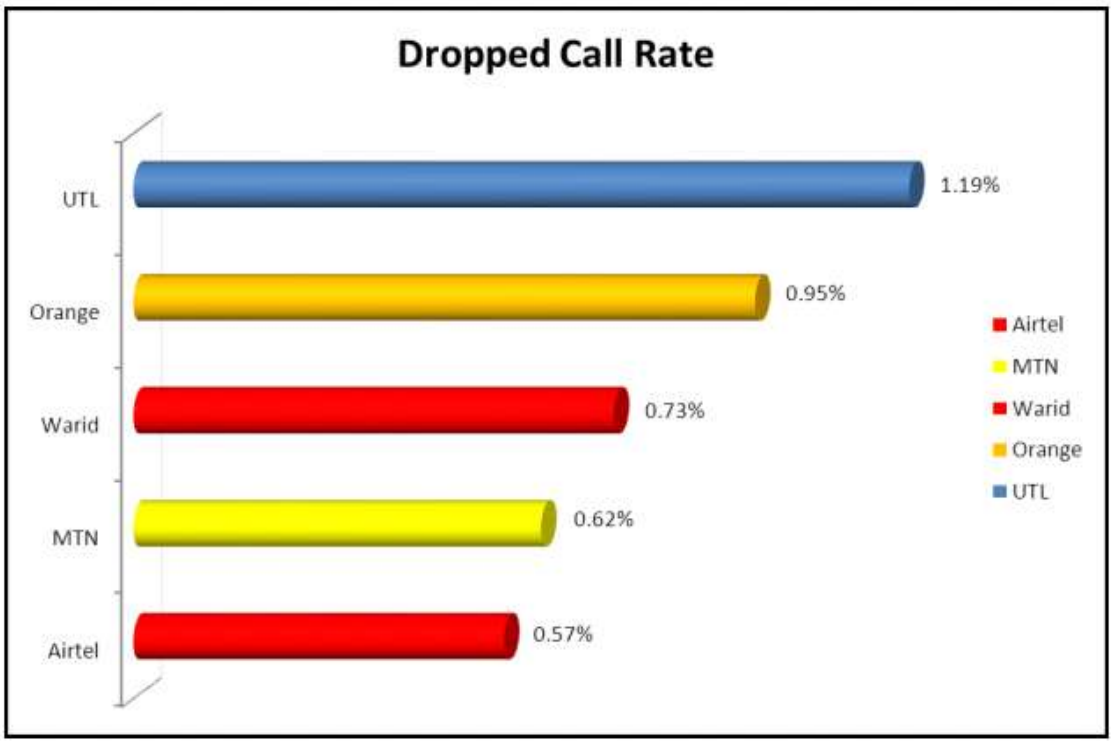
22. **UGANDA**[35]

The Uganda Communications Commission (UCC) is the regulator of the communications sector in Uganda. In this regard, UCC carried out a Quality of Service (QoS) performance exercise on the five operational Global System for Mobile communications (GSM) networks from February-June 2014 in Jinja, Kabale, Kampala, Kasese, Masaka, Mbale, Mbarara and Mukono. The five (5) operators are Airtel Uganda Limited, MTN Uganda Limited, Uganda Telecom Limited (UTL), Orange Uganda Limited and Warid Telecom Uganda Limited.The networks were evaluated against UCC Key Performance Indicators which are: less than 2% for dropped call rate (DCR), less than 2% for blocked call rate (BCR) and greater than or equal to 98% for successful call rate (SCR). The five GSM networks evaluated are Uganda Telecom Limited, MTN Uganda Limited, Airtel Uganda Limited, Warid Telecom Uganda Limited and Orange Uganda Limited. UCC hereby presents the results of the exercise. The graphs presented below are an average of all the towns monitored.

- **Dropped Calls:** A dropped call is one that is terminated by the network before it is ended by either parties participating in the call. UCC set limit for maximum proportion of call attempts on the network that may be dropped is 2%.

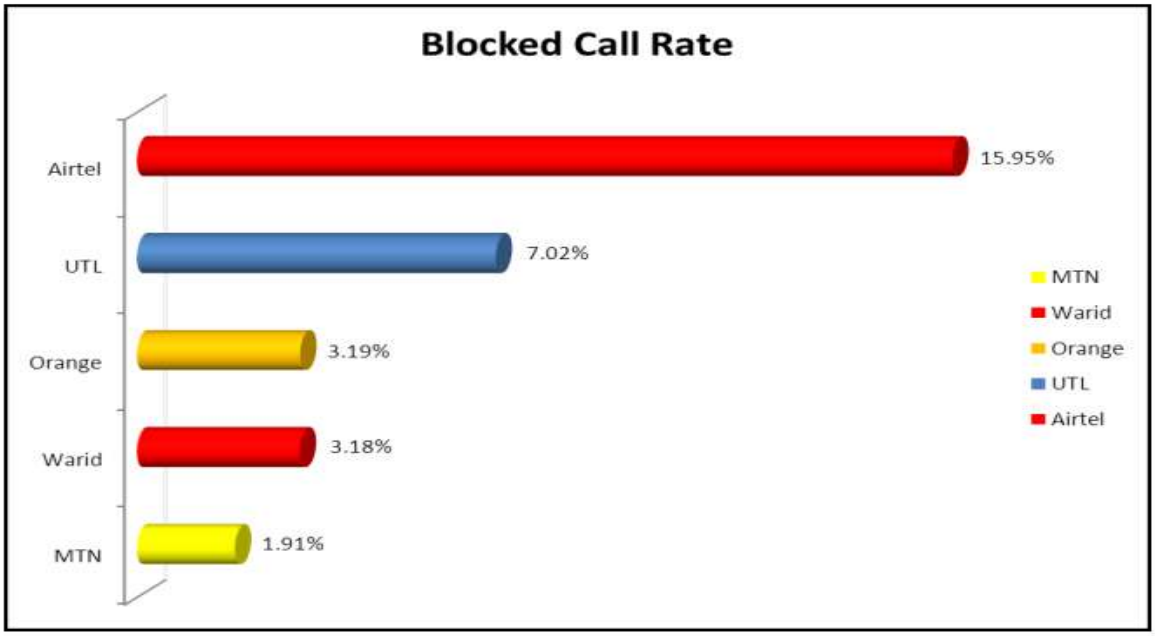
[35] http://ucc.co.ug/files/downloads/Quality%20of%20Service%20report%20for%20February-June%202014.pdf

Chart 2.69



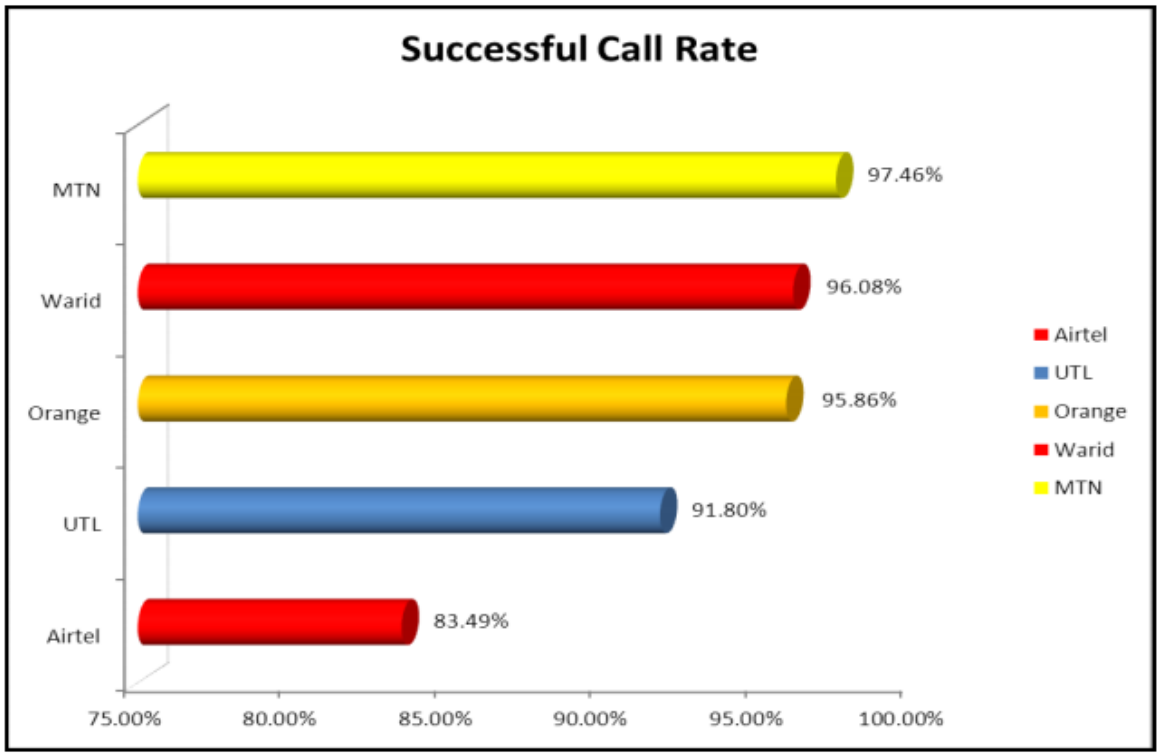
- **Blocked call:** A blocked call is an unsuccessful call attempt within a network coverage area due to the network failure. The UCC set limit for maximum proportion of call attempts on the network that may be blocked is 2%.

Chart 2.70



- **Successful Calls:** A successful call is one that progresses into conversation and is terminated by either the calling or the called party. UCC set limit for minimum proportion of call attempts on the network that may be successful is 98%.

Chart 2.71



- **Call setup time[36]:** The time interval from the instant the user initiates a connection request until the complete message indicating call disposition is received by the calling terminal.

- **Call audio quality:** Voice Call Audio Quality is the perceptibility of the conversation during a call –Listening quality Objective

- **Point of Interconnect blocking:** Proportion of unsuccessful interconnect call attempts due to insufficient interconnect capacity.

- **SMS Completion rate:** Successfully received SMS between two terminal equipments that are active and within coverage area.

- **SMS End to end delivery time:** The maximum delivery time from when an SMS is sent from one terminal (MO) to when it is received on another terminal (MT), both terminals being active and within coverage area.

23. OTHER INFORMATION REGARDING QOS IN VARIOUS COUNTRIES

Table: 2.23

Country	(comments, if any)	CDR Benchmark
Nigeria		2%
Singapore	across the entire month	1%
	during busy hour	2%
	during hour with worst performance	2%
Australia		1.2%
Ghana		3%
Malaysia		1.5%
Turkey		1%
Nepal		3%

[36]http://www.ucc.co.ug/files/downloads/QUALITY%20OF%20SERVICE%20MEASUREMENT%20AND%20MONITORING%20FRAMEWORK.pdf

UAE		2%
Uganda	Less than 2% of established calls dropped before either called or caller party terminates connection	2%
Japan		Voice quality is maintained by R-Factor[37]
Spain		
UK		
Europe		1.5%
Kenya		2%
Burundi		2%
Rwanda		3%
Channel Islands	includesJersey, Guernsey, Alderney, Sark, Herm, Jethou, Brecqhou**across the border of Europe**	3% (per busy hour)
		2% (across month[38])

[37]http://tel_archives.ofca.gov.hk/en/ad-comm/tsac/cc-paper/ccs2005p11.pdf
[38]http://www.cicra.gg/_files/Telecoms%20Quality%20of%20Service%20Consultation%20Paper%20Revised%20(2).pdf

CHAPTER – 3
INTERNATIONAL PRACTICES OF SPECTRUM MANAGEMENT

3.1 General

3.1.1 The Radio Frequency (RF) spectrum is a natural resource that can be used to increase the efficiency and productivity of a nation's work force as well as to enhance the quality of life of its people. It is used to provide a wide variety of radio-communication services including personal and corporate communications, radio navigation, aeronautical and maritime radio, broadcasting, public safety and distress operations, radio location and amateur radio.

3.1.2 The use of RF spectrum needs to be coordinated to avoid interference problem. Two radio-communication devices operating on the same frequencies, at the same time and in the same coverage area will produce interference to the receivers. The RF spectrum is a finite resource like land and water having competing users. It has the property of being conserved if used properly, and wasted if not. As the uses of wireless applications are wide and varied, it is crucial to ensure that the spectrum is efficiently and effectively managed to optimally benefit the society and economy. Spectrum management is an important part of telecommunications policy and regulation. The spectrum is allocated for particular uses, and specific technical and service rules, developed by spectrum managers, govern those allocations.

3.1.3 The management and coordination of spectrum use on the global level is done by the International Telecommunication Union (ITU) in particular, its Radiocommunication Sector (ITU-R). The mission of the ITU-R sector is, *inter alia*, to ensure rational, equitable, efficient and economic use of the radio frequency spectrum by all radio communication services, including those using satellite, and to carry out studies and adopt recommendations on radio communication matters. The international framework for the utilization of the radio frequency spectrum is set out in the ITU's Radio Regulations. The ITU

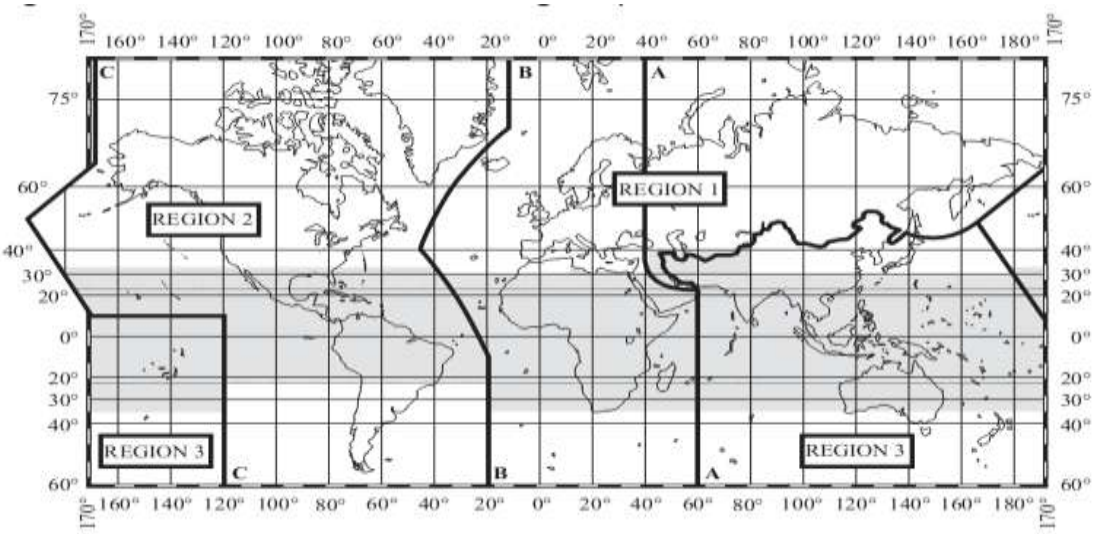
Radio Regulations form the international framework within which member nations allocate and manage spectrum at a more detailed level. For the allocation of frequencies the world has been divided into three Regions as shown below:

Regions1: Europe, Russia, Africa and Middle East of Asia

Region 2: North and South America

Region 3: Rest of the Asia and Australia

Chart 3.1



3.2 International Practices of Spectrum Management

Practices followed by some major countries of the world for spectrum management are detailed below.

3.2.1 Australia

The Australian Communications and Media Authority (ACMA) is responsible for the regulating broadcasting, radiocommunications, telecommunications and online content. ACMA's responsibilities include promoting self-regulation and competition in the telecommunications industry, while protecting consumers and other users; managing access to the radio frequency spectrum, including the broadcasting services bands.

The ACMA manages the radiofrequency spectrum in accordance with its obligations under the ACMA Act and the Radiocommunications Act 1992.
ACMA also has related spectrum management obligations under the Broadcasting Services Act 1992, which guide the use of spectrum in the broadcasting services bands[39].

Radiocommunications licences

Section 46 and 47 of the Radiocommunications Act 1992 provide that radiocommunications devices be operated only if authorized by a spectrum, apparatus or class licence. Radiocommunications licences are also subject to provisions in the trade Practices Act 1974, which prohibit acquisitions that result in a substantial lessening of competition.

Class Licences are open, standing authorization that allow anyone to operate particular radiocommunications equipment provided that the operation of the device is in keeping with the conditions of the licence.

Apparatus licenses system permits broad apparatus licence categories within which different radiocommunications applications are separately identified as individual licence options, for example broadcast, fixed or land mobile.

Spectrum licensing offers a technology flexible, market-oriented approach to manage the radio frequency spectrum. A spectrum licence authorizes the use of spectrum space in relation to both a frequency band and a geographical area. It allows licensees to deploy any device from any site within the specified spectrum space, provided that the device is compatible with the core conditions of the licence and the technical framework for the band. Spectrum licensing has been applied to frequency bands for which there is likely to be high demand, or bands which are considered likely to be of high value.

[39] The broadcasting services bands are those parts of the radiofrequency spectrum that, under s.31 of the Radiocommunications Act, are designated as being primarily for broadcasting purposes.

Principles for Spectrum Management

Followings are the principles that guide ACMA for spectrum management:

- Allocate spectrum to the highest value use or uses
- Enable and encourage spectrum to move to its highest value use or uses
- Use the least cost and least restrictive approach to achieving policy objectives
- To the extent possible, promote both certainty and flexibility
- Balance the cost of interference and the benefits of greater spectrum utilisation

  The key theme of the Principles is that maximising the overall public benefit from use of the radiofrequency spectrum requires balanced application of both regulatory and market mechanisms.

Duration of Spectrum Assignment

Spectrum licences are usually allocated by market-based mechanism such as auction. They are issued for a fixed term of upto 15 years, and may be sub-divided, combined and traded. Licensees are able to purchase or sell units of spectrum space to tailor the spectrum to their needs. This flexibility enables greater spectrum efficiency. Licensees are able to acquire the same parcel of spectrum over a large geographical area, up to nationwide coverage.

Flexible use of Spectrum

Technical conditions in spectrum licences are intended to promote technology flexibility. Spectrum licences permit the deployment of any device from any site within the space licensed spectrum, subject to the conditions of the licence and relevant technical specifications. The advantage of such a spectrum licensing system is that services can be deployed in a more flexible manner, whereas under the apparatus licence scheme, licensees are constrained by the licence to deploy a specified type of service.

Spectrum Trading

As per Radiocommunication Act 1992, spectrum licences can be traded[40] in part or whole to others by geographical area and bandwidth can be divided or amalgamated. For this purpose, ACMA permits spectrum space to be bought and sold in terms of standard trading units[41].

Spectrum requirement for future

In a paper titled "Towards 2020- Future Spectrum requirements for mobile broadband" dated May 2011, ACMA had estimated the requirement of an additional 150 MHz of spectrum by 2020 taking into account the 800 MHz of spectrum already dedicated for operation by mobile communications services. The estimate ensures that approximately 1100 MHz of spectrum is available in the Australian communications environment to support mobile broadband services by 2020.

Five-year Spectrum Outlook (FYSO) 2015-19:

The objective of the ACMA's Five-year spectrum outlook (FYSO) is to outline the fundamental issues that affect spectrum requirements and management over the next five years. It outlines the ACMA's proposed actions to address these issues, while also highlighting the spectrum issues that could arise for radiocommunications services beyond the issue year of the FYSO. It sets out the ACMA's strategic direction and priorities for the short to medium term in response to the environmental factors influencing spectrum demand and thus provides greater insight and transparency for spectrum users about both. The first FYSO was released in 2009 as part of its approach by the ACMA to improve our engagement with industry and Australian citizens on spectrum management issues. The purpose of the FYSO is to provide industry with an

[40] http://www.acma.gov.au/Industry/Spectrum/Radiocomms-licensing/Spectrum-licences/spectrum_21

[41] A single STU is the smallest unit of spectrum space that a spectrum licence can be divided into.

annually updated overview of spectrum priorities and issues over the near to medium term, at least so far as the ACMA views it.

3.2.2 Canada

The "Canadian Radio-television and Telecommunications Commission (CRTC)" regulates and supervises broadcasting and telecommunications. It focuses on achieving policy objectives established in the 'Broadcasting Act', and 'Telecommunication Act'. Industry Canada, through the Department of Industry Act, the Radiocommunication Act and the Radiocommunication Regulations, with due regard to the objectives of the 'Telecommunications Act', is responsible for spectrum management in Canada.

Assignment of licence[42]

Industry Canada generally considers the following broad conditions in determining whether an auction process will be used as the spectrum assignment mechanism:

- whether the demand for spectrum is expected to exceed the available supply; and whether government policy objectives can be fully met through the use of an auction.

Where the demand for spectrum is not expected to exceed the supply, Industry Canada generally uses a first-come, first-served licensing process to award spectrum licences. In instances where the demand for spectrum is expected to exceed supply, a competitive licensing process, such as an auction, is generally used.

It considers that the use of auctions as a spectrum assignment mechanism may not be appropriate for certain radio services for example: Broadcasting licences[43], priority users and satellite services.

[42] https://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/dgso-001-11-framework-e.pdf/$FILE/dgso-001-11-framework-e.pdf

[43] Issue of broadcasting licences is the responsibility of CRTC; priority services are those whose radiocommunications systems are vital to national sovereignty and defence, law enforcement, public safety and emergency services.

Licence term

Where spectrum use is not anticipated to change, longer terms (e.g. 20 years) is offered. As a condition of licence, licences have a high expectation of renewal, unless a breach of licence condition has occurred, and a fundamental reallocation of spectrum to a new service is required or an overriding policy need arises. Licences issued via auction have terms of up to 20 years, based on the specific spectrum being offered.

Spectrum Use

Industry Canada generally provides maximum possible flexibility to the licensees in determining the services which they will offer and the technologies that they will employ so that they can quickly and efficiently adapt their services to the changing demands of the business and consumers.

License transferability and divisibility

Licences acquired through an auction are transferable in whole or in part (divisibility) to a qualified recipient, in both the bandwidth and geographic dimensions, subject to the policy and licensing frameworks applicable to these specific licences. Generally, the area transferred may be no smaller than a single spectrum grid cell which is a hexagonal figure with an area of 25 square kilometres. However, limits may occasionally be required on the amount of spectrum that can be transferred in order to respect band channeling plans or other policy needs.

Repurposing of spectrum[44]

Industry Canada via its decision titled "Decision on Repurposing the 600 MHz Band" dated 14th august 2015 has announced repurposing of 600 MHz band for mobile use. The amount of spectrum to be repurposed to commercial mobile could be between 20 and 120 MHz.

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[44] http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf11049.html

Spectrum requirement for future[45]

"Commercial Mobile Spectrum Outlook" published in March 2013, states that Canada will require at least 473 MHz and as much as 820 MHz of spectrum to be allocated to commercial mobile services by 2017. Based on these projections, Industry Canada has set an objective of allocating a total of 750 MHz of spectrum to commercial mobile services by the end of 2017.

3.2.3 Germany

The Bundesnetzagentur (Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railway) is a separate higher federal authority within the scope of business of the Federal Ministry of Economics and Energy. On 13 July 2005, the Regulatory Authority for Telecommunications and Post, which superseded the Federal Ministry of Post and Telecommunications (BMPT) and the Federal Office for Post and Telecommunications (BAPT), was renamed the Bundesnetzagentur. It also acts as the root certification authority under the Electronic Signatures Act[46].

In the area of telecommunications and post, the Bundesnetzagentur ensures fair and workable competition across Germany; provision of basic telecommunications and postal services (universal services) at affordable prices throughout the country; promotion of telecommunications services in public institutions; efficient and interference-free use of frequencies, also taking into account broadcasting interests, and; protection of public safety interests. As per Section 55(1) of the Telecommunication Act (TKG)[47] of June 2004, anyone wishing to use a radio frequency must first be assigned the frequency by the Federal Network Agency.

[45] https://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/Outlook-2013-en.pdf/$FILE/Outlook-2013-en.pdf

[46] http://www.bundesnetzagentur.de/cln_1421/EN/General/Bundesnetzagentur/About/AboutTheBundesnetzagentur_node.html

[47] TKG stands for telecommunication Act. For detail refer. https://www.coe.int/t/dghl/standardsetting/dataprotection/National%20laws/GERMANY_TelecommunicationsAct-TKG.pdf

In addition to regulation, the Bundesnetzagentur has a range of other duties regarding the telecommunications and postal markets; it issues postal licences; contributes to solutions for standardisation issues; administers frequencies and phone numbers; resolves radio interference; combats telephone number misuse; monitors the market, and advises citizens on new regulations and the implications of these.

Frequency Assignment

Section 61 of the TKG enables the Federal Network Agency to tender or auction frequencies in special cases where demand outstrips the number of frequencies available for a particular application.

Spectrum for wireless access

In Germany, Over 1000 MHz of spectrum has been dedicated for 'wireless access for the provision of telecommunications services' as part of the allocation to "mobile services". These frequencies can in principle be used with a wide variety of technologies to connect terminal devices to radio networks via fixed stations.

Flexibilisation of Frequency Usage Rights[48]

The Bundesnetzagentur President's Chamber decision of 12 October 2009 on the flexibilisation of frequency usage rights in the bands at 450 MHz, 900 MHz, 1800 MHz, 2 GHz and 3.5 GHz lifted restrictions on the assigned frequency usage rights, allowing the network operators to use the frequencies on request on a technology-neutral basis for wireless access for the provision of telecommunications services. Spectrum assigned through subsequent auctions was also assigned in a technology-neutral manner.

[48] http://www.bundesnetzagentur.de/cln_1421/EN/Areas/Telecommunications/Companies/FrequencyManagement/FlexibilisationFrequencyUsageRights/flexibilisationFrequencyUsageRights_node.html

Mobile Broadband Project 2016[49]:

Mobile Broadband- Project 2016 is concerned with auctioning of spectrum in the 700 MHz, 900 MHz, 1500 MHz and 1800 MHz bands for electronic communications services (mobile broadband). The auction process took place in May-June 2015 and 270 MHz of spectrum in these bands have been awarded during the process to the following three companies:

Table 3.1

Name of Company	Spectrum Band	Quantum of spectrum
Telefónica Deutschland	700 MHz	2 x 10 MHz
	900 MHz	2 x 10 MHz
	1800 MHz	2 x 10 MHz
Telekom Deutschland	700 MHz	2 x 10 MHz
	900 MHz	2 x 15 MHz
	1800 MHz	2 x 15 MHz
	1500 MHz	20 MHz
Vodafone	700 MHz	2 x 10 MHz
	900 MHz	2 x 10 MHz
	1800 MHz	2 x 25 MHz
	1500 MHz	20 MHz

Shared use of wireless infrastructures

Shared use of wireless infrastructures is possible without further consent from the Bundesnetzagentur, as long as competitive independence is not compromised and infrastructure competition continues to be guaranteed.

Use of logically separate base stations (egNodeB+RNC / eNodeB) in a shared physical unit, referred to as RAN sharing, is permitted if the individual cooperation agreements guarantee that each assignee will retain independence as a competitor. The prerequisites for this are as follows:

- independent control by assignees of their own logical base stations so that each assignee can use only the frequencies assigned to them ("technical" and hence de facto control; no spectrum pool),

[49] http://www.bundesnetzagentur.de/cln_1411/EN/Areas/Telecommunications/Companies/FrequencyManagement/ElectronicCommunicationsServices/MobileBroadbandProject2016/project2016_node.html

- no exchange of competition-related data beyond operational information (eg customer data),
- separation of operation and maintenance centres,
- possibility of operating additional own base stations (planning autonomy guaranteed),
- no regional division of coverage areas that rules out network and coverage area overlap for the parties to the cooperation agreement**.**

Shared use of wireless infrastructures and spectrum resources that goes beyond this requires an examination by the Bundesnetzagentur of the individual case and, where appropriate, by the anti-trust authorities.

3.2.4 India

In India, Department of Telecommunication (DoT) is responsible for Implementation of Government's policy in all matters concerning telecommunication. It is responsible for policy, licensing and coordination matters relating to wireline, wireless, data, and other like forms of communications. It is the authority for spectrum allocation and management. It works under the aegis of the Ministry of Communications.

The Telecom Regulatory Authority of India (TRAI) is an independent regulator created by an Act of Parliament. The function of Authority to make recommendations, either *suo moto* or on a request from the licensor on the following matters which, *inter alia*, includes:

- the need and timing for introduction of new service provider,
- terms and conditions of license to a service provider,
- measures to facilitate competition and promote efficiency in the operation of telecommunication services so as to facilitate growth in such services,
- technology improvement in the services provided by the service providers,
- ensure compliance of terms and conditions of license,
- lay down the standards of quality of service to be provided by the service providers and ensure the quality of service and conduct the periodical

survey of such service provided by the service providers so as to protect interest of the consumers of telecommunication service,

- ensure effective compliance of Universal Service Obligations,
- notify the rates at which telecommunication services is to be provided in the Country.

Unified Licence

With a view to achieve the objective of New Telecom Policy (NTP)-2012 to create one nation – one license across services and service areas, the Department of Telecommunication (DoT) has issued guidelines on Unified Licence. As per the guideline, the allocation of spectrum is delinked from the licence and now it has to be obtained separately as per the prescribed procedure, i.e., bidding in public auction. Only one Unified License is required for all telecom services in the entire country. In addition, authorization for various services like access services, National Long Distance Services, International Long Distance Services, Internet Service Provider services etc will be required separately. Single authorization for Unified License (All services) category would cover all telecom services except ISP (B) and ISP (C) services. The tenure of such authorization will run concurrently with the Unified License.

Frequency Bands

In India, at present spectrum bands shown in the table below, are used for providing commercial mobile services.

Table 3.2

Sl. No.	Spectrum Band	Technology Deployed
1.	800 MHz Band	CDMA, LTE
2.	900 MHz Band	GSM, HSPA
3.	1800 MHz Band	GSM, HSPA, LTE
4.	2100 MHz Band	HSPA
5.	2300 MHz Band	LTE-TDD
6.	2500 MHz Band	LTE-TDD
7.	700 MHz Band	To be auctioned

Allocation of spectrum for Commercial Use in India- A brief history

In pursuance of National Telecom Policy-1994 (NTP-1994), the first phase of liberalisation in mobile telephony began with the award of eight Cellular Mobile Telephone Service (CMTS) licences in four Metros (Bombay, Delhi, Calcutta, Madras) in 1994. These were awarded on the basis of a public auction.

In year 1995, after following competitive bidding process, 34 Cellular Mobile Telephone Service (CMTS) licences were awarded in 18 licence service area. It is worth mentioning here that the country is divided in 22 licence service areas (LSAs) and separate licences are awarded for each of these LSAs.

The government companies (MTNL/BSNL) were given CMTS licence as the third CMTS operator. MTNL, which operates in Delhi and Mumbai, was given CMTS licence in 1997, whereas BSNL, which operates in rest of the country, was given CMTS licence in the year 2000. The fourth cellular operator was chosen through a multi-stage bidding in the year 2001 and licences were issued in 2001/2002. Afterwards, Universal Access Service Licences (UASL)[50] were given in the years 2003, 2004, 2006, 2007 and 2008 following the principle of First Come First Served (FCFS). The Entry Fee discovered in the 2001 auction was applied for all the UAS licences issued till 2008.

The Hon'ble Supreme Court of India found the process of award of licences on FCFS as arbitrary and flawed and through its order dated 2nd February 2012, cancelled 122 new licences, which were awarded in the year 2008. Hon'ble court ordered that spectrum, being the scare natural resource having alternate, must be assigned through the process of price discovery through public auction.

Unbundling of Spectrum from Licence

Till 2008, there was no separate fee for the assignment for the spectrum, which was bundled with the spectrum. Initially, 2x4.4 MHz of 900/1800 spectrum for GSM or 2x2.5 MHz of 800 MHz for CDMA service providers was

[50]UASL permits a licensee to offer any access service viz. basic services, mobile services and internet services

allotted and subsequently additional spectrum was assigned based on the subscriber linked allocation criteria administratively.

In Feb 2012, the DoT announced[51] that in future, the spectrum will not be bundled with the licence. The licence to be issued to telecom operators will be in the nature of a 'unified licence' and the licence holder will be free to offer any of the telecom services. In the event the licence holder likes to offer wireless services, it will have to obtain spectrum through a market-driven process. In future, there will be no concept of contracted spectrum and, therefore, no concept of initial or start-up spectrum. Spectrum will be made available only through a market-driven process of public auction.

Later on, the DoT has conducted auctions in 2012, 2013, 2014 and 2015 for the award of spectrum.

At present, in India, spectrum for IMT services is no longer assigned through administrative methods, only market based mechanisms are being followed and spectrum assignment through market based mechanism, i.e., valid up to 20 years.

Liberalised use of Spectrum

In India, spectrum assigned administratively till 2008 for mobile services is bound with the technology, either GSM or CDMA. However, the spectrum that has been assigned through auction in the 900MHz/1800 MHz band is a liberalised spectrum. Also, there has been a provision that a Telecom Service Provider may convert its existing spectrum holding to liberalised form by paying market determined price pro-rated for the remaining licence validity period.

[51]These are in accordance with the TRAI's recommendations on 'Spectrum Management and Licensing Framework' dated 11th May 2010 and 3rd November 2011.

Spectrum Sharing[52]

To improve spectral efficiency and quality of service, the government issued necessary guidelines on spectrum sharing on 24th September 2015. Salient features of the guidelines are given below:

- Spectrum sharing would be allowed only for the access service providers holding cellular Mobile Telephone Service (CMTS) License, Unified Access Service License (UASL), Unified License (Access Services) (UL(AS)) and Unified License (UL) with authorization of Access Service in a Licensed Service Area (LSA), where both the licensees are having spectrum in the same band.
- Sharing will be permitted when sharing entities possess spectrum which is either acquired through auctions in the year 2010 or afterwards /trading or for which market price has been paid. All access spectrum will be sharable for this purpose.
- Leasing of spectrum will not be permitted.
- For the purpose of charging Spectrum Usage Charges (SUC), licensees shall be considered as sharing their entire spectrum holding in the particular band in the entire LSA.
- The right to share spectrum shall be subject to fulfillment of relevant license conditions and any other conditions that may be specified by the licensor/Government from time to time.
- A licensee shall not be eligible to share its spectrum, if it has been established that it is in breach of terms and conditions of the licence, and the licensor has ordered for revocation/termination of its licence.
- The use of technology shall be governed by the terms and conditions of respective Notice Inviting Application (NIA)/license.
- Both licensees will be individually and collectively responsible for complying with sharing guidelines, including interference norms.

[52] http://www.dot.gov.in/sites/default/files/u77/2015_10_13%20Sharing-WPC.pdf

- Spectrum sharing will be restricted to sharing by only two licensees subject to the condition that there will be at least two independent networks provided in the same band.
- Spectrum Usage Charges (SUC) rate of each of the licensees post-sharing shall increase by 0.5 percent of Aggregate Gross Revenue (AGR).
- The prescribed limits for spectrum cap shall be applicable for both licensees individually. Further, spectrum holding of any licensee post-sharing shall be counted after adding 50 percent of the spectrum held by the other licensee in the band being shared, being added as additional spectrum to the original spectrum, held by the licensee in the band.
- Both licensees sharing the spectrum shall jointly give a prior intimation for sharing the right to use the spectrum at least 45 days before the proposed effective date of the sharing. Both the licensees shall also give an undertaking that they are in compliance with all terms and conditions of the guidelines for spectrum sharing and licence conditions, and will agree that in the event it is established at any stage in the future, that either of the licensee was not in conformance with the terms and conditions of the guidelines for spectrum sharing or/and of the licence, at the time of giving intimation for sharing of right to use the spectrum, the Government will have the right to take appropriate action which among other things may include annulment of sharing arrangement. A processing fee, of Rs. 50,000/- which could be modified from time to time, shall be payable individually by each licensee for each service area at the time of intimation.

  Guidelines for spectrum sharing, as approved by DoT, can be seen at http://www.dot.gov.in/licensing/access-services/guidelines-spectrum-sharing.

Spectrum trading

The government on 12th October 2015, issued spectrum trading guidelines that allow telecom operators to procure radio waves for mobile services from other companies to meet their requirements and improve service quality. Salient features of these guidelines are given below:

- Spectrum trading is allowed only between two access service providers, holding cellular Mobile Telephone Service (CMTS) License, Unified Access Service License (UASL), Unified License (Access Services) (UL(AS)) and Unified License (UL) with authorization of Access Service in a LSA.
- Under spectrum trading, only outright transfer of spectrum is permitted, i.e. the ownership of the usage right is transferred to the buyer. Spectrum leasing is not permitted at this point of time.
- All access spectrum bands earmarked for Access Services by the Licensor will be treated as tradable spectrum bands.
- Only that spectrum is permissible to be traded which has either been assigned through an auction process in the year 2010 or afterwards or though spectrum trading, or on which the Telecom Service provider has already paid the prescribed market price.
- Spectrum trading will not alter the original validity period of spectrum assignment.
- For the present, Spectrum Trading shall be permitted only on a pan-LSA (Licensed Service Area) basis i.e. spectrum cannot be traded for a part of the LSA.
- The seller and the buyer shall be required to inform the Licensor regarding the spectrum trade, at least 45 days before the proposed effective date of the trading.
- The entire spectrum held by the licensee in a particular spectrum band within an LSA should be tradable i.e. it has either been assigned through an auction in the year 2010 or afterwards, or on which the TSP has already paid the prescribed market value (as decided by the Government from time to time) to the Government.
- A TSP is required to hold spectrum for at least two years from the date it acquires the spectrum.

Guidelines for spectrum trading, as approved by DoT, can be seen at http://www.dot.gov.in/licensing/access-services/guidelines-spectrum-trading.

3.2.5 Malaysia

The Malaysian Communications and Multimedia Commission (MCMC or commission) has the overall responsibility for managing radio frequency spectrum under the Act. Among other responsibilities of the Commission include the task of developing a spectrum plan in respect of all or any part of the spectrum[53].

The primary functions of the commission include: advising the minister on all matters concerning the national policy objectives for communication and multimedia activities; implementing and enforcing the provisions of the communications and multimedia law; regulating all matters relating to communications and multimedia activities not provided for in the communications and multimedia law; Considering and recommending reforms to the communications and multimedia law; Supervising and monitoring communications and multimedia activities; encouraging and promoting the development of the communications and multimedia industry; encouraging and promoting self-regulation in the communications and multimedia industry; Promoting and maintaining the integrity of all persons licenced or otherwise authorized under the communications and multimedia industry; Rendering assistance in any form to, and to promote coorperation and coordination amongst, persons engaged in communications and multimedia activities; Carrying out any function under any written law as may be prescribed by the Minister by notification published in the Gazette.

53http://www.skmm.gov.my/About-Us/Our-Responsibility.aspx

Assignment of spectrum

There are three types of assignment under the Communications and Multimedia Act 1998 (CMA) viz.

- Class Assignment: A Class Assignment confers rights on a person to use a frequency band or bands for a specified purpose. There is no requirement for registration or prescribed fees for class assignments. The examples of class assignment are: Walkie-Talkie (Family Radio System) and Wireless LAN and Bluetooth.
- Spectrum Assignment: It confers rights on a person to use one or more specified frequency bands for any purpose consistent with the assignment conditions. The IMT-2000 (3G) assignment is an example of Spectrum Assignment.
- Apparatus Assignment: An apparatus assignment authorizes a person to use one or more specified frequency bands to operate a network facility of a specified kind or for a specified purpose.[54]

Method of Assignment

As per Section 177 the spectrum assignment and apparatus assignment are issued by way of auction, tender and fixed price.

In accordance with Section 169 of the Act, the class assignment takes place through notifications by commission.

Validity of the assignments

A class assignment is valid until it is cancelled by the commission; A spectrum assignment issued by the Commission shall be valid for a maximum period of twenty (20) years or such lesser period as may be specified in the spectrum assignment and the apparatus assignment issued for a maximum period of five (5) years or a specified lesser period.

[54] http://www.skmm.gov.my/skmmgovmy/files/attachments/Guideline_AA_form_v3.pdf

Transfer of Spectrum Assignment

The Act and the Spectrum Regulations provide provisions for transfer of spectrum assignment. Pursuant to Regulation 19 of the Spectrum Regulations, a spectrum assignment holder may transfer or otherwise deal with the whole or any part of a spectrum assignment subject to:the conditions of the spectrum assignment; the eligibility requirements applicable when the spectrum assignment was issued; the spectrum assignment not having been originally issued in the public or national interest; the rules made by the Minister under section 163 of the Act; and such other conditions as the Commission may impose.

Acquisition of spectrum[55]

Commission is allowed to recover spectrum from its existing users, for the purpose of reassignments. For this, commission may pay a reasonable amount of compensation to the holder of an assignment whose assignment has been acquired prior to its expiry, by a direction made under Section 178 of the Act but no compensation may be payable if an assignment is not renewed.

3.2.6 Mexico

Regulatory law and institutions[56]

In Mexico, The Federal Telecommunications Law (FTL) was adopted in 1995. It established the institutional basis and framework for policy and regulation of the telecommunication sector. It allocates responsibilities to the Ministry of Communications and Transport (*Secretaria de Comunicaciones yTransportes* (SCT)), such as the power to grant licences (concessions) for market entry, and also to revoke those licences under certain conditions. The FTL also codifies the goal of promoting network expansion and universal service, in particular for rural areas. The law established the framework for the creation of a sector specific regulator.

[55] http://www.skmm.gov.my/skmmgovmy/media/General/pdf/Spectrum-Plan2014.pdf

[56]OECD Review of Telecommunication Policy and Regulation in Mexico - https://www.oecd.org/sti/broadband/50550219.pdf

The Federal Commission for Telecommunications (Comisión Federal de Telecomunicaciones), or Cofetel is an independent telecom regulator in Mexico. It was created by Presidential decree in 1996. It advises and reports to the SCT for most matters, including human resources and budget. Its responsibilities are to supervise, review and promote competition in the sector. Cofetel has some operational and managerial autonomy.

The competition authority, Comisión Federal de Competencia (Cofeco), also oversees the sector, while the consumer protection agency, Procuraduria Federal del Consumidor (Profeco), has responsibility along with Cofetel to protect consumers. The Ministry of Finance (Secretaría de Hacienda y CréditoPúblico, SHCP) also plays a role in determining minimum prices for spectrum auctions and the prices for renewal of concessions.

Spectrum Allocation

Spectrum is allocated through auctions. The SCT issues spectrum licences and Cofetel runs the auction process and manages the spectrum plan. Cofeco approves requirements, including spectrum caps, for auctions and the Ministry of Finance sets spectrum fees.

License Assignment

As per Federal Telecommunications Law of June 1995, the SCT is responsible for providing licences for use of frequencies and public telecommunication networks. Foreign investment may not be higher than 49% except in the case of mobile services (up to 100%), permitted upon review by the Foreign Investment Commission.

Duration of License

Licences may be granted for up to 30 years for public telecommunications networks or up to 20 years for spectrum. Licences can only be granted to Mexican individuals or corporations.

Revocation of License

Licences may be revoked by the SCT in the cases like- if the licence is not taken up within 180 days of being granted; if service is interrupted without just cause; if a licensee undertakes acts which prevent other licensee from carrying out their business; if the licensee does not comply with the obligations in the licence; if the licensee refuses to connect to other licensees without just cause.

"Concession & Permits" License[57]

In Mexico, a concession title is a license given by the Government to the holder that grants the right to exploit national resources and operate services, subject to certain terms and conditions. A concession is required to install, operate or exploit public telecommunications networks, to use or exploit radio frequencies, to exploit geostationary satellite orbits and orbital positions, and to exploit the transmission and reception of foreign satellite signals. Concessions for the use or exploitation of radio frequencies and for exploitation of satellite communications are awarded by public auctions, whereas concessions for public telecommunications networks are issued upon request and are valid only for the services specified in the concession title.

A concession is not required for resellers that do not own transmission facilities but wish to offer telecommunications services by using the network capacity of a concession holder. In this case, the reseller must obtain a permit from the Secretariat of Communications and Transport (SCT). Similarly, the installation and operation of earth transmission stations requires a permit, although according to the law, a waiver can be issued if technical norms are followed[58].

Entry regulations

[57] https://www.itu.int/ITU-D/treg/Events/Seminars/GSR/GSR04/documents/Licensing%20_Mexico.pdf
[58] Installation or operation of ground reception stations does not require a permit.

In Mexico, Facilities-based carrier can enter into the market by obtaining a concession. The FTL allows for certain conditions and obligations to be imposed on concessionaires. Concessions specify network coverage and investment commitments and Resellers/MVNOs can enter into the market on the basis of permit whereas, the entry of Value-added service provider is based only on the registration. There does not exist any limit on the number of concessions, permissions or registrations.

Infrastructure sharing

Various obligations surrounding facility-sharing such as ducts, poles, antennas were established by the Fundamental Interconnection and Interoperability Plan published on 10 February 2009.

3.2.7 New Zealand

The primary mechanisms for managing radio transmissions are the Radiocommunications Act 1989 and the Radiocommunications Regulations 2001. Radio Spectrum Management (RSM) is a business unit of the Ministry of Business, Innovation and Employment (MBIE) and is responsible for administering national legislation to manage radio spectrum in New Zealand. This includes allocating rights for the use of the spectrum, and enforcing compliance with the requirements to ensure legitimate users are able to enjoy their rights[59]. RSM is responsible for providing policy advice to government on the allocation of New Zealand's radio spectrum, managing the allocation of spectrum and administering the Radiocommunication Act 1989 and the supporting Radiocommunication regulation 2001. Its broad functions related to the spectrum management in New Zealand are: granting radio licenses, registering management rights and spectrum licenses; interference complaints; compliance audit programmes to maximise the value of the spectrum resource; providing advice on radio spectrum matters, including legislation; licensing and license compliance; running radio spectrum auctions; planning future use of

[59]http://www.rsm.govt.nz/

the radio spectrum and representing New Zealand's position in the international coordination of radio spectrum use.

Licensing Regime[60]

The Radiocommunications Act establishes the licencing regime which manages interference issues between uses of radio spectrum. Three licencing regimes are used, radio licences under an administrative regime, spectrum licences under a management rights regime and General User Licences. Each of these have been discussed below:

Radio Licensing regime

Radio Licensing regime, earlier known as apparatus licensing, is an administrative assignment process which applies to spectrum used for applications in the public interest. Where the facility to trade spectrum rights is not seen as appropriate, and the demand for spectrum does not exceed supply, government directly allocates licences under the radio licensing regime. Examples of the use of spectrum under this licensing regime include: commercial applications such as land mobile radio and fixed link services; safety services (e.g. radio beacons and radar); services operated by the Crown[61] (e.g. defence and security); services that are subject to international accords (e.g. maritime and aviation); scientific applications (e.g. meteorology); other non-commercial purposes (e.g. amateur radio, personal radio services).

Management rights regime[62]

Management Rights cover a block of the radio spectrum. They are essentially the right to issue licences for the use of that part of the spectrum. Where management rights are created, the government's preferred means of allocating spectrum to its most valuable uses is through the price mechanism.

[60] http://www.rsm.govt.nz/about-rsm/spectrum-policy
[61] crown entities in NZ- http://www.mbie.govt.nz/about/who-we-are/our-partners/crown-entities-public-finance-act-schedule-4a-companies
[62] for details regarding management rights- http://www.rsm.govt.nz/about-rsm/spectrum-policy/acts-and-regulations/overview-of-licensing-regime-in-nz/management-rights

This allows spectrum to be allocated to those who are prepared to pay the highest price, reflecting the value that they place on the spectrum as an input to providing services. The government has used tenders and auctions to allocate spectrum. An example of allocation by auction is the 700 MHz auction for 4G LTE cellular mobile services.

After the initial allocation of spectrum by the government, generally rights can be freely traded and spectrum managers can make decisions whether or not to trade their rights and, if so, on what basis.This regime is applicable to spectrum used primarily for commercial purposes. Management rights are essentially the right to issue licences for the use of that part of the spectrum. Management Rights do not themselves confer the right to make any transmissions. Spectrum licences are granted by the owner of a management right. Management Rights used for cellular and fixed broadband wireless services have been sold to service providers, who then licence themselves to use the frequencies within their Management Rights. They may also licence third parties.

The Crown may retain the Management Right and grant Spectrum Licences to frequencies within the band, as is the case with most radio and television broadcasting bands, or dispose of the Management Right to another person who may then grant Spectrum Licences.

Spectrum licences are granted by the owner of a management right and are typically:

- assigned for a defined period of time.
- non-specific to equipment or transmission methods.
- prescribe an envelope within which the licence holder is free to operate at his or her discretion.

General User Licences (GUL)

General User Radio Licences (GURL) and General User Spectrum Licences (GUSL) provide for certain classes of radio transmitter to be used without the need for the owner to obtain an individual licence in their own name, provided

the equipment meets the applicable technical standards, operates only on the allocated frequencies and meets any other requirements specified in the licence, the equipment may be freely used by anyone in New Zealand. For example, low-powered devices such as garage door openers and WiFi

Duration of Licence

Licenses issued under Radio Licensing regime may not have an expiration date whereas; Spectrum licences are granted for periods up to 20 years and also require payment of an annual fee.

Spectrum Licence transfer[63]

Spectrum licences are transferred by presenting a registrable instrument to the Registrar of Radio Frequencies.

2.5 GHz Managed Spectrum Park[64]

The 2.5 GHz Managed Spectrum Park (MSP) is a new concept, catering for a situation in which a nationwide spectrum right is not required, but likewise a general user licence would be too open as services require some coordination or sharing. It is intended for local and regional services, and seeks to encourage a flexible, cooperative, low cost and self-managed approach to allocation and use. The MSP consists of 45 MHz of spectrum from 2575 – 2620 MHz, and licences are allocated on a 'first-come, first-served' basis. Along with any applicable licence administration fees, MSP licensees are also required to pay an annual charge consisting of a management charge and a resource rental. In order to ensure that the spectrum is efficiently utilised there is also a requirement to implement services within two years of allocation.

[63] http://www.rsm.govt.nz/licensing/how-do-i/transfer-a-spectrum-licence

[64] MSP has been established to allow access to a number of users in a common band of spectrum on a shared and as far as possible, self managed basis.

3.2.8 Nigeria

Regulatory Authorities[65]

National Frequency Management Council (NFMC):

NFMC is located within the Ministry of Information and Communications. It is the apex body for spectrum management. The NFMC is responsible for the planning, coordination and bulk trans-sectoral allocation of radio spectrum to the National Communications Commission, the National Broadcasting Commission and the Ministry. The NFMC is the focal coordinator of all frequency spectrum activities. It is chaired by the Minister of Information and Communications and consists of high-level representatives of other ministries.

The Nigerian Communications Commission (NCC):

In Nigeria, NCC is the regulator of the telecommunications industry, with wide discretionary powers to plan, manage, assign and monitor the use of spectrum by commercial users of telecommunications services. The Commission develops and publishes radio frequency regulations and standards for the industry. The NCC plays a significant role in telecommunications industry vis- à-vis broadcasting and public services, and its role in the economy.

NCC performs following key functions for frequency management;

- Spectrum Planning: Plan the spectrum under NCC's control in order to make adequate provision for various services based on their relative importance to Nigeria's socio-economic goals and also make forecast for future requirements.
- Frequency Assignment: Evolve fair, equitable and transparent procedures and conditions for the allocation and assignment of spectrum.

[65] https://www.apc.org/sites/default/files/countries/factsheet%20nigeria_eng.pdf

- Spectrum Farming: Continually and systematically phase out ageing technologies in order to free up new spectrum space for allocation to emerging technologies and new services.
- Licensing: Develop effective rules, operational procedures/guidelines for the purpose of regulating the use of spectrum in order to encourage sharing and ensure minimum interference with other users.
- Technical Specifications: Define technical utilization rules and specifications for radio frequency equipment and also administer equipment type approval and authorizations.
- Enforcement: Impose fines, penalties and sanctions for any violation of spectrum rules in order to maintain discipline in the use of spectrum.
- Tariff and Pricing: Determine fees payable for spectrum and evolve effective machinery for its collection.

National Broadcasting Commission (NBC):

It regulates broadcast industry and sets broadcast standards and upholding equity and fairness in broadcasting. It assigns the broadcast frequencies it receives from the NFMC to private and public radio and TV stations.

Ministry of Information and Communications (MoIC):

Through the Department of Spectrum Management, the MoIC is responsible for the formulation and monitoring of communications policies, international treaties and national representation in international organisations. With the establishment and increased legislative empowerment of both the NCC and NBC, the MoIC's functions have gradually been limited to the management and assignment of frequencies to government and non-commercial users, including the military, security services,

diplomatic missions, volunteer organisations and non-profit groups. The Ministry is the secretariat of the NFMC and acts as the custodian of all frequencies in Nigeria.

Frequency management objective:

The NCC's Frequency Management Policy Objectives are as follows;

- To control and encourage the use of spectrum as an instrument for developing telecommunication (being) which is an essential infrastructure for stimulating the economic growth and social development of the nation.
- To promote competition in the assignment of frequency in order to ensure innovative and efficient use of the radio spectrum (as a scarce resource).
- To achieve optimum pricing of spectrum in order to discourage wastage or speculative acquisition of the scarce resource.
- To generate moderate revenue for government.
- To ensure equitable and fair allocation of spectrum to benefit the maximum number of users.

Licensing Regime[66]:

As per the Nigerian Communications Act 2003 and Licensing Regulations, 2013, NCC issues two types of licenses[67] i.e.

- Individual license: An Individual Licence is a type of authorization in which the terms, conditions and obligations, scope and limitations are specific to the service being provided. Process of licensing can take the form of Auction,

[66] http://www.ncc.gov.ng/docman-main/legal-regulatory/regulations/drafts-regulations/408-regulations-on-licensing/file

[67] http://www.ncc.gov.ng/licensing-regulatory/licensing/licensing-faq#what-are-the-categories-of-licences-you-offer

"First Come First Served", "Beauty Contest" or a standard administrative procedure, etc.

- Class Licence: It is a type of general authorization in which the terms and conditions/obligations are common to all license holders. Requires only registration with the Commission for applicants to commence operation.

As per frequency pricing Regulations[68], Frequency spectrum license is classified as:

- short-term permit with a tenure of 4 months ; or
- Medium-term permit with a tenure of one year ; or
- Long-term licence with tenure of 5, 10 or 15 years.

Spectrum Trading

NCC has issued draft guidelines for spectrum trading in 2017.[69]It includes regulatory framework for various transactions through which Spectrum can be traded on the Secondary Market i.e. spectrum sharing, spectrum leasing and spectrum transfer.

3.2.9 Pakistan

To regulate telecom sector, under Telecom Reorganization Act 1996, Pakistan Telecommunication Authority (PTA) was established to regulate the establishment, operation and maintenance of telecommunication systems, and the provision of telecom services.

Function of PTA is:

- To regulate the establishment, operation and maintenance of telecommunication systems and provision of telecommunication services in Pakistan.
- To receive and expeditiously dispose of applications for the use of radio-frequency spectrum.
- To promote and protect the interests of users of telecommunication services in Pakistan.

[68] http://www.ncc.gov.ng/docman-main/legal-regulatory/regulations/104-frequency-pricing-regulations/file
[69] http://www.ncc.gov.ng/docman-main/legal-regulatory/guidelines/draft-guidelines/734-guidelines-for-spectrum-trading/file

- To promote the availability of a wide range of high quality, efficient, cost effective and competitive telecommunication services throughout Pakistan.
- To promote rapid modernization of telecommunication systems and telecommunication services.
- To investigate and adjudicate on complaints and other claims made against licensees arising out of alleged contraventions of the provisions of this Act, the rules made and licenses issued there under and take action accordingly.
- To make recommendations to the Federal Government on policies with respect to international telecommunications, provision of support for participation in international meetings and agreements to be executed in relation to the routing of international traffic and accounting settlements.
- To perform such other functions as the Federal Government may assign from time to time.

Frequency Allocation Board:

Frequency Allocation Board was established to take over the functions performed by the Pakistan Wireless Board. It has authority to allocate and assign portions of the radio frequency spectrum to the government, providers of telecommunication services and telecommunication systems, Radio and television broadcasting operations, public and private wireless operators and others.

Spectrum Assignment:

As per telecommunications Policy 2015, for licensed spectrum, a fee is charged based on the most appropriate of the following methods:

1. Auctions: spectrum, being a scare resource, is assigned through auction.
2. Administrative incentive Pricing (AIP): It reflects the opportunity cost of spectrum to encourage efficient use of spectrum and will be introduced for spectrum that has not been subject to an auction, for example microwave spectrum.
3. Administrative Cost Recovery (ACR): It will be adopted where auctions and AIP are inappropriate, for example in aeronautical, maritime and amateur

radio bands. The fee will be set to reflect the costs incurred in administering spectrum in the band from which frequency is to be assigned. This approach will be applied to spectrum that is not congested and where the risk of interference is low.

Mobile virtual Network Operator[70]:

PTA has issued MVNO regulations in 2012. Initial MVNO class license fee is US$ 5 Million. The duration of MVNO license is 10 years which can be extended for further 10 years.

Spectrum Refarming:

PTA in coordination and assistance with Frequency Allocation Board (FAB), carried out refarming in 900 MHz and 1800 MHz, 1900 MHz band. It has also refarmed the spectrum in 3500 MHz from FDD to TDD access technology.

3.2.10 South Africa

The Independent Communications Authority of South Africa (ICASA) is the regulator for the South African communications, broadcasting and postal services sector. ICASA was established by an Act of statute, the Independent Communications Authority of South Africa Act of 2000, as Amended. It was established in July 2000, as a merger of the telecommunications regulator, the South African Telecommunications Regulatory Authority (SATRA) and the Independent Broadcasting Authority (IBA). The Authority is responsible for regulating the telecommunications, broadcasting and postal industries in the public interest and ensures affordable services of a high quality for all South Africans. The Authority also issues licenses to telecommunications and broadcasting service providers', enforces compliance with rules and regulations, protects consumers from unfair business practices and poor quality services, hears and decides on disputes and complaints

[70] http://www.pta.gov.pk/media/mvno_reg_2012.pdf

brought against licensees and controls and manages the effective use of radio frequency spectrum.

Spectrum Management Agency[71]

The Department of Communications (DOC) proposes in an amendment to the Electronic Communications Act, 2005 (ECA Bill), to form a new Spectrum Management Agency (SMA) responsible for all spectrum allocations, while actual assignments of frequencies will be divided between the SMA and ICASA. ICASA will assign spectrum for non-government and the SMA for government use.

SMA will be responsible, on behalf of the State for:

- Long term spectrum planning including the development of the national radio frequency plan;
- The allocation of radio frequency spectrum for both government and non-government use; and
- The assignment of the radio frequency spectrum for government.

Spectrum Assignment[72]

The Authority may grant a radio frequency spectrum assignment to a person either on an exclusive usage basis or on a shared basis.

Licensees[73]

As per **Electronic Communications 2005 Act**, there are two types of licenses i.e. Individual License and class License. Both the licenses are issued for **E**lectronic communications network services (ECNS) and electronic communications services (ECS) and Broadcasting services subject to certain limitations.

[71] http://www.bmi-t.co.za/content/spectrum-management-agency-sa

[72] http://www.amateurradio.org.za/Government%20Gazzette%2038641_30-3_IcasaCV01%20-%20Radio%20Frequency%20Spectrum%20Regulations%202015%20(2).pdf

[73] http://www.wipo.int/edocs/lexdocs/laws/en/za/za082en.pdf

Duration of license[74]:

Individual License is issued for maximum period of 20 years whereas; class license is issued for maximum period of 10 years.

TV White Space[75]:

ICASA has issued draft regulation on the use of Television white space on 7th April 2017.

Transfer of License[76]:

Licensee cannot transfer a radio frequency spectrum licence without the prior written approval of the Authority. A radio frequency spectrum licence transfer application is evaluated on the basis of the Technical efficiency; Functional efficiency; Promotion of competition and interests of consumers; Equity ownership by HDPs; and Economic efficiency.

3.2.11 Turkey

While policy making is the responsibility of Ministry of Transport, Maritime Affairs and Communications, Telecommunications Authority, established in 2000, is the first sectoral regulatory body of Turkey. To remove the legislative untidiness, create competition in the sector, lessen the uncertainties for operators and allocate resources to R&D, Electronic Communications Law has come into force on 10 November 2008 and the name of the Authority has changed to Information and Communication Technologies Authority (ICTA)[77]. The duties of the Authority, as described in Electronic Communications Law, include:

[74]EC Act south Africa 2005.
[75]http://www.ellipsis.co.za/wp-content/uploads/2016/10/Draft-RTVWS-Regulations-Govermment-Gazette-No.-40772_gen283.pdf
[76]http://www.amateurradio.org.za/Government%20Gazzette%2038641_30-3_IcasaCV01%20-%20Radio%20Frequency%20Spectrum%20Regulations%202015%20(2).pdf
[77]https://www.btk.gov.tr/en-US/

- Creation and maintaining the competition in the sector,
- Protecting the rights of subscribers, users, consumers and end users,
- Carrying out dispute resolution procedures between operators,
- Tracking the developments and stimulating the development of the electronic communications sector,
- Planning and allocation of the frequencies,
- Satellite position and numbering, By taking into consideration the strategies and the policies of the Ministry of Transportation, Maritime Affairs and Communications,
- Performing necessary regulations and supervisions, including: Authorization, Tariffs, Access, Numbering, Spectrum Management, Licensing for the installation and use of radio equipments and systems, Monitoring and supervision of the spectrum, Market observance and supervision, Detection and elimination of electromagnetic interference etc.

Fundamentals and Principles of Spectrum Management

The Authority, in spectrum management, considers;

a) Providing efficient competition and ensuring non-discrimination among operators in electronic communications sector, providing transparency, effective and efficient usage of spectrum.
b) The strategies and policies set by the Ministry of Transport as well as the current and future needs of our country,
c) The decisions of the international and regional organizations such as International Telecommunication Union (ITU), International Maritime Organization (IMO), International Civil Aviation Organization (ICAO) and European Conference of Postal and Telecommunications Administrations (CEPT), in electronic communications sector, bilateral and multilateral agreements and European Union (EU) legislation,
d) Implementation of technological innovations and promoting research and development activities and investments,

e) Giving priority to national security and public order requirements and emergency situations such as natural disasters and extraordinary situations;
f) Preventing or minimizing the effects of harmful electromagnetic interference that may occur in the borders on the neighbouring countries when making frequency allocation and assignment and providing efficient and effective use of spectrum mutually.

Types of Authorization

Authorization means registration of entities providing electronic communications services and/or electronic communications network by the Authority and pursuant to such registration, granting of certain rights and obligations specific to electronic communications services to these entities. In Turkey, the following type of Authorization has been given: Satellite Communication Service, Satellite Platform Service, Infrastructure Operating Service, Internet Service Provision, Fixed Telephony Service, Wired Broadcasting Service, GMPCS Mobile Phone Service, Mobile Virtual Network Service, Public Access Mobile Radio Service, Directory Services.

3.2.12 United Kingdom

Ofcom is the communications regulator in the UKIt operates under a number of Acts of Parliament and other legislation like Communications Act 2003, the Wireless Telegraphy Act 2006, the Broadcasting Acts 1990 and 1996, the Digital Economy Act 2010 and the Postal Services Act 2011. It regulates the TV, radio and video on demand sectors, fixed line telecoms, mobiles, postal services, and the airwaves over which wireless devices operate[78].

Licensing

Ofcom issues following licenses[79]:

[78] http://www.ofcom.org.uk/about/what-is-ofcom/statutory-duties-and-regulatory-principles/
[79] http://licensing.ofcom.org.uk/

- Radio communication licenses: It includes license for Amateur Radio, Business Radio, Ships' radio and ships portable radio, Aeronautical Radio, Fixed terrestrial links, Fixed wireless Access, Mobile and broadband, Maritime Radio (excluding ship radio), Non-operational licenses, Programme Making and Special Events, Licensed Short Range Devices and Satellite earth stations
- Radio broadcast licenses: It includes license for community radio, Radio restricted service licenses, analogue commercial radio and Digital radio.
- TV broadcast licenses: It includes Local TV licensing, Television Licensable Content service License, Digital Television Programme Service (DTPS) & Digital Television Additional Service (DTAS) licenses, Restricted Television service License for an event (RTSL-E)

Assignment of spectrum:

As part of its overall review of spectrum management in the UK, Ofcom decided that new licences awarded by auction should generally have an indefinite term and with an initial term in which licensees would have high security of tenure. The initial term would be set taking into account the expected period required for a reasonable return on the investment and was set at 20 years for the 4G licences auctioned in 2013. During the initial term, licences would only be able to be revoked for a narrow range of reasons including breach of licence conditions and non-payment of the licence fee. Beyond the initial term, licensees would continue to have the rights to use the spectrum unless Ofcom decides to revoke the licence on spectrum management grounds after giving 5 years notice.

Ofcom noted that the combination of indefinite licence terms together with the introduction of spectrum trading would best promote investment to enable the efficient use of spectrum and do so in a relatively simple and low cost way. While Ofcom considered that tradability and liberalisation should generally ensure spectrum was being used optimally, the right to revoke licences on spectrum management grounds was retained because of the risk of specific

market failures such as coordination problems caused by high transaction costs where a new service requires gaining spectrum rights from multiple current licensees.

Liberalisation of Spectrum: Approach adopted by OFCOM

In their February 2009 consultation, OFCOM said that they believed that liberalisation of the 900MHz and 1800MHz spectrum had the potential to bring significant benefits to consumers but they were also concerned that liberalisation of the 900MHz spectrum in the hands of the incumbent holders could lead to competition issues. To address this risk, OFCOM proposed that O2 and Vodafone release 1 block (2x5 MHz) of 900MHz spectrum in total (i.e. 2x2.5 MHz each) and that this spectrum be awarded to a third party.

In the OFCOM's subsequent assessment, the likelihood and size of a competitive distortion arising out of the liberisation of 900/1800 MHz bands was significantly reduced when it prepared the advice to the Government in October 2010. The most important factor contributing to the change in the perception of OFCOM is the merger between Orange and T-Mobile creating Everything Everywhere (EE) which has the largest amount of 2100 MHz spectrum and access to the largest number of base station sites. Accordingly, 2G licences (900/1800 MHz) were liberalised in the hands of existing licence holders. In a statement titled "Statement on the Requests for Variation of 900 MHz, 1800 MHz and 2100 MHz Mobile Licences" published on 9th July 2013, Ofcom has permitted the use of 4G technology in each of the 900 MHz, 1800 MHz and 2100 MHz spectrum.

Spectrum Trading

In U.K, it is possible to transfer all or part of licence rights and associated obligations to another party, provided that the licence is in a class covered Wireless Telegraphy (Spectrum Trading) Regulations 2004 as amended. The trading framework, defined in the trading regulations, permits different types of

transaction or 'modes of trading': Outright total transfers (all the rights and obligations under a licence are transferred to a third party); Outright partial transfers (only some of the rights or obligations are transferred to a third party and the rest remain with the original holder); Concurrent total transfers (all the licence rights and obligations are transferred to a third party while continuing at the same time to apply also to the original holder); and Concurrent partial transfers (some of the licence rights and obligations are transferred to a third party while continuing at the same time to apply also to the original holder and the rest of the rights and obligations remain with the original holder).

3.2.13 United State of America

Under the provisions of the United States Communications Act of 1934, the authority for managing the radio frequency spectrum within United States is divided between the National Telecommunications and Information Administration (NTIA) and Federal Communication Commission (FCC).

National Telecommunications and Information Administration (NTIA)

NTIA manages the Federal Government's use of the spectrum (National defense, law enforcement & security, transportation, resource management & control and emergencies) while the FCC manages all other uses (Business, state & local government, entertainment, commercial and private). NTIA receives spectrum management and policy advice from Federal government experts through the Interdepartment Radio Advisory Committee (IRAC). The IRAC's basic function is to assist the Assistant Secretary in assigning frequencies to U.S. Government radio stations and in developing and executing policies, programs, procedures, and technical criteria pertaining to the allocation, management, and use of spectrum.

Federal Communication Commission (FCC)

The FCC is charged with regulating interstate and international communications by radio, television, wire, satellite, and cable. The Commission also regulates telecommunications and advanced communication services and video programming for people with disabilities, as set forth in various sections of the Communications Act. The FCC is directed by five Commissioners appointed by the President and confirmed by the Senate for five-year terms, except when filling the unexpired term of a previous Commissioner. Only three Commissioners can be from the same political party at any given time. The President designates one of the Commissioners to serve as Chairman.

The FCC is responsible to Congress and the American people for ensuring an orderly policy framework within which communications products and services can be efficiently and effectively provided to consumers and businesses. FCC is equally responsible to address the communications needs of public safety, health, and emergency operations; ensure the universal availability of broadband and telecommunications services; make communications services accessible to all people; and protect and empower consumers in the communications marketplace.

Spectrum Auctions

The US Congress first authorised the FCC to award spectrum rights through auctions in 1993. Since the first auction in 1994 for narrowband Personal Communications Service (PCS) licenses through the most recent auction in July 2011 for licenses in the 700 MHz band, the FCC has conducted over 80 spectrum licence auctions.

Secondary Market: Trading/Leasing/Merger

In addition to obtaining spectrum licences directly from the government, either through auction or application, wireless operators in the US can also obtain spectrum licences in the secondary market--that is, from an existing licensee. In general, licences can be obtained via: (1) direct transfer where the licence is assigned from one party to another; (2) indirect transfer where ownership of the entity holding the licensee, generally a corporation, limited liability

company or limited partnership, is transferred from one party to another; or (3) the lease of the spectrum. In addition, licences can generally also be transferred or leased in whole, or in part, by geographically partitioning and/or spectrum disaggregation.

Spectrum Policy Priorities in the US: National Broadband Plan

As directed by the US Congress, FCC has developed and published a National Broadband Plan (NBP). The NBP noted that "spectrum policy is the most important lever government has to help ensure wireless and mobile broadband thrive". Due to the expanding use and expected future growth of wireless broadband, the NBP recommended reallocating spectrum for mobile broadband. In October 2010, the NTIA, in collaboration with the FCC, released a Ten-Year Plan and Timetable (Ten-Year Plan) to make 500 MHz of federal and non-federal spectrum available for wireless broadband use. The Ten-Year Plan identified an initial list of candidate spectrum bands, outlined steps to determine additional candidate bands, and set out a process to evaluate their feasibility and identify the actions necessary to make that spectrum available within a decade. The Ten-Year Plan identified more than 2200 MHz of federal and non-federal spectrum that might provide opportunities for wireless broadband use.

FCC's Strategic Plan 2015-2018

The FCC, in accordance with its statutory authority and in support of its mission, has establishedfour strategic goals. They are:

Strategic Goal 1: Promoting Economic Growth and National Leadership Promote the expansion of competitive telecommunications networks, which are a vital component of technological innovation and economic growth and help to ensure that the U.S. remains a leader in providing its citizens opportunities for economic and educational development.

Strategic Goal 2: Protecting Public Interest Goals The rights of network users and the responsibilities of network providers form a bond that includes

consumer protection, competition, universal service, public safety and national security. The FCC must protect and promote this Network Compact.

Strategic Goal 3: Making Networks Work for Everyone In addition to promoting the development of competitive networks, the FCC must also ensure that all Americans can take advantage of the services they provide without artificial impediments.

Strategic Goal 4: Promoting Operational Excellence Make the FCC a model for excellence in government by effectively managing the FCC's resources and maintaining a commitment to transparent and responsive processes that encourage public involvement and best serve the public interest.

Broadcast Incentive Auction: FCC's Innovative Approach Repurpose/ Refarm Spectrum in UHF band

A key part of the FCC's efforts to meet the demand for spectrum is the first-of-its-kind Incentive Auction, a means of repurposing spectrum by encouraging licensees to voluntarily relinquish spectrum usage rights in exchange for a share of the proceeds from an auction of new licenses to use the repurposed spectrum. Initially described in the 2010 National Broadband Plan and authorized by Congress in 2012, the auction will use market forces to align the use of broadcast spectrum with 21st century consumer demands for video and broadband services It will preserve a robust broadcast TV industry while enabling stations to generate additional revenues that they can invest into programming and services to the communities they serve. And by making valuable "low-band" airwaves available for wireless broadband, the incentive auction will benefit consumers by easing congestion on wireless networks, laying the groundwork for "fifth generation" (5G) wireless services and applications, and spurring job creation and economic growth.

CHAPTER – 4

FINANCIAL RESULTS OF LEADING TELECOM COMPANIES

This Chapter contains the financial performance[80] of twenty five leading companies in telecom service sector operating in the selected twenty-three selected countries (as listed in Chapter-1). The following ratios have been used in the study report to work out the financial performance of the companies:

Table 4.1

Ratio	Method of Computation	Significance
Earnings before Interest, Tax, Depreciation and Amortization (EBITDA) Margin	EBITDA / Revenue	It is a measurement of a company's operating profitability and computed as a percentage of revenue. This indicates the operating profit of the company before taking into account the interest to creditors/lenders, taxes and non-cash expenses like depreciation and amortization etc. The higher the EBITDA margin, the company is operating more efficiently and vice-versa.
Profit Before Tax (PBT) Margin	PBT / Revenue	PBT margin is a company's earnings before subtracting direct taxes as a percentage of sales or revenues. The higher the PBT margin, the more profitable the company and vice-versa.
Debt Equity Ratio	Debt / Equity	The Debt Equity ratio indicates how much debt a company is using to finance its assets relative to the amount of value represented by shareholders' funds. A higher debt to equity ratio indicates that

[80]Source of information: Annual reports from Stock Exchanges and official websites of respective companies. Financial information for the year have been taken from the respective year's Annual Report. The financial results of group financials (i.e. on consolidated basis) have been considered. For comparison purpose,

- Accounting period January 2016 to December 2016, April 2016 to March 2017 and July 2016 to June 2017 have been taken as 'Accounting Year 2016'. The same is done for 2015, 2014 and 2013.
- The financial figures of the non-Indian companies are in their country's currency (e.g. US$, Australian $, Euro, Pesos, Yen, Yuan etc) as applicable. These financial figures have been converted into Indian rupees for comparison. To avoid the effect of fluctuation of currency exchange rate, the conversion has been done by applying single average conversion rate worked out based on quarterly exchange rates (at the end of the quarter) for last four years. The conversion rate used are given in Annexure 4.1

		more creditor financing (Debt, bank loans) is used than investor financing (shareholders).
Interest Coverage Ratio	PBIT / Interest Expense	This ratio is used to measure a company's ability to pay the interest on its debt. Higher the ratio better is the company's ability to pay the interest on its debt.
Capital Employed	Net Fixed Assets + Capital Work in Progress + Working Capital (current assets – current liabilities)	Capital employed represents the capital investment used for a business to function. It refers to the value of resources deployed towards operation of the business.
Return on Capital Employed	PBIT/Capital employed	It is a measure of the return that a business is achieving as a percentage of the capital employed. The higher the RoCE, the more profitable the company and vice-versa.
Gross Block	Plant, Property and Equipment + Intangible Assets + Capital Work in Progress	It represents the total investment made at acquisition of plant, property and equipment, intangible assets and capital work in progress.
Net Fixed Assets Turnover Ratio	Net Sales / Net Block	This ratio measures how able a company is to generate sales from fixed-asset investments. It indicates how well the business is using its fixed assets to generate sales.
Return on Shareholders' Funds	Profit After Tax / Shareholders Funds	It measures the rate of return that shareholders earn on their investment.
Current Ratio	Current Assets / Current Liabilities	The current ratio is a liquidity ratio, which measures short-term ability to pay off its short-term liabilities (current liabilities) from its current assets.
Cash from Operating Activities	-	Cash flow from operating activities (CFO) indicates the amount that a company brings in from ongoing, regular business activities, such as manufacturing and selling goods or

		providing a service. Cash flow from operating activities does not include cash flow from investing activities (capital investment) and financing activities (Debt , share capital etc.).
Cash from Investing Activities	-	It is a statement of cash flows which gives details of cash flows related to acquisition and disposal of a company's long-term investments such as property, plant and equipment, investment in subsidiaries and associates etc.
Cash from Financing Activities	-	Financing activities gives details of financial resources (share capital and debt) obtained/ returning to the shareholders/lenders of the organization. Cash flow from financing activities is the net amount that a company receives from issuing capital and bonds (debt).

Following companies have been selected for inclusion in this chapter:

- The data is easily available,
- These companies are the leading players in their own country.

Table 4.2

List of Telecom companies included in the report

Sl No.	Name of Country	Number of Companies included in Study Report	Name of Companies	Accounting Period
1.	Australia	1	Telstra Corporation Limited	July-June
2.	Canada	2	Roger Communications and Bell Canada Enterprises	Jan-Dec
3.	China	2	China Mobile and China Unicom	Jan-Dec
4.	France	1	Orange	Jan-Dec
5.	Germany	1	Deustche Telekom	Jan-Dec
6.	India	2	Bharti Airtel Limited	April-March

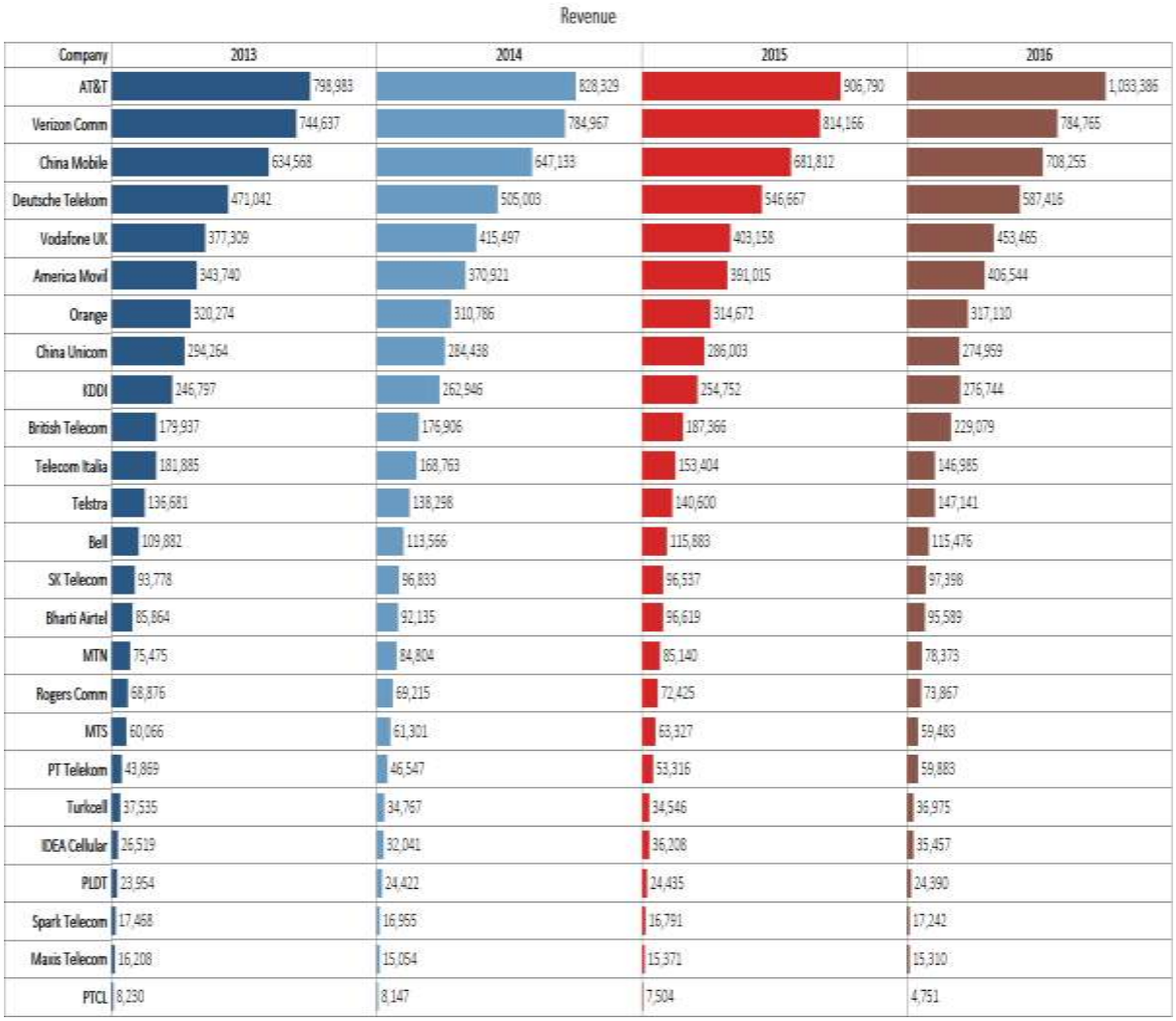
Sl No.	Name of Country	Number of Companies included in Study Report	Name of Companies	Accounting Period
			and IDEA Cellular Limited	
7.	Indonesia	1	P.T. Telekomumikasi (PT Telekom)	Jan-Dec
8.	Italy	1	Telecom Italia	Jan-Dec
9.	Japan	1	KDDI Corporation	April-March
10.	Malaysia	1	Maxis Berhad (Maxis Telecom)	Jan-Dec
11.	Mexico	1	America Movil	Jan-Dec
12.	New Zealand	1	Spark New Zealand Limited (Spark Telecom)	July-June
13.	Pakistan	1	Pakistan Telecommunication Company Limited (PTCL)	Jan-Dec
14.	Philippines	1	Philippine Long Distance Telephone Company Limited (PLDT)	Jan-Dec
15.	Russia	1	Mobile Tele Systems (MTS)	Jan-Dec
16.	South Africa	1	MTN	Jan-Dec
17.	South Korea	1	SK Telecom	Jan-Dec
18.	Turkey	1	Turkcell Iletisim (Turkcell)	Jan-Dec
19.	United Kingdom (UK)	2	British Telecom, Vodafone	April-March
20.	United States of America (USA)	2	Verizon Communications Inc and AT&T Inc	Jan-Dec

Brief profiles of these twenty-five companies are given in Annexure - 4.2.

4.1 REVENUE

The Graph given below represents the revenue[81] earned by respective telecom companies in four financial years.

Chart 4.1 **(Amount in Rs. crore)**



Revenue and growth trends of twenty five companies for the last four years ended 2016 are tabulated in Annexure 4.3

Year	Highest - Revenue		Lowest - Revenue		Average Revenue* (Rs. in crore)
	Name of company	Value (Rs. in crore)	Name of company	Value (Rs. in crore)	
2013	AT&T	798983	PTCL	8230	215914
2014	AT&T	828329	PTCL	8147	223591
2015	AT&T	906790	PTCL	7504	231940
2016	AT&T	1033386	PTCL	4751	243202

* Average based on selected 25 companies.

[81] Revenue includes revenue from operations as well as other income.

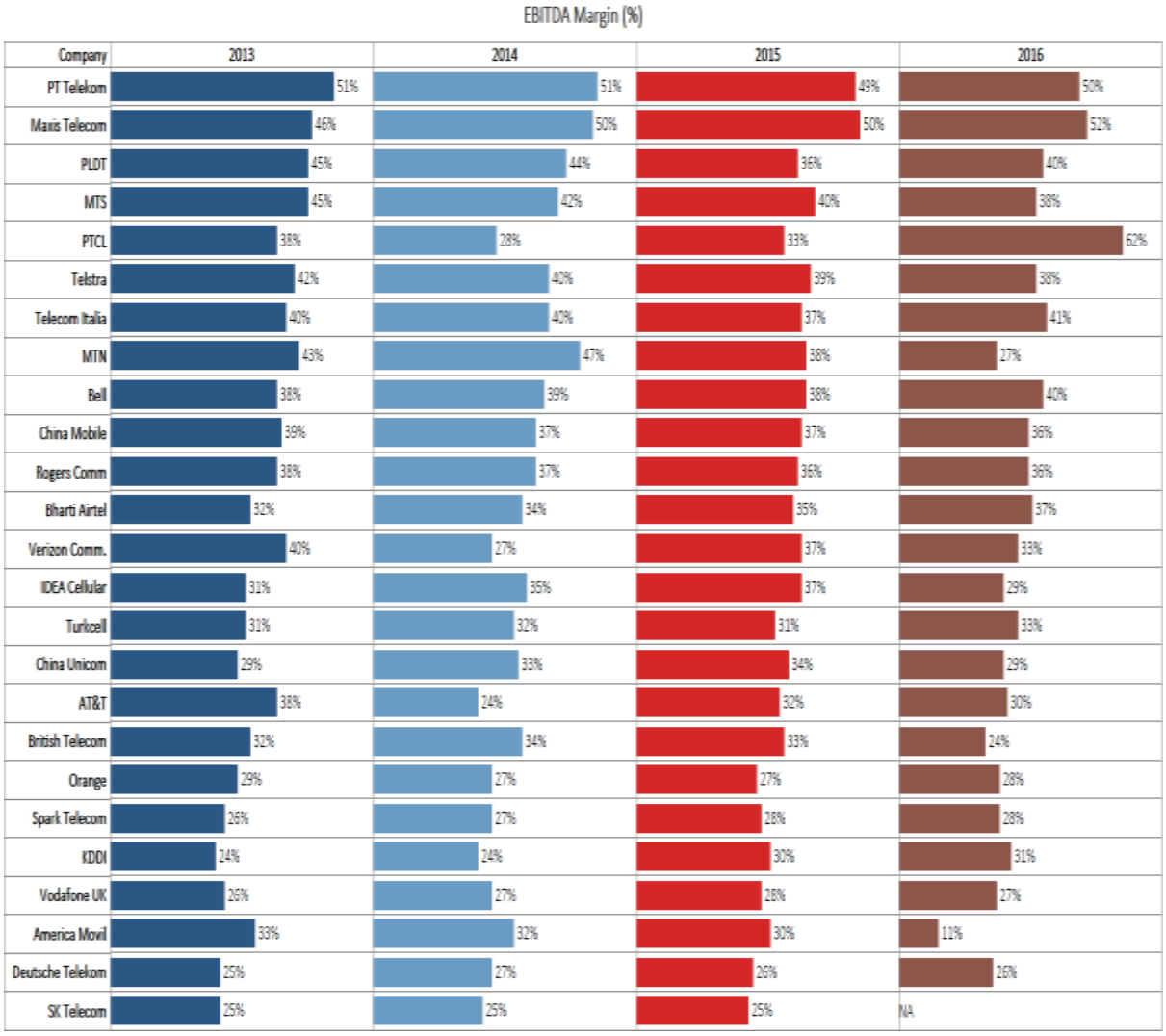
- The two USA based companies i.e. AT&T and Verizon Comm. were the top two companies with revenue of ₹ 1,033,386 crore and ₹ 784,765 crore respectively in the year 2016. China Mobile was at the third position with revenue of ₹ 708,255 crore in the same year.
- PTCL had the lowest revenue of ₹ 4,751 crore in 2016, followed by Maxis Telecom with revenue of ₹ 15,310 crore.
- Among the compared Indian companies, Bharti Airtel achieved the highest revenue at ₹ 95,589 crore in 2016; it stands at 14th position in the overall list of the 25 companies in the year.
- Of the twenty-five selected companies, fourteen companies had recorded growth in revenue in 2016. Eleven companies that did not record growth in revenue in 2016 were Verizon Comm, China Unicom, Telecom Italia, Bell Canada, Bharti Airtel, MTN, MTS, Idea, PLDT, Maxis Telecom, PTCL.
- British Telecom recorded the highest growth in revenue with22.26% in 2016(as compared to 2015), followed by AT&T and Vodafone UK with growth of 13.96% and 12.48% respectively. In 2015, PT Telekom had recorded the highest growth in revenue with 14.54% followed by Idea Cellular (13.01%) and AT&T (9.47%).
- PTCL had recorded the steepest decline in revenue with 36.68% in 2016(as compared to 2015), followed by MTN (7.95%) and MTS (6.07%).
- Twenty-three companies[82] had recorded growth in revenue in either 2016 or 2015. Out of these Twenty-three companies, ten companies (British Telecom, AT&T, PT Telecom, Deutsche Telekom, Telstra, American Movil, China Mobile, Bharti Airtel, Rogers Comm, Orange) had also recorded growth in 2015 as well as 2016.
- Thirteen companies (China Unicom, Verizon Comm, Bharti Airtel, Vodafone UK, KDDI, Turkcell, Spark Telecom, Idea Cellular, Maxis Telecom ,Bell Canada , S.K Telecom, MTN, MTS and PLDT) had recorded growth in 2015 but witnessed decline in 2016 or vice versa.
- Telecom Italia and PTCL are only two companies which had recorded decline in 2015 as well as 2016.

4.2 EARNING BEFORE INTERST, TAX, DEPRICIATION AND AMORTIZATION (EBITDA) MARGIN

The following Graph shows the EBITDA margin (in %) of the twenty five companies in four financial years ended 2016.

[82]Twenty three companies are AT&T, Verizon, China Mobile, Deutsche Telekom, Vodafone UK, America Movil, Orange, China Unicom, KDDI, British Telecom, Telstra, Bell Canada, Bharti Airtel, MTN, Rogers Comm., MTS, PT Telecom, S.K Telecom, Turkcell, IDEA Cellular, PLDT, Spark Telecom, Maxis Telecom.

Chart 4.2



EBITDA margin and growth trends for the last four years are tabulated in Annexure 4.4

Year	Highest – EBITDA Margin		Lowest - EBITDA Margin		Average EBITDA Margin*
	Name of company	Margin (%)	Name of company	Margin (%)	
2013	PT Telekom	51.29%	KDDI	23.80%	35.52%
2014	PT Telekom	51.25%	AT&T	23.62%	34.63%
2015	Maxis Telecom	49.61%	SK Telecom	25.28%	34.68%
2016	PTCL	62.42%	America Movil	11.03%	33.14%

* Average based on selected 25 companies.

- The top three revenue earners in 2016 (i.e. AT&T, Verizon and China Mobile) were not the top three companies as far as EBITDA margin is concerned.

- PTCL had achieved the highest EBITDA margin of 62.42% in 2016, followed by Maxis Telekom, with an EBITDA margin of 51.99%. PT Telekom stood at third position in the list with 49.70% EBITDA margin.

- In 2014 as well as in 2013, PT Telecom had recorded the highest EBITDA margin of 51.25% and 51.29% respectively.

- America Movil had recorded the lowest EBITDA Margin at 11.03% in 2016 amongst the selected Twenty-five companies; whereas in 2015, SK Telecom showed lowest EBITDA margin at 25.28%, however in 2014, AT&T showed lowest EBITDA margin at 23.62 and in 2013, KDDI was the lowest with 23.80% EBITDA margin.

- Amongst the compared Indian companies, Bharti Airtel had achieved the highest EBITDA Margin of 37.09% in 2016; it stood at 9thposition in the overall list of twenty five companies in the year.

- In 2016, twelve[83] companies had achieved growth in EBITDA margin.

- In terms of growth, EBITDA margin of PTCL showed highest growth in 2016 with 28.98%, followed by Telecom Italia with 4.66% growth.

- The highest decline in EBITDA margin in 2016 had been recorded by America Movil with 18.85%, followed by MTN with 10.54%.

- In 2016, [84]fifteen companies had achieved an EBITDA margin of more than 30%, as against nineteen companies in 2015.

- Four companies had recorded growth in EBITDA margin in 2016 as well as 2015. These companies are Bharti Airtel, PTCL, KDDI and Orange.

- MTN, MTS, Telstra, British Telekom and America Movil are the five companies, which had recorded decline in EBITDA Margin in 2015 as well as in 2016.

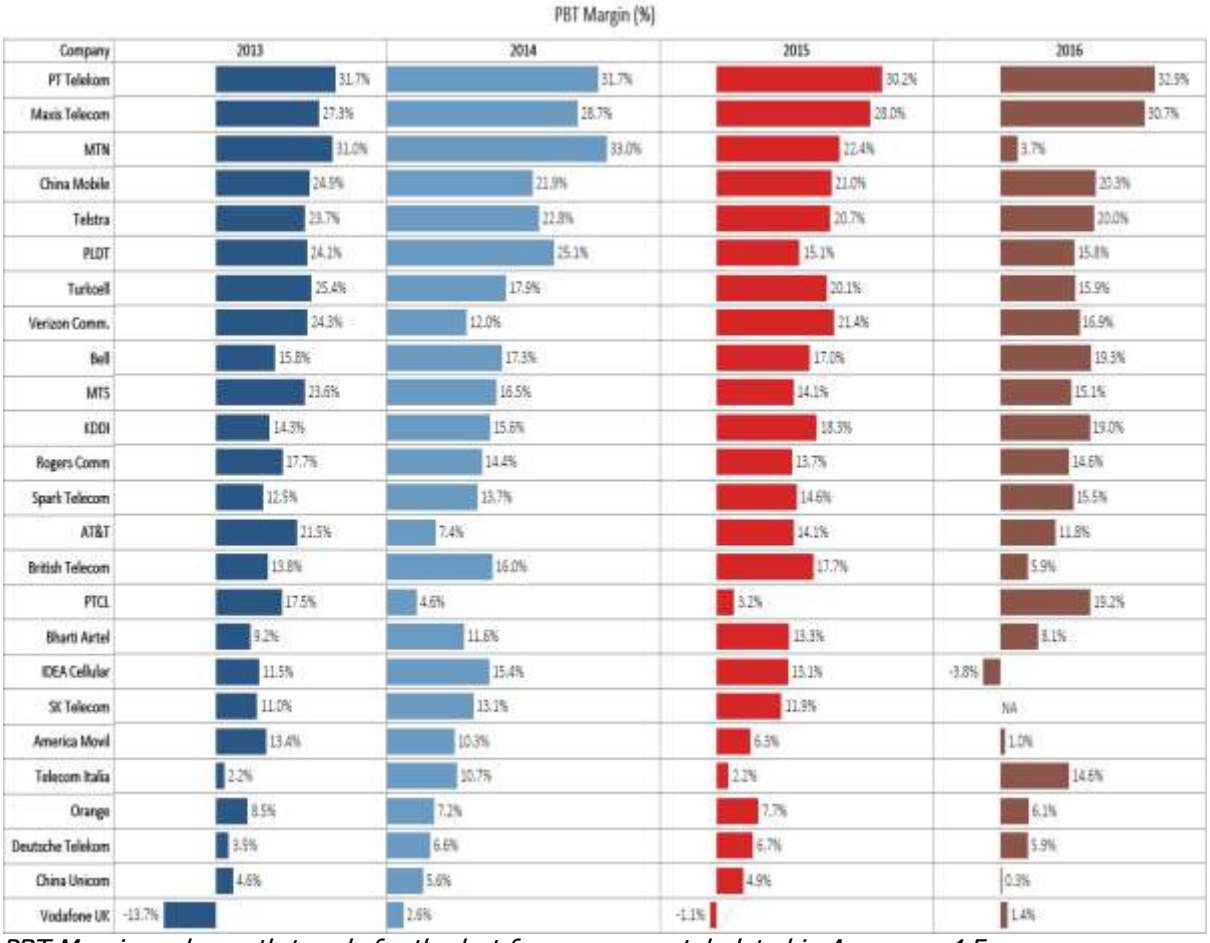
[83]Twelve Companies are Maxis Telecom, PT Telekom, Bell Canada, Bharti Airtel, Telecom Italia, Rogers Comm, PLDT, PTCL, Turkcell, KDDI, Orange, Deustche Telekom.

[84] Fifteen companies areMaxis Telecom, PT Telekom, Telstra, MTS, Bell Canada, China mobile, Verizon comm., Bharti Airtel, Telecom Italia, Rogers Comm, PLDT, PTCL, AT&T, Turkcell, KDDI.

4.3 PROFIT BEFORE TAX (PBT) MARGIN

The following Graph shows the PBT Margin (in %) of the companies in four financial years ended 2016.

Chart 4.3



PBT Margin and growth trends for the last four years are tabulated in Annexure 4.5

Year	Highest – PBT Margin		Lowest – PBT Margin		Average PBT Margin*
	Name of company	Margin (%)	Name of company	Margin (%)	
2013	PT Telekom	31.74%	Vodafone UK	-13.74%	15.96%
2014	MTN	32.97%	Vodafone UK	2.59%	15.26%
2015	PT Telekom	30.15%	Vodafone UK	-1.10%	14.26%
2016	PT Telekom	32.89%	IDEA Cellular	-3.75%	12.40%

* Average based on selected 25 companies.

- PT telecom recorded the highest PBT margin in 2016with 32.89%. In 2015 also, PT telecom recorded the highest PBT margin at 30.15%, while in 2014, it was MTN with 32.97% and in 2013, it was again PT telecom with 31.74% PBT margin.

- Vodafone UK showed the lowest PBT margin for three consecutive years with negative PBT margin of -13.74% in 2013, 2.59% in 2014, -1.10% in 2015. In 2016, Idea cellular showed the lowest PBT Margin with -3.75%. Idea Cellular is the only company which showed the negative PBT margin in 2016.

- Among the compared Indian companies, Bharti Airtel had the highest PBT Margin at 8.08% in the year 2016. It stands at 16th position in the overall list of twenty-five companies.

- In 2016, Twenty-four companies (except Idea Cellular) had recorded positive PBT margin.

- PTCL had recorded the highest increase (growth) of PBT Margin in 2016with 15.92% followed by Telecom Italia with 12.31% increase (growth) of PBT Margin.

- In 2016, the highest decline in PBT margin was recorded by MTN with negative growth of (-) 18.73% followed by Idea Cellular with negative growth of (-) 16.80%.

- Eleven[85] companies had shown increase (growth) in PBT margin in 2016 as against nine companies in 2015.

- Two companies had recorded increase (growth) in PBT margin in 2016 as well as 2015. These were Spark Telecom, and KDDI.

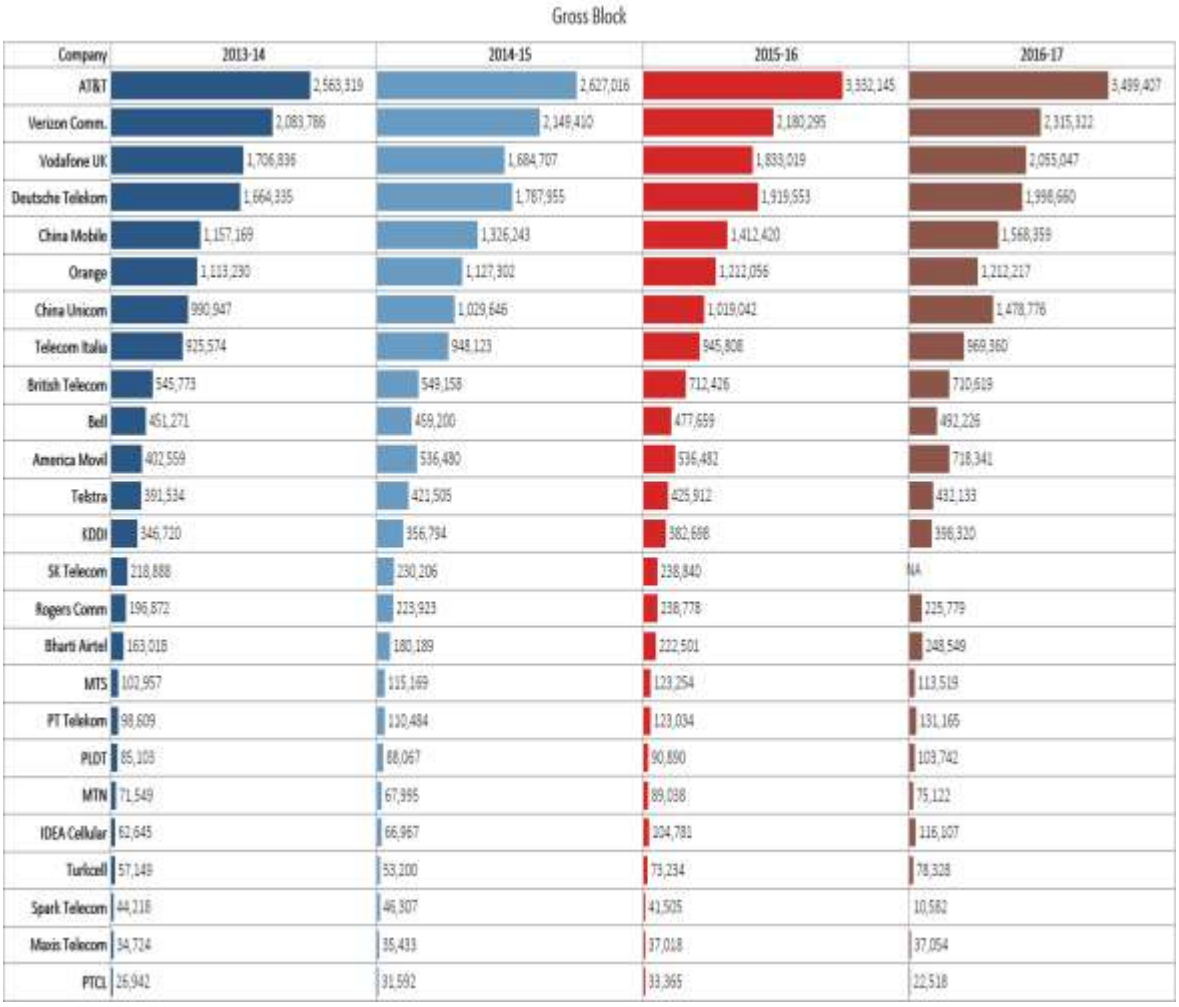
- Seven companies (America Movil, China Unicom, SK Telecom, China mobile, Idea Cellular, MTN and Telstra) had recorded decline in PBT Margin in 2016 as well as in 2015.

[85] Eleven Companies are PT Telekom, Maxis Telekom, Bell Canada, PTCL, KDDI, PLDT, Spark Telekom, MTS, Rogers Comm, Telecom Italia, Vodafone UK.

4.4 GROSS BLOCK

The following graph shows the Gross Block for the four years ended 2016.

Chart 4.4 **(Amount in Rs. Crore)**



Gross Block and growth trends for the last four years ended 2016 are tabulated in Annexure 4.6

Year	Highest – Gross Block		Lowest - Gross Block		Average Gross Block *
	Name of company	Value (Rs. in crore)	Name of company	Value (Rs. in crore)	
2013	AT&T	2563319	PTCL	26942	620229
2014	AT&T	2627016	PTCL	31592	650123
2015	AT&T	3332145	PTCL	33365	712230
2016	AT&T	3499407	PTCL	22518	760450

* Average based on selected 25 companies.

- AT&T had the highest investment in gross block followed by Verizon in all the four years ending 2016.

- AT&T had gross block of ₹3,499,407 crore in 2016 followed by Verizon at ₹2,315,322 crore.

- PTCL had the lowest gross block in all the four financial years ending 2016. Its gross block was ₹22,518 crore in 2016.

- Among the compared Indian companies, Bharti Airtel had the highest gross block in all 4 years. It showed gross block of ₹ 2,48,549 crore in 2016 and stood at 14th position in the list of twenty five companies.

- The top five companies (AT&T, Verizon Comm., Deustche Telekom, Vodafone-UK and China Mobile) having highest investment in Gross Block are also the top five revenue earners in 2016.

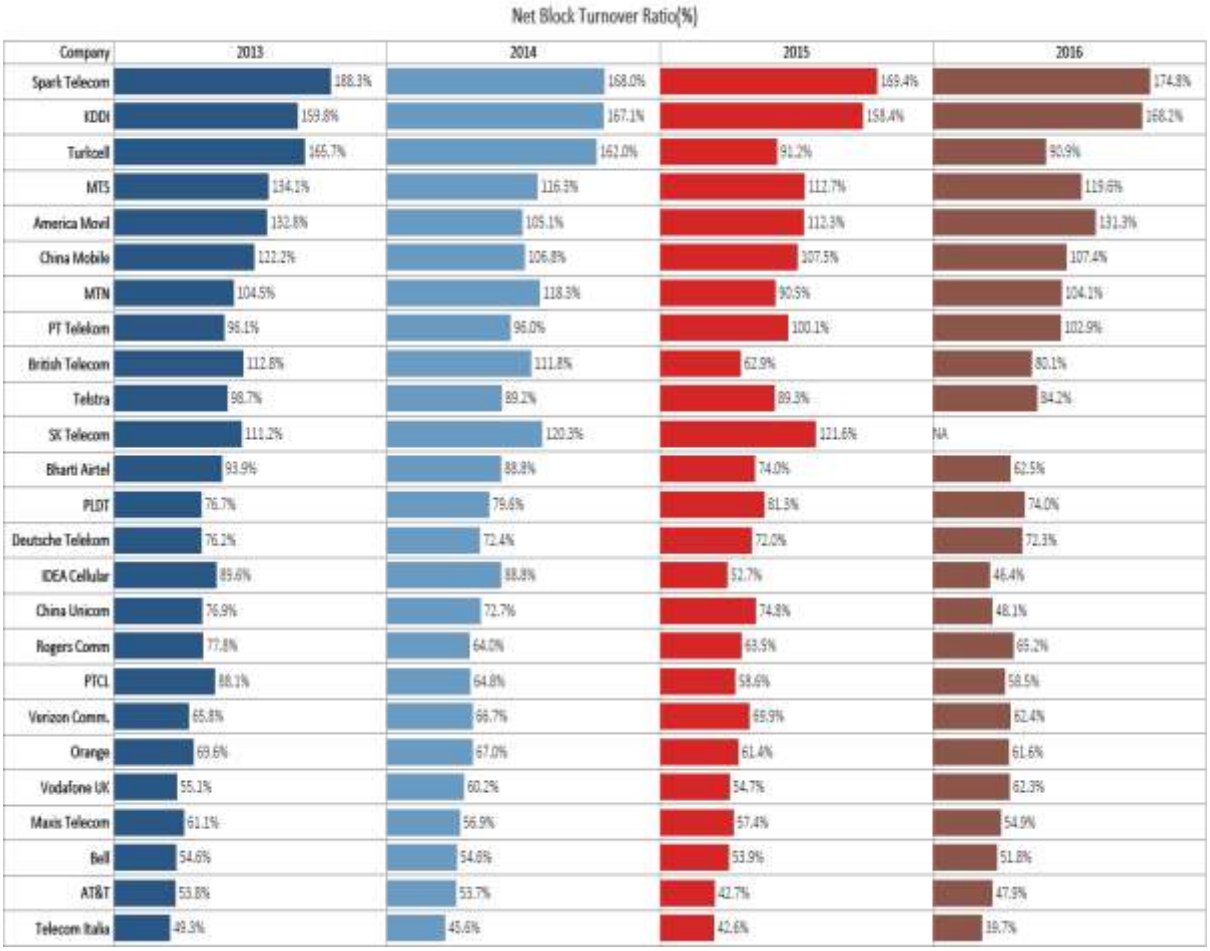
- Highest growth in Gross Block in 2016 was recorded by China Unicom (45.11%) followed by America Movil (33.90%), while the highest negative growth (decline)was reported by Spark Telecom(-74.50%) followed by PTCL (-32.51%).

- In 2016, six companies (PTCL, Spark Telecom, MTN, MTS, Rogers Comm and British Telecom) recorded decline in gross block as against three companies (Spark Telecom, Telecom Italia, China Unicom) in 2015. Of the twenty five companies covered in the report, only Spark Telecom had shown decline in gross block in both 2015 as well as in 2016.

4.5 NET BLOCK TURNOVER RATIO

The following graph shows the Net Block[86] (Fixed Asset) turnover ratio of the companies for the last four years ended 2016.

Chart 4.5



Net Block Turnover ratio and growth trends for the last four years are tabulated in Annexure 4.7

Year	Highest – Net Block turnover ratio		Lowest – Net Block turnover ratio		Average Net Block turnover ratio *
	Name of company	Ratio (%)	Name of company	Ratio (%)	
2013	Spark Telecom	188.27%	Telecom Italia	49.26%	96.58%
2014	Spark Telecom	167.98%	Telecom Italia	45.64%	91.87%
2015	Spark Telecom	169.43%	Telecom Italia	42.58%	83.01%
2016	Spark Telecom	174.84%	Telecom Italia	39.65%	78.84%

* Average based on selected 25 companies.

[86]Gross Block – Accumulated Depreciation – Capital Work in Progress

- Spark Telecom had recorded the highest Net Block Turnover Ratio in all the four years ended 2016. It had recorded Net Block Turnover Ratio of 174.84% in year 2016.

- KDDI stood at 2nd position in all the four years and it showed Net Block Turnover ratio of 168.18% in 2016.

- Telecom Italia had recorded the lowest Net Block Turnover ratio in all the four years. It recorded Net Block Turnover Ratio of 39.65% in year 2016.

- In 2016, seven companies (Spark Telecom, KDDI, America Movil, MTS, PT Telekom, China Mobile and MTN) had a Net Block Turnover ratio more than 100%.

- None of the Indian companies had a Net Block Turnover ratio of more than 100% in any of the four years ended 2016. Among Indian companies, Bharti Airtel showed the highest Net Block Turnover ratio of 62.45% in 2016 and stood at 14th in the overall list of twenty-five companies.

- In terms of growth, Net Block Turnover ratio of America Movil had the highest growth in 2016(19.06%) over 2015 followed by British Telecom (17.16%).

- The highest negative growth (decline) in Net Block Turnover ratio was recorded for China Unicom with (-26.61%) in 2016.

- Only three companies had recorded growth in Net Block Turnover ratio in 2016 as well as 2015. These were PT Telekom, America Movil, Spark Telecom.

4.6 CAPITAL EMPLOYED AND RETURN ON CAPITAL EMPLOYED (RoCE)

The following graphs show the Capital Employed and Return on Capital Employed (RoCE) for the last four years ended 2016.

Chart 4.6

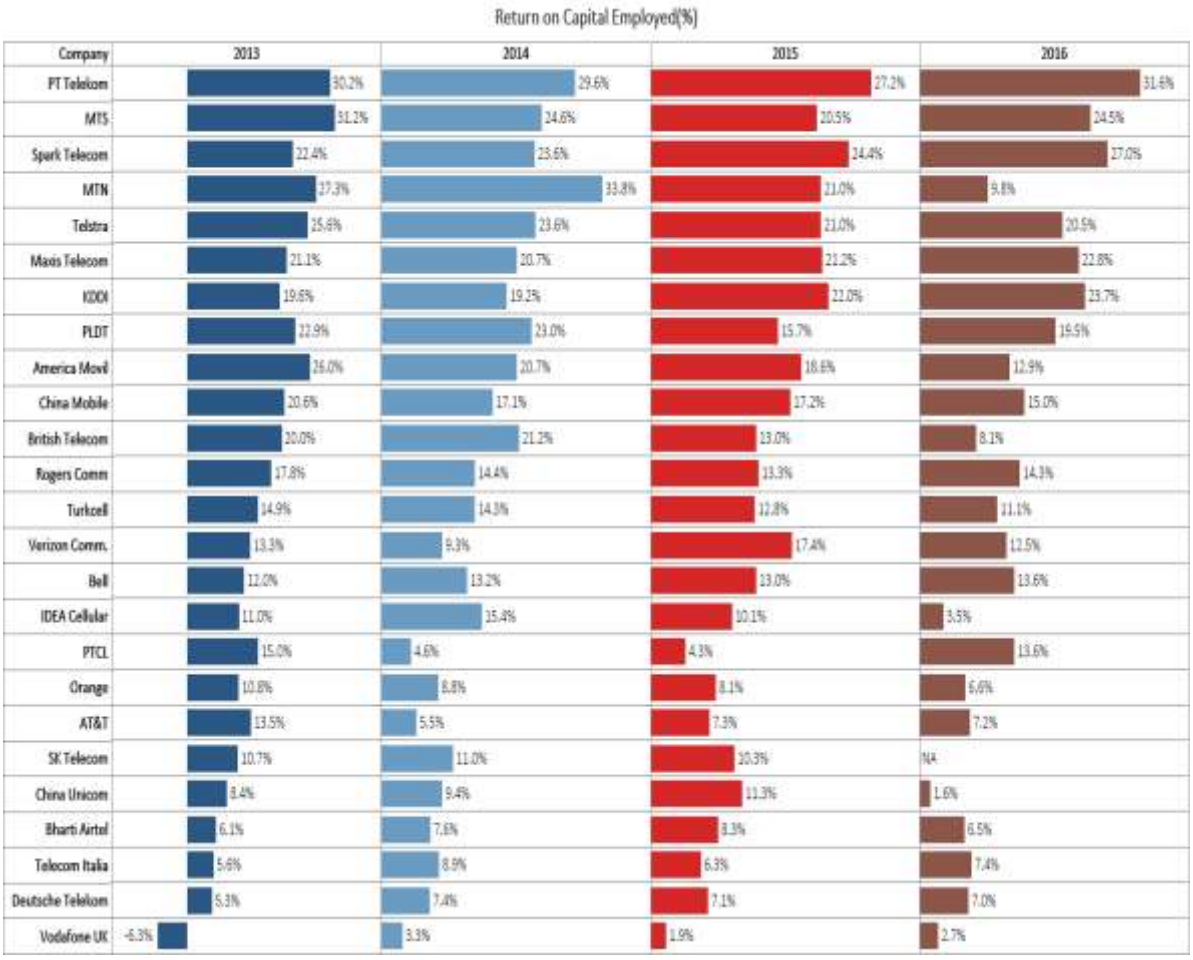
(Amount in Rs. Crore)

Capital Employed

Company	2013-14	2014-15	2015-16	2016-17
AT&T	1,424,750	1,509,035	1,087,233	2,112,180
Verizon Comm.	1,476,803	1,218,191	1,179,887	1,284,467
China Mobile	692,998	735,800	693,499	797,114
Deutsche Telekom	685,084	711,115	768,729	766,769
Vodafone UK	681,117	600,639	684,826	565,481
Orange	393,056	416,616	453,789	464,521
Telecom Italia	375,113	389,959	363,103	379,390
America Movil	359,983	330,501	332,844	147,469
China Unicom	198,369	213,640	187,653	266,079
British Telecom	154,570	162,019	283,292	261,039
KDDI	191,964	208,697	215,314	224,497
Bell	193,134	190,651	195,904	202,300
Telstra	145,424	148,776	155,736	158,279
Bharti Airtel	114,488	124,548	139,539	154,568
Rogers Comm	91,202	99,923	106,306	103,311
MTN	81,367	80,501	92,276	76,119
SK Telecom	82,955	82,279	81,471	NA
PT Telekom	47,643	50,895	51,247	64,201
MTS	52,831	60,633	50,617	47,081
IDEA Cellular	34,848	38,750	65,715	73,565
Turkcell	45,032	44,372	47,399	57,721
PLDT	28,504	27,389	27,875	24,718
Maxis Telecom	23,739	24,063	23,779	23,729
PTCL	10,717	12,793	13,018	6,808
Spark Telecom	10,376	10,439	10,712	10,439

Capital Employed and growth trends of all twenty-five companies for the last four years ended 2016 are tabulated in Annexure 4.8

Chart 4.7



RoCE and growth trends of all the twenty-five companies for the last four years ended 2016 are tabulated in Annexure 4.9

Year	Highest – Capital Employed		Lowest – Capital Employed		Average Capital Employed * (Rs. in crore)
	Name of company	Value (Rs. in crore)	Name of company	Value (Rs. in crore)	
2013	Verizon	1476803	Spark Telecom	10376	297843
2014	AT&T	1509035	Spark Telecom	10439	299689
2015	AT&T	2087233	Spark Telecom	10712	333187
2016	AT&T	2112180	PTCL	6808	330874

* Average based on selected 25 companies.

Year	Highest – Return on Capital Employed		Lowest – Return on Capital Employed		Average Return on Capital Employed *
	Name of company	Return (%)	Name of company	Return (%)	
2013	MTS	31.24%	Vodafone UK	-6.27%	16.19%
2014	MTN	33.77%	Vodafone UK	3.29%	15.61%
2015	PT Telekom	27.18%	Vodafone UK	1.91%	14.12%
2016	PT Telekom	31.59%	China Unicom	1.61%	12.91%

* Average based on selected 25 companies.

- USA based companies AT&T and Verizon were having the highest Capital Employed in all the 4 years ended 2016. AT&T topped the list in 2016 with ₹2,112,180 crore, followed by Verizon Comm. and China mobile with ₹1,284,467 crore and ₹797,114 crore respectively.
- PTCL had the lowest Capital employed with ₹6,808 crore in 2016 followed by Spark Telecom and Maxis Telecom at ₹10,439 crore and ₹23,729 crore respectively.
- Amongst the Indian companies, Bharti Airtel was having the highest capital employed of ₹154,568 crore in the year 2016 and stood at 13th among the selected twenty-five companies.
- In 2016, twenty[87] companies had witnessed growth in capital employed as compared to 2015.
- In 2016, the highest increase (growth) in capital employed was achieved by Idea Cellular (88.57%) followed by British Telecom (83.28%).
- Three companies had shown negative growth (decline) in the capital employed in 2016 as well as 2015. These companies were Verizon Comm., Telecom Italia and China Unicom
- In 2016, all the twenty-five companies were having positive RoCE.
- PT Telecom had recorded the maximum RoCE (31.59%) in 2016, followed by Spark Telecom (26.97%) and MTS (24.46%).

[87]Twenty companies are Maxis Telecom, PT Telekom, Telstra, MTS, Bell Canada, China mobile, Bharti Airtel, Rogers Comm, PTCL, AT&T, Turkcell, KDDI, Deutsche Telekom, Vodafone UK, orange, British Telecom, American Movil, MTN, Idea Cellular, Spark Telecom

- China Unicom recorded lowest RoCE with 1.61% for the year ended 2016 whereas Vodafone-UK recorded lowest RoCE in all the remaining three years ended 2015 with 1.91% in 2015, 3.29% in 2014 and negative RoCE of (-) 6.27% in 2013. It is the only company which showed negative RoCE in any of the four years ended 2016.

- Among the compared Indian companies, Bharti Airtel recorded the highest RoCE (6.45%) in 2016; it stood at 21st position in the overall list of the twenty-five companies. However, in 2015, Idea Cellular had reported higher RoCE than Bharti Airtel.

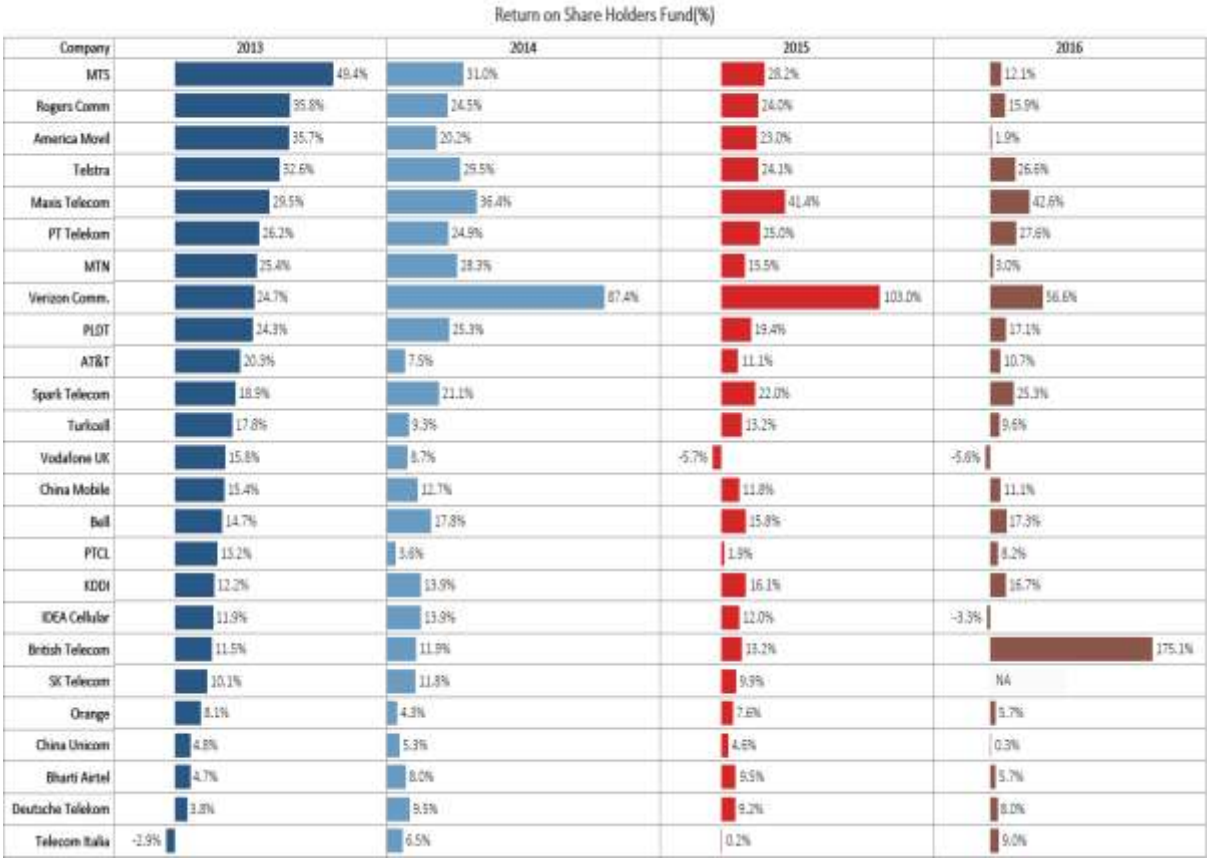
- Three companies had recorded growth in RoCE in 2016and 2015. These were Spark Telecom, KDDI and Maxis Telecom.

- British Telecom, America Movil, MTN, Telstra, Turkcell, Idea Cellular, Orange and Deutsche Telecom were the eight companies, which recorded negative growth (decline) in RoCE in 2016and 2015.

4.7 RETURN ON SHAREHOLDERS FUND

The following Chart presents the Return on Shareholders[88] Fund of the companies during the last four years ended 2016.

Chart 4.8



Return on Shareholders Fund and growth trends of all twenty-five companies for the last four years ended 2016 are tabulated in Annexure 4.10.

Year	Highest – Return on Shareholders Fund		Lowest – Return on Shareholders Fund		Average Return on Shareholders Fund *
	Name of company	Value (%)	Name of company	Value (%)	
2013	MTS	49.38%	Telecom Italia	-2.87%	18.54%
2014	Verizon Comm.	87.42%	PTCL	3.63%	18.93%
2015	Verizon Comm.	102.99%	Vodafone UK	-5.67%	18.23%
2016	British Telecom	175.11%	Vodafone UK	-5.57%	19.89%

* Average based on selected 25 companies.

[88]Shareholders' Funds includes share capital and reserve and surplus

- British Telecom had recorded the highest return on shareholders' fund with 175.11% for the year ended 2016. However, verizon had recorded the highest return on shareholders' fund in two successive years 2014 and 2015 at 87.42% and 102.99% respectively. In 2013, MTS showed the highest return on shareholder's fund at 49.38%.

- In 2016, Verizon Communication and Maxis Telecom stood at 2nd and 3rd position with 56.62% and 42.63% return on shareholders' fund respectively.

- Two companies (Idea Cellular and Vodafone-UK) had shown negative return on shareholder's funds in 2016.Vodafone UK had the lowest return on shareholder's fund at(-) 5.57%, followed by Idea Cellular with (-) 3.28% respectively.

- Among the compared Indian companies, Bharti Airtel had shown the highest return on shareholder's funds at 5.71% in 2016 and stood at 18th among the selected twenty-five companies. Amongst Indian companies, only Bharti Airtel had recorded positive return on shareholder's funds had in all the years ended 2016.

- Ten[89] companies had recorded increase (growth) in return on shareholder's funds in 2016vis-a-vis 2015. British Telecom had recorded the highest growth in return on shareholder's funds by 161.89% in 2016.

- Five companies had recorded growth in return on shareholder's funds in 2016 as well as in 2015.The companies are British Telecom, Maxis Telecom, PT Telecom, Spark Telecom and KDDI.

- PLDT, China Mobile, Rogers Comm., MTS, Deutsche Telecom, MTN, China Unicom and Idea Cellular are the seven companies, which recorded decline in return on shareholder's funds in 2016 as well as in 2015.

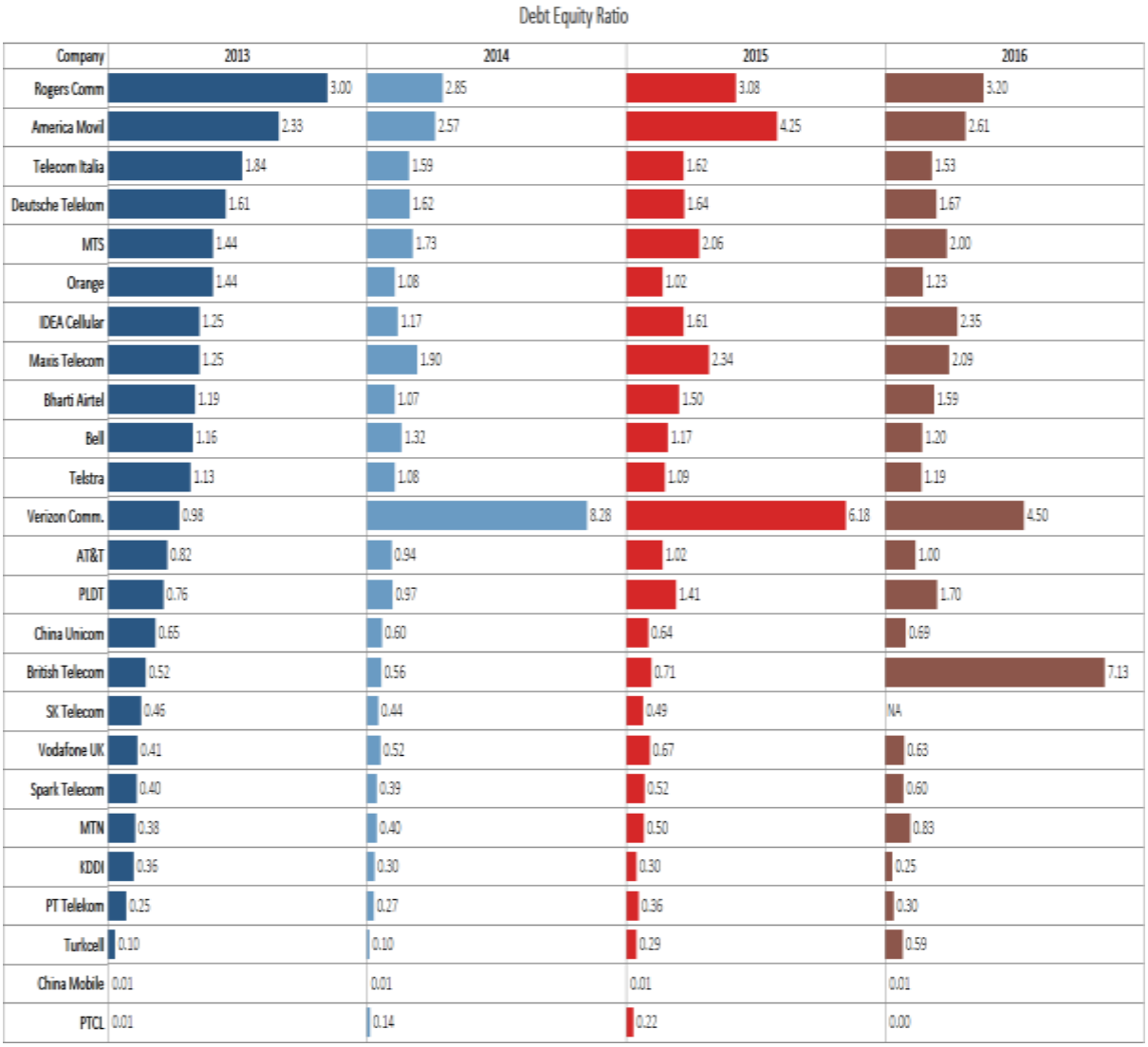
4.8 DEBT EQUITY RATIO

The following chart presents the debt equity ratio[90] of the companies over the period of 4-years ended 2016.

[89]Ten companies are British Telecom, Maxis Telecom, PT Telecom, Telstra, Spark Telecom, Bell Canada, KDDI, Telecom Italia, PTCL.

[90]Debt includes Long Term Borrowings and Short Term Borrowings (including current maturities of long term debt). Equity is represented by Shareholders funds.

Chart 4.9



Debt equity ratio of these twenty-five telecom companies is tabulated in Annexure 4.11

Year	Highest – Debt-Equity Ratio		Lowest – Debt-Equity Ratio		Average Debt-Equity Ratio *
	Name of company	Ratio (in times)	Name of company	Ratio (in times)	
2013	Rogers Comm.	3.00	China Mobile, PTCL	0.01	0.97
2014	Verizon Comm.	8.28	China Mobile	0.01	1.31
2015	Verizon Comm.	6.18	China Mobile	0.01	1.43
2016	British Telecom	7.13	PTCL	0.0001	1.62

* Average based on selected 25 companies.

- British Telecom had registered the highest Debt Equity ratio of 7.13 times in 2016 followed by Verizon Comm and Rogers Comm with 4.5 times and 3.2 times respectively.
- PTCL, China Mobile and KDDI were the three firms with lowest Debt Equity ratio in 2016with Debt Equity ratio of 0.0001 times, 0.01 times and 0.25 times respectively. China Mobile had registered the lowest Debt Equity ratio in all four years.
- Among the compared Indian telecom companies, Bharti Airtel had registered the lowest Debt Equity ratio of 1.59 times in 2016.
- Of the twenty-five companies, in 2016, seventeen[91] companies had registered Debt Equity ratio of less than 2 times. Out of these seventeen companies, nine[92] companies had Debt Equity ratio of less than 1 time.
- Seven companies, which had Debt Equity ratio higher than 2 times were Verizon Comm., America Movil, Rogers Comm., Maxis Telecom, MTS, Idea Cellular and British Telecom..
- Thirteen[93]companies recorded increase in the Debt Equity ratio in 2016vis-à-vis 2015 indicating that investments made by these companies were more using borrowed funds than shareholders funds.
- British Telecom and Turkcell had recorded an increase of more than 100% in Debt Equity ratio in 2016 with an increase of 904% and 103%respectively.
- Eleven companies had recorded increase in Debt Equity ratio in 2016 as well as in 2015. These were Rogers Comm., Bharti Airtel, PLDT, Deutsche, Idea Cellular, Telstra, British Telecom, China Unicom, Spark Telecom, MTN, Turkcell.
- Verizon Comm. is the only company, which had recorded decline in Debt Equity ratio in 2015 as well as in 2016 vis-à-vis corresponding previous years.

4.9 INTEREST COVERAGE RATIO

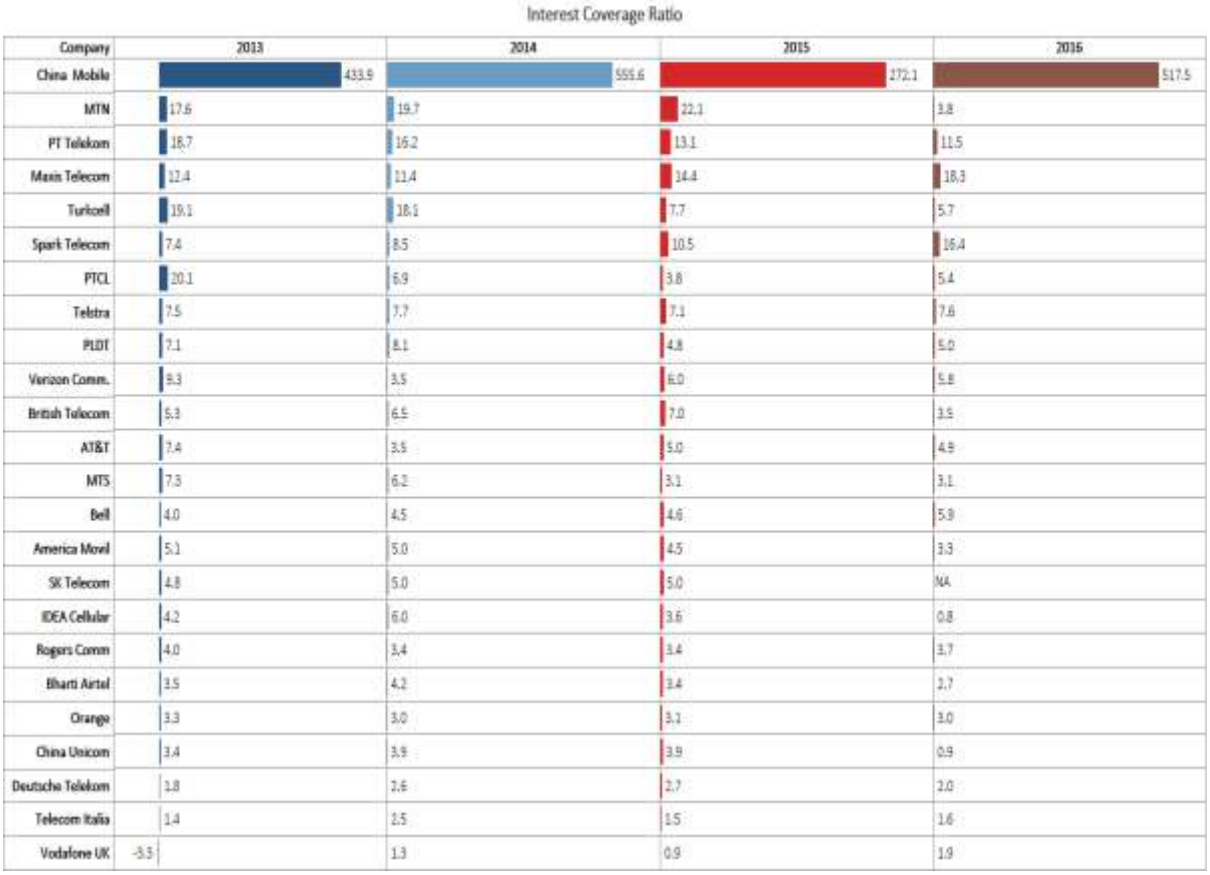
The following Chart presents the interest coverage ratio of the companies over the period of 4 years ended 2016.

[91] Seventeen Companies are PT Telekom, Telstra, Bell Canada, China mobile, Bharti Airtel, PTCL, AT&T, Turkcell, KDDI, Deutsche Telekom, Vodafone UK, orange, MTN, Spark Telecom, Telecom Italia , PLDT, China Unicom.

[92] Nine companies are Vodafone UK, China Unicom, MTN, Spark Telecom, PT Telekom, KDDI, Turkcell, PTCL, NTT Docomo.

[93]Thirteen Companies are Rogers Comm, Bharti Airtel, Deutsche Telekom, Idea Cellular, PLDT, Bell Canada, Telstra, Orange, British Telecom, China Unicom, Spark Telecom, MTN, Turkcell.

Chart 4.10



Interest Coverage Ratio of KDDI has not been shown on the above Chart as the same were very high (greater than 50 times) in comparison to other companies which ranges from 0.08 times to 25 times) and to depict the same in the graph was difficult. Interest coverage Ratio and growth trends of all the companies for the last four years ended 2016 are tabulated in Annexure 4.12

Year	Highest – Interest Coverage Ratio		Lowest – Interest Coverage Ratio		Average Interest Coverage Ratio *
	Name of company	Ratio (in times)	Name of company	Ratio (in times)	
2013	PTCL	20.07	Telecom Italia	1.44	7.92
2014	MTN	19.74	Vodafone UK	1.32	6.85
2015	MTN	22.14	Vodafone UK	0.92	6.14
2016	Maxis Telecom	18.32	Idea Cellular	0.78	5.30

* Average based on selected 25 companies.

- Maxis Telecom had the highest interest coverage ratio in the year ended 2016, with 18.32 times. Spark Telecom had the second highest interest coverage ratio with 16.39 times for the year ended 2016.

- Idea Cellular recorded the lowest interest coverage ratio with 0.78 times in 2016. The lowest interest coverage ratio was recorded by Vodafone UK at 0.92 times and1.32 times in 2015 and 2014 respectively.

- In 2016, among the compared Indian companies, Bharti Airtel had the highest interest coverage ratio of 2.68 times followed by Idea Cellular which stood at 0.78 times respectively. Bharti Airtel stood at 17th among the selected twenty five companies.

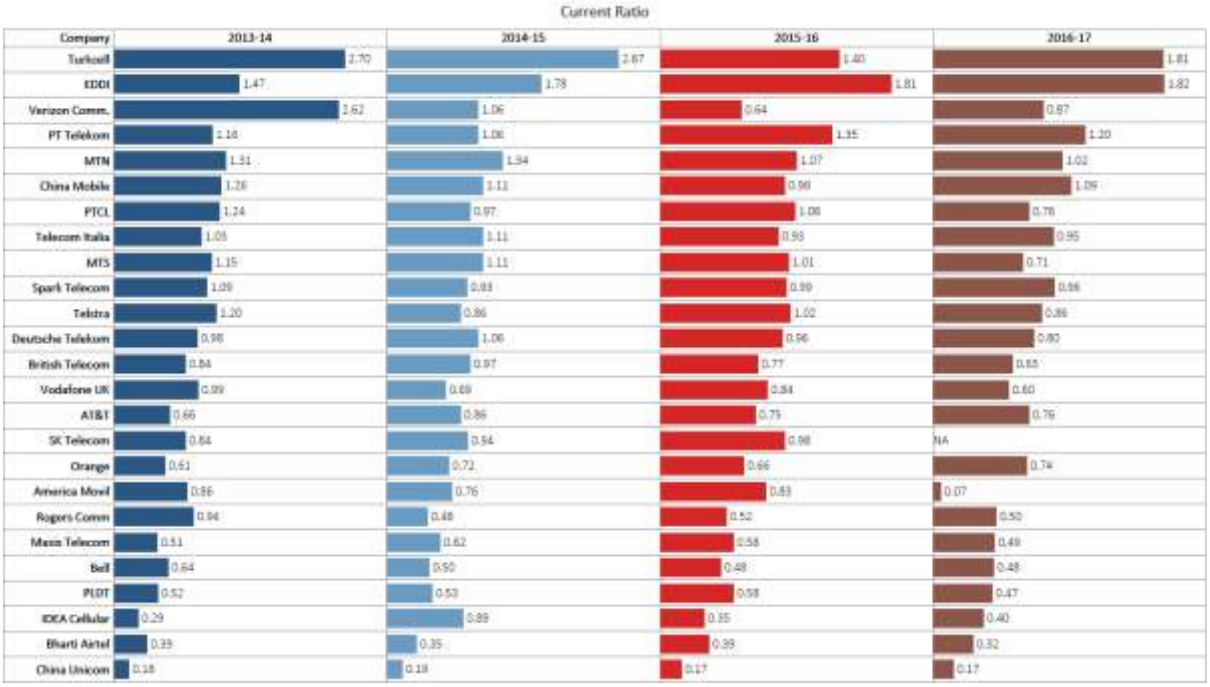
- Four companies (Rogers Comm, Maxis Telecom, Bell Canada and Spark telecom) had shown increase in interest coverage ratio in 2015 as well as in 2016.

- America Movil, Bharti Airtel, Idea Cellular, China Unicom, PT Telekom and Turkcell are the six companies that recorded decline in interest coverage ratio in 2015 as well as in 2016.

4.10 CURRENT RATIO

The following Chart presents the current ratio[94] of the companies over the period of 4 years ended 2016.

Chart 4.11 **(in times)**



Current Ratio and growth trends of all twenty-five companies for the last four years ended 2016 are tabulated in Annexure 4.13

[94]Current Assets / Current Liabilities

Year	Highest – Current Ratio		Lowest – Current Ratio		Average Current Ratio *
	Name of company	Ratio (in times)	Name of company	Ratio (in times)	
2013	Turkcell	2.70	China Unicom	0.18	1.02
2014	Turkcell	2.67	China Unicom	0.19	0.94
2015	KDDI	1.81	China Unicom	0.17	0.84
2016	KDDI	1.82	America Movil	0.07	0.94

* Average based on selected 25 companies.

- Japanese company KDDI had the highest current ratio for the year ended 2016 as well as 2015, with 1.82 times and 1.81 times respectively. However, in the year 2013 as well as 2014, Turkcell recorded the highest current ratio with 2.70 times and 2.67 times respectively.

- America Movil had recorded the lowest current ratio for the year ended 2016 with 0.07 times whereas China Unicom had recorded the lowest current ratio in all three years ended 2015 with 0.17 times in 2015, 0.19 times in 2014 and 0.18 times in 2013.

- In 2016, among the compared Indian companies, Idea Cellular had the highest current ratio of 0.40 times followed by Bharti Airtel with 0.32 times.

- Five companies (KDDI, Turkcell, PT Telekom, China mobile, and MTN) recorded current ratio between 1 to 2 times. Remaining twenty-one companies had registered current ratio of less than 1.

- Only one company (KDDI) had registered increase in current ratio in 2015 as well as in 2016.

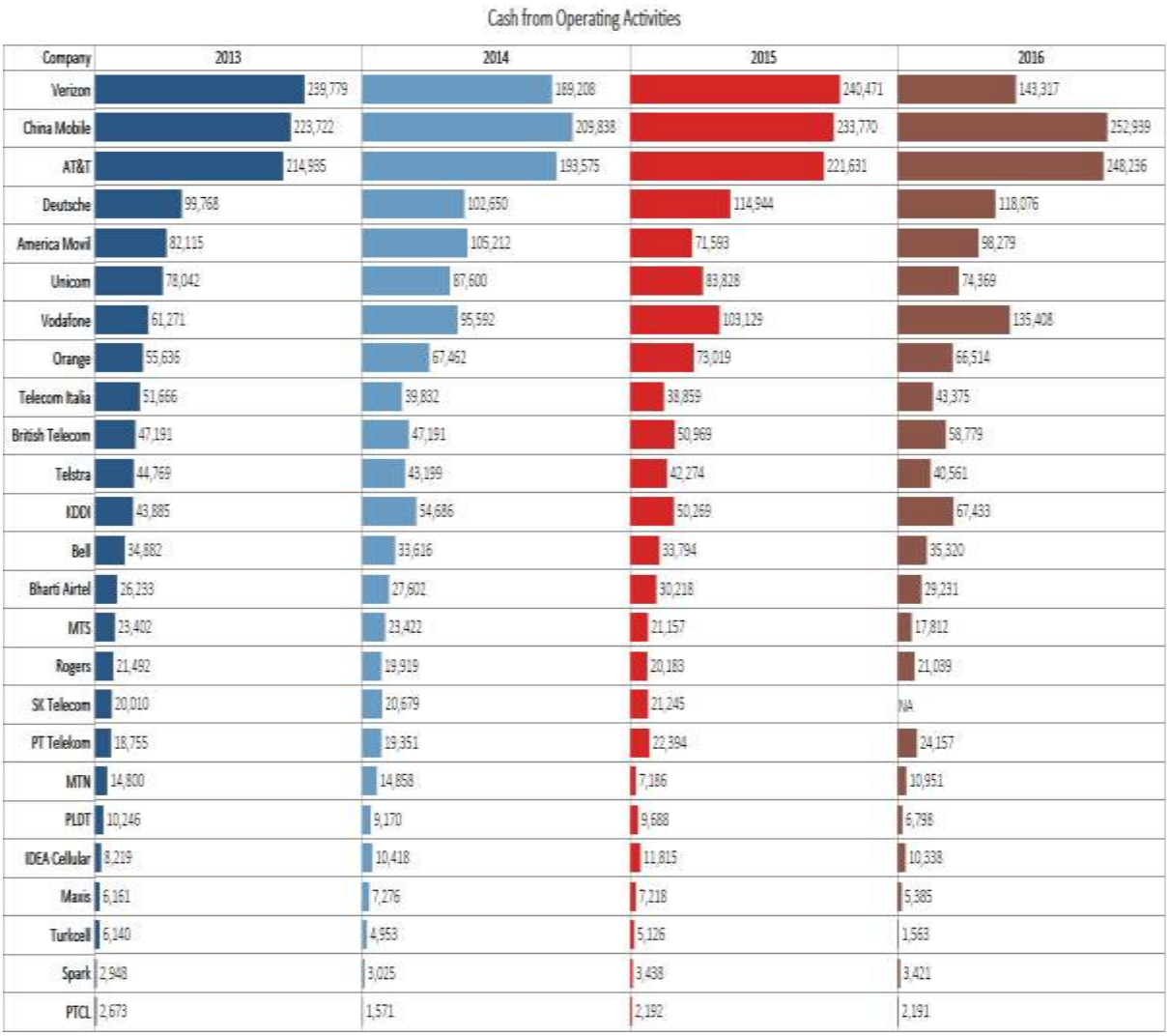
- MTN, MTS, Deutsche Telecom, British Telecom, Maxis Telecom and Bell Canada are the six companies that recorded decline in current ratio in 2015 as well as in 2016.

- In the year 2014, IDEA Cellular's current ratio increased by 208.94 % which was highest among all the twenty-five companies. The increase was primarily due to high increase of ₹ 11,311 crore in 2014 in current investments.

4.11 CASH FLOW FROM OPERATING ACTIVITIES[95]

The following Chart shows the Cash flow from Operating Activities of the companies for the last four years ended 2016:

Chart 4.12 **(Amount in Rs. Crore)**

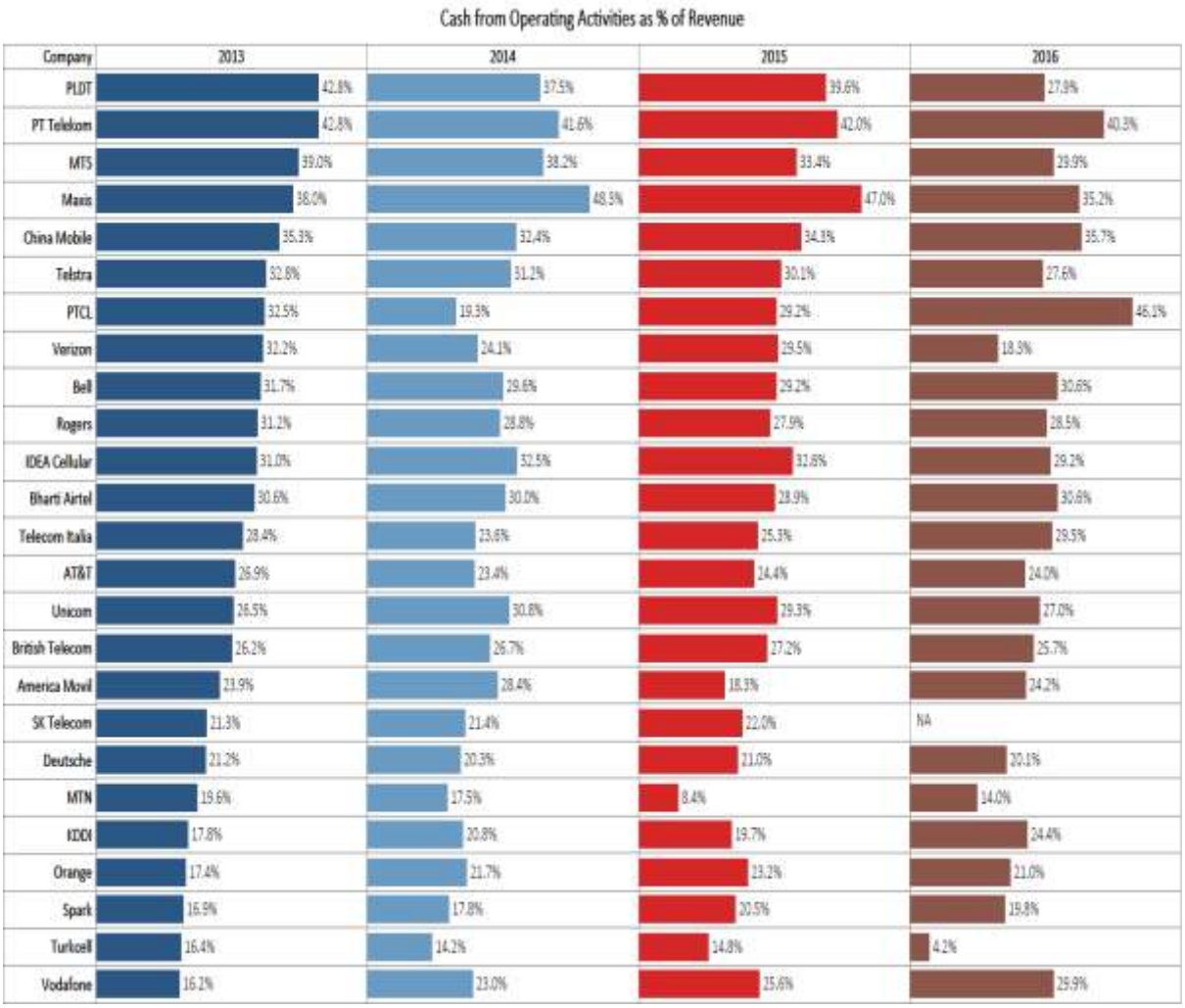


Company	2013	2014	2015	2016
Verizon	139,779	189,208	240,471	143,317
China Mobile	223,722	209,838	233,770	252,939
AT&T	214,895	193,575	221,631	148,236
Deutsche	99,768	102,650	114,944	118,076
America Movil	82,115	105,212	71,593	98,279
Unicom	78,042	87,600	83,828	74,369
Vodafone	61,271	95,592	103,129	135,408
Orange	55,636	67,462	73,019	66,514
Telecom Italia	51,666	39,832	38,859	43,375
British Telecom	47,191	47,191	50,969	58,779
Telstra	44,769	43,199	42,274	40,561
KDDI	43,885	54,686	50,269	67,433
Bell	34,882	33,616	33,794	35,320
Bharti Airtel	26,233	27,602	30,218	29,231
MTS	23,402	23,422	21,157	17,812
Rogers	21,492	19,919	20,183	21,089
SK Telecom	20,010	20,679	21,245	NA
PT Telekom	18,755	19,351	22,384	24,157
MTN	14,800	14,858	7,186	10,951
PLDT	10,246	9,170	9,688	6,798
IDEA Cellular	8,219	10,418	11,815	10,338
Maxis	6,161	7,276	7,218	5,385
Turkcell	6,140	4,953	5,126	1,563
Spark	2,948	3,025	3,438	3,421
PTCL	2,673	1,571	2,192	2,191

Cash from operating activities of all twenty-five companies for the last four years ended 2016 are tabulated in Annexure 4.14

[95]Operating Activities, Investing Activities (sale/purchase of fixed assets and investments etc.) and Financing Activities (funds transacted from share capital and long term borrowings)

Chart 4.13



Cash flow from operating activities as % of Revenue and growth trends of all twenty five companies for the last four years ended 2016 are tabulated in Annexure 4.15

Year	Highest – Cash Flow from Operating Activities		Lowest – Cash Flow from Operating Activities		Average Cash Flow from Operating Activities *
	Name of company	Value (Rs. in crore)	Name of company	Value Rs. in crore)	
2013	Verizon Comm.	239779	PTCL	2673	57550
2014	China Mobile	209838	PTCL	1571	57276
2015	Verizon Comm.	240471	PTCL	2191	60816
2016	China Mobile	252939	Turkcell	1563	63146

* Average based on selected 25 companies.

Year	Highest – Cash Flow from Operating Activities as % of Revenue		Lowest – Cash Flow from Operating Activities as % of Revenue		Average Cash Flow from Operating Activities as % of Revenue *
	Name of company	Value (%)	Name of company	Value (%)	
2013	PLDT	42.78%	Vodafone UK	16.24%	27.94%
2014	Maxis Telecom	48.34%	Turkcell	14.25%	27.33%
2015	Maxis Telecom	46.96%	MTN	8.44%	27.34%
2016	PTCL	46.11%	Turkcell	4.23%	25.74%

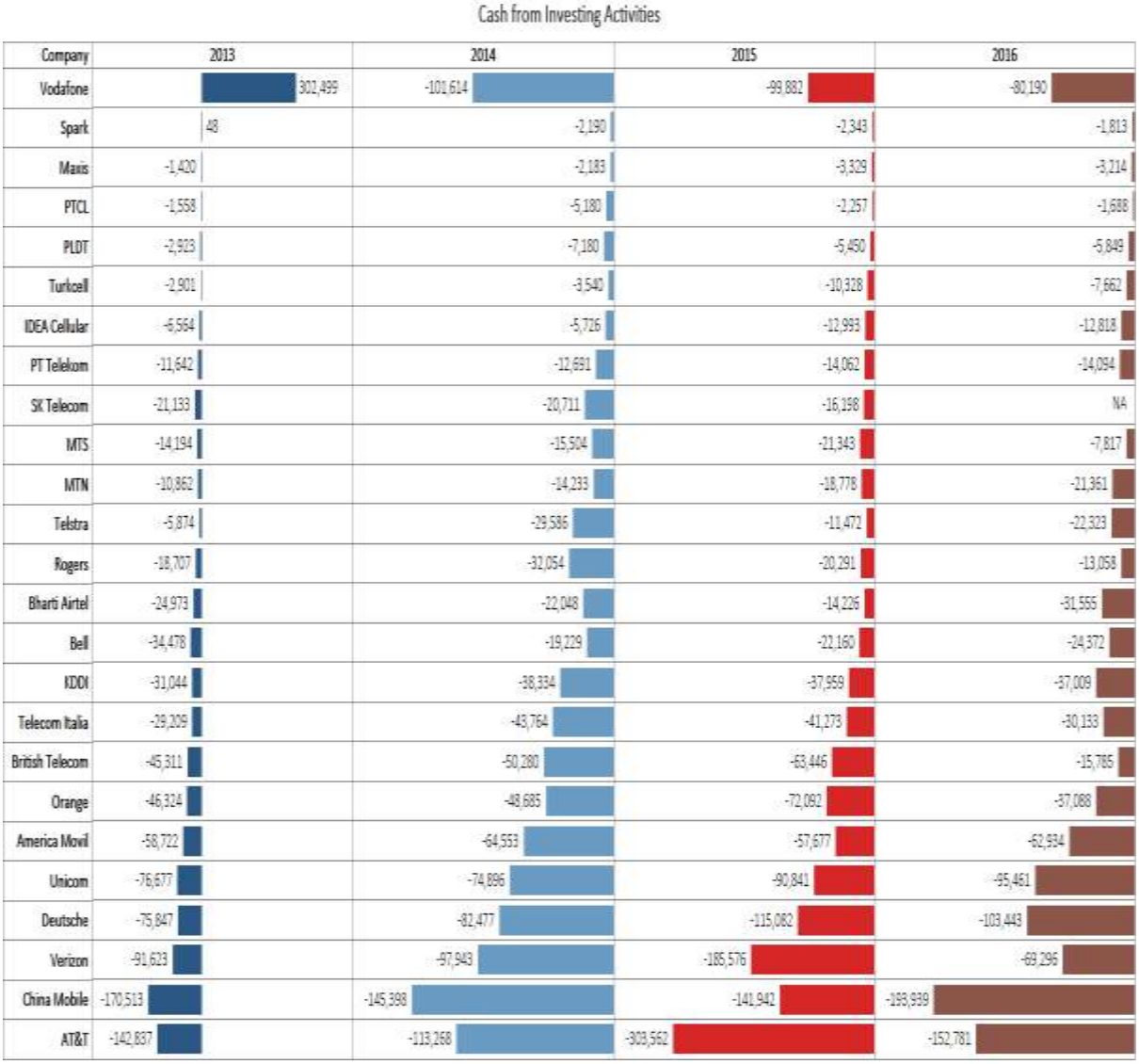
* Average based on selected 25 companies.

- In all the four years ended 2016, all the companies had registered cash generated from operating activities.
- China Mobile had generated the highest cash from operating activities in 2016 (₹ 2,52,939 crore), followed by AT&T (₹ 2,48,236 crore) and Verizon (₹ 1,43,317 crore).
- Cash from operating activities as % of revenue was highest in respect of PTCL (46.11%) in 2016 followed by PT Telecom (40.34%).
- Amongst the compared Indian companies, in 2016, Bharti Airtel had registered the highest cash from operating activities as % of revenue (30.58%).

4.12 CASH FLOW FROM INVESTING AND FINANCING ACTIVITIES

The following Chart shows the Cash flow from Investing Activities of the companies for the last four years ended 2016:

Chart 4.14 **(Amount in Rs. Crore)**

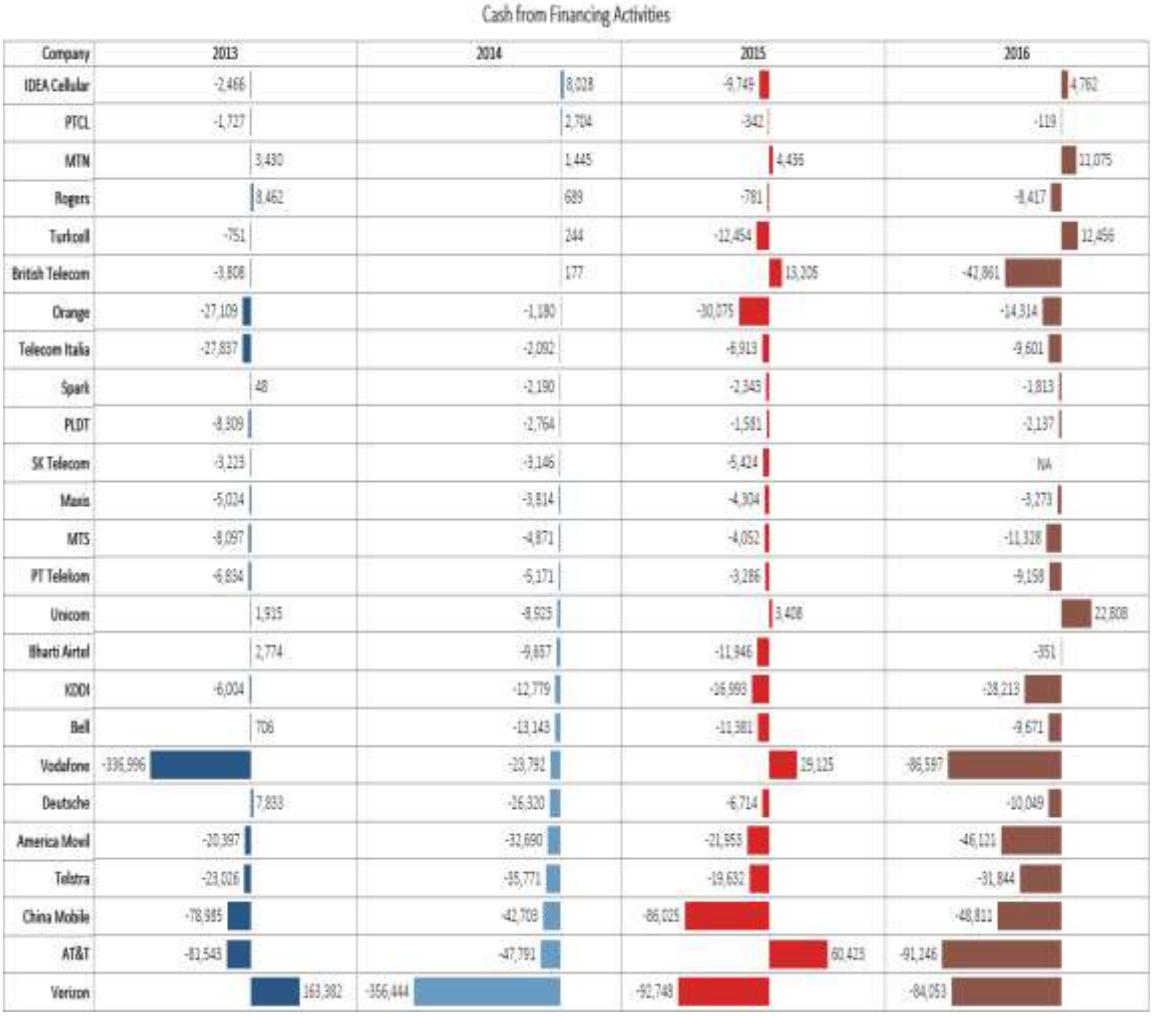


Company	2013	2014	2015	2016
Vodafone	302,499	-101,614	-99,882	-80,190
Spark	48	-2,190	-2,343	-1,813
Maxis	-1,420	-2,183	-3,329	-3,214
PTCL	-1,558	-5,180	-2,257	-1,688
PLDT	-2,903	-7,180	-5,450	-5,849
Turkcell	-2,901	-3,540	-10,328	-7,662
IDEA Cellular	-6,564	-5,726	-12,993	-12,818
PT Telekom	-11,642	-12,691	-14,062	-14,054
SK Telecom	-21,133	-20,711	-16,198	NA
MTS	-14,194	-15,504	-21,343	-7,817
MTN	-10,862	-14,233	-18,778	-21,361
Telstra	-5,874	-29,586	-11,472	-22,323
Rogers	-18,707	-32,054	-20,291	-13,058
Bharti Airtel	-24,973	-22,048	-14,226	-31,555
Bell	-34,478	-19,229	-22,160	-24,372
KDDI	-31,044	-38,334	-37,959	-37,009
Telecom Italia	-29,209	-43,764	-41,273	-30,133
British Telecom	-45,311	-50,280	-63,446	-15,785
Orange	-46,324	-48,685	-72,092	-37,088
America Movil	-58,722	-64,553	-57,677	-62,934
Unicom	-76,677	-74,896	-90,841	-95,461
Deutsche	-75,847	-82,477	-115,082	-103,443
Verizon	-91,623	-97,943	-185,576	-69,296
China Mobile	-170,513	-145,398	-141,942	-193,939
AT&T	-142,837	-113,268	-303,562	-152,781

Cash flow from investing activities of all twenty-five companies for the last four years ended 2016 are tabulated in Annexure 4.16

The following Chart shows the Cash flow from Financing Activities of the companies for the last four years ended 2016:

Chart 4.15 **(Amount in Rs. Crore)**



Cash flow from investing activities of all twenty five companies for the last four years ended 2016 are tabulated in Annexure 4.17

Cash from Investing Activities

Year	Highest – Cash Flow Towards Investing Activities		Lowest – Cash Flow Towards Investing Activities		Average Cash Flow Towards Investing Activities *
	Name of company	Value (Rs. in crore)	Name of company	Value (Rs. in crore)	
2013	Vodafone UK	302499	China Mobile	-170513	-24912
2014	Maxis	-2183	China Mobile	-145398	-42131

2015	PTCL	-2257	AT&T	-303562	-55382
2016	PTCL	-1688	China Mobile	-193939	-41827

* Average based on selected 25 companies.

- In all Four years, amongst all the companies (Spark Telecom and Vodafone-UK in 2013) had shown cash utilized in investing activities, which indicates investment on regular basis by these companies.

Cash from Financing Activities

Year	Highest – Cash Flow from Financing Activities		Lowest – Cash Flow from Financing Activities		Average Cash Flow from Financing Activities *
	Name of company	Value (Rs. in crore)	Name of company	Value Rs. in crore)	
2013	Verizon Comm.	163382	Vodafone UK	-336996	-18765
2014	Idea Cellular	8028	Verizon Comm.	-356444	-25784
2015	AT&T	60423	Verizon Comm.	-92748	-9695
2016	China Unicom	22808	AT&T	-91246	-20370

* Average based on selected 25 companies.

Annexure 1.1

Mobile Subscribers

(in millions)

Country	2013	2014	2015	2016	% Growth in 2015	% Growth in 2016
Australia	24.94	25.06	25.77	26.55	2.83%	3.03%
Brazil	271.09	280.72	257.81	244.06	-8.16%	-5.33%
Canada	28.36	28.78	29.76	30.45	3.39%	2.30%
China	1229.11	1286.09	1291.98	1364.93	0.46%	5.65%
Egypt	99.70	95.31	94.01	97.79	-1.36%	4.02%
France	63.32	65.42	66.68	67.57	1.92%	1.33%
Germany	100.03	99.53	96.36	94.43	-3.18%	-2.00%
India	886.30	944.00	1010.89	1127.37	7.09%	11.52%
Indonesia	313.22	325.58	338.94	385.57	4.11%	13.76%
Italy	96.86	89.91	87.69	85.95	-2.47%	-1.98%
Japan	147.88	155.14	160.47	164.26	3.44%	2.36%
Korea (Rep.)	54.68	57.29	58.93	61.29	2.87%	4.01%
Malaysia	43.00	44.92	44.10	43.91	-1.84%	-0.43%
Mexico	106.74	104.94	107.68	111.72	2.61%	3.75%
New Zealand	4.76	5.10	5.60	5.80	9.80%	3.57%
Nigeria	127.24	138.96	150.83	154.34	8.54%	2.33%
Pakistan	127.73	135.76	125.89	136.48	-7.26%	8.41%
Philippines	102.82	111.32	117.83	113.00	5.85%	-4.11%
Russian Federation	218.30	221.03	227.28	231.39	2.83%	1.81%
South Africa	76.86	79.28	87.99	76.65	11.00%	-12.89%
Turkey	69.66	71.88	73.63	75.06	2.44%	1.93%
United Kingdom	78.67	78.46	79.25	78.52	1.01%	-0.91%
United States	310.69	355.50	382.30	416.68	7.54%	8.99%

Annexure 1.2

Mobile Tele-Density (in %)

Country	2013	2014	2015	2016
Australia	106.84	106.05	107.72	109.61
Brazil	135.31	138.95	126.59	118.92
Canada	80.61	81.04	82.98	84.06
China	88.71	92.27	92.18	96.88
Egypt	121.51	114.31	110.99	113.7
France	98.50	101.21	102.61	103.45
Germany	120.92	120.42	116.71	114.53
India	71.69	75.43	79.82	88
Indonesia	125.36	128.78	132.55	149.13
Italy	158.82	147.23	143.42	140.43
Japan	116.32	122.16	126.54	129.75
Korea (Rep.)	111.00	115.71	118.46	122.65
Malaysia	144.72	148.83	143.89	141.17
Mexico	87.26	84.77	85.99	88.23
New Zealand	105.78	112.05	121.83	124.98
Nigeria	73.29	77.84	82.19	81.82
Pakistan	70.13	73.33	66.92	71.39
Philippines	104.50	111.22	115.75	109.17
Russia	152.84	155.14	159.95	163.26
South Africa	145.64	149.19	164.51	142.38
Turkey	92.96	94.79	96.02	96.87
UK	124.61	123.58	124.13	122.32
USA	97.08	110.20	117.59	127.16

Annexure 1.3

Fixed Line Subscribers

(in millions)

Country	2013	2014	2015	2016	% Growth in 2015	% Growth in 2016
Australia	10.35	9.19	8.5	8.18	-7.51%	-3.76%
Brazil	45.04	44.13	43.68	41.84	-1.02%	-4.21%
Canada	16.92	16.4	15.61	14.98	-4.82%	-4.04%
China	266.99	249.43	231	206.62	-7.39%	-10.55%
Egypt	6.82	6.32	6.24	6.11	-1.27%	-2.08%
France	39.08	38.81	38.93	39.006	0.31%	0.20%
Germany	48.7	47.02	45.35	44.31	-3.55%	-2.29%
India	28.89	27	25.52	24.4	-5.48%	-4.39%
Indonesia	30.72	26.22	10.38	10.37	-60.41%	-0.10%
Italy	21.1	20.57	20.21	20.26	-1.75%	0.25%
Japan	64.02	63.56	63.71	64.02	0.24%	0.49%
Korea (Rep.)	30.33	29.48	28.88	28.03	-2.04%	-2.94%
Malaysia	4.54	4.41	4.49	4.51	1.81%	0.45%
Mexico	18.59	18.56	19.34	19.59	4.20%	1.29%
New Zealand	1.85	1.85	1.85	1.82	0.00%	-1.62%
Nigeria	0.36	0.18	0.19	0.15	5.56%	-21.05%
Pakistan	6.37	4.9	2.99	3.06	-38.98%	2.34%
Philippines	3.15	3.09	3.22	3.83	4.21%	18.94%
Russia	40.47	38.21	35.55	32.27	-6.96%	-9.23%
South Africa	3.88	3.65	4.13	3.56	13.15%	-13.80%
Turkey	13.55	12.53	11.49	11.07	-8.30%	-3.66%
UK	33.38	33.24	33.21	33.51	-0.09%	0.90%
USA	133.23	128.5	124.85	121.53	-2.84%	-2.66%

Annexure 1.4

Fixed Line Tele-Density (in %)

Country	2013	2014	2015	2016
Australia	44.34	38.89	35.53	33.77
Brazil	22.48	21.84	21.45	20.39
Canada	48.10	46.18	43.52	41.38
China	19.27	17.90	16.48	14.67
Egypt	8.31	7.57	7.36	7.11
France	60.79	60.03	59.91	59.72
Germany	58.87	56.89	54.93	53.74
India	2.32	2.13	2.01	1.90
Indonesia	12.30	10.37	4.06	4.01
Italy	34.59	33.70	33.05	33.11
Japan	50.35	50.05	50.23	50.57
Korea (Rep.)	61.57	59.54	58.06	56.10
Malaysia	15.26	14.61	14.65	14.50
Mexico	15.20	14.99	15.44	15.48
New Zealand	41.06	40.65	40.25	39.22
Nigeria	0.21	0.10	0.10	0.08
Pakistan	3.50	2.65	1.88	1.60
Philippines	3.20	3.09	3.17	3.71
Russia	28.34	26.82	25.02	22.77
South Africa	7.34	6.86	7.72	6.62
Turkey	18.09	16.52	14.99	14.30
UK	52.88	52.35	52.02	52.20
USA	41.63	39.83	38.40	37.09

Annexure 1.5

Fixed Broadband Subscribers

(in millions)

Country	2013	2014	2015	2016	% Growth in 2015	% Growth in 2016
Australia	5.98	6.54	6.83	7.37	4.43%	7.91%
Brazil	21.36	23.59	24.94	26.62	5.72%	6.74%
Canada	12.09	12.57	13.03	13.5	3.66%	3.61%
China	188.91	200.48	277.05	322.59	38.19%	16.44%
Egypt	2.68	3.07	3.83	4.46	24.76%	16.45%
France	24.94	25.97	26.87	27.66	3.47%	2.94%
Germany	28.64	29.57	30.71	31.37	3.86%	2.15%
India	14.93	15.75	16.51	18.14	4.83%	9.87%
Indonesia	3.25	3.4	3.98	4.89	17.06%	22.86%
Italy	14.01	14.37	14.9	15.56	3.69%	4.43%
Japan	36.92	37.79	38.87	39.84	2.86%	2.50%
Korea (Rep.)	18.74	19.2	20.02	20.55	4.27%	2.65%
Malaysia	2.94	3.06	3.06	2.71	0.00%	-11.44%
Mexico	12.75	13.03	14.76	16.04	13.28%	8.67%
New Zealand	1.32	1.41	1.45	1.5	2.84%	3.45%
Nigeria	0.02	0.02	0.01	0.02	-50.00%	100.00%
Pakistan	1.63	2.01	1.79	1.64	-10.95%	-8.38%
Philippines	2.57	2.9	4.87	5.64	67.93%	15.81%
Russia	23.75	24.95	26.88	27.58	7.74%	2.60%
South Africa	1.62	1.71	1.41	1.52	-17.54%	7.80%
Turkey	8.89	8.87	9.5	10.49	7.10%	10.42%
UK	23.04	23.73	24.65	25.15	3.88%	2.03%
USA	96.03	100.19	102.19	106.07	2.00%	3.80%

Annexure 1.6

Percentage of Mobile Users using Internet

Country	2013	2014	2015	2016
Australia	83.45	84.00	84.56	88.24
Brazil	51.04	54.55	58.33	59.68
Canada	85.80	87.12	88.47	89.84
China	45.80	47.90	50.30	53.20
Egypt	29.40	33.89	37.82	39.21
France	81.92	83.75	84.69	85.62
Germany	84.17	86.19	87.59	89.65
India	15.10	18.00	26.00	30.56
Indonesia	14.94	17.14	21.98	25.37
Italy	58.46	55.64	58.14	61.32
Japan	88.22	89.11	91.06	92.00
Korea (Rep.)	84.77	87.56	89.65	92.72
Malaysia	57.06	63.67	71.06	78.79
Mexico	43.46	44.39	57.43	59.54
New Zealand	82.78	85.50	88.22	88.47
Nigeria	19.10	21.00	24.50	25.67
Pakistan	10.90	12.00	14.00	15.51
Philippines	48.10	49.60	53.70	55.50
Russia	67.97	70.52	73.41	76.41
South Africa	46.50	49.00	51.92	54.00
Turkey	46.25	51.04	53.74	58.35
UK	89.84	91.61	92.00	94.78
USA	71.40	73.00	74.55	76.18

Annexure 1.7

Telecommunication Revenue as % of GDP

Country	2013	2014	2015	World
Australia	3.80%	2.50%	2.50%	2.60%
Brazil	4.10%	2.70%	NA	2.60%
Canada	2.40%	2.40%	2.30%	2.60%
China	3.10%	2.00%	1.80%	2.60%
Egypt	3.80%	2.30%	2.20%	2.60%
France	2.30%	1.70%	1.60%	2.60%
Germany	2.90%	1.50%	1.40%	2.60%
India	2.40%	1.80%	1.80%	2.60%
Indonesia	2.20%	1.90%	NA	2.60%
Italy	2.30%	1.60%	1.40%	2.60%
Japan	2.90%	2.70%	NA	2.60%
Korea (Rep.)	4.40%	3.90%	3.80%	2.60%
Malaysia	4.60%	4.60%	3.80%	2.60%
Mexico	2.50%	2.60%	2.50%	2.60%
New Zealand	4.30%	2.30%	2.10%	2.60%
Nigeria	3.10%	1.60%	NA	2.60%
Pakistan	2.20%	1.90%	1.90%	2.60%
Philippines	4.20%	2.10%	1.90%	2.60%
Russia	2.90%	2.20%	1.90%	2.60%
South Africa	6.00%	4.30%	NA	2.60%
Turkey	2.60%	2.10%	1.90%	2.60%
UK	3.50%	1.80%	1.70%	2.60%
USA	2.90%	3.50%	3.40%	2.60%

Annexure 1.8

ICT Development Index

Country	2015	Rank in 2015	2016	Rank in 2016
Korea (Rep.)	8.78	1	8.84	1
UK	8.54	2	8.57	2
Japan	8.28	3	8.37	3
Germany	8.13	5	8.31	4
New Zealand	8.05	7	8.29	5
Australia	8.18	4	8.19	6
USA	8.06	6	8.17	7
France	7.95	8	8.11	8
Canada	7.55	9	7.62	9
Italy	6.89	10	7.11	10
Russia	6.79	11	6.95	11
Malaysia	5.64	13	6.22	12
Brazil	5.72	12	5.99	13
Turkey	5.45	14	5.69	14
China	5	15	5.19	15
South Africa	4.7	16	5.03	16
Mexico	4.45	17	4.87	17
Egypt	4.26	18	4.44	18
Philippines	3.97	19	4.28	19
Indonesia	3.63	20	3.86	20
Nigeria	2.48	22	2.72	21
India	2.50	21	2.69	22
Pakistan	2.15	23	2.35	23

Annexure 4.1

Foreign Currency Exchange Rate (Equivalent Rupees of one unit of foreign Currency)

S. No.	Country	Currency	Average from (Mar'13 to Dec'16)
1.	**US**	Dollar	63.09
2.	**Brazil**	Brazilian Real	22.83
3.	**Egypt**	Egyptian Pound	8.04
4.	**South Africa**	Rand	5.29
5.	**Australia**	Dollar	52.17
6.	**UK**	British Pound	95.20
7.	**Russia**	Russian Ruble	1.36
8.	**China**	Yuan Renminbi	9.97
9.	**Philippines**	Pesos	1.39
10.	**Italy**	Euro	76.02
11.	**New Zealand**	Dollar	47.71
12.	**South Korea**	Won	0.06
13.	**Germany**	Euro	76.02
14.	**France**	Euro	76.02
15.	**Turkey**	Turkish Lira	25.74
16.	**Mexico**	Pesos	4.17
17.	**Japan**	Yen	0.58
18.	**Canada**	Dollar	53.17
19.	**Pakistan**	Rupee	0.62
20.	**Indonesia**	Rupiah	0.01
21.	**Malaysia**	Ringgits	17.37

Annexure 4.2

S. No.	Country of Incorporation	Name of Company	Brief Profile	Accounting year
1.	Australia	Telstra Corporation	Telstra is a diversified telecom company based in Australia. It provides mobile services, fixed line, broadband etc to the consumers. It operates primarily in Australia and New Zealand.	July to June
2.	Canada	Bell Canada Enterprises	Bell Canada Enterprises (Bell Mobility) is a Canada based telecom company which provides mobile voice, data, and broadband Internet services across the Canada. The company has three reported segments i.e. (i) Bell Wireless (Canada), Bell Wireless (Canada) and (iii) Bell Allaint.	January to December
3.	Canada	Rogers Communications	Rogers Communications Inc. (RCI) is a diversified telecom company based in Canada. The Company has three reported segments i.e. (i) Wireless, (ii) Cable TV & Internet) and (iii) Media. It primarily operates in Canada.	January to December
4.	China	China Mobile	China Mobile Limited is China based telecom company which provides a range of mobile telecommunications services in the China, as well as in the Hong Kong and Pakistan. Reported segment is only mobile services.	January to December

S. No.	Country of Incorporation	Name of Company	Brief Profile	Accounting year
5.	China	China Unicom	China Unicom (Hong Kong) Limited (Unicom) is an integrated telecommunications operator in China providing mobile voice and value-added, fixed-line voice and fixed-line broadband, data communications and other telecommunications services primarily in China and Hongkong. It has two reported segments: (i) Mobile services and (ii) fixed-line services.	January to December
6.	France	Orange	Orange is a France based telecommunications operator. It offers services covering fixed and mobile communications, data transmission, the Internet and multimedia, and other value-added services for individuals, businesses and other telecommunications and operators. The company has significant operations in France, Spain, Poland, UK, Netherlands etc. The company has six reported segments i.e. (i) France, (ii) Spain, (iii) Poland, (iv) (v) Rest of the World and (vi) Enterprise, and International Carriers & Shared Services.	January to December

S. No.	Country of Incorporation	Name of Company	Brief Profile	Accounting year
7.	Germany	Deustche Telekom	Deutsche Telekom is Germany based telecommunications company and one of the world's leading integrated telecommunications operators. It provides fixed-network/broadband, mobile communications, Internet, and IPTV products and services for consumers, and information and communication technology (ICT) solutions for business and corporate customers. The Company has reported segments: (i) Germany, (ii) Rest of Europe, (iii) USA, (iv) System Solutions.	January to December
8.	India	Bharti Airtel Limited	Bharti Airtel limited is India based global telecommunications company with operations in number of countries primarily in Asia and Africa. The company offers mobile services, fixed line, internet services, long distance services to carriers etc. Bharti Airtel is the largest mobile service provider in the India, based on the number of customers. The reported segments are (i) Mobile services-India and South Asia, (ii) Mobile Services-Africa, (iii) Telemedia Services, (iv) Enterprise Services, (v) Passive Infrastructure Services	April to March

S. No.	Country of Incorporation	Name of Company	Brief Profile	Accounting year
			.	
9.	India	Idea Cellular Limited	Idea Cellular limited is India based telecommunications company. The company offers mobile services, long distance services to carriers etc. Idea Cellular is among top three companies in India in wireless segment. The reported segments are (i) Mobility, (ii) Long Distance services, (iii) Passive Infrastructure services	April to March
10.	Indonesia	PT Telekomumikasi	PT Telekom is an Indonesia based company and the largest telecommunication and network services provider in Indonesia. It provides fixed wireline and fixed wireless telephone, mobile cellular, data and internet, and network and interconnection services. The reported segments are (i) Mobile services and (ii) Fixed Line services.	January to December
11.	Italy	Telecom Italia	Telecom Italia is an Italy based company and leading telecom operators in the country. The Telecom Italia is providing fixed and mobile national and international telecommunications services, the television sector services and the office products sector services. Besides Italy, Company has operations in Brazil, Argentina and Paraguay. The reported segments are based on geographical operations.	January to December

S. No.	Country of Incorporation	Name of Company	Brief Profile	Accounting year
12.	Japan	KDDI Corporation	KDDI is a Japan Based company. It provides mobile services, fixed line services, carrier services, internet services IT solutions etc. to the consumers. The company primarily operates in Japan market and is the second largest telecom company in the Japan and has also presence in UK, France, China, South Korea, Singapore, USA etc. The company has two reported segments i.e. Mobile services and fixed line services.	April to March
13.	Malaysia	Maxis Berhad	Maxis Berhad (Maxis Telecom) is a Malaysia based company and one of largest operator in the country. The reported segments are (i) Mobile services, (ii) Fixed Line services, (iii) International Gateway services and (iv) Other operations. In India, it has controlling stake in the Aircel, a mobile and long distance telecommunication operator.	January to December

S. No.	Country of Incorporation	Name of Company	Brief Profile	Accounting year
14.	Mexico	America Movil	America Movil is a Mexico-based company primarily engaged in providing wireless communications services in Latin America. The Company has operations established in 18 countries, such as Mexico, Brazil, Argentina, Chile, Paraguay, Uruguay, Colombia, Panama, Ecuador, Peru and the United States, among others. The Company's activities include offering mobile and fixed telephony services, broadband access, as well as cable and satellite television.	January to December
15.	New Zealand	Spark New Zealand Limited	Spark New Zealand is a New Zealand based telecommunications service provider and the largest telecom operators in New Zealand. The company primarily operates in New Zealand and Australia. It provides services in fixed line, mobile, internet, integrated IT and ICT solutions etc. The reported segments are New Zealand, Australia and Others. Company also reported activity based segmentation.	July to June
16.	Pakistan	Pakistan Tele-communications Company Limited	Pakistan Telecommunication Company Limited (PTCL) is Pakistan based company. It provides services in wireline as well as wireless segment. PTCL is leader in the wireline segment and second largest operator in the wireless segment. It also	January to December

S. No.	Country of Incorporation	Name of Company	Brief Profile	Accounting year
			provides services in the segment of IPTV, broadband etc.	
17.	Philippines	Philippine Long Distance Telephone Company	The Philippine Long Distance Telephone Company (PLDT) is a telecommunications service provider based in Philippines. The Company's segments include wireless, fixed line and information and communications technology. The company primarily operates in Philippines telecom market.	January to December
18.	Russia	Mobile Tele Systems	Mobile Tele Systems (MTS) is a Russia-based telecommunications provide which offers services in Russia and overseas through its numerous branches, subsidiaries and affiliated companies. It provides mobile services and fixed line voice and data telecommunications services, including transmission, broadband, pay-television and various value-added services, as well as the distribution equipment and accessories. Company mainly operates in Russia, Armenia, Ukraine, Uzbekistan and Turkmenistan. The company has holding in the Indian company namely M/s Sistema Shyam. The company has two reported segments i.e. (i) Mobile services (Russia and Ukraine) and Fixed line services (Russia).	January to December

S. No.	Country of Incorporation	Name of Company	Brief Profile	Accounting year
19.	South Africa	MTN	MTN Group is a multi-national South African based telecommunications group offering voice and data communications products and services to individuals and businesses. MTN has GSM licenses in 21 countries and internet service provider businesses in 13 countries, spanning three continents. MTN primarily operates in South Africa and other African countries.	January to December
20.	South Korea	SK Telecom	SK Telecom Co., Ltd. is a South Korea-based wireless telecommunications services provider and is the leader company in the Korean market. SK Telecom provides wireless Internet services, game portal services, multimedia services, and wired & wireless integrated multimedia services and ubiquitous and convergence services. The company has two reported segments i.e. (i) Mobile services and (ii) fixed Line services. The company primarily operates in south Korean market and have investments in telecom companies in France, Germany, UK, Netherlands, Italy, , China, Japan, Malaysia, Thailand, Australia, USA, Brazil etc.	January to December

S. No.	Country of Incorporation	Name of Company	Brief Profile	Accounting year
21.	Turkey	Turkcell Iletisim	Turkcell IletisimHizmetleri A.S. (Turkcell) is a leading provider of mobile services in Turkey. The Company provides mobile voice and data services over its mobile communications network. Apart Turkey, Company has operations in Azerbaijan, Georgia, Kazakhstan, Ukraine, Belarus etc. The company has three reported segments i.e. (i) Turkcell (Turkey operations), (ii) Euroasia and (iii) Belarusian.	January to December
22.	United Kingdom(UK)	British Telecom	BT Group plc is a UK based communications services company. The Company's principal activities include the provision of fixed telephony lines and calls, broadband, mobile and television (TV) products and services, as well as managed networked IT services. In UK, the Company is a principal communications services provider. The Company also sells wholesale products and services to communications providers in the UK and around the world. BT has four reported segments of business i.e. (i) BT Global Services, (ii) BT Retail, (iii) BT Wholesale and (iv) Openreach.	April to March

S. No.	Country of Incorporation	Name of Company	Brief Profile	Accounting year
23.	United Kingdom(UK)	Vodafone	Vodafone Group Plc is UK based company and is one of the world's largest mobile communications companies by revenue operating across the globe providing a wide range of communications services. In India through eight subsidiaries companies, it offers mobile services, internet services, long distance services to carriers etc. In the analysis, financial results of Indian subsidiaries companies of Vodafone Group have been taken. These companies are Vodafone Essar Limited, Vodafone Essar South Limited, Vodafone Essar Spacetel Limited, Vodafone Essar East Limited, Vodafone Essar Digilink Limited, Vodafone Essar Cellular Limited, Vodafone Essar Gujarat Limited and Vodafone Essar Mobile Services Limited.	April to March

S. No.	Country of Incorporation	Name of Company	Brief Profile	Accounting year
24.	United States of America (USA)	AT&T Inc	AT&T Inc. is a USA based company. The Company is a provider of telecommunications services in the United States and worldwide. It provides wireless communications, local exchange services, long-distance services, data/broadband and Internet services, video services, managed networking, wholesale services and directory advertising and publishing. It provides services in four reported segments i.e. (i) Wireless: Provides both wireless voice and data communications services across the USA (ii) Wireline: Provides landline voice and data communication services in USA and managed networking to business customers; (iii) Advertising Solutions: Publishes Yellow and White Pages directories and sells directory advertising and Internet-based advertising and local search, and (iv) Other: Provides results from customer information services and all corporate and other operations.	January to December

S. No.	Country of Incorporation	Name of Company	Brief Profile	Accounting year
25.	United States of America (USA)	Verizon Communications Inc	Verizon Communications Inc. (Verizon) is a USA based company. It is provider of communications services across the world. It is a leader in wireless voice and data services. Its Offer carrier and data services in more than 200 destinations (including India) around the world. The Company provides services primarily in two reported segments i.e. (i) Domestic Wireless which includes wireless voice and data services and equipment sales, which are provided in USA and (ii) Wireline's communications products and services which includes voice, Internet access, broadband video and data, Internet protocol (IP) network services, network access, long distance and other services.	January to December

Annexure 4.3

Revenue

(Amount in Rs. crore)

Country	Company	2013	2014	2015	2016	Growth in 2015	Growth in 2016
Australia	Telstra	136681	138298	140600	147141	1.66%	4.65%
Canada	Bell	109882	113566	115883	115476	2.04%	-0.35%
Canada	Rogers Comm	68876	69215	72425	73867	4.64%	1.99%
China	China Mobile	634568	647133	681812	708255	5.36%	3.88%
China	China Unicom	294264	284438	286003	274959	0.55%	-3.86%
France	Orange	320274	310786	314672	317110	1.25%	0.77%
Germany	Deutsche Telekom	471042	505003	546667	587416	8.25%	7.45%
India	Bharti Airtel	85864	92135	96619	95589	4.87%	-1.07%
India	IDEA Cellular	26519	32041	36208	35457	13.01%	-2.08%
Indonesia	PT Telekom	43869	46547	53316	59883	14.54%	12.32%
Italy	Telecom Italia	181885	168763	153404	146985	-9.10%	-4.18%
Japan	KDDI	246797	262946	254752	276744	-3.12%	8.63%
Korea	SK Telecom	93778	96833	96537	97398	-0.31%	0.89%
Malaysia	Maxis Telecom	16208	15054	15371	15310	2.11	-0.40%
Mexico	America Movil	343740	370921	391015	406544	5.42%	3.97%
New Zealand	Spark Telecom	17468	16955	16791	17242	-0.96%	2.69%
Pakistan	PTCL	8230	8147	7504	4751	-7.89%	-36.68%
Philippine	PLDT	23954	24422	24435	24390	0.05%	-0.18%
Russia	MTS	60066	61301	63327	59483	3.30%	-6.07%
South Africa	MTN	75475	84804	85140	78373	0.40%	-7.95%
Turkey	Turkcell	37535	34767	34546	36975	-0.64%	7.03%
UK	Vodafone UK	377309	415497	403158	453465	-2.97%	12.48%
UK	British Telecom	179937	176906	187366	229079	5.91%	22.26%
USA	AT&T	798983	828329	906790	1033386	9.47%	13.96%
USA	Verizon Comm	744637	784967	814166	784765	3.72%	-3.61%

Annexure 4.4

EBIDTA Margin

Country	Company	2013	2014	2015	2016	Growth in 2015	Growth in 2016
Australia	Telstra	42%	40%	39%	38%	-1.00%	-1.00%
Canada	Bell	38%	39%	38%	40%	-1.00%	2.00%
Canada	Rogers Comm.	38%	37%	36%	36%	-1.00%	0.00%
China	China Mobile	39%	37%	37%	36%	0.00%	-1.00%
China	China Unicom	29%	33%	34%	29%	1.00%	-5.00%
France	Orange	29%	27%	27%	28%	0.00%	1.00%
Germany	Deutsche Telekom	25%	27%	26%	26%	-1.00%	0.00%
India	Bharti Airtel	32%	34%	35%	37%	1.00%	2.00%
India	IDEA Cellular	31%	35%	37%	29%	2.00%	-8.00%
Indonesia	PT Telekom	51%	51%	49%	50%	-2.00%	1.00%
Italy	Telecom Italia	40%	40%	37%	41%	-3.00%	4.00%
Japan	KDDI	24%	24%	30%	31%	6.00%	1.00%
Korea	SK Telecom	25%	25%	25%	NA	0.00%	NA
Malaysia	Maxis Telecom	46%	50%	50%	52%	0.00%	2.00%
Mexico	America Movil	33%	32%	30%	11%	-2.00%	-19.00%
New Zealand	Spark Telecom	26%	27%	28%	28%	1.00%	0.00%
Pakistan	PTCL	38%	28%	33%	62%	5.00%	29.00%
Philippine	PLDT	45%	44%	36%	40%	-8.00%	4.00%
Russia	MTS	45%	42%	40%	38%	-2.00%	-2.00%
South Africa	MTN	43%	47%	38%	27%	-9.00%	-11.00%
Turkey	Turkcell	31%	32%	31%	33%	-1.00%	2.00%
UK	British Telecom	32%	34%	33%	24%	-1.00%	-9.00%
UK	Vodafone UK	26%	27%	28%	27%	1.00%	-1.00%
USA	Verizon Comm.	40%	27%	37%	33%	10.00%	-4.00%
USA	AT&T	38%	24%	32%	30%	8.00%	-2.00%

Annexure 4.5

PBT Margin

Country	Company	2013	2014	2015	2016	Growth in 2015	Growth in 2016
Australia	Telstra	23.68%	22.82%	20.70%	20.02%	-2.12%	-0.68%
Canada	Bell	15.76%	17.30%	16.98%	19.32%	-0.31%	2.34%
Canada	Rogers Comm.	17.71%	14.37%	13.74%	14.58%	-0.64%	0.84%
China	China Mobile	24.85%	21.91%	20.96%	20.34%	-0.95%	-0.63%
China	China Unicom	4.63%	5.57%	4.88%	0.28%	-0.69%	-4.60%
France	Orange	8.47%	7.23%	7.69%	6.06%	0.46%	-1.63%
Germany	Deutsche Telekom	3.46%	6.60%	6.70%	5.85%	0.10%	-0.85%
India	Bharti Airtel	9.16%	11.63%	13.30%	8.08%	1.67%	-5.22%
India	IDEA Cellular	11.48%	15.39%	13.05%	-3.75%	-2.35%	-16.80%
Indonesia	PT Telekom	31.74%	31.71%	30.15%	32.89%	-1.57%	2.74%
Italy	Telecom Italia	2.24%	10.66%	2.23%	14.55%	-8.43%	12.31%
Japan	KDDI	14.29%	15.56%	18.27%	19.03%	2.71%	0.76%
Korea	SK Telecom	10.96%	13.09%	11.86%	NA	-1.23%	NA
Malaysia	Maxis Telecom	27.29%	28.67%	28.02%	30.67%	-0.65%	2.64%
Mexico	America Movil	13.40%	10.28%	6.28%	1.00%	-4.00%	-5.27%
New Zealand	Spark Telecom	12.48%	13.65%	14.64%	15.50%	0.99%	0.85%
Pakistan	PTCL	17.53%	4.61%	3.24%	19.16%	-1.36%	15.92%
Philippine	PLDT	24.14%	25.11%	15.14%	15.76%	-9.97%	0.61%
Russia	MTS	23.64%	16.46%	14.07%	15.10%	-2.40%	1.03%
South Africa	MTN	30.99%	32.97%	22.44%	3.71%	-10.53%	-18.73%
Turkey	Turkcell	25.35%	17.86%	20.06%	15.87%	2.20%	-4.19%
UK	British Telecom	13.79%	15.95%	17.66%	5.87%	1.71%	-11.79%
UK	Vodafone UK	-13.74%	2.59%	-1.10%	1.44%	-3.69%	2.54%
USA	Verizon Comm.	24.29%	12.02%	21.43%	16.87%	9.41%	-4.55%
USA	AT&T	21.47%	7.43%	14.10%	11.76%	6.67%	-2.34%

Annexure 4.6

Gross Block

(Amount in Rs. crore)

Country	Company	2013-14	2014-15	2015-16	2016-17	Growth in 2015	Growth in 2016
Australia	Telstra	391534	421505	425912	432133	1.05%	1.46%
Canada	Bell	451271	459200	477659	492226	4.02%	3.05%
Canada	Rogers Comm.	196872	223923	238778	225779	6.63%	-5.44%
China	China Mobile	1157169	1326243	1412420	1568359	6.50%	11.04%
China	China Unicom	990947	1029646	1019042	1478776	-1.03%	45.11%
France	Orange	1113230	1127302	1212056	1212217	7.52%	0.01%
Germany	Deutsche Telekom	1664335	1787955	1919553	1998660	7.36%	4.12%
India	Bharti Airtel	163018	180189	222501	248549	23.48%	11.71%
India	IDEA Cellular	62645	66967	104781	116107	56.47%	10.81%
Indonesia	PT Telekom	98609	110484	123034	131165	11.36%	6.61%
Italy	Telecom Italia	925574	948123	945808	969360	-0.24%	2.49%
Japan	KDDI	346720	356794	382698	398320	7.26%	4.08%
Korea	SK Telecom	218888	230206	238840	NA	3.75%	NA
Malaysia	Maxis Telecom	34724	35433	37018	37054	4.47%	0.10%
Mexico	America Movil	402559	536480	536482	718341	0.00%	33.90%
New Zealand	Spark Telecom	44218	46307	41505	10582	-10.37%	-74.50%
Pakistan	PTCL	26942	31592	33365	22518	5.61%	-32.51%
Philippines	PLDT	85103	88067	90890	103742	3.21%	14.14%
Russia	MTS	102957	115169	123254	113519	7.02%	-7.90%
South Africa	MTN	71549	67995	89038	75122	30.95%	-15.63%
Turkey	Turkcell	57149	53200	73234	78328	37.66%	6.96%
UK	British Telecom	545773	549158	712426	710619	29.73%	-0.25%
UK	Vodafone	1706836	1684707	1833019	2055047	8.80%	12.11%
USA	AT&T	2563319	2627016	3332145	3,499,407	26.84%	5.02%
USA	Verizon Comm.	2083786	2149410	2180295	2,315,322	1.44%	6.19%

Annexure 4.7

Net Block Turnover Ratio

Country	Company	2013	2014	2015	2016	Growth in 2015	Growth in 2016
Australia	Telstra	98.67%	89.17%	89.30%	84.16%	0.13%	-5.14%
Canada	Bell	54.55%	54.64%	53.93%	51.80%	-0.72%	-2.12%
Canada	Rogers Comm.	77.78%	64.00%	63.53%	65.17%	-0.47%	1.64%
China	China Unicom	76.92%	72.69%	74.75%	48.14%	2.06%	-26.61%
China	China Mobile	122.21%	106.75%	107.49%	107.43%	0.75%	-0.06%
France	Orange	69.58%	66.97%	61.37%	61.56%	-5.60%	0.19%
Germany	Deutsche Telekom	76.18%	72.42%	71.97%	72.32%	-0.45%	0.35%
India	IDEA Cellular	89.58%	88.83%	52.68%	46.37%	-36.15%	-6.31%
India	Bharti Airtel	93.85%	88.77%	74.01%	62.45%	-14.76%	-11.56%
Indonesia	PT Telekom	96.14%	96.01%	100.11%	102.92%	4.10%	2.80%
Italy	Telecom Italia	49.26%	45.64%	42.58%	39.65%	-3.06%	-2.93%
Japan	KDDI	159.84%	167.14%	158.35%	168.18%	-8.79%	9.83%
Korea	SK Telecom	111.16%	120.32%	121.56%	NA	1.24%	-NA
Malaysia	Maxis Telecom	61.08%	56.94%	57.43%	54.93%	0.49%	-2.51%
Mexico	America Movil	132.79%	105.08%	112.26%	131.33%	7.18%	19.06%
New Zealand	Spark Telecom	188.27%	167.98%	169.43%	174.84%	1.45%	5.41%
Pakistan	PTCL	88.06%	64.80%	58.61%	58.47%	-6.19%	-0.14%
Philippine	PLDT	76.68%	79.61%	81.29%	73.98%	1.68%	-7.31%
Russia	MTS	134.08%	116.31%	112.66%	119.60%	-3.65%	6.94%
South Africa	MTN	104.47%	118.34%	90.45%	104.09%	-27.88%	13.64%
Turkey	Turkcell	165.74%	161.96%	91.24%	90.86%	-70.72%	-0.37%
UK	Vodafone UK	55.14%	60.24%	54.74%	62.32%	-5.50%	7.58%
UK	British Telecom	112.76%	111.80%	62.90%	80.06%	-48.90%	17.16%
USA	AT&T	53.83%	53.73%	42.70%	47.91%	-11.03%	5.21%
USA	Verizon Comm.	65.78%	66.66%	69.86%	62.43%	3.20%	-7.43%

Annexure 4.8

Capital Employed

(Amount in Rs. crore)

Country	Company	2013-14	2014-15	2015-16	2016-17	Growth in 2015	Growth in 2016
Australia	Telstra	145424	148776	155736	158279	4.68%	1.63%
Canada	Bell	193134	190651	193904	202300	1.71%	4.33%
Canada	Rogers Comm.	91202	99923	106306	103311	6.39%	-2.82%
China	China Mobile	692998	735800	693499	797114	-5.75%	14.94%
China	China Unicom	198369	213640	187653	266079	-12.16%	41.79%
France	Orange	393056	416616	453789	464521	8.92%	2.36%
Germany	Deutsche Telekom	635084	711115	768729	766769	8.10%	-0.25%
India	Bharti Airtel	114488	124548	139539	154568	12.04%	10.77%
India	IDEA Cellular	34848	38750	65715	73565	69.59%	11.95%
Indonesia	PT Telekom	47643	50895	61247	64201	20.34%	4.82%
Italy	Telecom Italia	375113	389959	363103	379390	-6.89%	4.49%
Japan	KDDI	191964	208697	215314	224497	3.17%	4.26%
Korea	SK Telecom	82955	82279	81471	NA	-0.98%	NA
Malaysia	Maxis Telecom	23739	24063	23779	23729	-1.18%	-0.21%
Mexico	America Movil	259983	330501	332844	147469	0.71%	-55.69%
New Zealand	Spark Telecom	10376	10439	10712	10439	2.62%	-2.55%
Pakistan	PTCL	10717	12793	13018	6808	1.76%	-47.70%
Philippine	PLDT	28504	27389	27875	24718	1.77%	-11.33%
Russia	MTS	52831	60633	60617	47081	-0.03%	-22.33%
South Africa	MTN	81367	80501	92276	76119	14.63%	-17.51%
Turkey	Turkcell	45032	44372	47299	57721	6.60%	22.03%
UK	Vodafone UK	681117	600639	684826	565481	14.02%	-17.43%
UK	British Telecom	154570	162029	283292	261039	74.84%	-7.86%
USA	AT&T	1424750	1509035	2087233	2112180	38.32%	1.20%
USA	Verizon Comm.	1476803	1218191	1179887	1284467	-3.14%	8.86%

Annexure 4.9

Return on Capital Employed (RoCE)

Country	Company	2013	2014	2015	2016	Growth in 2015	growth in 2016
Australia	Telstra	25.60%	23.56%	21.01%	20.45%	-2.55%	-0.56%
Canada	Rogers Comm.	17.76%	14.36%	13.28%	14.34%	-1.08%	1.06%
Canada	Bell	11.98%	13.21%	12.98%	13.58%	-0.23%	0.60%
China	China Mobile	20.61%	17.12%	17.24%	15.02%	0.12%	-2.23%
China	China Unicom	8.35%	9.43%	11.30%	1.61%	1.87%	-9.70%
France	Orange	10.82%	8.80%	8.06%	6.57%	-0.74%	-1.50%
Germany	Deutsche Telekom	5.26%	7.42%	7.10%	7.00%	-0.33%	-0.09%
India	IDEA Cellular	10.95%	15.43%	10.05%	3.49%	-5.37%	-6.56%
India	Bharti Airtel	6.09%	7.61%	8.32%	6.45%	0.72%	-1.87%
Indonesia	PT Telekom	30.24%	29.61%	27.18%	31.59%	-2.43%	4.41%
Italy	Telecom Italia	5.55%	8.93%	6.27%	7.41%	-2.66%	1.14%
Japan	KDDI	19.63%	19.22%	21.96%	23.69%	2.73%	1.74%
Korea	SK Telecom	10.70%	10.99%	10.32%	NA	-0.67%	NA
Malaysia	Maxis Telecom	21.09%	20.73%	21.18%	22.83%	0.45%	1.64%
Mexico	America Movil	25.95%	20.71%	18.58%	12.91%	-2.13%	-5.67%
New Zealand	Spark Telecom	22.44%	23.55%	24.43%	26.97%	0.88%	2.54%
Pakistan	PTCL	14.95%	4.63%	4.30%	13.55%	-0.33%	9.25%
Philippine	PLDT	22.87%	23.00%	15.68%	19.45%	-7.32%	3.76%
Russia	MTS	31.24%	24.60%	20.46%	24.46%	-4.14%	4.01%
South Africa	MTN	27.26%	33.77%	20.97%	9.82%	-12.81%	-11.14%
Turkey	Turkcell	14.88%	14.34%	12.81%	11.13%	-1.54%	-1.68%
UK	British Telecom	20.03%	21.17%	12.98%	8.11%	-8.19%	-4.86%
UK	Vodafone UK	-6.27%	3.29%	1.91%	2.65%	-1.38%	0.74%
USA	Verizon Comm.	13.30%	9.33%	17.41%	12.51%	8.07%	-4.90%
USA	AT&T	13.47%	5.48%	7.32%	7.19%	1.84%	-0.13%

Annexure 4.10

Return on Shareholders Fund

Country	Company	2013	2014	2015	2016	Growth in 2015	Growth in 2016
Australia	Telstra	32.59%	29.54%	24.09%	26.61%	-5.45%	2.52%
Canada	Bell	14.70%	17.84%	15.75%	17.29%	-2.08%	1.54%
Canada	Rogers Comm.	35.75%	24.47%	24.04%	15.85%	-0.43%	-8.19%
China	China Mobile	15.40%	12.74%	11.81%	11.08%	-0.94%	-0.72%
China	China Unicom	4.75%	5.30%	4.57%	0.28%	-0.73%	-4.29%
France	Orange	8.10%	4.29%	7.55%	5.70%	3.25%	-1.85%
Germany	Deutsche Telekom	3.76%	9.52%	9.18%	8.02%	-0.34%	-1.16%
India	Bharti Airtel	4.72%	7.95%	9.54%	5.71%	1.59%	-3.83%
India	IDEA Cellular	11.91%	13.86%	11.95%	-3.28%	-1.91%	-15.23%
Indonesia	PT Telekom	26.21%	24.90%	24.96%	27.64%	0.06%	2.68%
Italy	Telecom Italia	-2.87%	6.54%	0.22%	9.03%	-6.32%	8.81%
Japan	KDDI	12.20%	13.88%	16.11%	16.70%	2.23%	0.58%
Korea	SK Telecom	10.07%	11.80%	9.86%	NA	-1.94%	NA
Malaysia	Maxis Telecom	29.46%	36.41%	41.40%	42.63%	4.99%	1.24%
Mexico	America Movil	35.65%	20.24%	22.98%	1.86%	2.73%	-21.12%
New Zealand	Spark Telecom	18.91%	21.09%	21.97%	25.32%	0.88%	3.35%
Pakistan	PTCL	13.20%	3.63%	1.93%	8.23%	-1.69%	6.30%
Philippine	PLDT	24.31%	25.31%	19.38%	17.08%	-5.93%	-2.30%
Russia	MTS	49.38%	30.98%	28.15%	12.10%	-2.82%	-16.05%
South Africa	MTN	25.38%	28.25%	15.52%	2.95%	-12.73%	-12.57%
Turkey	Turkcell	17.81%	9.31%	13.20%	9.61%	3.90%	-3.59%
UK	British Telecom	11.48%	11.90%	13.22%	175.11%	1.32%	161.89%
UK	Vodafone UK	15.76%	8.65%	-5.67%	-5.57%	-14.32%	0.10%
USA	Verizon Comm.	24.68%	87.42%	102.99%	56.62%	15.56%	-46.36%
USA	AT&T	20.28%	7.50%	11.07%	10.74%	3.57%	-0.33%

Annexure 4.11

Debt-Equity Ratio

Country	Company	2013	2014	2015	2016	Growth in 2015	Growth in 2016
Australia	Telstra	1.13	1.08	1.09	1.19	1%	9%
Canada	Rogers Comm.	3.00	2.85	3.08	3.2	8%	4%
Canada	Bell	1.16	1.32	1.17	1.2	-11%	3%
China	China Unicom	0.65	0.60	0.64	0.69	7%	8%
China	China Mobile	0.01	0.01	0.01	0.01	0%	0%
France	Orange	1.44	1.08	1.02	1.23	-6%	21%
Germany	Deutsche Telekom	1.61	1.62	1.64	1.67	1%	2%
India	Bharti Airtel	1.19	1.07	1.50	1.59	40%	6%
India	IDEA Cellular	1.25	1.17	1.61	2.35	38%	46%
Indonesia	PT Telekom	0.25	0.27	0.36	0.3	33%	-17%
Italy	Telecom Italia	1.84	1.59	1.62	1.53	2%	-6%
Japan	KDDI	0.36	0.30	0.30	0.25	0%	-17%
Korea	SK Telecom	0.46	0.44	0.49	NA	11%	NA
Malaysia	Maxis Telecom	1.25	1.90	2.34	2.09	23%	-11%
Mexico	America Movil	2.33	2.57	4.25	2.61	65%	-39%
New Zealand	Spark Telecom	0.40	0.39	0.52	0.6	33%	15%
Pakistan	PTCL	0.01	0.14	0.22	0.00	57%	-100%
Philippine	PLDT	0.76	0.97	1.41	1.7	45%	21%
Russia	MTS	1.44	1.73	2.06	2.00	19%	-3%
South Africa	MTN	0.38	0.40	0.50	0.83	25%	66%
Turkey	Turkcell	0.10	0.10	0.29	0.59	190%	103%
UK	British Telecom	0.52	0.56	0.71	7.13	27%	904%
UK	Vodafone UK	0.410	0.520	0.67	0.63	29%	-6%
USA	Verizon Comm.	0.98	8.28	6.18	4.5	-25%	-27%
USA	AT&T	0.82	0.94	1.02	1	9%	-2%

Annexure 4.12

Interest Coverage Ratio

Country	Company	2013	2014	2015	2016	Growth in 2015	Growth in 2016
Australia	Telstra	7.45	7.71	7.12	7.56	-7.65%	6.18%
Canada	Rogers Comm.	4.02	3.38	3.4	3.68	0.59%	8.24%
Canada	Bell	3.98	4.54	4.59	5.85	1.10%	27.45%
China	China Unicom	3.38	3.92	3.9	0.86	-0.51%	-77.95%
China	China Mobile	433.90	555.57	272.05	517.48	-51.03%	90.22%
France	Orange	3.29	3.01	3.06	3	1.66%	-1.96%
Germany	Deutsche Telekom	1.82	2.58	2.73	2.02	5.81%	-26.01%
India	Bharti Airtel	3.49	4.21	3.37	2.68	-19.95%	-20.47%
India	IDEA Cellular	4.21	6	3.59	0.78	-40.17%	-78.27%
Indonesia	PT Telekom	18.68	16.2	13.09	11.47	-19.20%	-12.38%
Italy	Telecom Italia	1.44	2.46	1.48	1.6	-39.84%	8.11%
Korea	SK Telecom	4.76	4.96	5.02	NA	1.21%	NA
Malaysia	Maxis Telecom	12.4	11.39	14.37	18.32	26.16%	27.49%
Mexico	America Movil	5.08	4.97	4.53	3.29	-8.85%	-27.37%
New Zealand	Spark Telecom	7.35	8.53	10.48	16.39	22.86%	56.39%
Pakistan	PTCL	20.07	6.93	3.78	5.39	-45.45%	42.59%
Philippine	PLDT	7.08	8.11	4.83	4.96	-40.44%	2.69%
Russia	MTS	7.25	6.17	3.14	3.14	-49.11%	0.00%
South Africa	MTN	17.61	19.74	22.14	3.83	12.16%	-82.70%
Turkey	Turkcell	19.06	18.07	7.67	5.74	-57.55%	-25.16%
UK	British Telecom	5.34	6.46	7	3.53	8.36%	-49.57%
UK	Vodafone UK	-3.27	1.32	0.92	1.89	-30.30%	105.43%
USA	Verizon Comm.	9.3	3.48	6.04	5.81	73.56%	-3.81%
USA	AT&T	7.36	3.48	5.03	4.9	44.54%	-2.58%

Annexure 4.13

Current Ratio

Country	Company	2013-14	2014-15	2015-16	2016-17	Growth in 2015	Growth in 2016
Australia	Telstra	1.2	0.86	1.02	0.86	18.60%	-15.69%
Canada	Rogers Comm.	0.94	0.48	0.52	0.5	8.33%	-3.85%
Canada	Bell	0.64	0.5	0.48	0.48	-4.00%	0.00%
China	China Mobile	1.26	1.11	0.98	1.09	-11.71%	11.22%
China	China Unicom	0.18	0.19	0.17	0.17	-10.53%	0.00%
France	Orange	0.61	0.72	0.66	0.74	-8.33%	12.12%
Germany	Deutsche Telekom	0.98	1.06	0.96	0.8	-9.43%	-16.67%
India	IDEA Cellular	0.29	0.89	0.35	0.4	-60.67%	14.29%
India	Bharti Airtel	0.39	0.35	0.39	0.32	11.43%	-17.95%
Indonesia	PT Telekom	1.16	1.06	1.35	1.2	27.36%	-11.11%
Italy	Telecom Italia	1.03	1.11	0.93	0.95	-16.22%	2.15%
Japan	KDDI	1.47	1.78	1.81	1.82	1.69%	0.55%
Korea	SK Telecom	0.84	0.94	0.98	NA	4.26%	NA
Malaysia	Maxis Telecom	0.51	0.62	0.58	0.49	-6.45%	-15.52%
Mexico	America Movil	0.86	0.76	0.83	0.07	9.21%	-91.57%
New Zealand	Spark Telecom	1.09	0.93	0.99	0.96	6.45%	-3.03%
Pakistan	PTCL	1.24	0.97	1.06	0.76	9.28%	-28.30%
Philippine	PLDT	0.52	0.53	0.58	0.47	9.43%	-18.97%
Russia	MTS	1.15	1.11	1.01	0.71	-9.01%	-29.70%
South Africa	MTN	1.31	1.34	1.07	1.02	-20.15%	-4.67%
Turkey	Turkcell	2.7	2.67	1.4	1.81	-47.57%	29.29%
UK	British Telecom	0.84	0.97	0.77	0.63	-20.62%	-18.18%
UK	Vodafone UK	0.99	0.69	0.84	0.6	21.74%	-28.57%
USA	Verizon Comm.	2.62	1.06	0.64	0.87	-39.62%	35.94%
USA	AT&T	0.66	0.86	0.75	0.76	-12.79%	1.33%

Annexure 4.14

Cash from Operating Activities

(Amount in Rs. crore)

Country	Company	2013	2014	2015	2016	Growth in 2015	Growth in 2016
Australia	Telstra	44769	43199	42274	40561	-2.14%	-4.05%
Canada	Bell	34882	33616	33794	35320	0.53%	4.52%
Canada	Rogers	21492	19919	20183	21039	1.33%	4.24%
China	China Mobile	223722	209838	233770	252939	11.40%	8.20%
China	Unicom	78042	87600	83828	74369	-4.31%	-11.28%
France	Orange	55636	67462	73019	66514	8.24%	-8.91%
Germany	Deutsche	99768	102650	114944	118076	11.98%	2.72%
India	Bharti Airtel	26233	27602	30218	29231	9.48%	-3.27%
India	IDEA Cellular	8219	10418	11815	10338	13.41%	-12.50%
Indonesia	PT Telekom	18755	19351	22394	24157	15.72%	7.87%
Italy	Telecom Italia	51666	39832	38859	43375	-2.44%	11.62%
Japan	KDDI	43885	54686	50269	67433	-8.08%	34.14%
Korea	SK Telecom	20010	20679	21245	NA	2.74%	NA
Malaysia	Maxis	6161	7276	7218	5385	-0.80%	-25.39%
Mexico	America Movil	82115	105212	71593	98279	-31.95%	37.27%
New Zealand	Spark	2948	3025	3438	3421	13.65%	-0.49%
Pakistan	PTCL	2673	1571	2192	2191	39.49%	-0.05%
Philippine	PLDT	10246	9170	9688	6798	5.65%	-29.83%
Russia	MTS	23402	23422	21157	17812	-9.67%	-15.81%
South Africa	MTN	14800	14858	7186	10951	-51.64%	52.39%
Turkey	Turkcell	6140	4953	5126	1563	3.49%	-69.51%
UK	British Telecom	47191	47191	50969	58779	8.01%	15.32%
UK	Vodafone UK	61271	95592	103129	135408	7.88%	31.30%
USA	AT&T	214935	193575	221631	248236	14.49%	12.00%
USA	Verizon	239779	189208	240471	143317	27.09%	-40.40%

Annexure 4.15

Cash from Operating Activities as % of Revenue

Country	Company	2013	2014	2015	2016	Growth in 2015	Growth in 2016
Australia	Telstra	32.80%	31.20%	30.10%	27.60%	-1.10%	-2.50%
Canada	Bell	31.70%	29.60%	29.20%	30.60%	-0.40%	1.40%
Canada	Rogers	31.20%	28.80%	27.90%	28.50%	-0.90%	0.60%
China	China Mobile	35.30%	32.40%	34.30%	35.70%	1.90%	1.40%
China	Unicom	26.50%	30.80%	29.30%	27.00%	-1.50%	-2.30%
France	Orange	17.40%	21.70%	23.20%	21.00%	1.50%	-2.20%
Germany	Deutsche	21.20%	20.30%	21.00%	20.10%	0.70%	-0.90%
India	Bharti Airtel	30.60%	30.00%	28.90%	30.60%	-1.10%	1.70%
India	IDEA Cellular	31.00%	32.50%	32.60%	29.20%	0.10%	-3.40%
Indonesia	PT Telekom	42.80%	41.60%	42.00%	40.30%	0.40%	-1.70%
Italy	Telecom Italia	28.40%	23.60%	25.30%	29.50%	1.70%	4.20%
Japan	KDDI	17.80%	20.80%	19.70%	24.40%	-1.10%	4.70%
Korea	SK Telecom	21.30%	21.40%	22.00%	NA	0.60%	NA
Malaysia	Maxis	38.00%	48.30%	47.00%	35.20%	-1.30%	-11.80%
Mexico	America Movil	23.90%	28.40%	18.30%	24.20%	-10.10%	5.90%
New Zealand	Spark	16.90%	17.80%	20.50%	19.80%	2.70%	-0.70%
Pakistan	PTCL	32.50%	19.30%	29.20%	46.10%	9.90%	16.90%
Phillippine	PLDT	42.80%	37.50%	39.60%	27.90%	2.10%	-11.70%
Russia	MTS	39.00%	38.20%	33.40%	29.90%	-4.80%	-3.50%
South Africa	MTN	19.60%	17.50%	8.40%	14.00%	-9.10%	5.60%
Turkey	Turkcell	16.40%	14.20%	14.80%	4.20%	0.60%	-10.60%
UK	British Telecom	26.20%	26.70%	27.20%	25.70%	0.50%	-1.50%
UK	Vodafone UK	16.20%	23.00%	25.60%	29.90%	2.60%	4.30%
USA	AT&T	26.90%	23.40%	24.40%	24.00%	1.00%	-0.40%
USA	Verizon	32.20%	24.10%	29.50%	18.30%	5.40%	-11.20%

Annexure 4.16

Cash from Investing Activities

(Amount in Rs. crore)

Country	Company	2013	2014	2015	2016
Australia	Telstra	-5874	-29586	-11472	-22322.91
Canada	Rogers	-18706.90	-32054.36	-20290.50	-13058.11
Canada	Bell	-34478.23	-19229.38	-22159.57	-24372.31
China	Unicom	-76677.27	-74896.32	-90841.34	-95461.35
China	China Mobile	-170512.71	-145398.45	-141941.95	-193938.61
France	Orange	-46323.92	-48684.57	-72091.79	-37088.38
Germany	Deutsche	-75847.37	-82477.11	-115081.67	-103443.04
India	IDEA Cellular	-6564.24	-5725.63	-12992.84	-12817.74
India	Bharti Airtel	-24973.30	-22048.10	-14225.70	-31555.40
Indonesia	PT Telekom	-11641.72	-12690.92	-14061.65	-14094.27
Italy	Telecom Italia	-29209.21	-43763.99	-41273.05	-30132.88
Japan	KDDI	-31044.43	-38333.76	-37958.51	-37008.93
Korea	SK Telecom	-21133.38	-20711.09	-16197.56	NA
Malaysia	Maxis	-1420.10	-2183.03	-3329.49	-3214.29
Mexico	America Movil	-58721.90	-64553.37	-57676.79	-62933.74
New Zealand	Spark	48.02	-2189.54	-2343.19	-1812.97
Pakistan	PTCL	-1557.59	-5180.15	-2256.98	-1688.21
Philippine	PLDT	-2923.32	-7179.60	-5450.47	-5849.04
Russia	MTS	-14194.40	-15503.70	-21342.92	-7817.44
South Africa	MTN	-10862.14	-14233.32	-18778.06	-21361.13
Turkey	Turkcell	-2901.08	-3540.09	-10327.86	-7662.33
UK	British Telecom	-45311.35	-50280.35	-63445.73	-15784.77
UK	Vodafone UK	302498.78	-101613.53	-99881.77	-80190.04
USA	Verizon	-91623.43	-97942.50	-185575.59	-69295.76
USA	AT&T	-142836.93	-113267.64	-303562.46	-152781.27

Annexure 4.17

Cash from Financing Activities

(Amount in Rs. crore)

Country	Company	2013	2014	2015	2016
Australia	Telstra	-23026	-35771	-19632	-31844
Canada	Rogers	8462	689	-781	-8417
Canada	Bell	706	-13143	-11381	-9671
China	Unicom	1915	-8923	3408	22808
China	China Mobile	-78985	-42703	-86025	-48811
France	Orange	-27109	-1180	-30075	-14314
Germany	Deutsche	7833	-26320	-6714	-10049
India	IDEA Cellular	-2466	8028	-9749	4762
India	Bharti Airtel	2774	-9657	-11946	-351
Indonesia	PT Telekom	-6834	-5171	-3286	-9158
Italy	Telecom Italia	-27837	-2092	-6913	-9601
Japan	KDDI	-6004	-12779	-16993	-28213
Korea	SK Telecom	-3223	-3146	-5424	NA
Malaysia	Maxis	-5024	-3814	-4304	-3273
Mexico	America Movil	-20397	-32690	-21953	-46121
New Zealand	Spark	48	-2190	-2343	-1813
Pakistan	PTCL	-1727	2704	-342	-119
Philippine	PLDT	-8309	-2764	-1581	-2137
Russia	MTS	-8097	-4871	-4052	-11328
South Africa	MTN	3430	1445	4436	11075
Turkey	Turkcell	-751	244	-12454	12456
UK	British Telecom	-3808	177	13205	-42861
UK	Vodafone UK	-336996	-23792	29125	-86597
USA	Verizon	163382	-356444	-92748	-84053
USA	AT&T	-81543	-47791	60423	-91246

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