Model outputs and assumptions

Cellular Operators Association of India

Determination of Mobile termination charges

February 2007

Contents

Spectrum has exercised all reasonable endeavours in performing the work relating to this assignment. Any assumptions, projections, findings, conclusions and recommendations and any written material provided represent our best professional judgement based on the information available to us during the project. This study determines the cost of interconnection on a LRIC and FAC basis using a bottom up model and we remain confident that the output cost calculated is a fairly accurate representation of the cost of providing termination services in India.

In addition, to fully understand the cost involved building and operating a mobile network in India, Spectrum has collected data from a range of GSM operators, this includes Aircel, Bharti, Hutch, IDEA, and Spice, and where possible we have cross checked the cost components with those of other regional operators. The existing network data of all the GSM service providers as on December 2006 has been used. Data from the PWC benchmarking study and the various TRAI reports has been used so as to make the model more robust. Spectrum Strategy has also used benchmarks from comparable Asian countries like Malaysia, Thailand, Philippines and Indonesia.

1 Executive Summary

Spectrum was engaged by the Cellular Operators Association of India ("COAI") in order to determine the fully allocated cost ("FAC") and long-run incremental cost ("LRIC") of terminating a minute of voice telephony on a mobile network in India and to recommend an appropriate cost-oriented price on the basis of these results. This report represents the culmination of this work. Its principal findings are that the current price of mobile termination in India is below cost. The cost of termination is derived from a detailed and comprehensive bottom-up model which is capable of calculating the costs of a theoretical mobile service provider operating in Metro, Circle A, Circle B and Circle C of a LRIC and FAC basis. The tables below summarise the output termination charges for the different methodologies adopted.

Exhibit 1: Summary of circlewise FAC based charges, 2005

Rs/min	2005
Metro	0.48
Circle A	0.76
Circle B	0.75
Circle C	0.77
Blended	**0.65**

Note: Based on estimated historical costs

Source: Spectrum

Exhibit 2: Summary of circlewise LRIC based charges, 2006-2010

Rs/min	2006	2007	2008	2009	2010
Metro	0.41	0.41	0.41	0.40	0.39
Circle A	0.50	0.51	0.51	0.46	0.45
Circle B	0.54	0.55	0.56	0.55	0.53
Circle C	0.61	0.61	0.66	0.60	0.55
Blended	0.49	0.50	0.51	0.47	0.46
3 year look ahead average	**0.50**				

Source: Spectrum

2 Introduction

Interconnection and retail price regulation are viewed as two of the most important aspects of telecommunication regulations in a liberalised environment and remain a high priority for telecoms regulators worldwide. Appropriate interconnection regimes are fundamental to the development of competition in liberalised markets.

This has led to more than 100 countries establishing some form of interconnection regulatory framework. The commercial terms of interconnection arrangements are increasingly regulated, and much of the recent focus of regulators worldwide has been to ensure interconnection rates are set fairly and more closely reflect underlying costs.

In general, in developed regulatory regimes, there is **an increasing standardisation around accepted 'best practice' in setting interconnection charges.** This includes:

1. **Increasing tendency to use cost-based rather than retail price based methods to determine appropriate interconnection charges; and**
2. **Increasing public provision of information on interconnection charges**
3. **Increasing use of incremental cost methodologies to determination interconnection charges.**

The proposed project relates to an ongoing debate between COAI and TRAI on low mobile termination charges in India. India has one of the lowest fixed and mobile interconnection charges in the world. Current termination charges for fixed and mobile operators are set at Rs0.30 per minute and many commentators believe that the existing call termination charge of mobile operators is below cost.

Spectrum Strategy Consultants ("Spectrum") was engaged by the COAI in order to conduct an independent study to determine the long-run incremental cost (LRIC) of terminating a minute of voice telephony on a mobile network in India and to help COAI make an appropriate submission to the TRAI on the issue of mobile termination charges.

This Document addresses the key following areas –

- **Assessment modelling outputs**
- **Overview of methodology**
- **Assumptions**

3 Overview of adopted methodology

3.1 Introduction

Cost-based pricing methodologies more accurately reflect the true underlying cost of providing interconnection services compared to retail price based. Therefore, in line with international best practices, Spectrum has adopted cost-based modeling methodologies for the purposes of this exercise. In particular we have used:

- **Fully allocated costs ("FAC") –** to assess the historical costs incurred in provision of interconnection services; and
- **Forward looking long run incremental costs ("FL-LRIC") –** to determine credible charges that reflect real economic costs of interconnection provision, promote efficient investment and avoid inclusion of historical inefficiencies

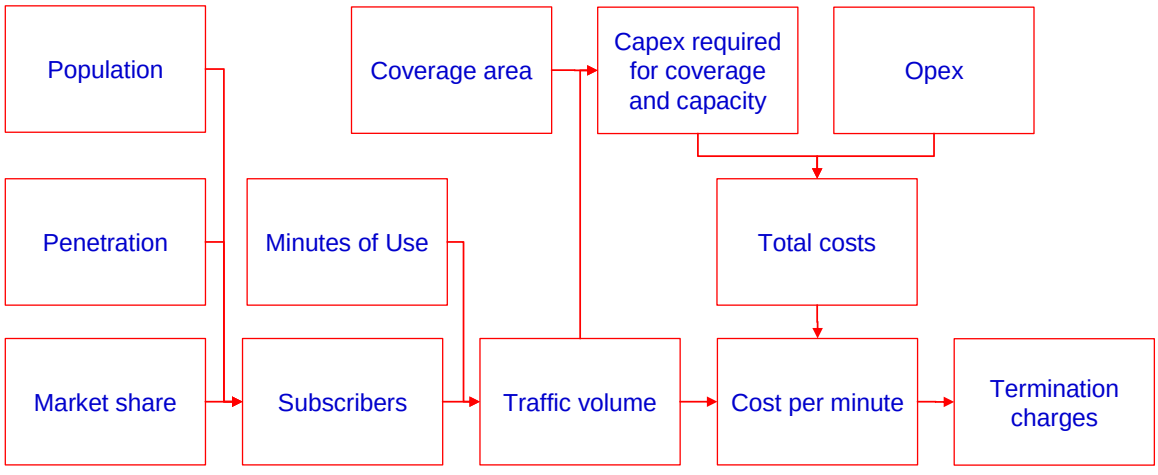
It should be recognised that whilst the above methodologies reflect generic approaches, the precise nature of the methodology used varies substantially according to requirements and circumstances. An introduction to the two adopted methodologies is provided in the following sections.

3.2 Fully Allocated Costs (FAC)

Calculation of a Fully Allocated Costs ("FAC") involves the allocation of all historical costs incurred to date in the provision of specific individual services, e.g. mobile termination, based on a set of allocation criteria such as relative capacity utilisation, minutes of use or proportionate revenues generated.

Spectrum developed a bottom up model to determine the capital expenditure required to build out a network and other costs associated to operating a network in India. The exhibit below shows a simplified FAC model structure

Exhibit 3: Simplified FAC model structure



For the purposes of this analysis, the FAC model has been constructed on the following best practice principles:

- The model is constructed for 2005;
- Operating expenditures are based on benchmarks and ratios obtained from various mobile operators

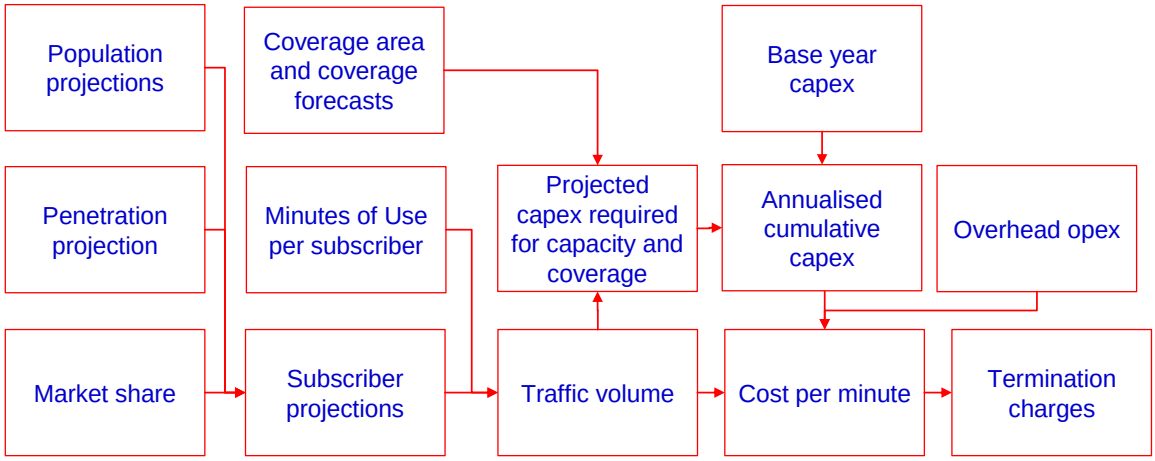
- Only those operating and capital expenditures relevant (both directly and indirectly) to the deployment and maintenance of a mobile network are included in the calculation;
- Retail dependent / related costs are excluded

3.3 Forward looking long run incremental costs (FL-LRIC)

A FL-LRIC model is constructed by determining the costs associated with mobile termination, i.e. the costs of building a mobile network, to existing and future specifications (i.e. in terms of coverage and capacity) at current network unit prices whilst assessing forward looking requirements, e.g. over the next 6 years.

Generally FL-LRIC models are difficult and complex to implement as it is based on future estimates / projections which can be a source of contention. Therefore we have adopted a simplified methodology which can be easily understood by operators and regulators. A high level schematic of the FL-LRIC methodology is detailed below.

Exhibit 4: Simplified FL-LRIC model structure



For the purposes of this analysis, the FL-LRIC model has been constructed on the following best practice principles:

- The FL-LRIC model is primarily based on a "bottom-up" assessment of a theoretical operator's cost of providing interconnection services;
- Historical data, for 2005, as provided by the operators has been used.
- Forward looking information has been estimated for 2006, 2007 and 2008 in terms of projected traffic volumes and required capital expenditures for capacity and coverage;

3.4 Issues for consideration

When assessing this methodology and the subsequent outputs, the following issues should be noted:

- The Long Run Incremental Costs (LRIC) approach attempts to achieve increased efficiency associated with the economic principle of marginal-cost pricing **and is increasingly regarded as international best practice.**
- Construction of "bottom-up" LRIC models using in-house financial data is difficult and shows variation
  - there is variation in the data provided by the operators; consequently we have used the average or median values where possible

  - there are different forecasts from the operators over existing and target geographical coverage
  - degree of uncertainty over the population density requirement for different category of cell sites in India
- Although the overhead operating expenditure has been estimated based on benchmarks and assumptions provided by the operators, the actual opex incurred by the operators may vary
- The universal service obligation and the licence fee costs associated with mobile services are fully included as a network related cost. The licence fees are included to reflect the spectrum costs of originating or terminating calls. The USO is included as a cost explicitly incurred as soon as an operator begins to originate or terminate mobile calls
- Projections are based on Spectrum's understanding of international experience and of the market development in India.

4 Modelling assumptions

4.1 Introduction

To determine the mobile termination costs for each type of circle, a region has been chosen under circle category i.e. Delhi under the Metro Circle, Maharashtra under Circle A, Kerala under Circle B and Orissa under Circle C. It should be noted that the mobile termination charge will not be exactly same in regions classified under a circle.

However, the regions have been classified into circles based on certain measures such as population density and wealth, and these measures impact network roll-out and usage of mobile services. Therefore, we would expect the costs in all regions under the same circle category to be largely similar due to their similar nature of the regions. The exhibit below shows the region selected for each licence category.

Exhibit 5: Region selected

Circle	Region selected
Metro	Delhi
Circle A	Maharashtra
Circle B	Kerala
Circle C	Orissa

4.2 Market share

In order to mitigate the effect of scale efficiencies and get a true representation of cost of delivering mobile services all operators are assumed to have equal share of subscribers in each region.

Exhibit 6: Number of operators and market share of theoretical operator in each region

Circle	Number of operators in the region	Market share (%)
Delhi	6	16.7%
Maharashtra	6	16.7%
Kerala	6	16.7%
Orissa	5	20.0%

Source: Spectrum

4.3 Categorisation of cells by population density

To accurately determine the number of cell sites required, the regions have further to be sub-divided into Dense-urban, urban, sub-urban and rural network topologies based on the population density. The population density requirement for each density category is listed below

Exhibit 7: Estimated population density for cell sites

Density category	Population density (pop / sq km)
Dense-urban	20,000
Urban	8,000
Sub-urban	400
Rural	-

Source: Spectrum

4.4 Categorisation of sites required by region

Given the above assumptions, the following tables sub-divide the regions into the stated network topologies.

Exhibit 8: Categorisation of sites for Delhi

Region	Area (sq km)	Population density	Average configuration
North	60.00	13,024.9	Urban
North West	440.03	6,501.6	Sub-Urban
North East	60.00	29,467.5	Urban
West	129.00	16,502.8	Urban
Central	25.00	25,855.2	Urban
South West	420.05	4,178.2	Sub-Urban
South	250.01	9,067.6	Urban
East	64.00	22,868.5	Urban
New Delhi	35.00	5,117.8	Sub-Urban
Total	**1,483**	**9338.9**	

Source: Census of India, Spectrum

Exhibit 9: Categorisation of sites for Maharashtra

Region	Area (sq km)	Population density	Average configuration
Ahmadnagar	17,035	237.20	Rural
Akola	5,431	300.20	Rural
Amravati	12,234	213.10	Rural
Aurangabad	10,105	286.70	Rural
Bhandara	3,890	292.10	Rural
Bid	10,694	202.10	Rural
Buldana	9,681	230.60	Rural
Chandrapur	11,417	181.40	Rural
Dhule	8,060	211.90	Rural
Gadchiroli	14,482	67.00	Rural
Gondiya	5,431	221.10	Rural
Hingoli	4,526	218.10	Rural
Jalgoan	11,758	313.20	Rural
Jalna	7,714	209.10	Rural
Kolhapur	7,693	458.00	Sub-Urban
Latur	7,166	290.30	Rural
Nagpur	9,809	414.70	Sub-Urban
Nanded	10,543	272.80	Rural
Nandurbar	5,035	260.50	Rural
Nashik	15,538	321.40	Rural
Osmanabad	7,550	196.90	Rural
Parbhani	6,512	234.60	Rural
Pune	15,638	462.50	Sub-Urban
Raigarh	7,162	308.30	Rural
Ratnagiri	8,197	207.00	Rural
Satara	10,474	268.20	Rural
Sangli	8,577	301.20	Rural
Sindhudurg	5,221	166.40	Rural
Solapur	14,886	258.60	Rural
Thane	9,564	850.30	Sub-Urban
Wardha	6,310	196.00	Rural
Washim	5,150	198.10	Rural
Yavatmal	13,597	180.80	Rural
Total	**307,681**	**314.9**	

Source: Census of India, Spectrum

Exhibit 10: Categorisation of sites for Kerala

Region	Area (sq km)	Population density	Average configuration
Kesragod	1,992.19	604.4	Sub-Urban
Kannur	2,967.06	811.9	Sub-Urban
Kozhikode	2,344.00	1,228.3	Sub-Urban
wayanad	2,010.87	388.2	Rural
Malappuram	3,551.60	1,020.8	Sub-Urban
Thrissur	3,033.07	980.6	Sub-Urban
Palakkad	4,481.22	584.1	Sub-Urban
Ernakulam	2,950.87	1,052.5	Sub-Urban
Kottayam	2,209.26	884.3	Sub-Urban
Alapuzha	1,413.93	1,491.7	Sub-Urban
Idukki	4,479.26	252.1	Rural
Pathanam.	2,637.35	467.9	Sub-Urban
Kollam	2,492.01	1,037.4	Sub-Urban
Thiruvan.	2,191.60	1,475.8	Sub-Urban
Total	**38,754**	**821.6**	

Source: Census of India, Spectrum

Exhibit 11: Categorisation of sites for Orissa

Region	Area (sq km)	Population density	Average configuration
Anugul	6,365.18	179.10	Rural
Balangir	6,580.68	203.20	Rural
Baleswar	3,802.61	532.40	Sub-Urban
Bargarh	5,825.77	231.10	Rural
Baudh	3,108.84	120.10	Rural
Bhadrak	2,504.22	532.60	Sub-Urban
Cuttack	3,933.95	595.10	Sub-Urban
Debagarh	2,947.40	93.00	Rural
Dhenkanal	4,460.19	239.20	Rural
Gajapati	4,320.04	120.10	Rural
Ganjam	8,211.57	384.90	Rural
Jagatsinghapur	1,669.24	633.60	Sub-Urban
Jajapur	2,497.07	650.50	Sub-Urban
Jharsuguda	2,077.93	245.30	Rural
Kalahandi	7,944.64	168.10	Rural
Kandhamal	8,002.48	81.00	Rural
Kendrapara	2,645.81	492.10	Sub-Urban
Kendujhar	8,304.04	188.10	Rural
Khordha	2,814.26	667.10	Sub-Urban
Koraput	8,791.04	134.30	Rural
Malkangiri	5,788.73	87.10	Rural
Mayurbhanj	10,429.0	213.20	Rural
Nabarangapur	5,303.86	193.40	Rural
Nayagarh	3,892.46	222.10	Rural
Nuapada	3,845.58	138.00	Rural
Puri	3,476.82	432.20	Sub-Urban
Rayagada	7,097.43	117.10	Rural
Sambalpur	6,635.55	141.00	Rural
Sonapur	2,341.55	231.40	Rural
Sundargarh	9,732.25	188.10	Rural
Total	**155,350**	**236.9**	

Source: Census of India, Spectrum

The above calculations result in the following topology distribution. It should be noted that some of the circles have very low dense urban network configuration because of geographical averaging of the population across large land areas.

Exhibit 12: Summary – average geographical network configuration

Density category	Dense-Urban	Urban	Sub-Urban	Rural
Delhi	10%	30%	60%	0%
Maharashtra	0.0%	0.0%	13.9%	86.1%
Kerala	0.0%	0.0%	83.3%	16.7%
Orissa	0.0%	0.0%	15.0%	85.0%

Source: Spectrum

4.5 Coverage requirements

The table below summarises the assumed coverage requirements for each density category

Exhibit 13: Metro - Assumed coverage requirement by network topology

Metro	2005	2006	2007	2008	2009	2010
Dense-Urban	95%	96%	97%	98%	99%	100%
Urban	95%	96%	97%	98%	99%	100%
Sub-Urban	95%	96%	97%	98%	99%	100%
Rural	95%	96%	97%	98%	99%	100%

Source: Spectrum

Exhibit 14: Circle A – Assumed coverage requirement by network topology

Circle A	2005	2006	2007	2008	2009	2010
Dense-Urban	95%	96%	97%	98%	99%	100%
Urban	95%	96%	97%	98%	99%	100%
Sub-Urban	14.5%	30%	45%	60%	65%	70%
Rural	14.5%	30%	45%	60%	65%	70%

Source: Spectrum

Exhibit 15: Circle B – Assumed coverage requirement by network topology

Circle B	2005	2006	2007	2008	2009	2010
Dense-Urban	95%	96%	97%	98%	99%	100%
Urban	95%	96%	97%	98%	99%	100%
Sub-Urban	33%	55%	65%	75%	80%	85%
Rural	33%	55%	65%	75%	80%	85%

Source: Spectrum

Exhibit 16: Circle C – Assumed coverage requirement by network topology

Circle C	2005	2006	2007	2008	2009	2010
Dense-Urban	95%	96%	97%	98%	99%	100%
Urban	95%	96%	97%	98%	99%	100%
Sub-Urban	19.5%	40%	50%	80%	85%	90%
Rural	19.5%	40%	50%	80%	85%	90%

Source: Spectrum

4.6 Cell Ranges

Once we have determined the area under each density category and coverage requirements we can calculate the number of sites required based on the area of each cell. The area of cell site in each density category is listed below

Exhibit 17: Default cell ranges

Density category	Cell range (meters)	Cell Area (sq km)
Dense-urban	470	0.430
Urban	860	1.441
Sub-urban	2180	9.260
Rural	4600	41.231

Source: Spectrum

However compared to the other international carriers operators in India are using higher cell ranges. This is reflective of the highly competitive mobile market where operators are using patchy coverage to offer cheaper tariffs. Therefore to take the larger cell radius into account the range of cell sites has been adjusted for each circle. The cell radius and area for each circle category are listed below.

Exhibit 18: Metro cell range assumptions

Density category	Cell range (meters)	Cell Area (sq km)
Dense-urban	470	0.430
Urban	860	1.441
Sub-urban	2180	9.260
Rural	4600	41.231

Source: Spectrum

Exhibit 19: Circle A cell range assumptions

Density category	Cell range (meters)	Cell Area (sq km)
Dense-urban	658	0.844
Urban	1204	2.825
Sub-urban	3052	18.150
Rural	6440	80.814

Source: Spectrum

Exhibit 20: Circle B cell range assumptions

Density category	Cell range (meters)	Cell Area (sq km)
Dense-urban	658	0.844
Urban	1204	2.825
Sub-urban	3052	18.150
Rural	6440	80.814

Source: Spectrum

Exhibit 21: Circle C cell range assumptions

Density category	Cell range (meters)	Cell Area (sq km)
Dense-urban	846	1.395
Urban	1548	4.669

Sub-urban	3924	30.003
Rural	8280	133.590

Source: Spectrum

4.7 Engineering ratios

The engineering ratios used in determining network roll out and calculation of required network components are given below

Exhibit 22: Metro – Engineering ratios

	Network component	Ratios
RAN	Available spectrum	6.2MHzx2
	Reuse factor	6
	Number of BTS per site	1
	Number of BSC per site	45
	Average length of microwave links	2Km
Core	Average number of MSCs per million subs	3.5
	Average number of HLRs per million subs	1
	Number of subs per IN	700,000

Source: Mobile network operators, Spectrum

Exhibit 23: Circle A – Engineering ratios

	Network component	Ratios
RAN	Available spectrum	6.2MHzx2
	Reuse factor	7
	Number of BTS per site	1
	Number of BSC per site	45
	Average length of microwave links	2Km
Core	Average number of MSCs per million subs	3.5
	Average number of HLRs per million subs	1
	Number of subs per IN	700,000

Source: Mobile network operators, Spectrum

Exhibit 24: Circle B – Engineering ratios

	Network component	Ratios
RAN	Available spectrum	6.2MHzx2
	Reuse factor	7
	Number of BTS per site	1
	Number of BSC per site	45
	Average length of microwave links	2Km
Core	Average number of MSCs per million subs	3.5
	Average number of HLRs per million subs	1
	Number of subs per IN	700,000

Source: Mobile network operators, Spectrum

Exhibit 25: Circle C – Engineering ratios

	Network component	Ratios
RAN	Available spectrum	6.2MHzx2
	Reuse factor	7

	Number of BTS per site	1
	Number of BSC per site	45
	Average length of microwave links	2Km
Core	Average number of MSCs per million subs	3.5
	Average number of HLRs per million subs	1
	Number of subs per IN	700,000

Source: Mobile network operators, Spectrum

4.8 Base stations

The coverage assumptions that are sourced from the operators along with the engineering ratios are used to determine the base station requirement for each region. The total number of required base stations is calculated as a sum of BTS required for coverage and additional BTS requirement for capacity. Finally, the number of BTS required going forward is determined using the coverage forecasts assumptions and subscriber projections. The exhibit below illustrates the BTS requirement for each region.

Exhibit 26: Base stations by circle

Rs/min	2005	2006	2007	2008	2009	2010
Delhi	884	1357	1473	1594	1720	1850
Maharashtra	879	1750	2594	3438	3745	4499
Kerala	609	1022	1208	1393	1486	1579
Orissa	344	706	982	1413	1501	1590

Source: Spectrum

4.9 Capital expenditure assumptions

The unit costs and benchmarks for all network components are listed below. Unit costs have been benchmarked against data obtained from other various operators

Exhibit 27: Unit costs of network components

	Network component	Cost (Rs 000s)
RAN	TRX	(included in BTS)
	BTS	3100
	BSC	14700
	Transmission – Fibre (per Km)	91
	Transmission – Microwave (per Km)	91
Core	MSC / VLR	32380
	HLR	45000
	IN	222500
	Transmission (per E1 link)	14240
IT and support systems	IT equipment	239,000 per million subs
	BSS/OSS	349,200 per million subs
Misc	Tools / test equipment	30,000 per million subs

Source: Mobile network operators, Spectrum

4.10 Depreciation schedules

For the purposes of annualising incurred and projected capex, the following straight-line financial accounting depreciation schedules are used

Exhibit 28: Asset useful life

	Component	Asset lifetime
RAN	TRX	7
	BTS	7
	BSC	7
	Transmission – Fibre	10
	Transmission – Microwave	10
Core	MSC / VLR	10
	HLR	10
	IN	10
	Transmission	10
IT and support systems	IT equipment	6
	BSS/OSS	6
Misc	Tools / test equipment	10

Source: Mobile network operators, Spectrum

4.11 Operating expenditure assumptions

The assumptions used in the calculation of each opex component relating to network activities, and appropriate justification, are given below.

Exhibit 29: Opex benchmarks

	Opex component	Driver	Assumption
Repair and maintenance	Network maintenance	Network maintenance as a % of RAN capex	8%
	Core maintenance	Repair and maintenance as a % of cummulative capex	1%
IT opex	IT Opex	IT opex as a % of IT capex	15%
Site costs	Site maintenance		Rs276,000 pa
	Utilities and rental		Rs524,000 pa
Staff costs	Staff costs	Average cost of GSM staff per sub	Rs303.6 pa
General admin	Spectrum	Spectrum fee as % of cost	Based on the allocated spectrum
	USO obligations	USO as a % of cost	5%

Source: Mobile network operators, Spectrum

4.12 Return on capital

Both FAC and LRIC approaches acknowledge that the reviewed operator should be allowed to claim an appropriate rate of return on the costs incurred in the provision of interconnection services.

4.12.1 Return on capital approach

The return on capital can be calculated using two best practice approaches, namely (a) annuity approach or (b) straight line depreciation+return on capital approach.

The annuity approach basically assumes that the operator will require a discounted cash flow return over the lifetime of the equipment which is equal to the upfront capex being deployed. The discount factor to be used in this case is the weighted average cost of capital ("WACC").

The straight line depreciation+return approach provides the operator a return through costing the depreciation of the asset and a return on capital which is equivalent to the WACC multiplied by the initial outlay (or upfront capex).

Both treatments have been used by regulators and operators throughout the world. We have used the annuity approach in our analysis as we believe this is better aligned to the concept of WACC. To have flexibility, we have built a switch in the model to present the impact of alternative approaches.

4.12.2 Cost of capital

WACC measures an operator's cost of equity and debt financing, weighted by the ratio of debt and ratio of equity of the operator's capital structure and is required to calculate the return on capital portion for interconnection costing. Generally, incumbent operators prefer to have a higher WACC used in interconnection calculations as this will imply higher interconnection rates.

However for operators to fully recover the costs, the return rate needs to be pre-tax. Hence, we have used a pre-tax WACC of 13.93%.

4.13 Cost summary

4.13.1 Capex summary

Given the above assumptions, the following table summarises the capex requirement by cost component

Exhibit 30: Metro operator – capex summary 2005-2010 (Rsm)

Cost component	2005	2006	2007	2008	2009	2010
RAN	680	1014	1122	1227	1329	1428
Core	92	127	132	147	166	175
IT and support systems	41	55	55	55	55	55
Misc	7	16	25	34	42	50
Total	820	1212	1334	1462	1591	1707

Source: Spectrum model

Exhibit 31: Circle A operator – capex summary 2005-2010 (Rsm)

Cost component	2005	2006	2007	2008	2009	2010
RAN	679	1286	1816	2294	2454	2795
Core	78	125	165	207	238	276
IT and support systems	32	46	46	46	46	46
Misc	5	15	26	39	54	69
Total	794	1471	2053	2586	2791	3186

Source: Spectrum model

Exhibit 32: Circle B operator – capex summary 2005-2010 (Rsm)

Cost component	2005	2006	2007	2008	2009	2010
RAN	471	758	874	978	1027	1069
Core	49	83	91	94	115	118
IT and support systems	21	29	29	29	29	29
Misc	3	9	15	21	26	32
Total	544	879	1008	1121	1197	1248

Source: Spectrum model

Exhibit 33: Circle C operator – capex summary 2005-2010 (Rsm)

Cost component	2005	2006	2007	2008	2009	2010
RAN	267	518	690	934	978	1019
Core	36	43	50	72	80	86
IT and support systems	8	12	12	12	12	12
Misc	1	4	7	11	15	19
Total	312	577	759	1028	1084	1136

Source: Spectrum model

4.13.2 Opex summary

Given the above assumptions, the following table summarises the opex requirement by cost component

Exhibit 34: Metro operator – opex summary 2005-2010 (Rsm)

Cost component	2005	2006	2007	2008	2009	2010
Repair and maintenance	93	138	153	167	181	195
IT opex	6	14	23	31	39	47
Site costs	707	1107	1226	1354	1489	1634
Staff costs	360	586	674	773	883	1006
General admin expenses	465	729	821	921	1029	1144
Total	1632	2574	2896	3245	3622	4025

Source: Spectrum

Exhibit 35: Circle A operator – opex summary 2005-2010 (Rsm)

Cost component	2005	2006	2007	2008	2009	2010
Repair and maintenance	92	172	242	305	328	374
IT opex	5	12	19	26	32	39
Site costs	703	1428	2159	2918	3243	3974
Staff costs	286	574	851	1170	1536	1955
General admin expenses	419	822	1202	1601	1896	2322
Total	1504	3008	4472	6020	7035	8663

Source: Spectrum model

Exhibit 36: Circle B operator – opex summary 2005-2010 (Rsm)

Cost component	2005	2006	2007	2008	2009	2010
Repair and maintenance	63	102	117	131	139	144
IT opex	3	7	12	16	21	25
Site costs	487	834	1005	1183	1287	1395
Staff costs	182	361	429	505	591	688
General admin expenses	249	445	525	609	681	757
Total	985	1749	2088	2444	2719	3009

Source: Spectrum model

Exhibit 37: Circle C operator – opex summary 2005-2010 (Rsm)

Cost component	2005	2006	2007	2008	2009	2010
Repair and maintenance	36	69	91	123	129	135
IT opex	1	3	5	7	8	10
Site costs	276	576	817	1200	1300	1404

Staff costs	71	162	237	323	422	535
General admin expenses	108	224	314	437	506	583
Total	492	1034	1463	2089	2366	2666

Source: Spectrum model

4.14 Minutes of Use

We have used historical minutes of use ("MoU") for 2005 and studied the past growth rates in usage to determine the appropriate levels of usage going forward. The exhibit below shows the historical MoU for 2005 and the projected MoU per subscriber per month for 2006-2010.

Exhibit 38: Summary of minute of usage per subscriber per month

Cost component	2005	2006	2007	2008	2009	2010
Metro	402	422	443	465	489	513
Circle A	410	422	435	448	461	475
Circle B	356	367	378	389	401	413
Circle C	438	442	447	451	456	460

Source: TRAI Dec 2005, Spectrum

5 Output assessment

5.1 Introduction

To test the hypothesis that the current mobile termination charges are currently below costs incurred by operators in that termination, Spectrum calculated the per minute costs incurred by a theoretical mobile operator in the termination of mobile traffic using two methodologies– fully allocated costs (FAC) and forward looking long run incremental costs (LRIC). A bottom-up model was created which was then reconciled with top-down data obtained from various operators. The following section summarises the results of the calculations for both methodologies adopted.

5.2 FAC outputs

The table below presents the operating and annualised capital expenditures for 2005.

Exhibit 39: Summary operating and capital expenditures, 2005 (Rsm)

Cost component		Metro	Circle A	Circle B	Circle C
Operating	Repair and maintenance	93.0	91.6	63.3	36.1
	IT opex	6.1	4.9	3.1	1.2
	Site costs	707.0	703.0	487.1	275.5
	Staff costs	360.2	286.1	182.2	70.9
	General admin expenses	465.3	418.7	249.2	108.2
	Total	**1632**	**1504**	**985**	**492**
Capital	RAN	680	679	471	267
	Core	92	78	49	36
	IT	41	32	21	8
	Misc	7	5	3	1
	Total	**820**	**794**	**544**	**312**
Total		**2451**	**2298**	**1529**	**804**

Source: Spectrum

Given allocated operating and capital expenditures, traffic patterns and pre-tax WACC (at 13.93%), the following network costs per minute of voice termination service are determined.

Exhibit 40: Summary of circlewise FAC based charges, 2005

Rs/min	2005
Metro	0.48
Circle A	0.76
Circle B	0.75
Circle C	0.77
Blended	**0.65**

Note: Based on estimated historical costs

Source: Spectrum

5.3 FL-LRIC outputs

The exhibits below present the operating and annualised capital expenditures for a region in all the different circle categories.

Exhibit 41: Metro operator – summary operating and capital expenditures, 2006-2010

Cost component		2006	2007	2008	2009	2010
Operating	Repair and maintenance	138	153	167	181	195
	IT opex	14	23	31	39	47
	Site costs	1107	1226	1354	1489	1634
	Staff costs	586	674	773	883	1006
	General admin expenses	729	821	921	1029	1144
	Total	**2574**	**2896**	**3245**	**3622**	**4025**
Capital	RAN	1014	1122	1227	1329	1428
	Core	127	132	147	166	175
	IT	55	55	55	55	55
	Misc	16	25	34	42	50
	Total	**1212**	**1334**	**1462**	**1591**	**1707**
Total		**3786**	**4230**	**4707**	**5213**	**5733**

Source: Spectrum

Exhibit 42: Circle A operator – summary of operating and capital expenditures, 2006-2010

Cost component		2006	2007	2008	2009	2010
Operating	Repair and maintenance	172	242	305	328	374
	IT opex	12	19	26	32	39
	Site costs	1428	2159	2918	3243	3974
	Staff costs	574	851	1170	1536	1955
	General admin expenses	822	1202	1601	1896	2322
	Total	**3008**	**4472**	**6020**	**7035**	**8663**
Capital	RAN	1286	1816	2294	2454	2795
	Core	125	165	207	238	276
	IT	46	46	46	46	46
	Misc	15	26	39	54	69
	Total	**1471**	**2053**	**2586**	**2791**	**3186**
Total		**4479**	**6525**	**8606**	**9826**	**11849**

Source: Spectrum

Exhibit 43: Circle B operator – Summary operating and capital expenditures, 2006-2010

Cost component		2006	2007	2008	2009	2010
Operating	Repair and maintenance	102	117	131	139	144
	IT opex	7	12	16	21	25
	Site costs	834	1005	1183	1287	1395
	Staff costs	361	429	505	591	688
	General admin expenses	445	525	609	681	757
	Total	**1749**	**2088**	**2444**	**2719**	**3009**
Capital	RAN	758	874	978	1027	1069
	Core	83	91	94	115	118
	IT	29	29	29	29	29
	Misc	9	15	21	26	32
	Total	**879**	**1008**	**1121**	**1197**	**1248**
Total		**2628**	**3097**	**3565**	**3916**	**4257**

Source: Spectrum

Exhibit 44: Summary operating and capital expenditures for Circle C region, 2006-2010

Cost component		2006	2007	2008	2009	2010
Operating	Repair and maintenance	69	91	123	129	135
	IT opex	3	5	7	8	10
	Site costs	576	817	1200	1300	1404
	Staff costs	162	237	323	422	535
	General admin expenses	224	314	437	506	583
	Total	**1034**	**1463**	**2089**	**2366**	**2666**

Capital	RAN	518	690	934	978	1019
	Core	43	50	72	80	86
	IT	12	12	12	12	12
	Misc	4	7	11	15	19
	Total	**577**	**759**	**1028**	**1084**	**1136**
Total		**1611**	**2222**	**3117**	**3450**	**3802**

Source: Spectrum

Given allocated operating and capital expenditures, traffic patterns and pre-tax WACC (at 13.93%), the following network costs per minute of voice termination service are determined. Based on the results, it can be observed that the mobile termination charges increase from 2007 to 2008 as operators increase their coverage in rural areas and start declining 2009 onwards as subscriber take up and usage increases in these areas. Similar trends have also been observed in other countries such as Malaysia.

Exhibit 45: Summary of circlewise LRIC based charges, 2006-2010

Rs/min	2006	2007	2008	2009	2010
Metro	0.41	0.41	0.41	0.40	0.39
Circle A	0.50	0.51	0.51	0.46	0.45
Circle B	0.54	0.55	0.56	0.55	0.53
Circle C	0.61	0.61	0.66	0.60	0.55
Blended	0.49	0.50	0.51	0.47	0.46
3 year look ahead average	**0.50**				

Source: Spectrum

The termination rates calculated in both approaches are higher than the Rs.0.30 proposed by TRAI. Low mobile termination charges can be detrimental to development of the mobile industry. The impact of low MTC is beyond the scope of this document.

5.4 Summary of outputs

The tables below summarise the output termination charges for the different methodologies adopted

Exhibit 46: Summary of circlewise FAC based charges, 2005

Rs/min	2005
Metro	0.48
Circle A	0.76
Circle B	0.75
Circle C	0.77
Blended	**0.65**

Note: Based on estimated historical costs

Source: Spectrum

Exhibit 47: Summary of circlewise LRIC based charges, 2006-2010

Rs/min	2006	2007	2008	2009	2010
Metro	0.41	0.41	0.41	0.40	0.39
Circle A	0.50	0.51	0.51	0.46	0.45
Circle B	0.54	0.55	0.56	0.55	0.53
Circle C	0.61	0.61	0.66	0.60	0.55
Blended	0.49	0.50	0.51	0.47	0.46
3 year look ahead average	**0.50**				

Source: Spectrum

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