Economics of Network Sharing – A Case Study of Mobile Telecom Sector in Pakistan

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Abstract— **The cellular mobile industry in Pakistan has shown an unprecedented growth since the promulgation of Pakistan Telecommunication (Reorganization) Act of 1996. Over 90 million cellular mobile users and penetration grew to 55.6% and 4.8 million landlines connections provide a teledensity of 58.8% to the nation. The mobile networks provide coverage to over 90 percent of the population. During 2007-08 mobiles traffic exceeded 42 billion minutes while ARPU decreased to US$ 3.11. Total telecom investment during the year 2007-08 was US $ 3.12 billion while the share of telecommunication sector in GDP was 2.0%. Telecom companies invested over US$ 10 billion during the last five years, mobile sector investment share accounted for 66% of the total investment. China Mobile alone invested about US$ 2 billion during 2007-08 for expansion of its CMPak networks. The mobile sector paid over a billion dollars in taxes to the National Exchequer during the year 2007-08. The telecom sector received above US$ 1.438 billion FDI, i.e., 28% of the total FDI and helped create over one million jobs since the deregulation of the telecom sector began. The competitive pressures and decline in ARPU has increased the need for improving technical as well as economic efficiencies. Our analyses indicate there are serious economic efficiencies embedded in infrastructure sharing paradigm for mobile operators. Only the passive sharing of additional sites can yield CAPEX savings of over 5000 million US dollars and OPEX savings of these sites can yield another billion US dollars every year. It is thus concluded that the growing business model of decoupling the revenues from that of mobile traffic warrant serious consideration.**

Keywords-component; network sharing, economic benefits, regulatory tools

I. BACKGROUND AND LITERATURE REVIEW

The revolution in the information technologies, miniaturization of the electronics devices, enhanced number of circuits on the chip coupled with other technological breakthrough and introduction of cellular mobile technologies unleashed the unlimited opportunities and permutation of business models. The models that were state of the art in the 1980s and 1990s are facing major redesign and realignments.

Telecom sector reforms by way of creation of independent regulators, privatization of the incumbents, licensing and competition in the mobile operators around the globe both in developed and developing countries is the hall mark of the 21st century. According to an ITU[1] World Information Society Report 2007, partial or full privatization of incumbent telecom operators grew from 10% in 1990 to 50% in 2006. Over the same period the number of telecom regulatory authorities also grew from 14 in 1990 to 147 in 2007. Pakistan's telecommunication sector has made significant progress during these years and has traveled a long way since its independence in 1947, yet more work is needed to keep the momentum. Melody[2] suggested that "dominant activity in telecom reforms is now shifting from policy development to implementation. This is a more difficult task that depends heavily on competent, independent regulation on both developed and developing countries. Telecom reform is leading to increasing integration of telecom with other sectors of economy and telecom policy with broader economic and social policy. As mobile telecom networks are becoming cornerstone of any information infrastructure, they in turn are rapidly becoming an indispensable component of 21st century business landscape and social networks. For the future both technical and economic efficiency coupled with responsive enterprise to growing demand of knowledge society is imperative. Chaudhary[3] provides a comprehensive analysis about the Indian mobile telecom sector while advocating the urgency and need for infrastructure sharing by mobile operators.

Southwood [4] provides a more inclusive view of the infrastructure sharing without differentiating between the mobile and fixed operations and presents the examples of STOCKAB, Sweden, Mid-Atlantic Broadband Cooperative, USA, and SERPANT of Ireland. Cohen and Southwood[5] also provide a comprehensive discussion on the issues of infrastructure sharing with particular emphasis to developing countries. They also advance the concept of Open Access and propose Best Practice for national infrastructure sharing. Telecom Regulatory Authority of India[6] address both active and passive sharing as well as backhaul sharing and propose incentives for using non conventional energy resources. The recommendations also present examples of USA, France, Germany, Brazil and other countries in support of their recommendations for infrastructure sharing. GSMA[7] based on their research has advocated the use of renewable energy sources for powering telecom operations at remote locations because of their off-grid nature and increasing cost for powering such locations. Industry Canada[8] has detailed the procedures for tower and site sharing and sets out conditions of license for mandatory roaming and antenna tower and site sharing to prohibit exclusive site arrangements. The New Zealand Commerce Commission[9] in its decision details co-

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location framework and roles, responsibilities and procedures for Access Seekers and Access Providers. Ireland's Commission for Communications Regulation[10] established the code of Practice on Sharing of Radio Sites. Telecommunications Regulatory Commission of Jordan[11] also strives for the collocation and infrastructure sharing amongst mobile operators. Review of the literature indicates that there is a general consensus amongst all the stake holders that infrastructure sharing is warranted and it will yield operational and economic efficiencies if implemented properly. Equipment vendors as well as the network operators also have the consensus on the desirability of the network sharing approaches and efforts are underway to develop seamless Mobile Virtual Network Operations.

This paper describes the fundamental changes that are taking place in the mobile telecom sector i.e., from independent networks to collaborative networks their technical complexities and business approaches. The paper analyses, how the collaborative model can leverage the companies for quicker network roll-out, more efficient use of network resources and savings that may accrue. The changing landscape of mobile telecom sector is posing serious challenges as well as offering the opportunities and driving the actions of the government, regulators as well as of the operators.

II. OVERVIEW OF MOBILE TELECOM SECTOR IN PAKISTAN

The growth in the mobile subscribers and throbbing traffic on these networks along with innovative mobile applications from simple conversation to virtual wallets has created opportunities as well as posed serious technical and economic challenges to the telecom operators. Operators like it or not they are under continuous pressures to upgrade their networks to successive generations of technology as the growing menu of demanding application can only run on the upgraded platforms. This section provides a summarized picture of Pakistan's mobile telecom sector and highlights its strengths as well as its limitations. Telecom sector was single most important sector fetching the highest level of investment over the past several years as shown in Table I.

TABLE I. SHARE OF TELECOMMUNICATIONS SECTOR IN THE FDI FROM 2002-03-2007-08

Sector	2003	2004	2005	2006	2007	2008
Textile	3.30	3.70	2.60	1.30	1.20	0.6
Oil & Gas	23.40	21.30	12.70	8.90	10.60	12.3
Power	4.10	1.50	4.80	9.10	3.80	1.4
Telecom	**1.70**	**21.80**	**32.40**	**54.10**	**35.60**	**27.9**
IT Services	0.50	0.60	0.60	0.70	1.20	3.1
Fin Services	26.00	25.50	17.70	9.30	18.20	31.2

Source: State Bank of Pakistan

A. Mobile Telecom Landscape

Pakistan has six mobile telecom companies, all of them owned by collaborative consortiums of local and/or foreign companies. All companies employ GSM technology. The companies, their ownership, and market share is presented in table 2 bellow. Telenor and Mobilink are the leaders with largest market share while China Mobile, Warid and Ufone are trailing to increase their market share.

TABLE II. MOBILE COMPANIES IN PAKISTAN, OWNERSHIP, YEAR LAUNCHED AND MARKET DHARE

Operator	Owner	Launched	Technology	Share
Instaphone	Sanbao	1990	AMPS	0.50
China Mobile	Millicom /CM	1990/2008	GSM	1.90
Mobilink	Orascom	1994	GSM	44.30
Ufone	PTCL/Etisalat	2001	GSM	20.90
Telenor	Telenor	2005	GSM	16.30
Warid Telecom	Al-Warid	2005	GSM	16.10

Source: Various reports and published data

The historic and projected future growth of the cellular mobile subscribers is presented in figures 1 and 2 respectively. As shown in these diagrams, subscribers have grown rapidly over the last several years particularly during the last five years and after the entry of Ufone, Warid, Telenor and China Mobile. Cut-throat competition amongst the operators has generally benefited the consumers. The sector has also attracted huge new investments, generated employment and created entirely a new industry with significant economic impact. As shown in figure 2, the subscribers will continue to grow until 2017 but at a decreasing rate starting from 2010 onwards. As such the companies have to compete for the same clientele by increasing coverage.

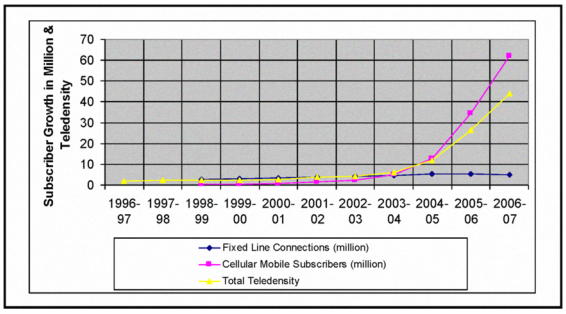

Figure 1. Subscriber growth and teledensity 1996-97 to 2006-07

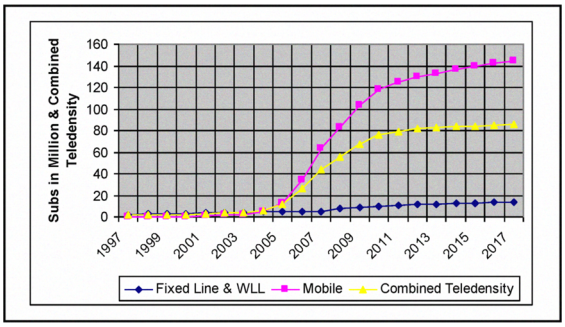

Figure 2. Project Subscriber Growth and Teledensity 1997-2017

Cellular Mobile coverage has reached almost all population centers except remote and far flung as well as thinly scattered rural populations in Balochistan, Sindh, NWFP and Southern Punjab. The mobile networks cover over 90 percent of the population as shown in figure 3.

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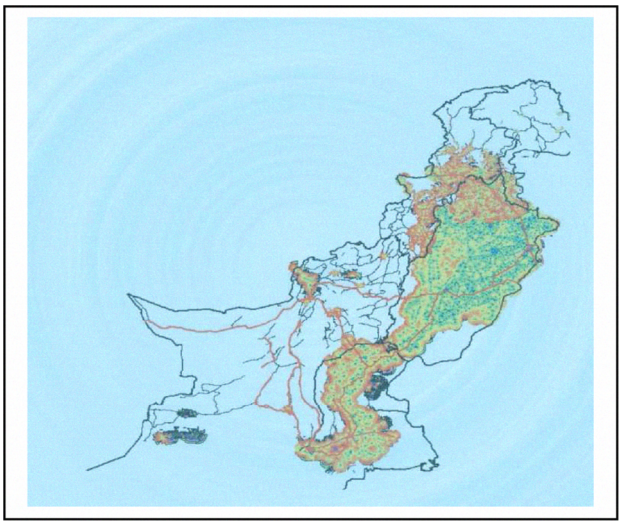

Figure 3. Pakistan's Cellular Mobile Coverage Map

B. *Business Models*

By virtue of the growing menu of demanding mobile applications, the telecom traffic is dominated by data and is increasing at an increasing rate. Contrary to that the competitive pressures have led to the flattening tariffs and increasing revenues but at a decreasing rate. As a result the network traffic and revenues are moving in two different directions. This phenomenon is described in figure 4.

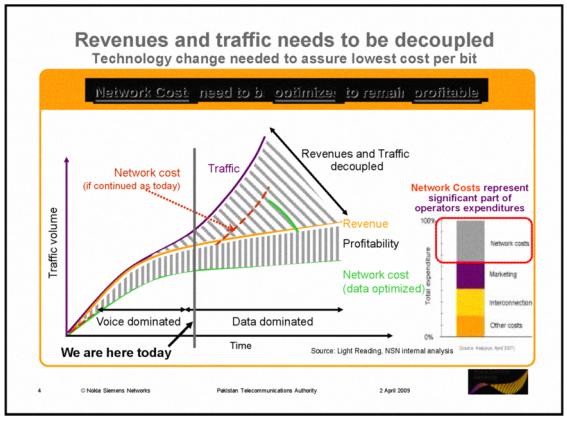

Figure 4. Decoupling Revenues and Tariffs for Least Cost Transmission Option (adopted from NSN presentation, available at PTA Website)

This situation has posed serious challenges for the operators to decrease costs to the maximum. According to various analyses the networks cost accounts for 35-40% of the total cost. If the existing business model of independent networks continue the operations are likely to become unprofitable at a certain point, or stall the network roll-out or cease the network up gradation. None of the paradigm is and should be acceptable to the operators. Network sharing paradigm both active and passive provides a solution and operators can decrease their capital expenses (CapEx) as well as Operating Expenses (OpEx) thereby decreasing the cost per bit of traffic delivery. The growing competition has pressed the operators to look toward the new business models to keep the technological edge as well as the economic models and resulting profitability. The changed scenario demand accelerated network rollouts, enhanced operational flexibilities and efficiencies.

III. CONCEPT AND RATIONAL OF NETWORK SHARING

Frisanco et al[12] have provided very detailed discussion on three major dimensions of network sharing i.e. business model, technology solution along network layers and geographic model. The sharing options in business model range from unilateral service provision to mutual service provision to joint venture to network provider option model. The network sharing model describes various technology solutions along network layers from passive RAN/site sharing to active RAN sharing; roaming based sharing, fixed access sharing, broadcast network sharing to application sharing. The options under geographical model range from full split, common shared region, unilateral shared region, full sharing to full technology split. They have also described the technical solutions from multi-operator radio access network (MORAN) to multi-operator core network (MOCN) as well as pros and cons of each option and scenario. Figure 5 bellow provides the schematics of network sharing.

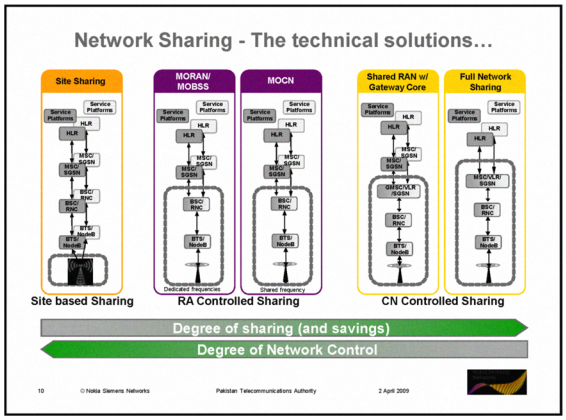

Figure 5. Network Sharing Technical Solutions[13] (Adopted from NSN presentation to PTA 2008 available at PTA website)

Similarly, Lefevre[14] identified number of sharing options, "dividing them into two basic categories: (i) passive sharing and (ii) active sharing. Passive sharing refers to the sharing of space in passive infrastructure, such as building premises, sites and masts. Passive sharing is typically a moderate form of network sharing, where there are still separate networks that simply share physical space. Active sharing is a more intensive type of sharing, where operators share elements of the active layer of a mobile network, such as antennas, radio nodes, node controllers, backhaul and backbone transmission, as well as elements of the core network (such as switches). Active sharing includes mobile roaming, which may probably be considered as the most far reaching option for sharing infrastructure, since one operator would make use of another operator's network in a certain geographical area where it has no coverage or no infrastructure. Active mobile sharing also has a number of risks, the biggest one being the limitation of the ability of operators to distinguish their service offerings from one

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another where the elements which determine network quality and transmission rates are identical". Green[15] highlights some of the emerging trends in mobile industry including fewer vendors, operator's consolidation but overall number of operators remains the same, smart and lean operators and enterprise vendors. Lefevre's proposed technical solution is presented in figure 6 bellow.

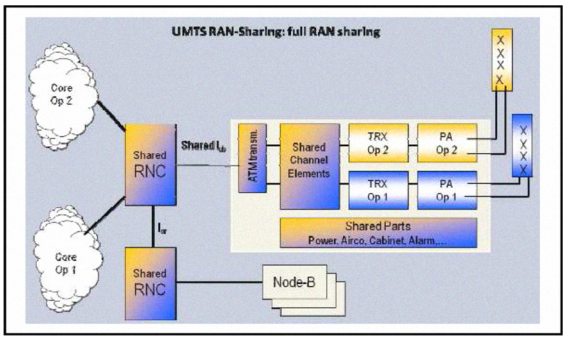

Figure 6. Full RAN Sharing (Adopted from ITU Working Paper)

IV. ECONOMICS OF SHARING – PAKISTAN'S CASE

Apart from the equipment vendors, ITU has taken the lead to promote the concept of network sharing, its technical and economic viability and financial rational. A number of countries including United States, UK, Canada, Brazil, India, Malaysia, Jordan, Hong Kong, Australia, Norway, France, Germany, Netherlands, Sweden and Saudi Arabia have taken network sharing initiatives from conservative to liberal[16].

We have tried to calculate the financial impact both in terms of capital expenses as well as operating expenses for the available network expansion options. The information about the cell site was collected from PTA sources as well as operator representatives. Currently Telenor has the highest number of cell sites followed by Mobilink, Zong, Warid and Ufone respectively. If all these operators are ready to network sharing with each other, no additional site is required as whole Pakistan can be covered with about 10,000 cell sites and two largest operators have cell sites reaching this number. Table III provides the number of cell sites, number of towers and number of network operating centers belonging to each operator. As such there are over 28,000 cell sites and over 25,000 towers scattered across the country.

TABLE III. NUMBER OF CELL SITES, TOWERS AND NETWORK OPERATING CENTERS FOR PAKISTAN MOBILE COMPANIES

Mobile Company	Cell sites	Towers	NOC
Telenor	9778	9555	23
Mobilink	7338	6789	27
Zong	4380	3631	16
Warid	3880	3233	13
Ufone	2989	2745	12
Total	28365	25953	91

A. *Sharing Progress*

Currently some operators are making progress towards passive sharing and sharing towers with each other on site for site basis i.e. operator A share tower with operator B at a site and operator B share a tower with operator A at alternate site. Pakistan Telecommunications Authority (PTA) has also moved in this direction and issued Telecom Infrastructure Provider licenses. The scope of the license covers the range of infrastructure elements including earth stations, satellite hub, optic fiber cables, radio communications links, submarine cable landing centre, towers, poles, ducts and pits used in conjunction with other infrastructure facilities and other telecommunication infrastructure as the PTA require. Until now PTA has issued 5 Infrastructure Provider (Tower) licenses. PTA as well as Telecom Regulatory Authority of India (TRAI) has also prepared guidelines for lease, rental, and sale of infrastructure and telecommunications towers.

B. *Sharing Scenerios*

Currently two companies i.e., Telenor and Mobilink have over 90% geographical coverage with 9778 and 7338 cell sites respectively. It is generally assumed that 10,000 cell sites would be sufficient to provide 100% geographical coverage throughout the country. Telenor has a mobile tower sharing program and have made tower swapping arrangement of one-for-one with other operators. If we assume that Telenor and Mobilink has reached near 100% and that they are in the position of renting and sharing their cell sites through workable arrangements with the other three companies which are the potential contenders for using these services. Table IV bellow describes that number of sites the companies up in the hierarchy with larger number of sites can share with companies lower in the hierarchy. For example Telenor can share 2440 sites with Mobilink, 5398 with Zong, 5898 with Warid and 6789 with Ufone subject to technical and commercial feasibility.

TABLE IV. CELL SITE SHARING SCENARIO

Company	Telenor	Mobilink	Zong	Warid	Ufone
Telenor	0	2440	5398	5898	6789
Mobil ink	0	0	2958	3458	4349
Zong	0	0	0	500	1391
Warid	0	0	0	0	891
Ufone	0	0	0	0	0

Similarly Table V below provides the number of tower that the companies up in the infrastructure hierarchy can share with the companies bellow in the hierarchy. In this case Telenor can share up to 2766 towers with Mobilink, 5924 with Zong, 6322 with Warid and 6810 with Ufone subject to technical and commercial feasibility. It is observed that sharing tower for tower is a good beginning but is not sufficient and does not make a tangible business case with

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reasonable financial savings thus sufficient financial incentives for operators.

TABLE V. TOWER ONLY SHARING SCENARIO

Company	Telenor	Mobilink	Zong	Warid	Ufone
Telenor	0	2766	5924	6322	6810
Mobil ink	0	0	3158	3556	4044
Zong	0	0	0	398	886
Warid	0	0	0	0	488
Ufone	0	0	0	0	0

We made a generic assumption that every company needs to have 10,000 cell sites in order to provide near 100 % population coverage and compete in all markets with each other. Table VI provides the financial impact both CapEx and OpEx in case of no sharing, passive sharing and semi-active sharing for additional sites only. Table VI provides the CAPEX and OPEX figures for creating and operating a cell site. The prices and costs used in this table are based on our own market survey. We understand that there is likely to be variation in these prices based on the locale of the site and origin of the equipment as rural area site will have lower rents while the equipment of European origin is likely to be costlier that Chinese or Korean origin equipment.

TABLE VI. CAPEX AND OPEX FOR A SINGLE CELL SITE

Cost Element	Cost/Unit US$
Transceivers	10,000
Base Transceivers Station (BTS)	110,000
Base Station Control (BSC)	100,000
Microwave Equipment	15,500
Tower Cost with Accessories	25,000
Generator Cost	10,000
Total Capital Expenses	**270,500**
Electricity	500
Fuel Supply	500
Average Monthly Rent	1,000
Security Expenses	500
Monthly Operating Expenses/site	**2,500**
Annual Operating Expenses/site	**30,000**

Table VII bellow provides the capital expenses per site for passive network elements only and with sharing overhead @ 30% added. This entails that a single site can accommodate two additional operators with only 30% additional expenses. Similarly with over 20% additional operating expenses the existing operator can accommodate two other operators in their site. These assumptions would mean that with only 35-40% of the capital cost to each of the three operators a new site can be generated. Similarly, it would only cost 40% to run the site to each of the three operators.

TABLE VII. CAPEX AND OPEX FOR PASSIVE SHARING

Cost Element	Cost in US$
Tower Cost with Accessories	25,000
Generator Cost	10,000
Sharing Overhead @ 30%	**10500**
Total Capital Expenses	**45,500**
Electricity	500
Fuel Supply	500
Average Monthly Rent	1,000
Security Expenses	500
Monthly Operating Exp	2,500
Monthly Sharing Overhead @ 20%	**500**
Annual Operating Expenses	**36,000**

C. *Economic Benefits*

Assuming that existing sites of Telenor or Mobilink can accommodate two more operators for passive cell site components then a reasonable scenario emerges. Telenor accommodates Mobilink for 2440 sites and Zong with 5940 sites making a total of 8,380 shared sites. Similarly, Mobilink shares 3,458 sites with Warid and 4349 with Ufone making a total of 7807 sites. The calculations presented here assume that two larger companies do not create additional cell sites and accommodate up to two other operators at their existing sites. As such, they do not incur any extra investment rather they charge rental for shared resources i.e. premises, masts, generators, fuel supply, electricity charges, security arrangements for the sites shared with other operators. On the other hand the operators renting the site do not make capital investment on capital items and only pay for the rental of shared operating expenses for the resources used. For the passive sharing scenario for the additional sites required to provide 100% coverage by all operators the analysis is presented in table VIII bellow. For the passive infrastructure elements only the operators will be required to invest US$ 757.225 million and operating expenses of 649.050 million for the additional sites only if they rely on the conventional independent model. However; the CapEx is reduced to US$ 173 million in case of passive sharing. Similarly, each of the companies will spend 1/3 as operating expenses in shared model compared to the individual non-shared model. Although it seems that Telenor and Mobilink savings much less than the other four companies, however, actually they will be spending less but earning more in the shape of rental from other companies for the sites provided. Actually all the companies will be optimizing their capital expenses as well as the operating costs. Most of the operating costs will revert back to the companies who actually own the passive infrastructure components i.e. the two larger companies Telenor and Mobilink. As such, pure passive sharing will have more than

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one billion US Dollars economic impact to the sector. We have only calculated the capital costs for Base Transmission Station (BTS) and Base Control Station (BCS) and for additional sites only the operators will be required to invest over US$ 4 billion in stand-alone paradigm. However, in semi-active sharing paradigm (sharing BTS and BCS) the capital expenses will reduce to 1/3 increasing the capital efficiency.

TABLE VIII. ECONOMIC IMPACT OF SHARING OPTIONS FOR ADDITIONAL SITES ONLY, ALL FIGURES IN MILLION US DOLLARS

Item Description	Telenor	Mobilink	Zong	Warid	Ufone	Total US$
Additional Sites Needed for 100% Coverage	222	2,662	5,620	6,120	7,011	
BTS &BSC	44.400	532.400	1,124.000	1,224.000	1,402.200	4,327.000
Capital Expenses (Individual Model)	7.770	93.170	196.700	214.200	245.385	757.225
Operating Expenses (Individual Model)	6.660	79.860	168.600	183.600	210.330	649.050
Passive Sharing Capital Exp.	1.776	21.296	44.960	48.960	56.088	173.080
CapEx Savings for Additional Sites	5.994	71.874	151.740	165.240	189.297	584.145
OpEx - Three Companies Passive Sharing	7.992	95.832	202.320	220.320	252.396	778.860
OPEX for Each Company	2.664	31.944	67.440	73.440	84.132	259.620
OPEX saving to Operators	3.996	47.916	101.160	110.160	126.198	389.430
Total CAPEX and OPEX Saving -Passive	8.658	103.818	219.180	238.680	273.429	843.765

These calculations are based on financial assumptions presented in table VI and table VII above.

V. CONCLUSIONS

The analysis presents a strong case for passive and active network sharing by mobile operators. The results support the thesis that infrastructure sharing increased the efficiency of the investments already made, reduce the future capital requirements, accelerate the network roll-out, and least cost technology up gradation. The sharing options also have environmental and aesthetics advantages compared with independent model which resulted in springing constellations of the telecom towers in densely populated areas. Despite all the expected benefits there are many technical and commercial issues to be addressed particularly in case of active sharing.

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