The Potential of Inter Operator Roaming for the future of Mobile Communication Industry in Sri Lanka

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Abstract— *This paper presents the potential towards developing green mechanism in infrastructure and spectrum development of mobile communication industry in Sri Lanka. It outlines the mobile communication industry of Sri Lanka and highlights evolutionary changes that explored in the local mobile communication industry. Subsequently, paper reviews and analyses network infrastructure and spectrum development as a growing trend in local mobile communication industry, and highlight the barriers which have been reflected. Pointing out cost and differentiation competitive factors, paper blueprint Inter Operator Roaming to overcome such barriers, and optimizes Inter Operator Roaming as a green development mechanism to local mobile network operators to sustain in the long run.*

Keywords— Inter Operator Roaming, Capital and Operational Expenditures, Green Development

I. INTRODUCTION

The mobile communication industry in Sri Lanka is one of the most dynamic sectors, contributing significantly both directly and indirectly to the economic and social development of the country. Industry has grown at a rapid speed during the last few years after the re-establishment of peace, and it has become the fastest growing industry in Sri Lanka's economy, with a growth rate of 7.9% (The department of census and statistics ministry of finance and planning Sri Lanka, 2012). Mobile communication industry has been the core driving force for the growth of the service sector in the recent past of Sri Lanka, and it is one of the most competitive markets in the South Asian region, with five operators, Dialog, Mobitel, Etisalat, Airtel and Hutchison.

As the second largest and fastest growing market in the world, mobile communication networks and services have become an essential part of everyday life in Sri Lanka. As per the GSMA Intelligence report for year 2013, around 45-50% of people in Sri Lanka own a mobile phone and it is a 3% growth compared to 2012 statistics (Jain, Hatt and Wills, 2013).

Table 1. Key indicators of the Sri Lankan Mobile Market

Indicator	2011	2012	2013E
Market penetration	41%	43%	46%
Active Subscribers (million)	8.6	9.3	9.9
Subscriber growth annual	7%	8%	7%
SIMs per subscriber	1.95	2.02	2.07

(Jain, Hatt and Wills, 2013)

These indicators clearly highlight the fact that, the mobile communication industry in Sri Lanka is making a heavy impact on the economic growth. It should be encouraged and well controlled. Therefore it would provide more overall benefits towards the country with its growth in performance. With these growing indicators, the community has more dependent on mobile network operators and expect to be conveniently communicated from any destination at any time. This leads to high rivalry in the local mobile market and mobile network operators have a range of possible value chain mechanisms to retain or increase their market share as well as to provide a robust service to their customers.

Providing a robust service to the customers is not an easy task faced by mobile network operators. High energy sources are required by them to carry out their operations. The expense on energy accounts are a significant share of the both operational and capital expenditure of their networks. With the growth in local mobile networks, the challenge is to provide energy to these expanding networks while ensuring an increasing in emission will not be taken place over the coming years.

Conducted scientific research demonstrate that, the factors “mobile network operator supports environmentally friendly measures” and “network operator supports social initiatives” rank among the lowest in local consumer importance. It is clearly highlighted that local consumers are not aware about the environmental and health hazards created from mobile communication industry.
However, making their operations to operate in a green manner is a complex task currently is faced by local mobile network operators. The go green solutions which global mobile network operators depends are mainly based on network infrastructure design and efficiency of electronic equipment, optimized network sharing or planning, efficient transmission techniques, and physical layer characteristics station (Koutitas, 2010). Therefore, there is considerable margin to improve go green mechanisms in local mobile communication industry via optimizing network infrastructure.

II. NETWORK INFRASTRUCTURE SPECTRUM DEVELOPMENT

The drastic evolution of the mobile communication industry in Sri Lanka, and the impacts of mobile communication industrial value chain have given local mobile network operators, an overactive structure to make more competition. Stable development of network infrastructure and spectrum, development of network services and focus on the value-creating activities could give the local mobile network operators many advantages. For example, the ability to charge higher prices, lower the capital and operational expenditure, better brand image, provide better service as some major aspects.

Though there are number of value chain mechanisms available in the mobile communication industry, most local mobile network operators are trying to expand their customer base value for money. They are widely planning on expanding their coverage by tapping the untapped markets. It has become cash cows for the local mobile network operators, and it has also built up the competition between each competitor.

The local mobile network operators are being made special efforts to tap unmet demand and win new customers in the underserved northern and eastern regions in the country, where government troops had finally defeated from rebel forces (Sri Lanka - Mobile Communications and Broadcasting, 2010).

Those network infrastructure and spectrum expansions are in line with the accelerated development program that had been put in place in the affected areas, and they are being observed under the Telecom Regulatory Council of Sri Lanka. Although, the network infrastructure and spectrum development programs are very much useful to win new customers, nonetheless the barriers to those development entries are very high. This has led to some operators to withdraw from the competition as they are not able to compete with the intense market rivalry.

III. BARRIERS TO NETWORK INFRASTRUCTURE SPECTRUM DEVELOPMENT

Despite the significance of development entry barriers, there is lack of investigation over how these new infrastructure and spectrum development entrants serve the Sri Lankan mobile market. Further, how the local mobile network operators competition levels will influence these new development entrants in the long run. Based upon Bain (1956) and Stigler (1968) there are important market characteristics that can have significant effect on both structural and strategic parts of barriers of entry. Structural barriers will display operational and capital expenditures and market conditions and Strategic barriers will display the investment in capacity, pricing etc. To highlight the barriers to network infrastructure and spectrum development entries, Brain and Stinger barriers to entry model has been adapted (see table 2).

Table 2. Barriers to network infrastructure and spectrum development entries

Type of Barrier	Market Characteristics	Relevance to network infrastructures and spectrums	Potential (High/Medium /Low)
Structural barriers to entry	Economies of scale	▪ Operators should adapt long term sustainable mechanisms to gain high economies of scale.	Low
	Capital and Operational expenditure	▪ The costs of deploying third and second	High

Type of Barrier	Market Characteristics	Relevance to network infrastructures and spectrums	Potential (High/Medium /Low)
	s	generation networks are high. ▪ An average of, 83% of mobile network operators energy requirements are due to network infrastructure maintenance.	
	Brand Loyalty	▪ Low network coverage leads to high impact on customer retention.	High
	Patent, intellectual property	▪ New developments leadto better opportunities and sustainability.	Medium
	Regulatory barrier (license)	▪ Minimum influence from TRCSL.	Medium
Strategic barriers to entry	Low R&D on eco-friendly mechanisms	▪ Global eco-friendly trends ▪ Lack of green developments and technologies are high and time consuming.	High
	Health Hazards due to Electromagnetic Radiation	▪ Radio Frequency Standards for GSM antennas.	High
	Intense advertising	▪ Vast network coverage will be an added advantage when advertising.	Low
	Price discrimination	▪ High competition of network operators.	High
	Reputation	▪ High impact on customer reputation due robust service. ▪ Operator reputation will increase among the competitors.	High

An important feature of network infrastructure and spectrum development is that they are typically composed of various complementary components that are combined to create composite goods that are substitutes for each other. Given the importance of time, dimension and contextual factors emphasized by Carlton and Perloff (2005) there are four main market characteristics that mainly highlight for barriers to network infrastructure and spectrum development entries.

A. Economies of Scale

Economies of scale have been one of the most important features in the mobile communication industry regardless of whether it is considered an entry barrier to network infrastructure and spectrum development or not.

Gabel (2002) describes three sources of economies of scale in the mobile communications market and define the economies of scale as a critical barrier to entry. Those three sources can also be applied to local mobile communication market as well. First source is, new entrants have to install facilities such as putting up limits, digging channels, or laying channel. In this case, economies of scale exist because of the high capital and construction costs are required in network infrastructure and spectrum development at a larger scale. Due to the high cost of deploying third and second generation network infrastructures and spectrums are causing local operators to look at more potential approaches to sustain.

Secondly, the back office fixed cost of setting up a business and operational support system will be a source of economies of scale. At this time, the operational support systems play a core role than the business support systems towards network infrastructure and spectrum development. By way of operational support systems very much involves and are linked with network elements, master switching centers etc. capability of adapting to their developments is essential. Otherwise, it would be an additional barrier to entry because the fixed costs also sunk once the facilities are built.

Thirdly, the economies of scale exist in customer acquisition costs. As the local operators moving in to untapped market they incurs certain expenses that are largely independent of the number of customers they are planning to serve. Developing an advertising and marketing campaign for a particular geographic area could be an additional barrier to the entry due to number of reasons. Language barriers, lack of awareness, lack of adaptability etc. may have contributed to this barrier.

B. Capital and operational expenditure

According to Michael Porters competitive model, the threat of new entrants is low in network infrastructure and spectrum development entry due to capital requirements which are extremely high and require investment over a period of time prior to profit making. Base station deployment can be highlighted as a core capital expenditure in infrastructure and spectrum development entry. The capital expenditure on base station was increased over last few years due to the rapid development of the country. Setting up a roof top tower with the capacity of two tenants costs about Rs. 5 - 10 million. Constructing a base station with a single cell tower will cost about Rs. 10.25 - 20.7 million. About Rs. 3.25 - 10.5 million of that is for pouring concrete, the mast and its assembly, backup generators, fencing, cooling systems, security systems etc. Local mobile network operators will generally spend a minimum of Rs. 3 - 8 million for the equipment (baseband processors, transceivers, power supplies, amplifiers, etc.), and another Rs. 2 - 3 million for installation and connect the base station to the core network.

In addition to capital requirements, industry knowledge and expertise also play a key role in shaping the infrastructure and spectrum development including sourcing, infrastructure design as well as research and development. These factors largely affect the growth and state of the infrastructure and spectrum development and are significant hurdles that need to be overcome.

Capital expenditure counterpart operational expenditure refers to the day-to-day costs of operations. In network infrastructure and spectrum development operational expenditures are associated with setting up a core network and maintaining it. Operational expenditures for setting up a network include the costs for upfront planning, field rent charges, planning studies to evaluate the structure of the new network infrastructure, changing the network topology, introducing a new technology or a new service platform etc. However, maintenance expenditure is higher than the setting up expenditure due to several reasons. Core reason which Perry, et al. (2012) highlight here is field rent charges, power and cooling energy expenditures in network infrastructure maintenance. However, solar power and wind power infrastructure bases pose a significant threat as substitute energy sources switching cost is relatively high in to theses mechanisms. Due to high investments, threat of substitutes is also low in network infrastructure and spectrum development can be experienced.

C. Low R&D on eco-friendly mechanisms

Mobile communication network infrastructure and spectrum development can be characterized by high threshold levels of investment, research and development, which causes the existence of substantial sunk costs and a high fixed to variable cost ratio, significant economies of scale and scope, and externalities (Miller, 1995; Brock, 1981). Nevertheless, with the global environmental trends and mechanisms, moving or adapting in to a green infrastructure and spectrum development could be a supplementary barrier to the local mobile network operators due to the high investment. The green development mechanisms aim to extend mobile network operators beyond the grid simultaneously reducing energy costs and minimizing environmental impacts (Energy+Mobile at Mobile World Congress, 2012). Despite the fact, there is a growing potential in local mobile network operators to adapt to green development mechanisms as energy consumption of their networks is an increasing contributor to global green house gas emission.

The rising cost of energy and increasing rate of green house gas emissions, are deeply concerned about energy efficiency and green development mechanisms in local mobile network operators. Green Power for Mobile Interactive Replication Guide (2012), pointed out two main concepts which a network operator can adapt/switch in terms of green development. First concept is adaptation to green power equipment as an alternative source of energy. This is the growing concept in the local mobile communication industry. Scientific research concludes that energy consumption is an industry-wide issue which affects each local mobile network operators operations. In addition to their benchmarking practices to environment standards, but few of them have adapted numerous energy efficiency developments in their network infrastructure bases.

Second concept is network infrastructure sharing. Increasing competition, along with investments in ever-changing technology, has been pushing mobile network operators towards new ways of maintaining margins. Considering that, developing and operating network infrastructure and spectrum is a significant cost for local operators. Network Infrastructure sharing is the ideal way to find quick wins in the competitive mobile market. Rivalry of Network Infrastructure sharing is low in the local mobile communication industry as the concept is novel to the local mobile network operators.

D. Health Hazards due to Electromagnetic Radiation

The base stations are normally configured to transmit different signals into each region or sectors. These base stations are normally connected to directional antennas that are mounted on the roofs of buildings or on free-standing masts. Local mobile network operators have adopted both 2G and 3G technologies in their base stations. Scientific research pointed out that 2G directional antennas transmit in the frequency range of 935 - 960 MHz (GSM900) and 1810 – 1880 MHz (GSM1800). Likewise, 3G (3G 2100) antenna transmits in the frequency range of 2110 – 2170 MHz.

The power of a transmitter that is radiated from a base station antenna will have a uniform power density (power per unit area) in all directions. The power density at any distance from an antenna is simply the transmitter power divided by the surface area of a sphere ($4\pi R^2$) at that distance. These directional antennas transmit electromagnetic radiation 24x7, therefore people living around the tower will receive stronger signal than required for mobile communication. Radiated power Density must be considered when calculating electromagnetic radiation strength around a directional antenna.

When a human body is exposed to the electromagnetic radiation, it absorbs radiation, because human body consists of 70% liquid. It is similar to that of cooking in the microwave oven where the water in the food content is heated first. Further, human height is much greater than the wave length of the base station tower transmitting frequencies. Therefore there will be multiple characters in the body, which creates localized heating inside the body. This results in boils, drying up of the liquids around eyes, brain, joints, heart, abdomen, etc. Table 3 lists down some biological effects of electromagnetic radiation.

Table 2.Biological effects of electromagnetic radiation

Power Density ($\mu W/cm^2$)	**Reported Biological Effects**	**Reported by**
0.002	Sleep disorders, abnormal blood pressure, nervousness, weakness, fatigue, limb pain, joint pain, digestive problems,	Altpeter 1995,1997
0.2 to 8.0	Childhood leukemia, Change in calcium ion efflux from brain tissue	Hocking 1996 and Dutta 1986
1.0	Headache, dizziness, irritability, fatigue, weakness, insomnia, chest pain, difficulty breathing, indigestion	Simonenko 1998
5.0	Biochemical and histological changes in liver, heart, kidney, and brain tissue	Belokrinitskiy l982
10.0	Damaged mitochondria, nucleus of cells in hippocampus of brain and Redistribution of metals in the lungs, brain, heart, liver, kidney, muscles, spleen, bones, skin, blood	Belokrinitskiy 1982a and Shutenko 1981
100.0	Dropping insulin percentage	Navakatikian and Tomashevskaya, 1994

500.0	High Blood Pressure due to imbalances of Potassium and Sodium levels in the body	R.H. Lovely, A.W. Guy, R.B. Johnson, and M. Mathews 1978
1000.0	Change in bioelectric activity of human muscles during deep stages of hypnosis after 10-20 second exposure at 57-78 GHz	S.I. Gerashchenko, O.I. Pisanko and Yu.N. 1991

(Stewart, 2000; Havas, 2007)

IV. COMPETING BARRIERS WITH INTER OPERATOR ROAMING

According to GSMA – Mobile Infrastructure Sharing, inter operator roaming been more controversial than the other forms of network infrastructure sharing, although there is an established regulatory view today that is also widely accepted amongst operators. Generally, inter operator roaming is accepted and sometimes encouraged in many scenarios:

A. Reduced or delayed infrastructure investment

Mobile towers are a shared cost supporting multiple base transceiver stations units, reducing deployment costs (Prasad, 2012). Power sourcing and backup can be consolidated to provide economies of scale and improved stability by service level agreements, typically in excess of 99.99% (GSMA - Green Power Vender Directory, 2013).

B. Increased coverage

Intelecon, 2013 highlights, the implementation of inter operator roaming would increase coverage of an operator in country. In Sri Lanka where the war to gain a customer is still being fought on the grounds of better network coverage, local operators will be willing to share their network infrastructure assets as it would give the same opportunity for them to wider/better network coverage as well. Further to that, the growing markets which local mobile network operators are moving in to means an ever-increasing need to expand network for them. If they have the ability to share network infrastructures, they will typically be able to roll networks out much faster.

C. Capital/Operational expenditure optimization.

In an increasingly competitive market, low cost is the key to profitability, and local operators can save on capital and operation expenditure largely by inter operator roaming. Inter operator roaming provides significant advantages versus individual network infrastructure (Green Power for Mobile Interactive Replication Guide, 2012). Outsourced infrastructure permits operators to emphasize core business operations, although consideration for competitive interests must be sustained as well. The application of green power equipment for network infrastructure shared sites is impacted by significantly increased power requirements of shared sites. Green power is shown to be most cost-effective at lower power levels, and is expected to be an absolutely required power solution which can be adapted by local operators when moving in to a network infrastructure and spectrum development entry with inter operator roaming.

D. Reduce green house gas emission and health hazards.

The importance of inter operator roaming in terms of clean development mechanism, could be the advantage of shifting existing network infrastructure instead deploying new third or second generation networks. The energy used for network operation 90% is used for radio network and 10% for the core network (Bhawan, 2011). On the other hand, reducing the deployment of third and second generation networks can decrease the health deceases which faced by the community by exposing to powerful high frequency radio waves that are generated by those cell towers. Further to this, it also can be used as corporate social responsibility tool to reduce the carbon footprint generate by mobile network operators infrastructures.

V. CONCLUSION

Mobile communication industry is where competition is inflexible. As the service continues to perform more, go green mechanisms should definitely be implemented for the long term sustainability and offer a competitive niche. Nowadays, Sri Lankan mobile network operators are facing new challenges to maintain revenue levels and profitability. Even before the recent economic downturn, mobile network operators, like other businesses are faced with the need to go green. The idea behind the paper is to develop an IT solution for local mobile network operators, to optimize network infrastructure sharing as a go green concept. This will enable mobile network operators to improve the quality of service by better service coverage. Further, this can help to reduce costs of network infrastructure creations, cost of energy consumption, and carbon footprint.

ACKNOWLEDGMENT

I wish to thank everyonewho guided and supported me and kept me going in the right track throughout the research. Your assistance, no matter how small, has undoubtedly been instrumented in the completion of this research.

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