Policy Implications of the Digital Opportunity Index (DOI) Analysis for India: Capabilities of Measurement and Importance of Extending DOI to a Regional Level

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Information Communication technology (ICT), in India, contributes to change at various levels-social, political and economic. ICT has brought rural areas much closer to the markets and has improved business transactions. There has been an increased flow of information thereby increasing productivity and innovation. There has been increase in the monitoring and accountability of governments. While quantification of the benefits of ICT is a challenge, ICT has contributed to economi rowth. India has emerged as one of the fastest growing economies in 2003-04 with its gross domestic product (GDP) rising by 8.2 percent (Central Statistical Organisation Report, June 30, 2004). India's technological capabilities and rising exports in information technology (IT) have been one of the major drivers of growth.

Therefore, as countries desire to increase the availability of ICT there is also a growing need for reliable, comprehensive and comparable statistical information on ICTs. Existing data in India remain sketchy and in any case establishing the pathways of influence of ICT on a number of development indicators is complicated. Still reliable, standardized ICT indicators provide policy-makers and regulators with an accurate picture of the state of the ICT sector; which can be the basis for designing policy and regulatory measures that influence the spread, utilisation and impact of ICTs in the country (LIRNE*asia* 2006). On a national level robust ICT data helps countries to identify the progress, their strengths and their weaknesses, so as to tackle and finally overcome barriers to wider and better access to ICT. On the other hand, international comparisons allow economies to assess their performance objectively, identify realistic targets and create pressures for improvement. In this background the importance of robust ICT indicators is obvious.

The Digital Opportunity Index (DOI) in that sense is a composite index that measures ICT diffusion using diverse set of indicators that reflect a profile of a forward-looking Information Society. It is an all-inclusive measure that incorporates both demand as well as supply-side factors that influence the uptake of ICT. Based on a basket of individual ICT indicators, it allows for tracking changes over time—both changes in absolute scores, as well as changes in rankings relative to other economies— and provides the most useful tool for measuring progress in narrowing the international digital divide between countries (World Information Society Report, 2006). Thus, the importance of DOI stems from the fact that it not only provides a objective reality check on the effectiveness of the previous policies and their impact on the various DOI indicators, but also identifies weaknesses and the direction which the future policy and regulatory design must take if the national governments are serious about developing an inclusive information society.

In the above context, this case study on India is a *smorgasbord* of three important aspects of DOI as a measure of a nation's ICT development. ***Section 1*** of this study briefly reviews the policy and regulatory environment in India that had an impact in influencing DOI in India. What are the lessons to be learned and how can these lessons be extended to address the issue of digital divide in a country of the size and heterogeneity of India? This section also discusses the policy and regulatory constraints on India achieving a higher DOI and seeks to provide appropriate policy solutions to address these constraints and boost the DOI by analysing the sub-indices of DOI. Recognising the importance of good statistical data that are essential to compose the index (as good data leads to proper measurement and hence provides a robust guide for informed policy decisions) ***Section 2*** gauges the availability and sources of DOI indicators in India. In this section, we propose to take stock of DOI indicators statistics in India, benchmarked against the classifications and methodologies formulated by the Partnership on Measuring ICT for Development. The reference point for the exercise is the 'metadata survey, a global exercise to collect information from all countries regarding the statistical measurement of ICT (reported in "The global status of ICT indicators") conducted by global Partnership on Measuring ICT for Development. ***Section 3*** explores the possibility and the importance of extending DOI measurement to the different regions or States of India. Given the heterogeneity and continental scale of India, we believe that a Pan Indian DOI will aggregate the achievers with the laggards, while a state-wise/region-wise DOI can also provide an indication of how states are performing over time. In a federal structure such as that in India state level DOI is important for policymaking.

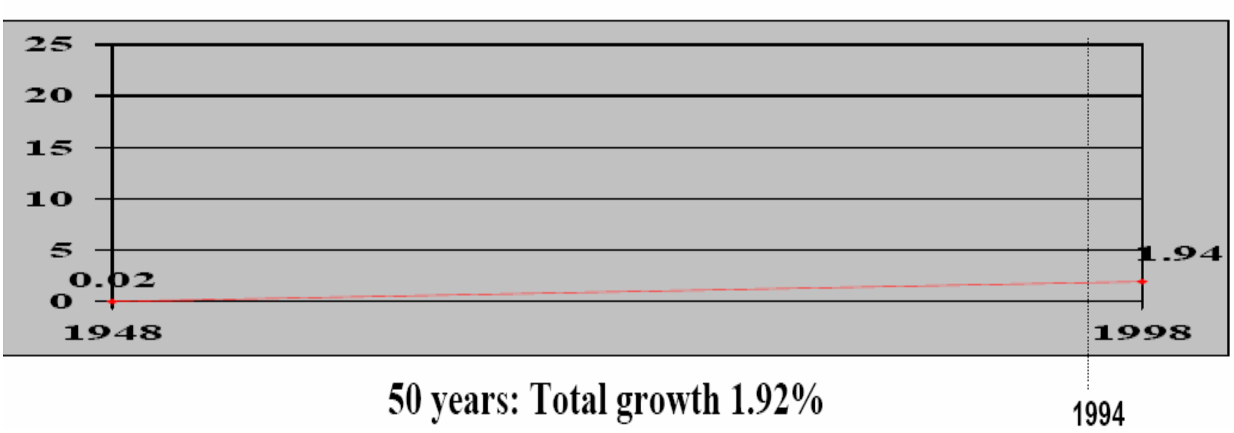
1. POLICY IMPLICATIONS OF THE DOI ANALYSIS

Policy developments influencing India's DOI Score

Privatization and liberalization in telecom came to be viewed as necessary to overcome organizational inertia and to attract new investment. The transformation of telecommunications markets in India as elsewhere took several dimensions- in the changing structure of demand, in the convergence of services and in the evolving structure of the industry. The two key elements defining the change in the market structure were (i) the restructuring of the government operator and (ii) the entry of private operators. Thus, there has been a shift from a static, monopolistic industry that provides a single product, telephone service, to a dynamic, multiproduct, multioperator industry. It should, however, be noted that this change in market structure has taken place without the privatization of the domestic incumbent service provider BSNL and MTNL. The privatization of the overseas carrier Videsh Sanchar Nigam Limited (VSNL) in April 2002, with the strategic sale of a stake of 45% to Tatas and the government and employees retaining a stake of 26.13% and 1.97% respectively, represents the first and only instance of the government transferring control of a telecom undertaking to the private sector (Malik 2005).

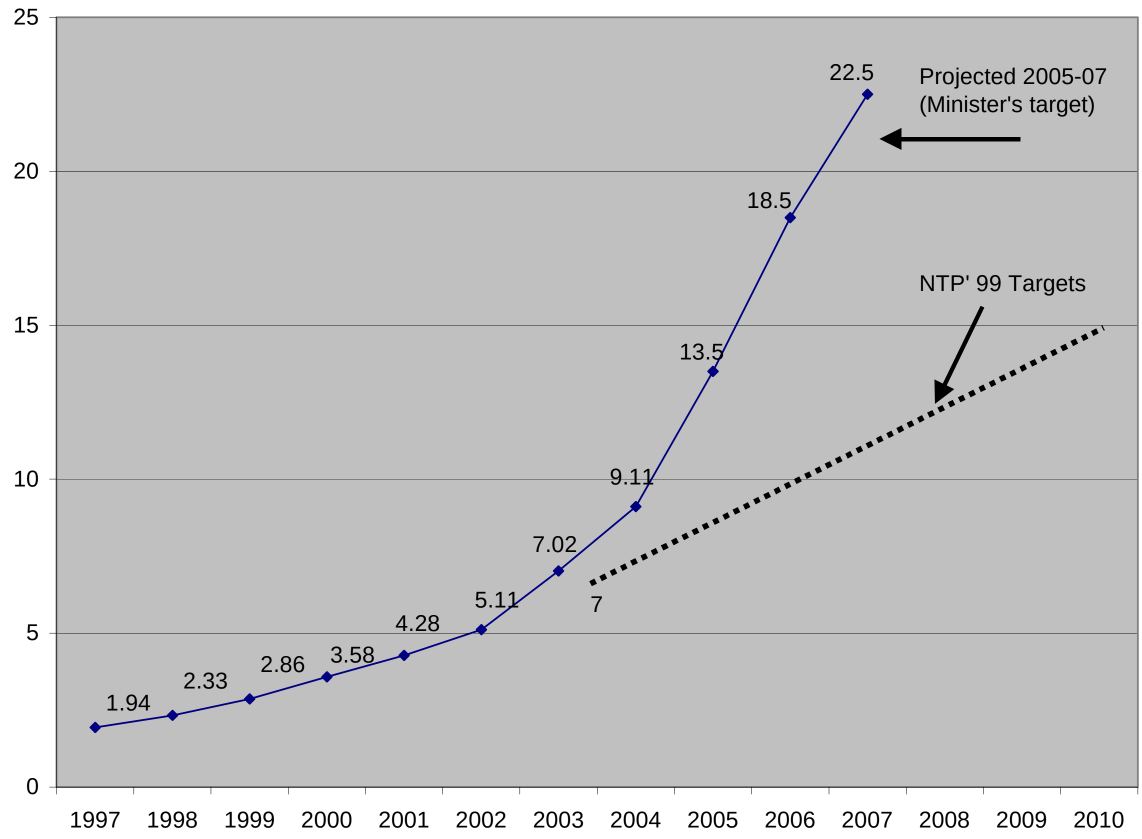
The results of liberalisation have been impressive. Teledensity has increased from merely 2 percent or so in 1999 to around 12.80 percent in 2006, and is set to cross 20 percent in the next 5 years beating the government's target by 3 years. As in many developing countries the telecom growth in India, has been **fuelled by wireless growth**. The wireless subscriber base has grown from 1.6 million in 1999 to 90.14 million in March, 2006 and has outstripped the subscriber base of 50.18 million of fixed service users. The mobile sector grew at 72.62 percent in comparison to an 8.64 percent growth of fixed sector between March 2005-06. The introduction of the calling party pays principle, and a combination of TRAI tariff orders (including both general tariff forbearance when effective competition was present and regulated termination prices where it wasn't) and increased competition has reduced prices to among the lowest in the world and increased penetration rapidly.

Figure 1: Pre-Reform Growth in Teledensity



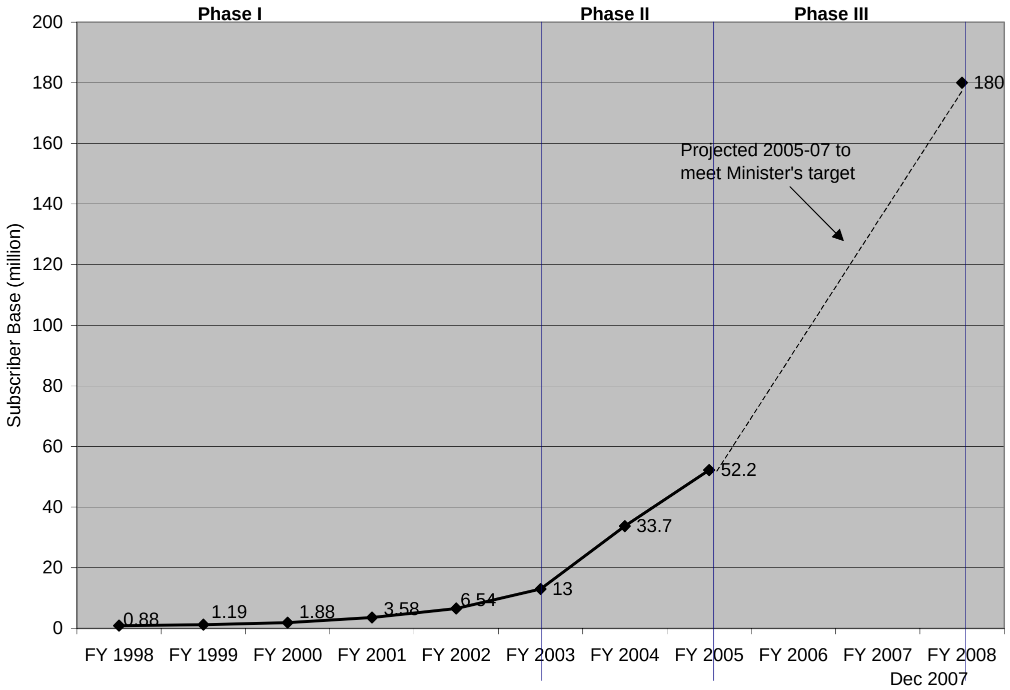
Source: TRAI

Figure 2: Tele-density Growth-Post Reform Different phases



Source: TRAI

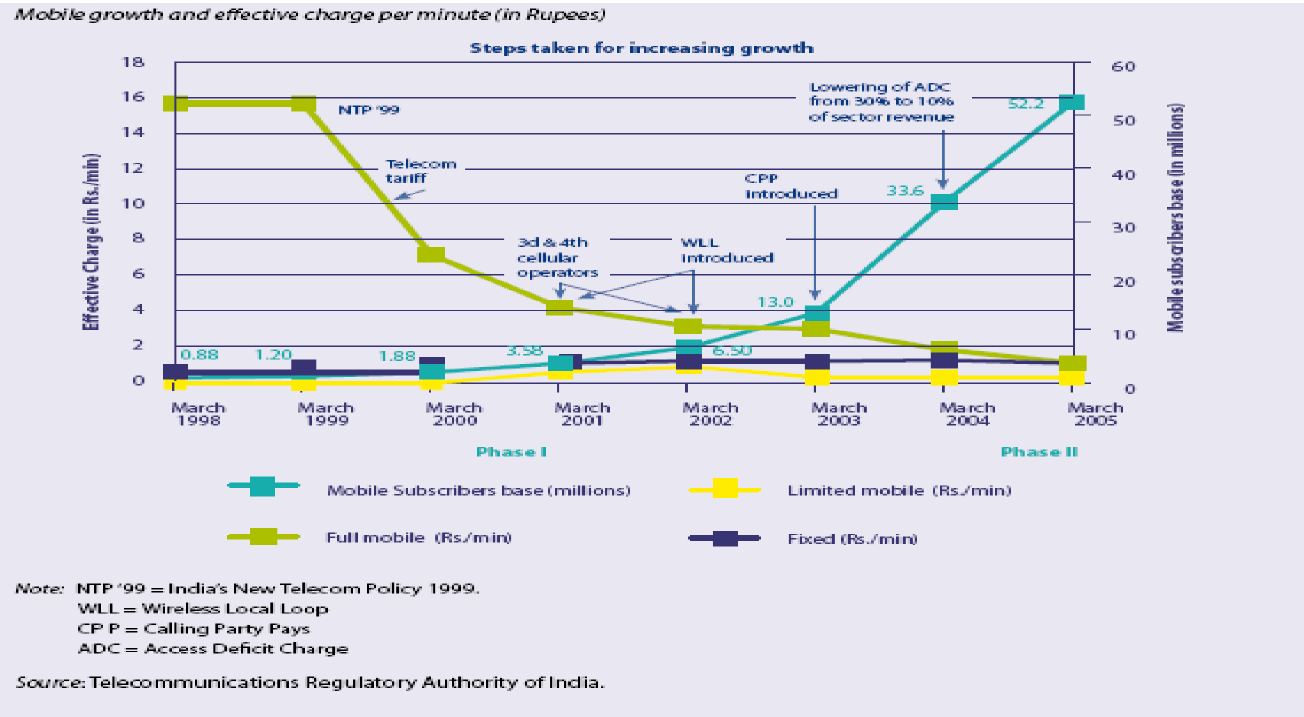
Figure 3: Mobile Subscriber Base



Source: TRAI

Public private partnership in telecommunication infrastructure has brought great benefits to the Indian economy and to telecom subscribers. This growth occurred after the Government of India/TRAI made major changes in the policies, structure and the regulation in the telecommunication sector. India is enjoying strong and sustained reductions in the price of telecommunications, and that had a positive impact on increasing the level of mobile coverage.

Figure 4: Improving India's DOI: Impact of Policy Measures



Source: TRAI, 2005 NTP: National Telecom Policy; CPP: Calling Party Pays; ADC: Access Deficit Charge

The above charts show that the growth has been primarily mobile telephony oriented. The mobile growth chart above clearly shows that the growth picked up substantially after 2003 i.e. when the mobile tariffs started approaching fixed tariffs. It was only at this stage, when tariffs went down severely because of competition, did the growth pick up. The measures taken by TRAI to reduce tariffs, i.e., through encouraging increased competition, were: introduction of Unified Access Licensing Regime, introduction of calling party pays regime, lowering of ADC from 30 percent to 10 percent of the sectoral revenue, allowing cheaper handsets to be sold at the time of delivery (with rest of the money charged in instalments), allowing cheaper intra-network calls, etc., led to the phenomenal growth. The Government encouraged the process by changing high entry fee with revenue share and reducing the revenue share further in 2001 and 2003. In summary the driving forces of the Indian telecom growth story were:

- Introduction of mobile technology which allowed telecom services to be given at lower costs
- Mobile tariff reduction by 35 percent during 2003-04, driven by fierce competition. India now offers what may be cheapest mobile tariffs in the world. Mobile growth in the years 2003-2005 has been 12 times more than the mobile growth in the earlier years. Between 1998-2005, while fixed lines subscriber addition was just 5.09 million lines, the mobile subscriber addition was 40.36 million lines.
- The Government and the Regulator facilitated tariff reduction by various measures such as tariff rebalancing (by removing cross -subsidization of local calls from NLD and ILD rates) and the reduction in licence fee by moving to revenue share arrangement
- IPLC charges decreased by 35% for low capacity and 70% for higher capacities

Thus, the overall message is very clear that it is now possible to make much more rapid progress in telecommunications than at any time in the past, thanks to technology and policy changes. This is especially good news for India with a mobile teledensity of 8.22 in 2006. Thus, there is no surprise that due to these policy and regulatory intervention India was one of the fastest growing countries in its DOI position and the major contributor to this was a healthy DOI opportunity score of 0.80.

Table 1: Major Gainers in the DOI Index, 2001 and 2005

Economy	DOI 2001	DOI 2005	Change 2001-2005 (%)	Drivers (+.O.2)
India	0.17	0.29	73	O
China	0.29	0.42	46	I
Russia	0.32	0.44	41	I
Hungary	0.40	0.55	37	I,U
Peru	0.28	0.38	37	O,I,U
Indonesia	0.24	0.33	36	O
Brazil	0.32	0.43	35	O,I,U
Poland	0.39	0.52	34	I,U
Japan	0.54	0.71	33	U
Venezuela	0.32	0.43	33	U
Chile	0.40	0.52	32	U
Egypt	0.29	0.38	32	I
Rep. of Korea	0.60	0.78	31	U,I
Israel	0.50	0.66	31	U
Spain	0.47	0.61	28	U
Average	0.37	0.50	37	
40 Economies	0.43	0.54	27	

Source: WISR, 2006

This was the good part of the Indian telecom growth story, however, scrutiny of the DOI indicators and the policy implications thereof are testimony to the fact that India is far below its potential in terms of its DOI ranking. In what follows, we identify the supply-side constraints emanating from the policy and regulatory environment that provide explanation for the low DOI ranking that India still has. In this sense DOI is a powerful tool to isolate and pinpoint the indicators that pull down India's DOI and provide a roadmap for future policy and regulatory interventions.

Table 2: India's DOI: Analysis of the Micro picture

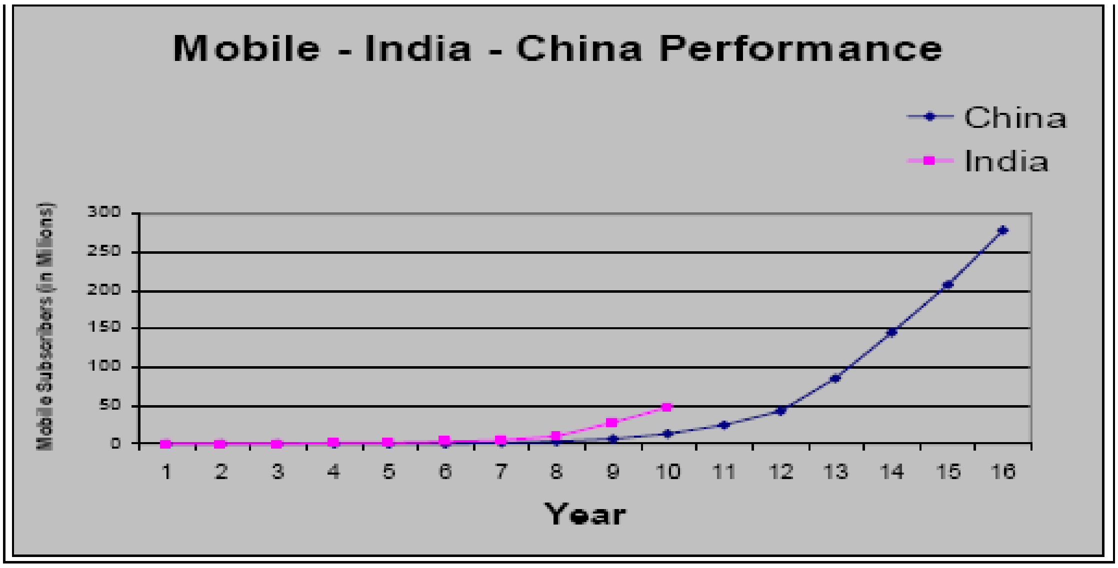
DOI Indicator	DOI Score	Disaggregated DOI
Percentage of population covered by mobile cellular telephony	**0.6001**	**Opportunity Index:** 0.801; Rank: 110 **Infrastructure :** 0.044; Rank: 139 **Utilization:** 0.038; Rank:93 **DOI:** 0.294; Rank: 119.000 **Mopp:** 0.768 **Minfra:** 0.023 Mobile DOI: 0.263; Rank: 124 **Mutilization:** 0.000 **Fopp:** 0.869 **Finfra:** 0.058 Fixed DOI: 0.328; Rank: 112 **Futilization:** 0.056
Mobile cellular tariffs as a percentage of per capita income	0.935	
Internet access tariffs as a percentage of per capita income	0.869	
Proportion of households with a fixed line telephone	0.103	
Mobile cellular subscribers per 100 inhabitants	0.045	
Proportion of households with Internet access at home	0.023	
Mobile Internet subscribers per 100 inhabitants	0.000	
Proportion of households with a computer	0.048	
Internet users per 100 inhabitants	0.023	
Ratio of Fixed Broadband Internet subscribers to total Internet subscribers	0.090	

[1] TRAI/COAI estimate for this indicator are however much lower. For the year ending 2005, TRAI at the NCAER-NBER conference presented a paper titled "Chinese Growth-Chinese numbers, cited the population coverage of cellular mobile in India at 25-30 percent. The present coverage is estimated to be around 40 percent. We refer to that later in this paper.

Ratio of Mobile Broadband Internet subscribers to mobile Internet subscribers	0.000	

As pointed out in the WISR, 2006 it is instructive, for policy purposes, to look at the different components of India's DOI score. We saw earlier in this section that the policy and regulatory environment succeeded in improving the Opportunity sub-index, as a result of increasing mobile coverage and reducing tariffs. However, it is also the same policy and regulatory environment that is impinging upon the Infrastructure component of DOI (where India falls to 139th position). It is the low infrastructure component ranking that has diluted its gain in the opportunity and utilization sub-indices. Thus, while China, Brazil and Indonesia are in the medium-DOI countries, India is not. Ironically, an inefficient Universal Service Policy is inhibiting the expansion of mobile infrastructure to the unserved rural areas. The figure below shows that India has the potential to catch up with its neighbours like China, since the growth has been impressive in the mobile sector. However, TRAI recognises that corrective policy measures especially in the Universal Service policy have to be implemented if the growth momentum is to be maintained. Thus, India cannot be complacent with 2 million subscriber additions per month; the additions have to be greater than 4 million per month in order to achieve the government's stated targets.

Figure 5: Mobile - India - China Performance



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
China	0.003	0.01	0.02	0.1	0.2	0.6	1.6	3.6	6.8	13.2	24	43	85	145	207	279
India	0.03	0.22	0.8	1.1	1.6	3.1	5.5	10.5	28	48						

Introduction of Mobiles:

China year 1 : 1988 Year 17 : 2004

India year 1 : 1995 Year 10 : 2004

Note: Values are for end of year (December)

- So far, on any year to year basis, after late start of mobiles in India, we have done better than China
- We must continue – but corrective measures required for phase III (2005-07)

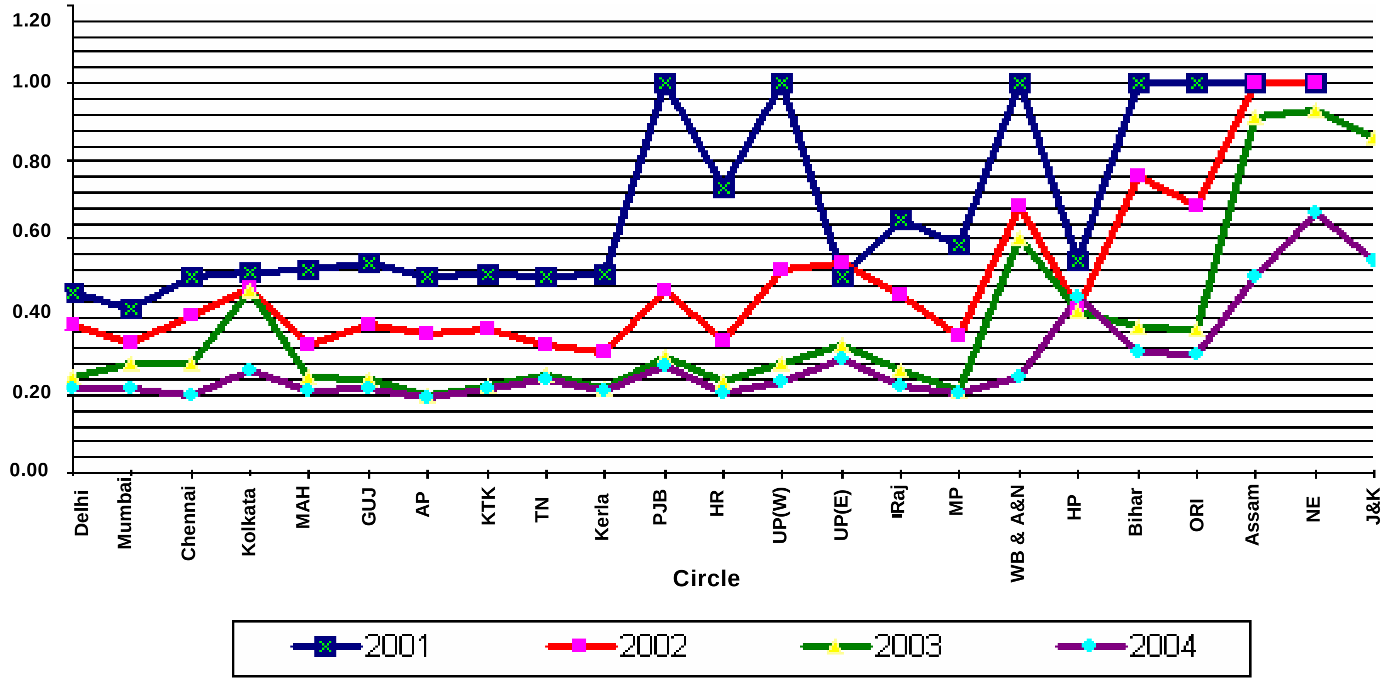
Source: TRAI

While recognising the demand-side constraints on the infrastructure DOI indicators such as proportion of households with a computer and proportion of households with internet, supply-side constraints are still important. Supply side constraints are important in explaining low mobile teledensity. These constraints come mainly from the fact that the urban competitive model has not been replicated in the rural areas, as the policy is not conducive for that. Thus, the following observation is quite apt if India is to move up in its DOI ranking:

…. India is let down by its relatively low proportion of households with fixed-line access and by the fact that, despite recent growth, mobile penetration is still much lower than its neighbours, …India's current mobile boom still has further to run, as India closes the gap with other developing countries (ITU, 2006)

While noting that mobile technology has been the key driver in boosting urban tele-density, one also notes the low penetration of cellular mobile services in rural areas due to the inadequate BTS infrastructure (towers, power supply, etc.). This observation shows the non-connectivity and non-exposure of large percentage of the population (rural population) which translates into low rural tele-density. Thus, it is an inescapable policy implication that in order to improve the DOI ranking the mobile revolution has to seep into the rural areas and the laggard regions have to address the demand-side constraints in order to allow a larger penetration of mobile telephony. However, competition is the key explanatory variable when it comes to the spread of mobile telephony and TRAI proposes (elaborated in the universal service section) that some infrastructure sharing competition will facilitate the spread of mobile technology to the rural areas. The following chart shows how entrenched competition is in the cellular segment, however it is restricted to only 50 percent of towns and cellular presence is negligible in the rural areas.

Figure 6:Circle-wise HHI for Mobile Services



Source: TRAI, 2005

Figure 7: Percent Coverage of Mobile Networks 2003-3004

(Population Coverage ~ 20-25%)

	By area	*Population Coverage*
Towns	~2000 out of 5100	~250 Million
Rural areas	Negligible	Negligible

Proposed Network Coverage by 2006 ; operators plan (Population Coverage 75%)

	By area	*Population Coverage*
Towns	~4900 out of 5100	~300 Million
Rural areas	~350,000 out of 607,000 villages	~450 Million

Source: TRAI

Even utilization (where India ranks 93rd) is far below than its potential. We demonstrate in the following sub-sections that the ratio of fixed-broadband subscribers to total Internet (an important component of the DOI utilization index) can be pulled up if the policy and regulation is conducive.

Universal Service Policy and DOI: The Indian Case

As shown by Bauer (2004) the universality of service through targeted subsidies and competition in ICT affect almost all the sub-indices of the DOI significantly. Similarly, competitive behaviour in the form of open market entry, antitrust oversight and access to incumbent network through open access, interconnection, unbundling obligations also have an important impact on all the sub-indices. However, in the Indian context, the two major policy and regulatory barriers to improving the DOI are precisely these: (a) An ineffective Universal Service Policy and (b) Weak regulation of anti-competitive behaviour of the incumbent. Given the direct link between these two policies and regulatory interventions on all indicators of DOI we discuss how the Indian Universal Service policy has in fact led to the attenuation of competition and therefore the mobile revolution has not translated into a high mobile teledensity, thereby pulling down the DOI infrastructure sub-index ranking to 139. On the other hand, China's meteoric rise in the DOI since 2001 derives from its strong gains in Infrastructure, in part due to universal-access obligations defined by China's State Council in 2000, as well as central and local government action on infrastructure rollout.

Though the approach that has been followed in the selection of the universal service provider in India is a transparent multi-layered reverse bidding process (in which the least quoted subsidy below the reserve price became the representative rate at which subsidy was disbursed to the successful Universal Service provider) and the competitive bid process has led to a significant lowering of the benchmark subsidy rates, bringing it down to 65 to 70% in the case of rural direct exchange lines (RDELs), there have been concerns that in the absence of network competition the incumbent has leveraged its vertically integrated status even in a transparent disbursement mechanism. The competitive neutrality of these instruments is therefore a major concern.

The incumbent had an edge over its competitors as it had a large amount of the infrastructure or backbone already in place and it has been able to foreclose entry by making rural markets unviable for new entrants even with subsidy. Rural connectivity could have been seen as an opportunity and not an obligation, if this essential facility (backbone), on which the new entrants relied had been shared for extending access. If that had been allowed then the viability concerns for the new entrants would have been limited to the costs of technology that go into the backbone i.e. the access network costs. In the current design, the new entrant has to factor in the costs of laying the backbone while deciding its entry into the rural markets. Malik (2006a) shows that this was not done despite the presence of excess capacity in the backbone infrastructure. India has vast infrastructure resources lying in the ground or under water – but the fibre has not been lit. Thus, in future the universal service policy should be devised by factoring this in. The advantages will be twofold: (a) costs of universal service will be low and hence coverage greater for the same costs; (b) universal service will be competitively more neutral and avoid the pitfalls of market abuse by the incumbent. In such a scenario the universal service costs will be largely due dynamic costs of the backbone technology, i.e. the cost of access technology.

Moreover, if the access technology is not predefined (In India Universal Service Fund was initially only for fixed telephony) various technological options to minimize costs can be chosen. For example, it is irrational to build a circuit-switched network infrastructure in India when an IP based network infrastructure is cheaper by at least 70 percent. Given the multifunctionality of this technology the costs can be spread over its diverse uses, voice and data. To this end it is therefore important that universal service is accompanied by regulations which impose special obligations on the dominant operator and enforces its compliance, which in turn will counterbalance its market power. The premise of this open access approach is that optimal operations of IP networks dictates the separation of the transport layers (physical and logical) from the higher layers (applications and content) to create maximum growth through competition in all other layers. In order to make it possible at the local level to have small-scale 'plug and play' operators, using IP network, interconnecting with much larger operators this is a very important regulatory intervention. Only then can local networks co-exist as infrastructure providers alongside more traditional operators. The regulator and the policymaker in India cannot ignore this logic and premise, if they has to address the problem of the digital divide. To exploit the benefits of the new technology the policy should not be an impediment. If the state is serious of diversifying network participation then it should see that narrow ministerial considerations do not impede such regulations. Once the regulatory design is in place, the private sector and competition will take care that affordable services are available to all.

Second, certain other steps like lowering the tax burden on the operators can reduce the endogenous costs of telecom business and make rural entry a viable business opportunity. This measure will also encourage other small private sector operators with not so deep pockets provide innovative and cheap solutions for access as long as they have access to the state-owned incumbents already developed trunk fiber. To encourage such niche operators in the market TRAI has suggested various incentives in the form of low license fee, low spectrum charges etc. in its Unified licensing recommendations.

Thus, greater rural connectivity in the presence of new technologies like mobile and Internet Protocol is possible; but what is crucial is a regulatory regime that mandates open access to the backbone infrastructure. This regulatory design is a precondition for effective use of subsidies in the absence of which entry into the rural telecom markets will be limited. By restricting entry, universal service will be unachievable and unfortunately become a tool used by incumbent to serve its narrow interests.

TRAI has made progressive recommendations when it links subsidy provisioning away from Village Public Telephones (VPTs) and individual phones to the creation of infrastructure. The most important recommendation is that, once this infrastructure is created, then all new and existing infrastructure would be mandated to be shared on reasonable terms, with adequate incentives for sharing put in place. This will ensure that no single operator as an owner of a large network can exploit its monopoly position. This proposed regulatory intervention is mandated by standard economic doctrine, which teaches us that sunk costs should be irrelevant for allocation decisions at the margin. After all, bygones are bygones. Moreover, there are no private property rights issues involved as BSNL is a public entity and its infrastructure properly belongs to all citizens.

Moreover, as the scope of the subsidy has been expanded to include "niche" players and not merely the large licensed players, small and medium service providers may also participate in the rural telephony market. The assumption is that once the huge sunk cost component of the infrastructure is shared the market will take over and the urban telephony model can be replicated. This is a step in the right direction in order to make the universal subsidy support more transparent and less distortionary. A LIRNE*asia*[2] study has documented that South Korea has achieved extraordinary results through public finding of backbone networks. The assurance of open access to these networks and the increasing realization that the lack of

[2] Asian Backbone Study: A General Model Applied to India, see http://www.lirneasia.net/projects/completed-projects/asian-backbone-study/

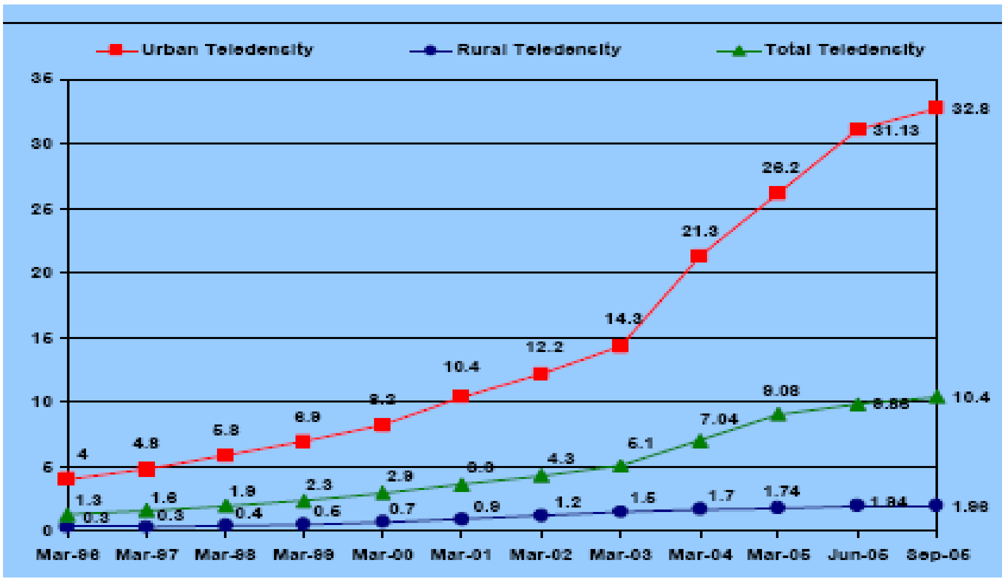
cheap long-haul capacity was stifling the provision of connectivity, especially by new entrants, creation and availability of backbone access was the *sine qua non* of an efficient Universal Service policy[3]. Under these circumstances, which are quite close to the Indian reality, TRAI has in its recommendations addressed the problem of backbone capacity.

However, in order for this to become a reality, the government will have to translate these recommendations into a new policy. The regulator has done its job and the government should take the initiative and implement the policy (Malik 2006a).

In summary, the infrastructure component and subsequently the DOI infrastructure sub-index for India can be improved dramatically if the following preconditions are met:

- Improved use of existing Assets: 670,000 route kms OFC network. Connecting 30,000 exchanges out of which 27,000 in rural area. Backbone OFC is covering almost whole country.
- Reduction in provisioning costs: Sharing of Central /State Govt. Infrastructure in rural areas.
- Provision of spectrum in non – congested bands 450 MHz : Lower Spectrum charges
- Use of Wi-Fi / Wi-Max

Figure 8: Widening Gap between the Rural and Urban Tele-density in India



3 The Republic of Korea launched its Korea Information Infrastructure (KII) project in 1995 to drive gains in infrastructure and establish high speed, high-capacity optical transmission networks in 144 regions by 2000.

Internet Diffusion

In this sub-section we show the progress of the Internet diffusion, which is one of the infrastructure component as well as a utilization component in the DOI. As the data below shows that internet growth has been slow. One major constraint is of course the unaffordable device. The Government of India had made promises to introduce, cheap indigenous computers, the Simputer, costing 250-500 USD, however this has not yet caught up with the masses. Another partial explanation could be that despite the presence of many ISPs the market is still incumbent dominated, with the other ISPs having very low market shares

Figure 9: Quarterly growth in the number of registered cyber cafes

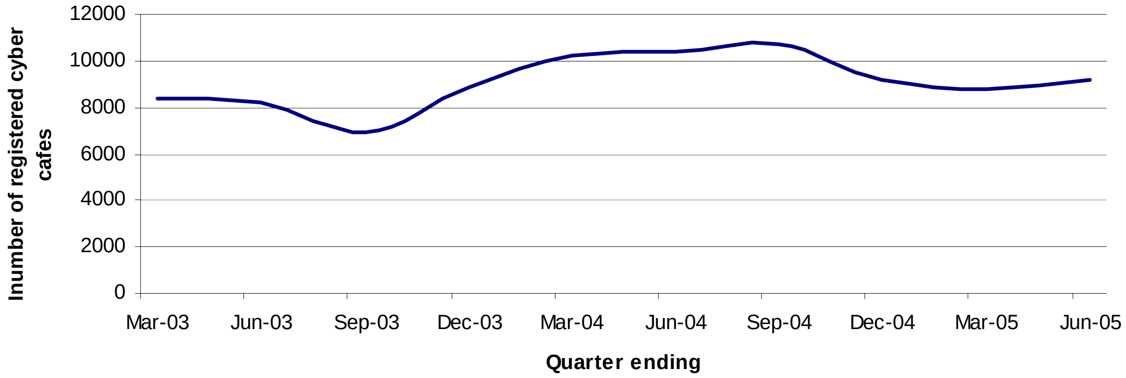


Figure 10: Quarterly growth in internet subscribers in India

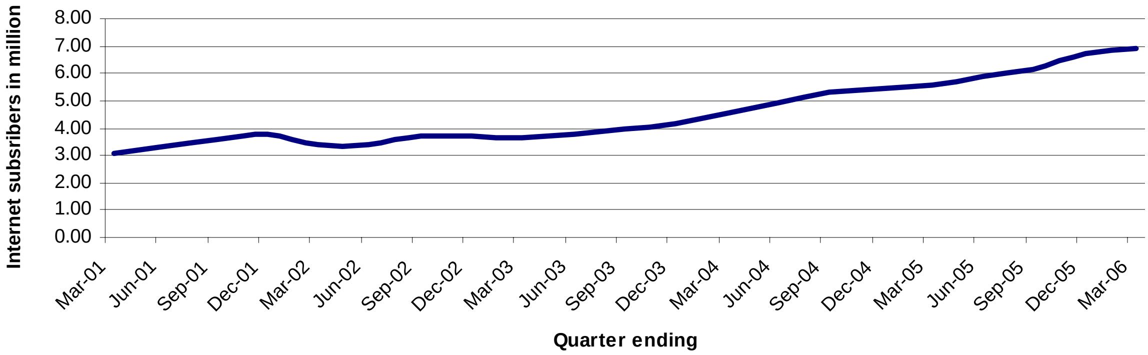


Table 3: Quarter to Quarter Market shares of the Internet Service Providers

Quarter end	BSNL	MTNL	VSNL	Sify	Data Info.	TATA	Reliance	Dishnet	Bharti	Others
Jun-03	15.35	15.54	18.38	17.5	3.8	4.71		4.65		20.07
Sep-03	20.52	17.7	16.3	16.9	1.6	3.77		4.76		18.45
Dec-03	24.26	16.71	15.2	16.59	4.21	4.32		4.24		14.47
Mar-04	24.79	16.78	13.19	16.46	4.37	3.93		5.69		14.79
Jun-04	25.59	17.21	18.77	14.07	4.54	3.64	4.55			11.63
Sep-04	29.03	17.78	19.14	14.08	4.38		4.06		1.57	9.96
Dec-04	30.79	17.41	17.16	14.16	4.55		4.02		1.91	10
Mar-05	33.4	18.22	12.65	14.61	4		4.44		2.33	10.35
Jun-05	34.23	18.84	11.88	14.36	3.91		4.81		2.63	9.34
Sep-05	36.93	19.71	8.31	13.97	3.65		5.06		3.15	9.22
Dec-05	38.74	19.59	6.96	13.08	4.65		5.07		4.67	7.24
Mar-06	42.24	14.19	8.02	12.95	3.54		5.18		5.65	8.23

Source: Internet Service Providers Association of India (ISPAI)

Broadband Policy and DOI

Ratio of Fixed Broadband Internet subscribers to total Internet subscribers is an important indicator in the utilisation sub-index of DOI. Thus, any improvement in this utilization indicator will positively impact the DOI utilisation ranking leading to an overall improvement of the DOI ranking. In this section we make some observations on the Broadband policy environment, its constraints and the policy solution to address the same. Though the proclaimed objective of the Indian Government is:

India recognises '… the potential of ubiquitous broadband service in growth of GDP and enhancement in quality of life…'

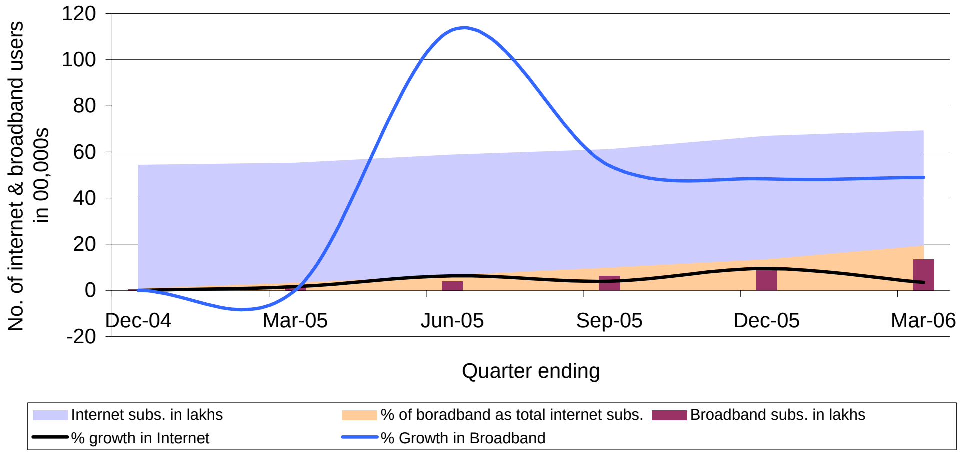
But as we point out the policies are not in line with the stated objective. Due to the strong position of the incumbent competition is being limited and it has not resulted in a faster expansion of the broadband. There are about 50 million fixed lines in India, out of which BSNL and MTNL own more than 80%. The current broadband penetration stands at 1.55 million, well short of the target of 3 million by 2005 as set out in Broadband Policy 2004. The broadband target set out in the Broadband Policy 2004 is 3 million for 2005, 9 million for 2007 and 20 million for 2010. Another not so obvious but subtle target therein was that by 2005 end, at least 50% of all Internet subscribers would be under the 'Broadband' category. However, as of December 2005 India was just at 0.9 million of broadband subscribers and as of June end, it inched up to 1.55 million, implying that in the following 18 months on an average, we need to add more than 0.4 million Broadband subscribers every month. Considering that with every passing month, the asking rate is going up it is indeed a tall order.

Table 4: Ratio of Fixed Broadband Internet subscribers to total Internet subscribers

Quarter end	Dec-04	Mar-05	Jun-05	Sep-05	Dec-05	Mar-06
Internet subscriber in (00,000s)	54.5	55.4	58.92	61.25	67.03	69.35
Broadband subscribers in (00,000s)	0.49	1.86	3.96	6.1	9.05	13.48
% of broadband of total internet subs	0.90	3.36	6.72	9.96	13.50	19.44
% Growth Q-o-Q in Internet	0	1.65	6.35	3.95	9.44	3.46
% Growth Q-o-Q in Broadband	0	0.0	112.9	54.0	48.4	49.0

Source: ISPAI

Figure 11: Comparison of quarterly growth of Internet and broadband subscribers



One major policy stumbling block in the growth of broadband services is the issue of Local Loop Unbundling (LLU). TRAI had suggested way back in April 2004, non-discriminatory

LLU so that the access networks of the basic service operators (BSOs) could be shared with internet service providers and other competing operators for improving broadband penetration. However, BSNL and MTNL view LLU as infringements on their property rights and hence have prevented the government from implementing the same. TRAI in its letter[4] to the Department of Telecommunication (DoT) has pointed out the following:

While recommending for Broadband Policy, TRAI had made many significant recommendations, few critical ones out of which were not accepted which are mentioned below:-

- *Recommendations pertaining to Local Loop Unbundling*
- *Other Fiscal measures like tax concessions for Broadband equipments & services*

While framing the recommendation for Local Loop Unbundling, TRAI had detailed discussions with the incumbents (BSNL & MTNL) as well as other service providers and considered the best international practices. It was suggested in the recommendations that Local Loop owners should be given an opportunity to decide the areas where they would make their own investments for providing the broadband services and also to decide on the type of unbundling depending on their commercial objectives. Also the local loops which were installed 5 years back only were recommended to be unbundled and those installed in last 5 years were left to be utilized by the owner themselves.

It was also suggested that in case the broadband target is not achieved in the first year, review of above specified arrangement should be conducted. It can be observed from the current trend that the incumbents (BSNL & MTNL) are not able to make full utilization of their infrastructure themselves and neither through franchisee option provided to them through Broadband policy. Because of this the existing local loops could not be utilized by incumbents as well as by the private operators.

Though success rate of LLU in other countries is still being debated, in a competitive basic service market, LLU as a regulatory intervention is an instrument to discipline market power, reduce monopolistic bottlenecks and possibly provide way for innovative service offerings such as broadband connectivity. Most of the current broadband connections are in the large cities where private BSOs and cable operators are also providing service with their own local loop. However, penetration is poor in smaller cities and outside urban areas where only government operators are providing service.

This is where sharing will have a positive impact. TRAI recommended LLU of only lines installed five years back. LLU will not be successful if competing operators could share only older lines with longer loop lengths and poor line conditions as these are not suitable for broadband connectivity. Pricing of unbundled local loops as set by the regulator is crucial. If the price is set too high, it may not be attractive for competing operators. If it is too low, investment incentives are destroyed. Ideally, prices should reflect their long run incremental cost plus a mark-up to ensure that costs which are common to the line and other services of the incumbent carrier can be recovered.

Sharing gives BSOs, especially BSNL, to leverage on its infrastructure of 50 million copper cables. However, it can be successful only if the incumbents do not view it as a threat and competing operators sense opportunity for broadband services. In India besides

[4] Letter dated November 3, 2005, available at www.trai.gov.in

BSNL/MTNL we have GAIL, Rail Telecom & Information Technology & PGCL provide the broadband, optical fibre –based transmission infrastructure which may be leased by service providers at competitive prices. The licensed service providers may put up their national and international gateways and connect them with every other network.

Issues of infrastructure sharing do not lend themselves to any "cookie cutter" solutions and the regulator indeed has to tread carefully in these matters. Many tradeoffs are involved and the final solution has to keep in mind the incentive structure that the regulations will produce. Our view is that it all depends on the details and on the presence of alternative infrastructures (e.g., cable). In the US mandatory unbundling (UNE-P) did not work as they did "too much", so entrants could just sit on the incumbent's network. The European perspective is that some unbundling is necessary as otherwise you will never be able to create competition, however at some stage entrants must have their own facilities. This is sometimes referred to as the "ladder of investments", so unbundling can help move up the ladder. Unbundling should be one of the several tools in the policy maker's arsenal of pro-entry policies that will hopefully lead to facilities based infrastructure competition (on either a wholesale or vertically-integrated basis). Once this demand is realised and facilities based competition exists, in that case, mandatory asymmetrical unbundling should, in theory, no longer necessary[5.] Precaution should be taken that unbundling should not be used to create a static incumbent centric perpetual resale model, where everybody purchases their primary input from a single monopoly provider. Unbundling can be viewed as a two-stage process. In the first stage, unbundling should be used to stimulate new alternative non-incumbent demand. In the second stage, new facilities-based entry should be encouraged to serve this consolidated demand.

In conclusion to this section, the overall impression is that the regulator has not been very successful in proving that it has enough powers over the incumbent. However, it is not clear whether this inability is on account of the limited jurisdiction that TRAI had in the licensing process or because it is carrying forward the universal access policies of the government. Whatever maybe the case, the point is that the regulator can and must improve its perception on this count and not be seen as subservient to the government and hence the incumbent. Some initial results of the Telecom Regulatory Environment (TRE) scorecard[6] study being done by LIRNE*asia* for India has shown that the regulator is performing poorly precisely on the parameters: Regulation of Anti-Competitive Practices and Universal Service.

2. CAPABILITIES OF MEASURING DOI INDICATORS

In this section we provide a quick review of the most reliable data sources for the various DOI indicators and make some observations on how to improve data and the problems of associated with the available data. For sake of simplicity and cross-references, we itemize the availability according to the indicators list provided

Opportunity:

[5] From a transaction cost perspective a more efficient alternative would be to impose mandatory divestiture of the incumbent's loop plant from its marketing arm, rather than imposing stringent price, conduct and structural regulation on the incumbent for infrastructure sharing. This option may however be politically difficult.

[6] Telecom Regulatory Environment Assessment (TRE) perception survey in India is a part of Six Country, Multi-component Study being conducted in India, Indonesia, Pakistan, Philippines, Sri Lanka and Thailand. The TRE Assessment, developed by LIRNEasia and already implemented in a number of countries, is a perceptual index which gauges the performance of telecom regulatory agencies. The TRE is based on the perception of efficacy by a set of representative and informed group of respondents. This group includes top-level management of operators, government, journalists, financial institutions and generally any organization or individuals with direct or indirect knowledge of the sector for the period June 2005-June 2006.

1. Percentage of population covered by mobile telephony: TRAI, Cellular Operators Association of India (COAI); Population coverage as reported by COAI is considered by TRAI, it is a difficult parameter to monitor

2. Internet access tariffs as a % of per capita income: Internet Service Providers Association of India. Tariff data may not be in consonance with the DOI methodology

3. Mobile cellular tariffs as a % of per capita income: TRAI (See the methodology later); May not be in consonance with the OECD/DOI methodology

Infrastructure:

4. Proportion of households with a fixed-line telephone: Department of Telecommunications (DoT) , Census of India, Survey Data, NSSO 61st round, Market information Survey of Households (MISH), NCAER

5. Proportion of households with a computer: National Association of Software and Service Companies (NASSCOM), Market information Survey of Households (MISH), NCAER

6. Proportion of households with internet access at home: NASSCOM, IDC

7. Mobile cellular subscribers per 100 inhabitants: TRAI, COAI

8. Mobile Internet subscribers per 100 inhabitants: TRAI, ISPAI, IDC

Utilisation:

9. Proportion of individuals that have used the internet: NASSCOM, IDC

10. Ratio of fixed-broadband subscribers to total internet: TRAI, ISPAI

11. Ratio of mobile-broadband subscribers to total internet: IDC

Box 1: Cellular Tariff : Methodology adopted by TRAI

The data on tariffs for mobile as reported by TRAI is collected as follows:

GSM Service Providers
Lowest Tariffs available in the market (for local outgoing usage) as of March- 06 for GSM services

Effective charge represents the actual payout by a user with a defined traffic pattern. Total outgoing traffic have been distributed between fixed and mobile with further break up into on-net and off-net, based on the information furnished by the GSM Service providers in the quarterly report.

- **Postpaid Service**

  Effective charge has been calculated for a monthly local usage of 250 outgoing minutes. Around 600 postpaid tariff plans in the country were analyzed to arrive at the lowest effective charge per minute. The lowest available effective charge per minute is Rs. 1.01

- **Prepaid Service**

  Majority of the prepaid subscribers are using the Rs.300 or lower recharge coupon and hence the tariffs applicable for these recharge coupons (or its minor variants) have been taken as the representative tariffs for the pre-paid service. On analysis of about 200 prepaid tariff plans, it is found that the lowest effective charge per minute is Rs. 1.21.

For CDMA
Lowest Tariffs available in the market (for local outgoing usage) as of March-06 for Basic services
Effective charge represents the actual payout by a user with a defined traffic pattern. Total outgoing traffic have been distributed between fixed and mobile with further break-up into on-net and off-net, based on the information furnished by the CDMA Mobile in the quarterly report.

- **Fixed (Wireline + Wireless)**

Effective charge has been calculated for a monthly local usage of 250 outgoing minutes. All the Postpaid tariff plans in the country were analyzed to arrive at the lowest effective charge per minute. The lowest available effective charge per minute is Re. 0.71

- **CDMA Mobile Postpaid**

  Effective charge has been calculated for a monthly local usage of 250 outgoing minutes. All the Postpaid tariff plans in the country were analyzed to arrive at the lowest effective charge per minute. The lowest available effective charge per minute is Rs. 1.09

General Observations on DOI Indicators data in India

TRAI is not following the OECD basket methodology for the collection of tariff data and hence, the regulator should be encouraged to adopt the methodology in order to allow for a harmonised and comparable set of tariff indicators.

Crucial next steps for making the data more robust is to encourage the Indian NSSO to carry out detailed household usage surveys, at least once in five years. The last reported ICT usage survey by the NSSO in India has been in1998 and that too it was restricted to telephones, TV and radio usage. NSSO rounds collecting information on household expenditures do have information on consumer durables like radio, television, VCR/VCP, tape recorder, CD player etc. but nothing on expenditure telephone or computer. In the 61st round for the first time a line item on telephone charges has been included. This provides monthly household expenditure on telephone for the owners of telephone. One reason for the slow incorporation of ICT usage questions in these surveys is that these surveys reflect the data requirements typical of a developing country and hence the consumption expenditure surveys are more skewed towards the consumption patterns of the representative households. As pointed out in the OECD Guide to Measurement of Information Societies, in developing countries, there are various socio-economic problems, which create barriers to people owning, accessing and using ICT. These problems, amongst others, include illiteracy, language, socio-cultural barriers (the social divide), and lack of ICT skills, lack of access to ICT and low income and hence this explains slow adaptation of ICT questions in the official large sample household surveys. Organizations like NCAER carrying out MISH survey can also be encouraged to widen their scope of household surveys (Malik 2006b)

As mentioned in WISR, 2006, the cases of Hong Kong (China) and Australia illustrate the positive impact of coordination among the stakeholders involved in the provision and collection of ICT data, such as National Statistical Offices (NSOs), Telecommunication Regulatory Agencies (TRAs), telecommunication ministries, industry and even academia. Considered among the economies with the best practices in data collection, Hong Kong (China) and Australia have succeeded in establishing mechanisms for different stakeholders to participate and provide inputs in the selection of ICT indicators, the formulation of surveys, as well as the analysis of results. The strong connection between their policy-making processes and statistical data collection is reflected in their regular revision of ICT indicators based on policy needs. Given the diversity of sources from which data is available India should also endeavor to refine its data collection practices with a closer coordination among the TRAI, CSO and DoT. Having, said that the private sector organizations like the COAI, AUSPI, IDC and NASSCOM should be in discussion with these official organizations in order to collect and provide policy relevant data.

3. RELEVANCE OF A STATE LEVEL DOI ANALYSIS

The importance of regulation and competition in making ICT accessible and affordable to all is well established. Other aspects of demand impacting the utilization of ICT are also important in determining a country's DOI. This is particularly true for a developing country like India, where ability to access ICT is as important as availability. Moreover, disparity within the country in ability to access is substantial. Indian states are heterogeneous in terms of basic socio-economic indicators like per capita income and education, which represent the ability to access a technically sophisticated and costly (compared to foodstuff) service like ICT. In this section, we explore the disparity in socio-economic indicators within Indian states that in turn make DOI at state-level relevant.

DOI has been found to be positively associated with the income of countries. High-income countries have been found to be positively associated with greater digital opportunity and vice versa. Moreover, some countries have established virtuous circles, with high GDP per capita facilitating investment in ICTs, while ICT-intensive industries generate further income. However, there are countries like Maldives, Morocco, Peru, Myanmar, Senegal and Venezuela, which have DOI scores above expectations based on income. Adoption of broadband technology has raised the DOI index in Morocco and Peru, despite their weak infrastructure (International Telecommunication Union 2006). Other forms of ICT indicators like the ICT Diffusion Index 2005, which measures the average achievements in a country in connectivity and access of ICT, also depicts that there exists an immense information and communication technology (ICT) gap, a "digital divide", between developed and developing countries. A person in a high-income country is over 22 times more likely to be an Internet user than someone in a low-income country.

Internet servers are secured over 100 times more in high-income than low-income countries. In high-income countries, mobile phones are 29 times more prevalent and mainline penetration is 21 times than that of low-income countries. Relative to income, the cost of internet access in a low-income country is 150 times the cost of a comparable service in a high-income country. There are similar divides within individual countries. Moreover, ICT is often non-existent in poor and rural areas of developing countries (UN, 2006). Therefore, it seems to be all the more important to construct a DOI indicator at the state and sub-state (rural/urban) level in India. Abject poverty and illiteracy in many regions may lead to very low DOI for these regions when the pan-Indian DOI is also low.

ICT index at the sub-country level in India has been constructed for e-readiness assessment of the states (DIT and NCAER 2004). The sub-indicators included here are (a) environment for ICT offered by a given country or community; (b) readiness of the community's key stakeholders to use ICT; and (c) usage of ICT among these stakeholders. On the basis of the e-Readiness composite index, states have been classified as leaders, aspiring leaders, expectants, average achievers, below average achievers and least achievers. It has been found in the study that the correlation between per-capita Net State Domestic Product (NSDP) and Usage Score (one component of E-readiness index) is reasonably high (Table 5). The correlation between User Score and E-readiness index has also been found to be very high. It implies the per-capita income or the demand side in general is extremely important in e-readiness.

Figure 12: E-Readiness - Indian States

Source: Department of Information Technology, MC&IT, www.doit.nic.in.

Table 5: Correlation Coefficients between Per-capita Net State Domestic Product and Composite index and its Components, and Correlation Coefficient between E-readiness and its Components

	E-readiness	Environment Score	Readiness Score	Usage Score
Per-Capita Net State Domestic Product	0.21	0.21	0.15	0.89
E--readiness Score	1.00	0.95	0.90	0.89

Source: DIT and NCAER (2004)

Other studies on developed countries have also shown that along with supply side, demand side is also important for spread of ICT. Impact of income as well as poverty has been found to be significant in demand for ICT. A study by Garbacz and Thompson (1997) has found that in USA income elasticity of telephone demand was 0.097 over the several time periods studied (1970, 1980 and 1990). Perl (1983) has found it to be 0.13. Garbacz and Thompson (2002) has found that the elasticity of disposable personal income per household ranges between 0.043 to 0.082. The poverty elasticity estimated on basis of the same data also varies widely. It ranges from a low of about –0.025 by Crandall and Waverman (2000) to about double that by Garbacz and Thompson (1997) to an impossibly high –0.25 by Schement et al. 1997. Garbacz and Thompson (2002) shows that elasticity of poverty is at –0.049 for telephone demand.

Socio-economic Variation and its Impact on Demand of ICT

Demand side is also expected to play an important role in spread of ICT in India. Per-capita income and literacy are expected to play an important role in usage of ICT services. Availability of electricity at home is also expected to influence the utilisation of ICT services. In India there is a wide variation of socio-economic indicators across the states. The three socio-economc indicators mentioned above vary widely across the states. As a result, tele-density, which represents penetration of ICT also varies across states of India. State-wise these socio-economic indicators and tele-density (fixed + mobile) has been presented in Table 6.

Table 6: Socio-economic Variation Across Stated of India

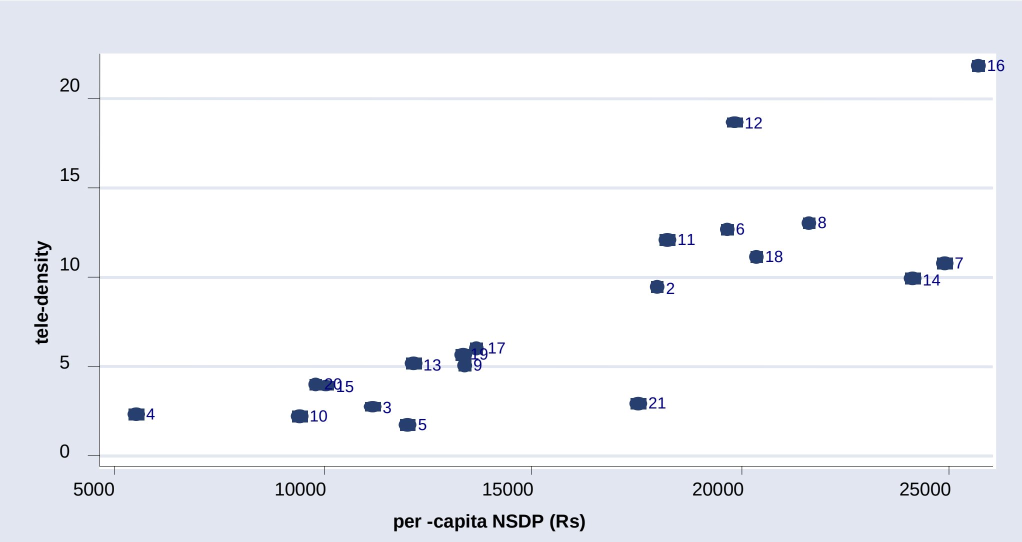
	Literacy Rate (2001)	Percentage of households Having Electricity (2001)	Per capita NSDP (Rs)-(2001-02)	Tele-density (2004-05)
Andhra Pradesh	61	67.17	17932	9.48
Assam	63	24.90	11132	2.79
Bihar	47	10.25	5445	2.36
Chhatisgarh	65	53.10	11952	1.8
Gujarat	69	80.41	19607	12.73
Haryana	68	82.90	24851	10.83
Himachal Pradesh	77	94.82	21570	13.12
Jammu & Kashmir	56	80.60	13320	5.09
Jharkhand	54	24.30	9392	2.3
Karnataka	67	78.55	18196	12.19
Kerala	91	70.24	19803	18.77
Madhya Pradesh	64	69.98	12125	5.21
Maharastra*	77	77.49	24052	9.96
Orissa	63	26.91	10021	3.96
Punjab	70	91.91	25625	21.94
Rajasthan	60	54.69	13621	6.12
Tamil Nadu**	74	78.18	20315	11.21
Uttar Pradesh	56	31.90	9753	4.06
Uttaranchal	72	60.33	13260	5.74
West Bengal***	69	37.45	17499	2.98
All States	65	55.85	19972	8.95

Note: * In case of Tele-density it is Maharastra (-) Mumbai; ** In case of Tele-density it is Tamil Nadu (-) Chennai; *** In case of Tele-density it is West Bengal (-) Kolkata

Source: Census of India 2001, CMIE 2005 and Lok Sabha Starred Question No. 244, dated 10.8.2005

The impact of demand side in the spread of ICT in India can be observed by high correlation between per-capita Net State Domestic Product (NSDP) and state-wise tele-density. It has been observed that the correlation coefficient between these two variables is 0.81. The two-way scatter diagram showing the relation between per capita NSDP and tele-density has been presented in Figure 13. It implies that demand for ICT services crucially depends on per-capita income, which is the ability to pay for services.

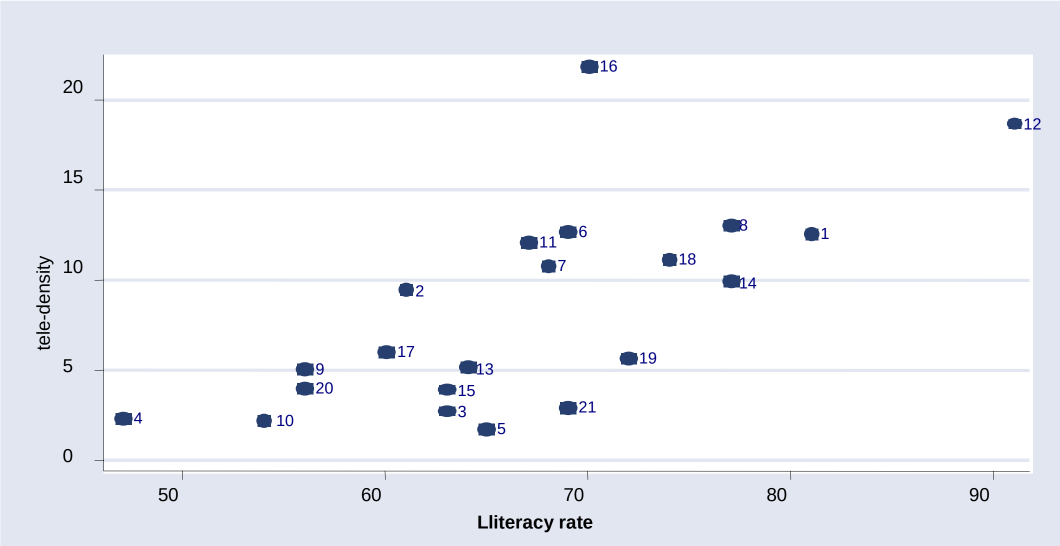
Figure 13: State-wise Per-capita NSDP and Tele-density



Note: The names of the states are numerically presented here. For details name of the state see Annex Table A1.

Literacy rate is also expected to be an important determinant of utilisation of ICT services. It has been found that state-wise literacy rate and tele-density is correlated and the correlation coefficient is around 0.70. The two-way scatter diagram presented below also shows that there is a positive relation between literacy rate and tele-density (Figure 14).

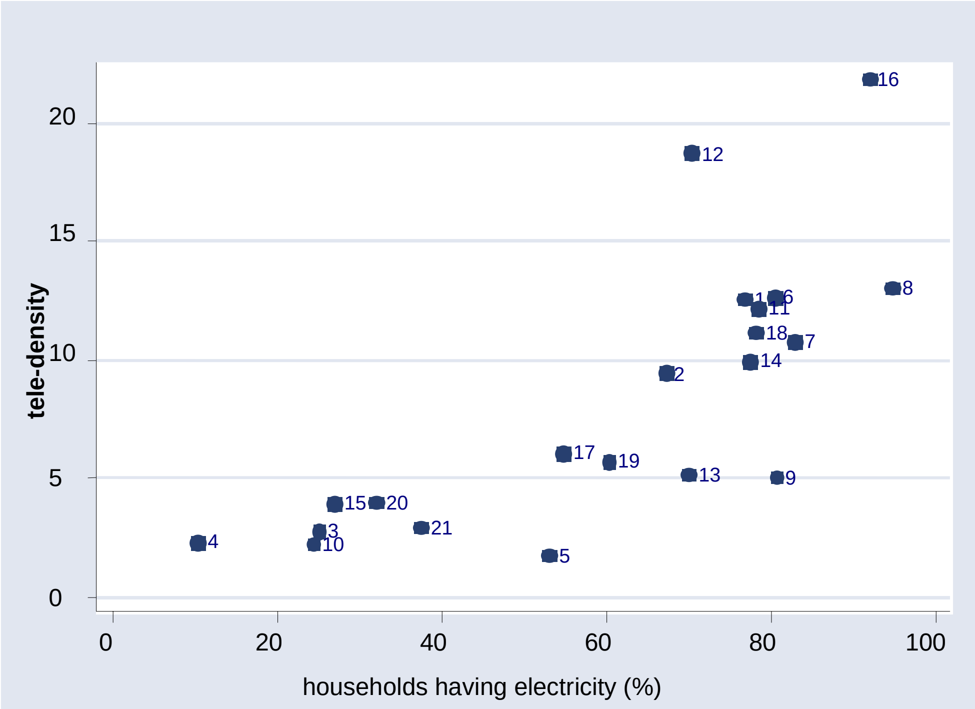
Figure 14: State-wise Literacy Rate and Tele-density



Note: The names of the states are numerically presented here. For details name of the state see Annex Table A1.

Access to electricity at home is also expected to increase the usage of ICT services. It has been found that correlation between state-wise percentage of households having electricity at home and tele-density is also substantially high. The coefficient of correlation has turned out to be 0.76 in this case. The scatter in Figure 15 depicts the relation between these two variables.

Figure 15: State-wise Households having Electricity and Tele-density



Note: The names of the states are numerically presented here. For details name of the state see Annex Table A1.

The role of the demand side in the spread of ICT in India is also evident from the difference in urban-rural tele-density. Rural areas are socio-economically less developed than the urban areas in India. It has been found that tele-density in the rural area is much less than the same in urban area. The difference (urban - rural tele-density) is highest in Himachal Pradesh at 62% during 2004-05 (Table 7). It is at 25%, putting all the states together. In Graph 4 we have presented the urban-rural difference in tele-density in India.

Table 7: State/Circle-wise Tele-Density in Rural and Urban Areas of India during 2004-05

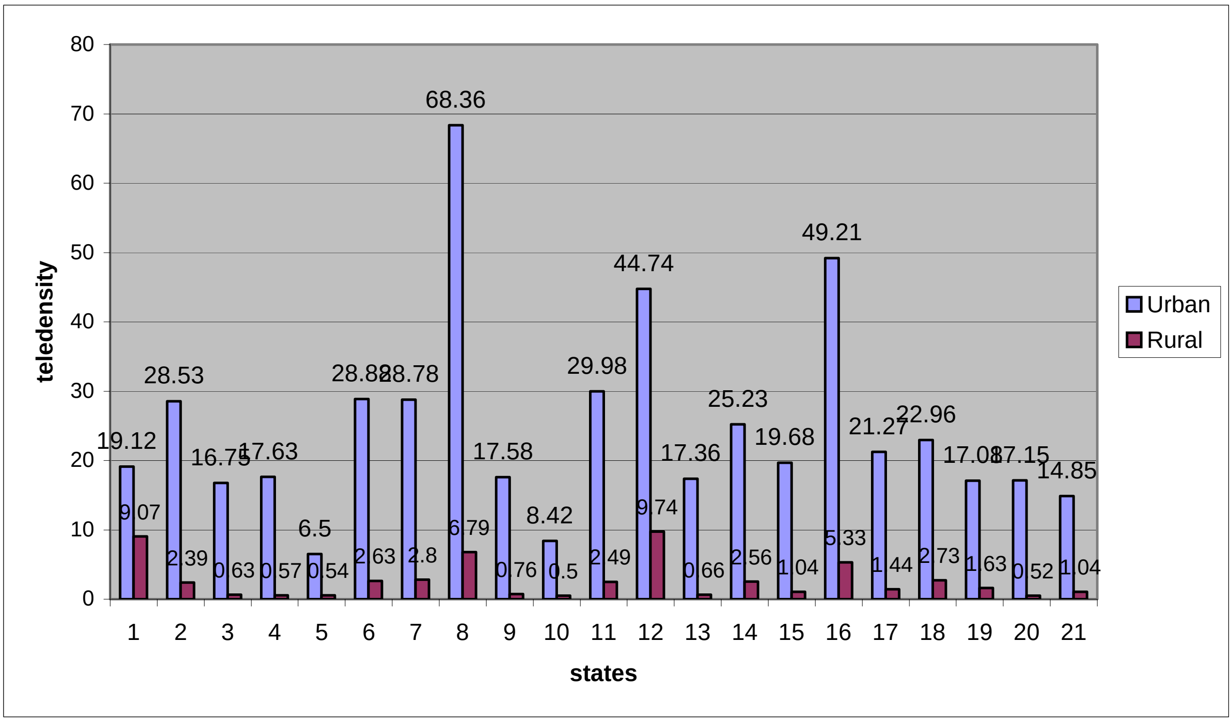
State/Circle	Urban	Rural	Overall	Difference (Urban- Rural)
Andaman & Nicobar Island	19.12	9.07	12.63	10.05
Andhra Pradesh	28.53	2.39	9.48	26.14
Assam	16.75	0.63	2.79	16.12
Bihar	17.63	0.57	2.36	17.06
Chhatishgarh	6.5	0.54	1.8	5.96
Gujarat	28.88	2.63	12.73	26.25
Haryana	28.78	2.8	10.83	25.98
Himachal Pradesh	68.36	6.79	13.12	61.57
Jammu & Kashmir	17.58	0.76	5.09	16.82
Jharkhand	8.42	0.5	2.3	7.92
Karnataka	29.98	2.49	12.19	27.49
Kerala	44.74	9.74	18.77	35
Madhya Pradesh	17.36	0.66	5.21	16.7
Maharashtra(-) Mumbai	25.23	2.56	9.96	22.67
North East-I	14.63	1.22	4.33	13.41
North East-II	12.83	1.2	3.66	11.63

State/Circle	Urban	Rural	Overall	Difference (Urban- Rural)
Orissa	19.68	1.04	3.96	18.64
Punjab	49.21	5.33	21.94	43.88
Rajasthan	21.27	1.44	6.12	19.83
Tamil Nadu(-) Chennai	22.96	2.73	11.21	20.23
Uttaranchal	17.08	1.63	5.74	15.45
Uttar Pradesh	17.15	0.52	4.06	16.63
West Bengal (-) Kolkata	14.85	1.04	2.98	13.81
Kolkata	24.22	0	24.22	24.22
Chennai	47.56	0	47.56	47.56
Delhi	50.94	0	50.94	50.94
Mumbai	45.43	0	45.43	45.43
Total	**26.88**	**1.73**	**8.95**	**25.15**

Source: Lok Sabha Starred Question No. 244, dated 10.8.2005.

Note: The names of the states are numerically presented here. For details name of the state see Annex Table A1

Figure 16: State-wise Urban-Rural in Tele-density in India (2004-05)



Summing up, it has been observed that demand side, represented by the socio-economic status of households, plays an important role in diffusion of ICT in India. India being a large country with huge heterogeneity among the states and rural/urban areas in socio-economic indicators, regional ICT indicators are also expected to vary widely across regions. That is why constructing regional DOI at both state level and at the level of rural/urban areas, is extremely important in countries like India.

4. CONCLUSIONS

Recognizing the fact that DOI indicators are quite sensitive to the policy and regulatory interventions, the Indian case study has demonstrated how DOI can be used as an effective policy tool not only to see which policies worked over time and which failed but also provide a guide for the future policy and regulatory environment. We also emphasized the importance of coordination between the various government agencies and the private sector in order to collect robust data for the DOI analysis. Last, we provided a brief overview of the factors influencing the regional disparities in the adoption of ICT and recognized that given these differences, the next obvious step will be to extend DOI measurement for different regions in India. However, this is contingent upon the data collection improvements especially demand side survey data.

The Indian case study has pointed out that, in the 2003-2005 period, the regulator's perseverance in promoting mobile technology was the single most important factor in explaining India being a major gainer in its DOI score between 2001 and 2005. Thus, the conclusion from the DOI analysis is that if India has to catch up with its neighbors like China, it has to constantly improve its mobile coverage and mobile teledensity. Moreover, the ratio of fixed Broadband internet to all internet users can be a major driver of the DOI utilization index. Thus in the context of Indian reality the DOI indicators (a) Percentage of population covered by mobile cellular telephony (b) Proportion of households with a fixed line telephone (c) Mobile cellular subscribers per 100 inhabitants and (d) Ratio of Fixed Broadband Internet subscribers to total Internet subscribers can be the drivers of its DOI. However for this to happen, based on dynamic efficiency policy must encourage growth of new technologies, end-to-end platforms, market institutions, and packages of services and content. This means policy should encourage multi-platform competition and does not perpetually have to play catch-up with technological progress.

As we saw, India has the potential but what is important is to replicate the urban competitive model in the small towns and the rural areas with a less distortionary and more enabling Universal Service Policy.

Annex

Annex Table A1: State-code and Name of the State

State-code	State/Circle
1	Andaman & Nicobar Island
2	Andhra Pradesh
3	Assam
4	Bihar
5	Chhatishgarh
6	Gujarat
7	Haryana
8	Himachal Pradesh
9	Jammu & Kashmir
10	Jharkhand
11	Karnataka
12	Kerala
13	Madhya Pradesh
14	Maharashtra*
15	Orissa
16	Punjab
17	Rajasthan
18	Tamil Nadu**
19	Uttaranchal
20	Uttar Pradesh
21	West Bengal***

Note: * In case of Tele-density it is Maharastra (-) Mumbai; ** In case of Tele-density it is Tamil Nadu (-) Chennai ; *** In case of Tele-density it is West Bengal (-) Kolkata

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