Note on Spectrum Requirement for 2G cellular operators

- The total spectrum availability for 2G (primarily voice service) cellular services varies between 2x75 and 2x100 MHz across the country. Two technologies, GSM and CDMA, are deployed, with GSM deployed in more spectrum that CDMA.

- It is widely accepted that CDMA gives equal or more capacity than GSM per MHz. So, for purposes of calculation of capacity, we may assume conservatively that only GSM is deployed.

- Shortage of spectrum occurs primarily in the dense urban areas where the subscriber density and voice traffic levels are the highest. The cell density in these areas is also the highest. Inter-site distances are as low as 300m in such areas in today's network deployments, and 400m is common.

- When considering network capacity (Erlangs/sq.km) for a given amount of spectrum, it is important note that capacity increases non-linearly per MHz of incremental spectrum allotted upto a point, and thereafter the relationship becomes more and more linear. This aspect has been dealt with in more detail in the May 2009 Report on "Allocation of Access Spectrum and Pricing" in Para 2d of Chapter II. It has been shown that from a point of view of capacity, and therefore efficiency of spectrum utilization, 2z10 MHz more or less yields the maximum efficiency. An additional 2x2 MHz is possibly needed if in-building deployments are envisaged.

- However, if one considers Appendix A4 of the same Report, it is seen that the capacity (in Erlangs per BTS or site) per MHz is quite high even for 2x8 MHz, while being rather poor for 2x6.2 MHz and lower. Thus, it does not pay to have a very large number of operators with less than 2x6.2 MHz spectrum each.

- Let us calculate how much capacity, in Erlangs per sq. km, we obtain if multiple networks had 2x8 MHz allotments. Let us assume that the total spectrum availability is 2x80 MHz. Thus, we can have 10 co-existing operators or networks. We assume an inter-site distance of 350 m, or cell radius of 200m. This gives around 10 sites per sq. km per network. Since 2x8 MHz gives 65E per site, we obtain a capacity of 650E per sq. km per network. For all 10 networks put together, we obtain 6500E per sq. km.

- Assuming even a high traffic level of 0.1E per sq. km as for landlines, we can support 65000 subscribers per sq. km. The population density rarely exceeds this level even in the most congested parts of India's metros.

- The above figure does not include capacity improvements due to some technology innovations that are already available on the ground. These innovations take time to penetrate, and it is therefore conservative to leave them out of a baseline calculation. However, they can be expected to provide further increase in capacity. The above calculation does provide for a certain level of deviation in practice from theoretical calculations. Appendix A4 of the above-mentioned Report discusses these aspects in more detail.

- In summary, we have argued that 2x8 MHz is sufficient for (i) an operator to deploy a 2G network with reasonable levels of spectrum efficiency, and (ii) achieving the level of subscriber densities needed in the densest areas. Lower allotments leads to substantial loss in spectrum efficiency.

- However, it may be that one does not need (and indeed, it may increase the network cost to have) so many operators from the market efficiency point of view. In which case, 2x10 MHz per operator does increase the spectrum efficiency a little more, as already discussed. Further, one may wish to allot a further 2x2 MHz for in-building deployment. Viewed in such a multi-dimensional context, a more appropriate allotment per operator would be 2x12 MHz.

- In any case, the total spectrum available for 2G services is sufficient. Since there is a case for increasing the availability in the dense urban areas, and spectrum availability varies between 75 and 100 MHz across the country, there may be a case for making efforts to release as much as possible at least for the dense metros.