COMMENTS ON IDA'S CONSULTATION DOCUMENT: PROPOSED APPROACH TO FIXED-WIRELESS BROADBAND NETWORK DEPLOYMENT AND SERVICE PROVISIONING IN SINGAPORE

At NTU, we have been studying rain and its effect on microwave systems (both terrestrial and earth-space) for many years. We have been investigating rainfall rates and rain drop-size distributions for Singapore. We have also monitored rain attenuation and the performance of 23 and 38 GHz links, and C-band and Ku-band satellite links in Singapore. I am offering my comments based on our researches and personal experience designing radio systems including those for Cable and Wireless Plc., while working in London.

I have the following comments:

(A) 2.2.3 QUALITY OF SERVICE STANDARD

The very heavy rain encountered in Singapore will severely attenuate the LMDS signals operating in the higher microwave frequencies. Singapore comes under the ITU-R rain zone P that is the highest rain climatic zone in the ITU-R classification. Hong Kong and Florida comes under a lower rain rate climatic zone N. For a target availability objective of say 99.99%, the range of the LMDS will be limited to approximately 1.5 to 2.0 km, depending on the frequency of operations and the equipment parameters. LMDS systems operating with such short ranges may not be economically viable especially if the number of customers in each cell is small. The range can be increased if the availability objective is relaxed to a lower value of say 99.95%.
It is imperative that the line-of-sight (LOS) from the base station to the customer's terminal is clear. This is another problem encountered with LMDS systems operating in the higher microwave bands. In built-up areas, the line-of -sight to some percentage of customers could be obstructed by buildings, trees and other large objects, hence service to such customers cannot be provided from that base station. To overcome this problem the coverage area of adjacent cells could be planned with significant overlaps so that the customer could be served from another adjacent cell. This effectively reduces the size of each cell.

I would like to suggest that more than one availability QOS standard objectives should be set; the objectives would be related to the tariffs. A residential customer or a commercial customer who does not require real-time service may be satisfied with a lower availability service provided at a lower cost. A heavy rain event could disrupt service for several minutes. This would be acceptable if the customer is made aware of the occurrences and frequency of occurrences of such disruptions. A residential customer may be quite happy to wait for the rain to stop before re-accessing the network. Astro viewers in Malaysia are already experiencing such disruptions to the Ku-band Direct-to-Home Satellite TV service. As far as I am aware, new subscribers are not warned of such disruptions. Customers requiring higher availability objectives will have to pay more (maybe much more for such services) or use other transmission media.
The availability QOS standard objectives once set by IDA would be used as a bench-mark by operators, hence consultations with potential customers, operators and equipment suppliers will be necessary to ensure that such objectives are acceptable. These objectives must be close to that achievable with present day technology.

(B) 2.4 SPECTRUM FOR FIXED-WIRELESS BROADBAND SERVICES

(B1) General Comments:

Rain attenuation is the main limiting factor in the operations of LMDS system operating in the upper microwave frequency bands. Rain attenuation is more severe as the operating frequency increases. Therefore it is preferable to operate in as low a frequency band as possible, even below the frequency bands specified in the Consultation Document. For example, there is a difference of about 8 dB for the rain specific attenuation (0.01% of time) between systems operating at 23 GHz and 31 GHz (see Section C1).

(B2) Use of the 5GHz Band in Singapore:

CRC in Canada has developed an LMDS operating in the 5 GHz band. The rain attenuation on signals operating at 5 GHz is not significant. Although there could be a problem operating in this band due to possible interference from radar systems, it would be worth investigating in more detail the possible use of this band for LMDS. The susceptibility of LMDS to radar interference could be further investigated. There is the NII band proposed in the US.

(B3) 2.4.1 Spectrum Availability:

Some of the frequency bands for terrestrial fixed -wireless should be kept aside for future services like the stationary balloon positioned 20-km above sea level. The Americans are developing the SkyStation; the Japanese are committed to development of their stratospheric balloon using existing satellite technology and the European are also putting research in the same concept of the High Altitude platform.

(B4) Future Satellite systems:

Although rain attenuation could seriously affect satellite systems operating at the higher Ka-band, such systems will be implemented in the future because the system availability obtained in low-rainfall rate regions like Japan, US and Europe is acceptable. The Americans have their ACTS program. The Japanese have their Gigabit satellite program, which would provide fibre-optic capacities over satellite operating in the Ka-band; their satellite would be launched in 2005. The frequency bands for such services should be protected.

(B5) Provision of Broadcasting Services

Although there is a convergence of broadcasting, data and other services into one multi-media service, it may be prudent to set aside the 40 GHz band for the time being. The take-up rate for this band would be slow due to the even higher rain attenuation expected.

(C) TECHNICAL CONSIDERATIONS
(Climatic Considerations)

(C1) The very heavy rain encountered in Singapore will severely attenuate the LMDS signals. Singapore comes under the ITU-R rain zone P that is the highest rain climatic zone in the ITU-R classification. Hong Kong and Florida come under a lower rain climatic zone N.

The specific rain attenuation for a range of microwave frequencies (attenuation per kilometre) for Singapore (ITU-R rain climatic zone P) for 0.05%and 0.01% of the year are as follows:

Frequency (GHz)	13	15	18	23	26	28	29	31
Spec. Atten. (dB/km) [0.05%]	4.7	5.4	7.0	10.4	12.4	13.7	14.4	15.6
Spec. Atten. (dB/km) [0.01%]	8.3	9.2	11.8	17.1	20.2	22.2	23.2	25.0

The above figures are for vertically polarised signals. The corresponding values of specific attenuation for horizontally polarised signals are higher. Therefore it is preferable to operate in as low a frequency band as possible. For example there is a difference of about 8 dB for the specific attenuations between 23 GHz and the 31 GHz bands (for 0.01% of the year)

(C2) Availability Objectives:
For a target availability objective of say 99.99%, the range of the LMDS will be limited to approximately 1.5 to 2.0 km, depending on the frequency of operations and the equipment parameters. LMDS systems operating with such short ranges may not be economically viable especially if the number of customers in each cell is too small. The range can be increased if the availability objective is relaxed to a lower value of 99.95%. [See comments in Section A].

(C3) Other Attenuation Mechanism:
We have been studying rain and its effect on microwave systems (both terrestrial and earth-space) for many years. We have been monitoring rainfall rates and rain attenuation and the performance of 23 and 38 GHz links in Singapore. Although the rainfall rate is lower compared with that obtained from the ITU model, the measured rain attenuation (collected over a limited period of about a year) is much higher than that obtained from the ITU-R model. We have reason to believe that there is at least another attenuation mechanism in addition to the rain attenuation along the path, which gives rise to the additional attenuation. This could be due to rainwater streaming down the antenna radome. This is a cause for concern in the design of microwave links operating at the higher microwave bands. We therefore strongly recommend that this factor should be investigated in any future trials. Any additional loss would further reduce the range of the LMDS system.

(C4) Possible Solution [See Annex 1]

(D) TRIALS

(D1) Period of Trial:
The performance of the LMDS is very much related to the weather conditions - mainly rain. The limited trial period of two to three months is too short for a realistic evaluation of the typical performance for the system operating under heavy rain conditions in Singapore. Both operators and to some extent the customers will have to take a risk in this venture if the results of the trials over such a short period is taken as typical for Singapore. There are significant seasonal and yearly variations. I would recommend that the trials should not terminate when the operating licences are issued. The trials should continue for at least one year or the monitoring should be carried over and continued for the operating system when installed. (One year for a trial is still too short).
Details of the trials should be carefully worked out and different equipment suppliers should actively coordinate their activities to ensure that maximum benefits would be obtained from the trials (including where the trials are to be conducted).

(D2) The effects of rain on the performance of system should an important part of the trials' objectives. From what I can gather from the HK OFTA website, the effects of rain was not seriously studied in the Hong Kong trials.
Meteorological parameters like rainfall rate, wind speed & direction, temperature and humidity should be logged, together with the received signal levels, error and error rates in accordance with ITU-T recommendations.

(D2) Effects of Rain on Antennas/Radomes:
Since this is a new factor, this matter should be investigated in the trials. Parallel links may have to be set up, one with the antenna sheltered from rain and the other, without.

I would be too happy to work with IDA or any interested parties in future trials. Our role is to further our research in the area of rain, its effects on terrestrial and earth-space systems and techniques for improving the performance of system affected by rain attenuation.

I was involved in the design of a similar system for Mercury Communication Ltd., UK when I was working for Cable and Wireless Plc, in London.

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