Distribution Systems (MVDS) and the currently licensed American LMDS are highlighted. The unambiguous conclusion is that *the 40 GHz activity in Europe is irrelevant to American LMDS and LMDS is not viable in the bands above 40 GHz.*

No 40 GHz MVDS Systems in Europe Due to Cost / Performance Problems

It is interesting to note that, in spite of the availability of the 40.5 - 42.5 GHz band for such services and the discussion of European MVDS in the band for more than four years, there are no MVDS systems installed or operating in Europe today. This is because of clear drawbacks to operation of terrestrial broadband wireless systems of any type in that band, let alone the cellular LMDS, which are obvious to those who closely examine alternatives. The technical shortcomings of potential systems for operation in the bands above 40 GHz are obvious to systems designers.

These shortcomings are clearly identified by the U.K. Radiocommunications Agency (FCC equivalent) in its Report of the 40 GHz MVDS Working Group (November 1993). In recognizing these problems above 40 GHz, the U.K Independent Television Commission has formally advertised areas for local one-way video delivery services, allowing the choice of cable or MVDS delivery because of the inability of potential service providers to serve subscribers with even one-way video service in the bands above 40 GHz. The potential for two-way interactive LMDS in the bands above 40 GHz is even more bleak--as reported by the MVDS Working Group.

European 40 GHz MVDS was Conceived for the Low-Rain-Rate European Climate

Rain rates in western Europe for 99.9% availability are in the range of 3 to 7 mm/hour. In the U.S. and other parts of the Americas, the same availability requires a design for rain rates of 5.5 to 35 mm/hour. These rates are two to five times higher than the rates in Europe. It is estimated that only about 15 percent of the North and South American land mass falls within the European rain rates for the same availability. Unfortunately for LMDS operators, these areas are in uninhabited or sparsely populated areas where LMDS is not practical. However, and fortunately for potential FSS providers, the lower rain rate areas, where the design "penalty" associated with moving satellite uplinks from 28 GHz to 40 GHz is the least significant, are "underserved" with telecommunications services--this is the precise characterization of the areas the FSS providers wish to serve.

Europe Acknowledges Severe 40 GHz System Range / Coverage Problem

The Report of the 40 GHz MVDS Working Group shows that the single transmitter coverage for the equivalent of the U.S. 28 GHz LMDS transmitter translated to 40 GHz is 12.5 km^2 -- this result is consistent with the range and coverage demonstrated in Table 1 (above--note that the link budget of Table 1 projects a 1.85 km range), and supports the MVDS Working Group conclusion that "presently available technology only permits transmission over a few kilometers" (page 6 of the report). Furthermore, the MVDS link budgets demonstrating the 2 kilometer range are based on a rain rate of *only* 2.1 mm/hour, as opposed to the 15 mm/hour rate projected for 99.9 percent availability over much of the U.S.

The reason for the equivalent range given such divergent rain rates (and corresponding path loss) is that the MVDS Working Group was much more conservative regarding projections of available 40 GHz system component specifications such as antenna gain, receiver noise figure, etc., than was taken into account in Table 1 of this report. Thus, we have been generous in specifying available technology for potential LMDS implementation above 40 GHz and the conclusion is still extremely negative. If the U.K. Working Group's conclusions about available technology were taken into consideration, the projected range of 40 GHz LMDS in the American climate region would be even worse! In spite of these differences in input to the analyses, the conclusion remains the same: *in U.S. climate regions, 40 GHz LMDS is not viable.*

European MVDS Working Group Admits Frequency Reuse Problem at 40 GHz

The limitations of frequency reuse in the 40 GHz band for MVDS are acknowledged in the MVDS Working Group results where, because of sidelobe suppression, cross polarization, oscillator stability, phase noise and power combining limitations, 60-degree sector antennas must be used to keep the service constrained to a "reasonable" bandwidth. Even with this approach frequency reuse range is 20 to 30 kilometers! Given this limitation of the 40 GHz technology along with the 32 channel plan for European MVDS, 2 GHz of spectrum is required to provide 32 channels of video *without* two-way services, while the current U.S. 28 GHz LMDS allows three times the video capacity *plus* two-way data services in the same amount of bandwidth.

40 GHz Equipment Considerations Force a Choice in Europe: Double (Again) the Required Bandwidth or Erect Dozens of Transmitters Every Few Kilometers

A frequency-reuse related issue in the European 40 GHz system is the need to combine the outputs of separate power amplifiers for individual channels, since solid-state power devices are envisioned due to the lack of suitable TWT amplifiers at 40 GHz for multichannel signal amplification. To combine separate power outputs in a resonant combiner with the necessary stop band rejection is likely to require an RF bandwidth of 2 GHz, not one GHz, so receiver equipment would have to cover a 2 GHz bandwidth as opposed to one. This is not desirable--and it may not be possible at consumer prices. The alternative is a separate transmit antenna for every channel--a prospect frightening for any local zoning board! The Current U.S. LMDS system uses a single, discrete antenna for the entire 50 channel service.

Propagation Losses at 40 GHz Force Inefficient Channel Spacing

In the European 40 GHz MVDS system specification, the channel spacing is 29.5 MHz to accommodate a 26 MHz bandwidth for individual FM video channels. The 26 MHz bandwidth is required to achieve additional FM improvement gain in the demodulator over the U.S. FM bandwidth of 20 MHz because the additional gain is needed to achieve even a minimally acceptable range in the European climate for the one-way MVDS service. This is a significant factor in the inferior system spectral efficiency of the 40 GHz MVDS system relative to the U.S. 28 GHz LMDS system--spectral efficiency is sacrificed to gain minimally acceptable performance. Such a tradeoff is not necessary in the currently licensed U.S. LMDS system.

European MVDS Is Not American LMDS -- 40 GHz MVDS Cannot Compete with Cable

The U.K. Radiocommunications Agency in its Report of the 40 GHz MVDS Working Group found that MVDS at 40 GHz cannot compete with cable in the U.K. because cable is "seen as offering long-term benefits that cannot be matched by MVDS (for example, two-way telecommunications capability)". The reason the European MVDS cannot compete is because it lacks sufficient bandwidth to compete with cable on a head-to-head basis. This is due to the system architecture and the inherent limitations of the 40 GHz band which preclude frequency reuse in every cell. Frequency reuse in every cell is possible in the American 28 GHz LMDS system, but not possible at 40

GHz (see discussion below in this paper). Without frequency reuse in every cell, MVDS would be forced into using 4 to 8 GHz of spectrum to duplicate the two-way capacity of broadband cable or 28 GHz American LMDS. To call this a critical limitation of the 40 GHz system is quite an understatement. Moreover, this MVDS frequency-reuse handicap is the fundamental reason why there are no 40 GHz systems planned--*they cannot compete with existing priced broadband alternatives.* The introduction of a spectrum-wasteful, expensive MVDS as a cable alternative would fail against the entrenched cable alternative due to MVDS cost disadvantages.

40 GHz MVDS Was Never Intended To Compete with U.S. Interactive Cable

The European MVDS system was envisioned as competitive with *one-way* video distribution via cable more than four years ago when the benchmark for viability in Europe was the capacity to deliver 25 to 30 channels of video. This capacity is no longer competitive and was fundamental to the system architecture developed for the European 40 GHz MVDS system. In the ensuing four years, even the European community has concluded that MVDS at 40 GHz is not competitive given the one GHz bandwidth that cable can now deliver to each subscriber. Furthermore, a 25 to 30 channel capacity is no greater than existing MMDS systems in the U.S. can provide today. Why would the U.S. authorize a service at 40 GHz that cannot provide what is already available in the 2 GHz MMDS systems?

40 GHz MVDS Limitations are Recognized Outside and Inside Europe

The CEPT, in recommending that 40.5 - 42.5 GHz be the harmonized frequency band for MVDS in Europe noted "that in some countries there is a need to use substantially lower frequency bands." (Recommendation T/R 52-01 E as adopted by the European Radiocommunications Committee, Athens, 1990). This was noted for MVDS within Europe--which is a clear recognition that the rain statistics associated with local deployment areas may render the 40 GHz band inappropriate in many locales for the one-way video services of MVDS, let alone two-way telecommunications services.

The CEPT recognized, even five years ago in 1990, that the performance projections leading to the harmonized frequency band for 40 GHz European systems were based on rainfall attenuation statistics valid only for *part* of Europe and that the technical and economic viability believed to be associated with MVDS at 40 GHz in (at least part of) Europe could *not* be extended to continental and subtropical climate zones, such as the

U.S. In Northern Europe, with a climate dominated by drizzle, the differences between 28 and 40 GHz are economically acceptable; in continental and subtropical climate zones the penalty is so severe as to jeopardize the viability of the system.

Attempted 40 GHz System in Hong Kong Fails -- System Deployed at 29 GHz

The recently initiated system for broadband wireless distribution developed in Hong Kong by Wharf Communications offers a real-world lesson in 40 GHz viability. Wharf first intended to use the 40 GHz band for the service, but resorted instead to using some 12 GHz links for signal distribution and the 29 GHz band for delivery of services. Why was the 40 GHz band abandoned? The rainfall statistics in the local area would not support an economically viable 40 GHz system with an acceptable minimum system availability. This experience in a region which differs significantly in climate from the Northern European climate, as the Americas do, is highly instructive as regards the potential of the bands above 40 GHz for multipoint distribution.

No 40 GHz LMDS Systems Exist Due to Lack of Viability -- Summary

In spite of the 1990 European recommendation that the 40 GHz band be established as the target for multipoint video distribution, no such systems are in existence and none appear to be in the deployment stage. Cost, performance, and a lack of capacity to compete with cable are the reasons for the dearth of such systems. The 40 GHz MVDS specification was established to offer competition for a now-outdated cable service model, and no suppliers have stepped forward to compete in the 40 GHz market which appears to have little hope for a future.

The 40 GHz system concept was acknowledged by its creators as inappropriate outside the low-rain-rate European climate area and it suffers from severe range, coverage, and frequency re-use efficiency problems both inside and outside its intended geographical deployment area.

Whatever the proposed European MVDS system may become (if it ever is deployed at all), it is *not* LMDS. MVDS cannot offer the information capacity, frequency re-use efficiency, coverage, or range of services already being provided by today's licensed LMDS in America.

SATELLITE SPECTRAL "EFFICIENCY" IS MAINTAINED ABOVE 40 GHZ, BUT LMDS AT 40 GHZ REQUIRES FOUR TIMES AS MUCH SPECTRUM !

Given the discussion above, it is clear that LMDS is not viable above 40 GHz due to the system cost increase of 30 to 40 that would accompany the move in frequency. Additionally, it is clear that although the bands above 40 GHz have been considered for one-way video service in Europe, the differences between Europe and the Americas and the differences between the proposed European service and the cellular LMDS preclude the use of the bands above 40 GHz for LMDS in the Americas and in most of the populated world. Beyond the issues of cost and system practicality, however, it is interesting to consider the impact of LMDS operation above 40 GHz assuming (which of course is ludicrous) that potential cost and practicality are not important issues.

The key impact is a four-fold decrease in the spectrum efficiency of the LMDS system. In short, the cellular LMDS concept, which allows frequency re-use in every cell due to a combination of propagation characteristics, equipment performance and system deployment geometry in the 28 GHz band, is *not workable at any cost above 40 GHz* due to the inability to achieve the necessary polarization and sidelobe isolation in the system components to achieve 100 percent frequency reuse in every cell. The direct impact of this is that the LMDS service requires *four times the spectrum allocation per service provider at 40 GHz as is required at 28 GHz.*

The prospect of operating LMDS in a frequency band above 40 GHz and accepting a less-than-achievable spectrum reuse efficiency is an unthinkable waste of the public spectrum resource.

LMDS Above 40 GHz Likely to Require 4 Times as Much Spectrum as at 28 GHz

LMDS Receiver Sidelobe and Cross-Polarization Performance:

Due to manufacturing tolerance limitations (as discussed above regarding the LMDS receiver figure of merit) and temperature sensitivity, antenna performance projections indicate that the receiver sidelobe suppression and cross-polarization isolation in the 41 GHz subscriber antenna will be 3 to 5 dB and 4 to 6 dB worse (respectively) than in the 28 GHz antenna design. This component issue goes far beyond cost--achievable sidelobe performance and cross-polarization isolation as demonstrated in the current 28 GHz LMDS system are both key to the overall LMDS system architecture. If these

performance features are degraded in moving from 28 GHz to the bands above 40 GHz, the ability to reuse the LMDS spectrum *in every cell* will be lost and *each LMDS service provider will require at least two GHz of bandwidth instead of the 1 GHz bandwidth that is sufficient for each service provider in the 28 GHz band to compete with cable.* This is an unattractive and undesirable attribute of any imagined LMDS system above 40 GHz.

The European technical and regulatory community has recognized this limitation in using the bands above 40 GHz for video services and has specified the frequency reuse distance at twenty to thirty (20 to 30) kilometers. This value is at least two to three times the minimum frequency reuse distance for the U.S. 28 GHz system. This fact is consistent with the need in the European MVDS architecture for increased spectrum to maintain the same cable-competitive service capacity.

Receiver Local Oscillator Stability and Phase Noise:

As with other components, the stability and phase noise of the receiver local oscillator will increase in absolute terms if the system is moved from 28 to 40 GHz. Stability is expected to be 30 to 50 percent worse, based on U.S. projections, and 400 percent worse based on projections in the United Kingdom for the 40 GHz video delivery service. A 3 dB increase in oscillator phase noise is expected. The magnitude of these increases is expected to cause severe problems in maintaining receiver frequency tracking of the transmitter. Because of these factors and the need to closely-space two-way data signals on a frequency division basis, a two-to-one reduction in two-way interactive data communication capacity of the LMDS system is anticipated. This latter factor would result in the need for an *additional* doubling of the spectrum available for each LMDS service provider to maintain a cable-competitive data transmission capacity on top of the allocation doubling due to the frequency reuse problems addressed in the section immediately above.

Taking these two doubling factors together, LMDS would then require *four times the spectrum at 40 GHz as is required at 28 GHz.* While such an approach is unlikely, even if such a vast amount of spectrum were made available LMDS service would still be unviable due to the cost issues addressed above. Furthermore, the equipment performance issues would compound since a 4 GHz-wide spectrum for LMDS would require design of components for operation over a ten percent bandwidth--which is typically a threshold for the onset of *major additional design problems.*

Fixed Satellite Service Maintains Spectral Efficiency from 28 to 40 GHz

Unlike the terrestrial LMDS service, which based on its system architecture and geometry can reuse the spectrum more than 20,000 times on the earth surface, FSS systems proposed for the 28 GHz band are only capable of reusing the allocated spectrum from12 to a few hundred times. The reason for the huge difference in the efficiency of use of the public spectrum resource is the difference in system architectures.

A given LMDS cell at 28 GHz illuminates approximately 73 square kilometers, and frequencies can be reused approximately every 10 kilometers based on the cell radius of 5 kilometers. The FSS service, because of the size of the footprint of the satellite receiver antenna on the earth and the depolarization on the earth-space path at 28 GHz, cannot reuse frequencies in the same orbital slot by exploiting polarization. This has been acknowledged in recent ITU and Commission proceedings and is fully considered in spectrum requests to the Commission by FSS applicants. In moving the FSS uplink services from 28 to 40 GHz the same considerations would apply--no frequency reuse in orbital slots. There would be no *additional* degradation in spectrum efficiency for the FSS in moving from 28 GHz to the bands above 40 GHz.

Regarding cost, it is undoubtedly true that the cost of satellite service would be slightly higher at 40 GHz than at 28 GHz. However, the cost impact of moving the FSS service in frequency is probably not significant. The reason for the disparity in cost impact between moving LMDS and moving FSS to the bands above 40 GHz is, again, system architecture and geometry. Moving LMDS in frequency increases the number of cells and other (e.g., real estate) costs. Moving GEO FSS in frequency does not change the number of transmitters (analogous to cells) because there is still only one. There is no problem with increased shadowing of non-line-of-sight paths, because FSS systems do not function that way in the first place. The increase in system component costs is not a significant cost factor since expensive manufacturing and launch costs dominate the cost equation for FSS, unlike LMDS. Finally, since proposed FSS systems in the 28 GHz band are targeted at areas which cannot receive service by other means, while LMDS is being deployed now as a cost-competitive broadband cable *alternative*, service cost sensitivity is a much greater issue for LMDS than for FSS.

U.S. MILSTAR Program Proves 40 GHz Satellite Service Viability:

The U.S. military EHF satellite system (MILSTAR) has proven the viability of satellite uplinks in the bands above 40 GHz. Its uplinks are located in the 44 GHz band, and utilize the very technology for which the Commission is seeking potential commercial applications.

Key Differences between LMDS and Satellite on Point-Point Paths:

Propagation effects such as rain, dispersion, foliage blockage and scattering effects are significant to the operation of the LMDS system because they are most severe at low altitudes over horizontal paths. This is precisely the type of path over which the terrestrial LMDS system must operate. Alternatively, FSS systems work on point-point slant paths which may approach zenith, using highly-directional, high-gain antennas. Under these circumstances, the earth station-to-satellite path traverses a much lower percentage of low-altitude components. Because of this, satellite systems are much more likely to be successfully operated in the 40 GHz band than the LMDS systems. Care must be taken to examine the key differences in attenuative and dispersive effects at 40 GHz between the near-earth, horizontal paths for LMDS, and the near-zenith paths associated with satellite communications. The disadvantageous effects of operating LMDS at 40 GHz are of sufficient magnitude to threaten its technical and economic viability, while satellite and other point-point services would suffer no such negative effect. The ITU and other international bodies recognized this fact years ago when the primary allocations above 40 GHz were assigned to satellite services.

FSS System Design Margins Allow Simple Transition to Bands Above 40 GHz:

FSS systems conceived for the 28 GHz band can compensate for the additional path losses associated with operation above 40 GHz simply by exploiting existing design margins and available state-of-the-art components. Two key design elements of the satellite and earth station transmitters are currently envisioned by FSS proponents as well below the state-of the art: transmitter power and antenna gain. Transmitters are envisioned which operate at a few milliwatts per carrier--this power level is at least 15 to 20 dB below what is achievable in the solid-state transmitter devices advocated for FSS use. Additionally, since 28 GHz FSS antennas are designed for a given physical aperture size at 28 GHz, translating the (presumably) manufacturable design to 40 GHz will result in additional gain. The combination of these simple design flexibilities will

allow FSS uplink operation above 40 GHz. If this was not true, how could it be that the U.S. military has exploited these very design features to deploy a 44 GHz uplink technology now in orbit? MILSTAR is the system--which is not a planned, uncapitalized system concept, but a working system. Further, it is a system working today with the satellite technology that 28 GHz FSS applicants have repeatedly praised.

FSS Maintains Spectral Efficiency Above 40 GHz and LMDS Does Not -- Summary

It is obvious, given these facts and the desire to maximize the potential of the spectrum resource, that should FSS proponents continue to be unwilling to work toward a compromise to accommodate both LMDS and FSS in the 28 GHz band, the best solution is to move the FSS to the bands above 40 GHz. Due to its system architecture, LMDS will require four times as much spectrum above 40 GHz as is needed at 28 GHz. FSS spectral efficiency, already hundreds of times worse than LMDS at 28 GHz, is not further degraded if moved above 40 GHz. U.S. MILSTAR technology has proven the viability of FSS service above 40 GHz using the key technologies for which the Commission is seeking commercial applications. The architecture of the FSS systems and existing design margins using today's technology make a move of FSS services to the bands above 40 GHz viable.

APPENDIX 3

Spectrum Allocation Considerations

by Bernard B. Bossard

January 30th 1995

Conclusions

1. Present monopoly delivery systems such as cable, telephony, and satellite can not satisfy the demands of the Information Age.

2. Worldwide allocation of millimeter waves spectrum for outdoor use is not practical due to the wide variance in weather conditions and performance from country to country.

3. Many countries are allocating frequencies form 12 GHz to 29.5 GHz for LMDS type operations.

4. Proposed 40 GHz operation is not practical in the US since channel capacity is low (30 channels), no two-way operation, very high cost, and based on 3mm/hr rainfall which occurs in low population desert areas covering less than 15% of continental US land mass.

5. Use of the 40 to 45 GHz is possible for satellite systems without hardship and will aid the transition of employment from the military sector to the commercial sector.

6. LMDS at 27.5-29.5 GHz offers competition to the two major entrenched monopolies: cable and telephony.

1. The Microwave Journal[1] reports that in 1990, 80 percent of its readers were working primarily on military projects. Today 81.5 percent of its readers work primarily on commercial products with 72 percent in communications and 46 percent in wireless (cellular telephony).

2. It is also estimated that 4 million Americans between 1986 and 1996 will have lost their jobs in the defense sector.[2]

3. We have left the Agricultural Revolution and Industrial Revolution behind with greater operating efficiency-- its unfortunate consequence, however, is less jobs. We are about to enter the Information Technology Revolution. We have developed great concepts of interactivity and informative access but are unable to deliver the "promised" land to industry, education and medical operations, or residences because of the lack of available low-cost high-bandwidth distribution systems.

4. Continental Cablevision, Inc., the Nation's third largest cable television company, offers a "high speed" link to the Internet Data Network over the coaxial cables that carry television channels into the home (Cambridge, Mass) at a rate of $125 per month for residential customers and higher for business customers (regular phone lines service is $25 per month for 9,600 bits per second whereas the coaxial cable offers 500,000 bits of per second.[3]) Compare this with the

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[1] Microwave Journal January 1995, page 62
[2] 'A Troubled Presidency' Boston Globe Magazine January 22, 1995, page 22
[3] NY Times March 9th, 1994 page D24

potential million bits of information per second in a wireless system.[4] In order to accommodate the required interactive bandwidths for local and long range information transfer required T-1 (1,544,000 bits per second) or T-3 (45,000,000 bits per second). Coaxial cable is only able to provide this service with a complete replacement of their already highly capital leveraged video distribution system. Cable, then does not offer any immediate solution to the broadband interactivity required in the Information Age.

5 It is estimated that a method of delivering high data rates to industry and the home is through fiber optic cable. Unfortunately, at this time, fiber, with its numerous tap points, is not technically feasible due to resultant mode dispersion and eccentric cores. Fiber, with limited number of tap points and multiple strands, can be used as an effective backbone but not as a major distribution network. Most important, however, is the enormous cost of fiber implementation - estimated by Telenet's Corporation to be "20 years and trillions of dollars away. But the Fiberless Optics Network is around the corner at a fraction of the cost".[5] Hence fiber to the home throughout the United States is not an immediate solution.

6. Various telephone companies have proposed video dialtone service and high speed data over twisted pair technology using sloped amplifier characteristics to overcome the rapid fall off attenuation prevalent in twisted pair cable as an intrinsic function of higher frequencies beyond 4,500 hertz.

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[4] LMDS 28 GHz Rule Making

[5] Telenets Corporation, " Fiberless Optics -- Aviable and Imminent Alternative to Cable and Fiberoptics" A report on the potential of 28 GHz LMDS network, page 4.

This approach has turned out to be unreasonable since at the higher frequencies the twisted pair cable radiate causing cross modulation of signals when various twisted pair cables are placed in close proximity as required by cable sheath used in telephony.

Hence, twisted pair will probably be replaced by coaxial cable for broadband applications. If telephone companies resort to the deployment of a broadband coaxial plant, redundant with cable, to provide individual households with broadband services, nothing will be gained in the effort to provide broadband services to consumers at the lowest cost, and long delays can be anticipated. This situation again underscores the need for widespread availability of LMDS in the 28 GHz band throughout the US.

7. The satellite industry would like to bring broad band interactive information directly to the home but they are severely hampered by one overriding factor, i.e. the cell sizes are very large with limited capacity. For example, even the technically unsound Teledesic proposal using 400 MHz of bandwidth at 28.6 to 29.0 GHz only serves 14 simultaneous T-1 customers in a minimum of 1,000 sq. mil coverage area. Since the continental US is approximately 3,000,000 square miles and 90 percent of the population lives in 10 percent of the land mass, then only 300,000 divided by 1,000 or 300 satellite beam cells cover 90 percent of the population. Since each cell can simultaneously broadcast only 14 T-1 (1.544 Mbs) transmissions, then for 234 million people (90 percent of the 260 million US population) only 4,200 T-1 simultaneous lines are available or 0.018 percent population coverage. Hence satellites do not represent a solution which would aid the introduction of the information age with broadband access to the US population.

8. Clearly the three major monopoly industries

a) Cable

b) Telephone

c) Satellite

are not able to provide the information technology revolution with its required fuel, namely, bandwidth. Their tactic is to delay other potential entries into this multi-billion dollar annual market place until they have sufficient resources to replace their equipment or even limit the Information Age to low speed, low bandwidth, low resolution present day technology.

9. The FCC has requested comments on the potential use of the frequency spectrum above 40 GHz. It seems that premature regulations will stifle growth, since regulations imply restrictions and therefore inhibit innovation. Spectrum should only be allocated with sufficient bandwidth (for expansion) to be competitive with an immediate defined marketplace and not speculation for future applications. Moreover, millimeter wave propagation is extremely weather dependent, hence international regulations are not practical.

10. The vast majority of present spectrum allocations (approximately 97 %) is for some form of point to point usage, yet with modern technology, coexistence of point to point microwave links could reduce the spectrum required to only a few frequency bands. Simply stated 14,536 point to point radios can coexist with 50 MHz of information per channel in a 9 square mile area

using the allocated frequency bands of 18 GHz, 21 GHz, 30 GHz of 4,600 MHz [6]. Even the liberally licensed 21 - 24 GHz band contains less than 50,000 radios throughout the US or 0.15 radios per 9 square miles. Cellular telephony and MMDS with their minimum allocated bandwidth are finding niche markets which have allowed engineers and manufacturers to move from the defense sector into commercial applications. Proper allocation of frequencies which efficiently provide broadband point to multipoint systems will offer competition to the two largest monopolies (cable and telephony) resulting in reduced prices, more service, and clearly an enormous boost to the economy.

11. The most important fact regarding the allocation of millimeter frequencies for use is the recognition that this spectrum has propagation characteristics that are extremely weather dependent and therefore drastic performance variations occur from country to country. Therefore, millimeter waves above the 40 GHz band should never be considered as a candidate for universal standardization. For example, the 28 GHz is considered for multipoint distribution in the US, Canada, South America, Asia, Africa and parts of Europe, other frequencies such as 25.25 - 27.0 GHz and 12 GHz are also being used. In fact Hong Kong uses 28 GHz (short haul) and 12 GHz (long haul) for their multipoint distribution system. Poor propagation characteristics of 40 GHz precludes use of this frequency in most applications, even in very congested locations such as Hong Kong.

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[6] David Sarnoff Research Carter Report - Page 120 September 17th, 1991. Suite 12 System Analysis for Victor Distribution and Secondary Services.

"Consistent with the ITU constraints, each nation determines its own use of radio frequencies as applies solely within its borders".[7] "Thus national spectrum management administrations can use frequencies inconsistent with the Radio Regulation if they avoid interference to other countries. While this option has limited use in the High Frequency band and in satellite bands, it does grant considerable flexibility in the millimeter wave bands due to their short propagation characteristics - especially to those nations with distant neighbors."[8]

12. The European proposed system in the 40 GHz band has been available for licenses since January 1991. The video delivery systems in England are "technology independent, that is any technology, wireless, fiber or cable can be utilized by the party granted a franchise, yet none in a three year period have been implemented. The drawbacks of the 40 GHz system even in the proposed light 3 mm rain are recognized and stated in their reports highlighted below:[9] (Note that any increase in rainfall above 3mm per hour will cause the availability of less than 99.8%; 3mm rain only occurs in approximately 15% of the US area which are mostly low population areas).

a) Coverage area 12.5 Km^2 (4.8 square) in 3 mm of rain (pp2)
b) Receive antennas- need to have direct light of sight to the transmitter. (pp2)
c) 32 Channel capacity using 2,000 MHz of bandwidth. (pp2)
d) August 1989 statement that DTI would make available the 40 GHz band (i.e. 40.5 to 42.5 Hz) of MVDS. (pp3)
e) System based on "one-way" only the 64 degree sector antennas for very small 4.8 square mile coverage area in 3 to 7 mm/hrs rainfall. Hence an immediate requirement of six times the number of transmitters for omni coverage.
f) "The Group did not address the possibility of using frequencies outside the 40 GHz band" (pp4)

[7] 'Millimeter Waves Spectrum Management' Applied Microwave and Wireless Summary, 1994, Michael J. Marcus.

[8] 'Millimeter Waves Spectrum Management' Applied Microwave and Wireless Summary, 1994, Michael J. Marcus.

[9] "Multipoint Video Distribution Systems" Report of the 40 GHz MVDS Working Group, Radio Communications Agency, November 1993.

g) "Developments of other frequencies, e.g. 28 GHz in the USA, are being following with interest"

Suite 12 does recommend the use of 40 GHz broadband satellite Gigabit terminals. Present proposals indicate that these terminals can exist with only 1 mW of power at 30 GHz. This same satellite technology at 40 GHz could operate with more margin and better performance with slightly greater power.

13. The paper by Michael J Marcus of the FCC states, "Location with respect to military frequency allocations. If a civil allocation can be located adjacent to a military allocation, this can be expected to result in the production of a large number of components that could be used for both applications, thereby providing economy of scale benefits to both military and civil users. This is consistent with FCC policy of awarding allocations so as to provide the greatest benefit to the largest number of users"[10]

In this regard there has been an enormous amount of military investment in the bands near 45 GHz for satellite communications links with many systems already in place. This technology can be used for both geostationary (30 watts of power required) or non geostationary (1 to 40 milliwatts of transmitter power required for a T-1 (1.54 Mbs) system. Note that in the frequency band 42.5 to 43.5 GHz the rainfall attenuation is relatively small due to the slant range. For availability of 99.9% the attenuation for various antenna angles to the horizon is

15 degrees 31 dB

20 degrees 27.5 dB

30 degrees 18.7 dB

[10] "Millimeter Waves Spectrum Management' Applied Microwave and Wireless Summary, 1994, Michael J. Marcus.

Hence, since Teledesic system of new 30 GHz proposed only 1 milliwatt of transmission power and is approximately 15 dB for rainfall attenuation, the same system parameter could be closed with 18.7 dB to 27.5 dB margin for rainfall attenuation or a transmission power requirement of 74 milliwatts during rain (30 degrees).

It is important to recognize that the satellite communication systems are basically point to point links with two major differences when compared with point to multipoint LMDS systems namely:

a) large antenna gains, not both transmitter at receiver; whereas point to multipoint has large antenna gain only at receiver.

b) rainfall only on small distance of transmission path.

Hence 40 to 51.4 GHz is ideal for satellite communication giving use of 11.4 GHz of bandwidth, thereby allowing multiple operators and avoiding monopolies..

The following chart (See Table 1) indicates that these bands and more are already allocated for satellite use. In fact, over 100 GHz of bandwidth is primarily satellite allocations. It is time to give terrestrial broadband wireless services a chance since LMDS at the lower frequencies 12-29 GHz can be used whereas LMDS cannot exist at frequencies greater than 40 GHz.

TABLE 1.

30	-30	GHz	(Earth-to-Space)
32	-33	GHz	(Intersatellite)
37.5	-40.4	GHz	(Space-Earth)
40.5	-42.5	GHz	(Broadcasting Satellite)
42.5	-43.5	GHz	(Earth-to Space)
43.5	-47	GHz	(Mobile Satellite)
47	-47.2	GHz	(Amateur Satellite)
47.2	-50.2	GHz	(Earth-to-Space)
50.4	-51.4	GHz	(Earth-to-Space)
54.2	-58.2	GHz	(Intersatellite)
59	-64	GHz	(Intersatellite)
66	-71	GHz	(MobileSatellite & Radionavigation Satellite)
71	-75.5	GHz	(Earth-to-Space)
75.5	-76	GHz	(Amateur Satellite)
81	-84	GHz	(Space-to-Earth)
84	-86	GHz	(Broadcasting Satellite)
92	-95	GHz	(Earth-to-Space)
95	-100	GHz	(Radionavigation Satellite)
102	-105	GHz	(Space-to-Earth)
116	-134	GHz	(Intersatellite)
134	-142	GHz	(Mobile Satellite & Radionavigation Satellite)
142	-144	GHz	(Amateur Satellite)
49	-150	GHz	(Space-to-Earth)

Certificate of Service

I, Owen J. McGovern, hereby certify that the foregoing "Comments" were delivered by hand on January 30, 1995 to the following:

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