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MEMORANDUM

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JUN - 3 1997

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

To: William F. Caton, Acting Secretary

Fr: Chris Murphy, Attorney-Advisor, International Bureau (418-2373)

Date: June 3, 1997

Re: *Order: Amendment of the Commission's Rules to Relocate the Digital Electronic Message Service From the 18 GHz Band to the 24 GHz Band and to Allocate the 24 GHz Band for Fixed Service*
OET Docket No. 97-99; FCC 97-95

Please find attached a set of documents for inclusion in the record in the above-referenced proceeding. These documents provide background information submitted in connection with the technical aspects of the Commission decision in the case, particularly the discussion in Appendix B of the Order.

The eight documents are as follows:

1. December 6, 1996 facsimile from Larry Williams to Steve Sharkey;
2. January 7, 1997 facsimile from Larry Williams to Steve Sharkey;
3. January 13, 1997 facsimile from Laurence E. Harris to Steve Sharkey;
4. January 14, 1997 facsimile regarding Satellite Modem (EF Data);
5. January 13, 1997 telefax from Bosch Telecom GmbH to Raj Singh;
6. January 14, 1997 facsimile from Dr. Rajendra Singh to Steve Sharkey;
7. A set of undated slides that memorialize information presented in meetings with FCC and NTIA staff on January 17, 1997 and January 22, 1997, respectively, entitled "Overview of Fixed Broadband Wireless Local Loop System Using 18 GHz DEMS Band vs. 24 GHz Band";
8. January 22, 1997 Letter from Jay L. Birnbaum to Steve Sharkey.

Thank you.

encl.

No. of Copies rec'd 0+1
List A B C D E

DOCUMENT #1

Teledesic

1150 Connecticut Avenue, N.W., Suite 200, Washington, D.C. 20036
Tel: 202-296-8047 - Fax: 202-296-8953

TO: Steve Sharkey

FROM: Larry Williams

DATE: December 6, 1996
10:18 AM

FAX NO.:

NO. OF PAGES: (including cover)

Per our conversation yesterday, attached is the 24 GHz atomospheric attestation chart (see page 4) that we discussed. In addition, I have spoken with Farzad about the potential coordination problems down the road with point-to-point links. He is concerned that there will be, if it hasn't already started, a "gold rush" across the entire band. In that respect, we concur with the conclusions of the fixed service at 38 GHz. I have attached a paper they prepared on this issue that they put forward in the above 30 GHz meetings that Damon has been attending. It may be helpful for us to discuss this further. When you have a moment please give me a call.

Teledesic

MEMO

FILE: DEMS to 24 GHz Rev 2.doc **DATE:** 05 December 1996

SUBJECT: Technical Impacts of Operating DEMS in the 24 GHz Band

TO: Russ Daggatt

FROM: Mark A. Sturza

DEMS is currently allocated 100 MHz of spectrum in the 18 GHz band, as shown in Table 1.

Table 1. Existing DEMS Allocation

Channel No.	Nodal Channel (GHz)	Subscriber Channel (GHz)
30	18.87 - 18.88	19.21 - 19.22
31	18.88 - 18.89	19.22 - 19.23
32	18.89 - 18.90	19.23 - 19.24
33	18.90 - 18.91	19.24 - 19.25
34	18.91 - 18.92	19.25 - 19.26

It has been proposed that DEMS be relocated to the 24 GHz band, specifically, 24.25 - 24.65 GHz. Three possible channel parings are shown in Tables 2, 3, and 4, for 5, 7, and 10 channel pairs, respectively.

Table 2. Possible Channel Paring for Five Pairs

Channel No.	Nodal Channel (GHz)	Subscriber Channel (GHz)
New 30	24.25 - 24.26	24.60 - 24.61
New 31	24.26 - 24.27	24.61 - 24.62
New 32	24.27 - 24.28	24.62 - 24.63
New 33	24.28 - 24.29	24.63 - 24.64
New 34	24.29 - 24.30	24.64 - 24.65

Table 3. Possible Channel Paring for Seven Pairs

Channel No.	Nodal Channel (GHz)	Subscriber Channel (GHz)
New 30	24.25 - 24.26	24.58 - 24.59
New 31	24.26 - 24.27	24.59 - 24.60
New 32	24.27 - 24.28	24.60 - 24.61
New 33	24.28 - 24.29	24.61 - 24.62
New 34	24.29 - 24.30	24.62 - 24.63
6th of 7 Pairs	24.30 - 24.31	24.63 - 24.64
7th of 7 Pairs	24.31 - 24.32	24.64 - 24.65

Table 4. Possible Channel Paring for Ten Pairs

Channel No.	Nodal Channel (GHz)	Subscriber Channel (GHz)
New 30	24.25 - 24.26	24.55 - 24.56
New 31	24.26 - 24.27	24.56 - 24.57
New 32	24.27 - 24.28	24.57 - 24.58
New 33	24.28 - 24.29	24.58 - 24.59
New 34	24.29 - 24.30	24.59 - 24.60
6th of 10 Pairs	24.30 - 24.31	24.60 - 24.61
7th of 10 Pairs	24.31 - 24.32	24.61 - 24.62
8th of 10 Pairs	24.32 - 24.33	24.62 - 24.63
9th of 10 Pairs	24.33 - 24.34	24.63 - 24.64
10th of 10 Pairs	24.34 - 24.35	24.64 - 24.65

The change in frequency has the following impacts:

- To maintain the same coverage area, the hub antenna gain remains constant and the hub antenna size is reduced by 22%. The free space propagation loss increases by 2.2 dB, but this is completely offset by the increased gain of the subscriber antenna, which does not change in size.
- For a 5 km path, the atmospheric attenuation is 0.4 dB higher for typical climate conditions, and 2.2 dB higher for hot humid conditions. This increase is due to the water vapor absorption band centered at 22.235 GHz. Figure 1 shows the atmospheric attenuation for a 5 km path and for two different climate conditions, 20 °C at 42% relative humidity and 35 °C at 80% relative humidity.
- For a 5 km path and 99.7% rain availability, the rain attenuation is 1.9 dB higher in CCIR region K (New York City), and 3.3 dB higher in CCIR region N (Miami). Figure 2 shows the rain attestation for a 5 km path and CCIR rain regions K and N. Rain region N is the most severe in the U.S. It is interesting to note that the rain attenuation in the 24 GHz band is several dB better than for the 28 GHz LMDS band.
- Since DEMS is a fixed service, Doppler shift is not an issue.
- The transmit/receive frequency separation distance of interest is from the center frequency of one of the channels to the closest edge of the paired channel. For the current DEMS allocations that is 335 MHz. Divide that into the center frequency to get a parameter reflecting the complexity of required filter. The smaller the number, the easier the filter. For 18 GHz DEMS the worst case value is 56. For the proposed five, seven, and ten frequency pair 24 GHz DEMS allocations, the transmit/receive separations are 345 MHz, 325 MHz, and 295 MHz, respectively. The resulting worst case parameter values are 71, 76, and 84, respectively. These represent 27%, 36%, and 50% increases, respectively, compared to the value for 18 GHz DEMS. These increases may result in a small cost impact. For example, assume that the DEMS subscriber terminal costs $150 (optimistic), that the transmit/receive filter, at a parameter value of 57.5, costs $5 (pessimistic) , and that

the filter cost, for the increased parameter values, increases to $7 (pessimistic), then the resulting worst case cost impact is less than 2%.

- Component availability and cost are not anticipated to be issues. While it is true that there are more 18 GHz terminals in use today, then 24 GHz ones, components applicable to 24 GHz terminals are produced in much larger quantities then those applicable to 18 GHz components. Thus, in large quantities, it is anticipated that 24 GHz terminals will not cost more than 18 GHz ones.
- There are no inter-system interference issues in the new band.
- The band is already allocated in Regions 1 and 3 for fixed service.

In summary, the only potentially significant issue is propagation losses. For worst case conditions they could be almost 6 dB higher in the 24 GHz band compared to the 18 GHz band. For more typical conditions the difference is less than 2 dB. From a technical standpoint, relocating DEMS to the 24 GHz band results in a viable system. The increase required in propagation margin must be balanced against the non-technical advantages of the 24 GHz band.

If the increased transmit/receive filter parameter were a concern, the requirement for the filter can be eliminated by operating the system in a time division duplex (TDD) mode, where the hub transmits during one time interval and the subscriber terminals transmit during the next time interval. The added advantage of this approach is that the entire 400 MHz of spectrum could be utilized, effectively quadrupling the capacity of the DEMS compared to the 18 GHz allocation.

Figure 1. Atmospheric Attenuation

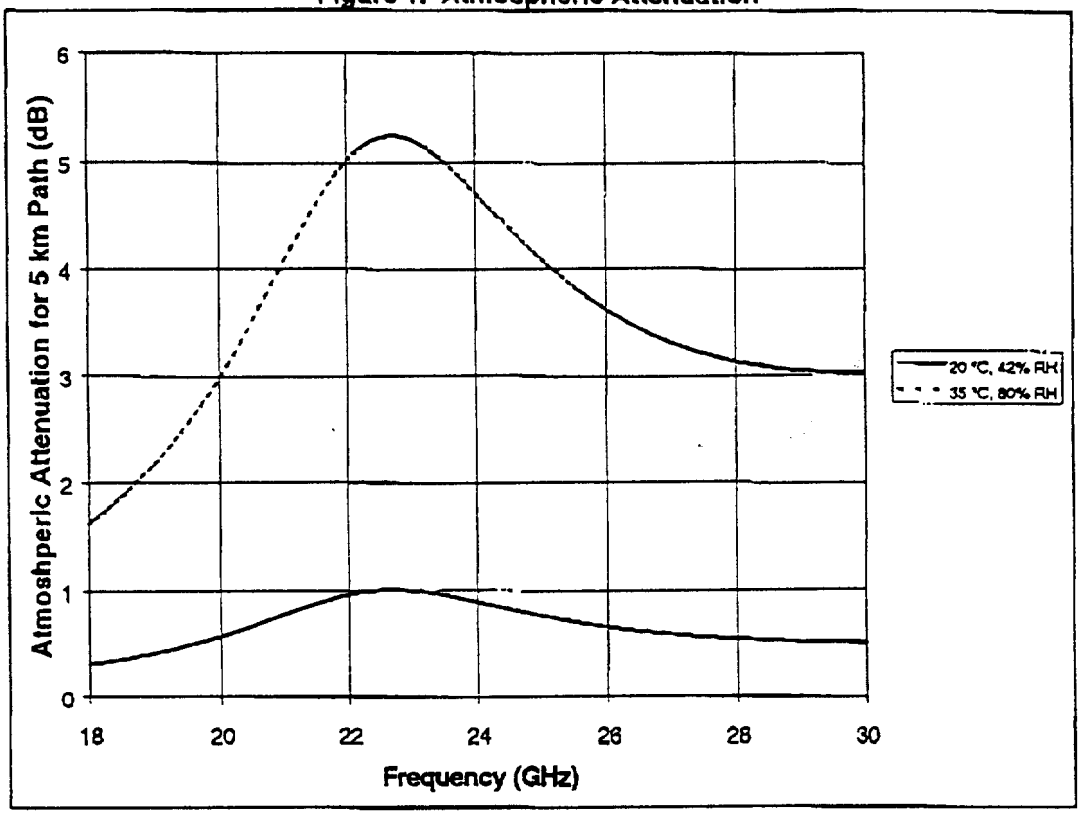
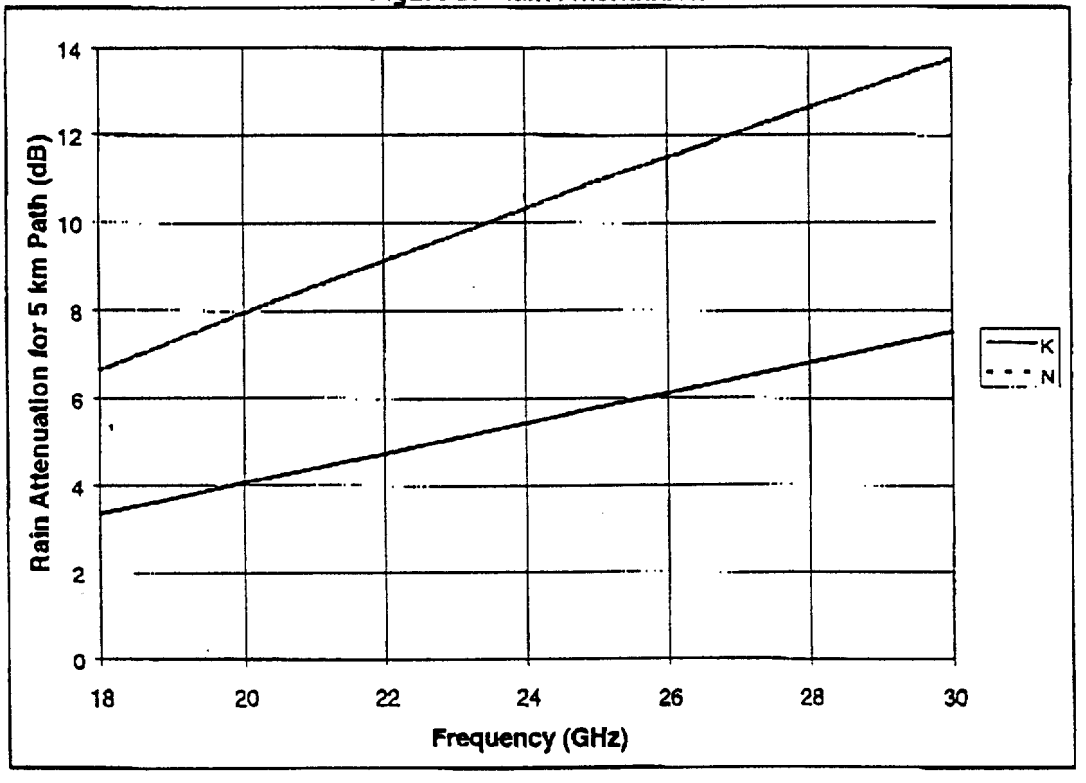


Figure 2. Rain Attenuation



RADIOCOMMUNICATION STUDY GROUP
ITU-R FACT SHEET

Working Party: ITU-R USWP 9B
Document: USWP 9B/3 Rev. 1
Reference: Document 9B/TEMP/7

Date: 19 November 1996

Document Title: Proposed Amendment to Document 9B/TEMP/7: IDENTIFICATION OF FREQUENCY BANDS ABOVE 30 GHz FOR USE BY THE FIXED SERVICE

Author	Organization	Phone/Fax/E-Mail
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Walter H. Sonnenfeldt	WS&A	301-770-3299 / 301-468-5953

Purpose/Objective:

To contribute to the drafting of Section 7.5 of the CPM-97 Report that addresses WRC-97 Agenda item 1.9.6 concerning the identification of suitable frequency bands for high-density fixed service deployment above 30 GHz.

Abstract:

The introduction clarifies the motivation for WRC-97 Agenda item 1.9.6 which derives from the identified difficulties of band sharing with proposed satellite services, and submits that, in the case of the currently allocated bands in the 30 - 50 GHz range, the obvious workable alternative consists of modifying existing shared co-primary allocations to form exclusive fixed service and fixed satellite service allocations. The three core sections elaborate on the evolutionary shift in the progressing expansion of both the fixed service and the fixed satellite service into higher frequency bands and toward higher deployment densities, and point out that coordination between satellite Earth stations and fixed service stations thus becomes the critical sharing condition which would make either one or both services operationally and economically unjustifiable. The creation of exclusive spectrum allocations within existing co-primary bands is indispensable to allow each service to be deployed to its full potential and to achieve high spectral efficiency. Accordingly, there is a sound technical basis for changes to the Table of Allocations at WRC-97 in conjunction with Agenda item 1.9.6, particularly with respect to the 30 - 50 GHz range. There also appears to be a need for a follow-up WRC-99 agenda item to address Agenda item 1.9.6-related issues in bands above 50 GHz.

Fact Sheet Preparer: Ferdo Ivanek

Documents
Radiocommunication
Study Group

Document: USWP 9B/3 Rev. 1
19 November 1996
Original: English

United States Of America

Proposed amendment to Document 9B/TEMP/7

IDENTIFICATION OF FREQUENCY BANDS ABOVE 30 GHz FOR USE BY THE FIXED SERVICE

(Item 1.9.6 of the WRC-97 agenda)

This document is submitted to the January 1997 meeting of Working Party 9B for consideration as an alternative draft of Section 7.5 of the CPM-97 Report.

ANNEX

7.5 Fixed service above 30 GHz (WRC-97 Agenda item 1.9.6)

WRC-97 Agenda item 1.9.6 concerns "the identification of suitable frequency bands above 30 GHz for use by the fixed service for high-density applications". It is motivated by (i) the rapid expansion of large-scale fixed service deployment in ever higher frequency bands; (ii) the unprecedented high and growing deployment densities; (iii) the co-primary frequency allocations to two or more services in the same frequency band, (iv) the growing number of proposals for the introduction of high-density fixed satellite services in the shared frequency bands, and (v) the accumulating indications that such co-primary band sharing between two high-density services tends to critically impair the viability of either one or both services. The most plausible alternatives to co-primary band sharing under such unfavorable conditions are (1) creation of separate exclusive allocations in current co-primary frequency blocks that allow both the fixed service and the fixed satellite service to independently optimize the multiple trade-offs between coverage density, service quality, cost effectiveness and spectral efficiency; and (2) the allocation of new expansion bands for the fixed service, either exclusive or shared with a compatible other service, if suitable spectrum can be identified.

7.5.1. The frontier of fixed service expansion towards higher frequencies is above 30 GHz

ITU-R chose to draw the line between two broad categories of radio-relay systems at about 17 GHz (Recommendations ITU-R F. 1101 and F.1102). Conventional long distance services operate in the bands below this limit, mostly below 10 GHz, where multipath fading is the controlling propagation impairment mechanism and hop lengths of a few tens of kilometers are typical. Above 17 GHz the usable hop lengths are determined by precipitation fading and atmospheric absorption; they are on the order of 10 kilometers and shorter. This frequency range is therefore used for a variety of local access services. The evolutionary shift is gradual over the allocated communications frequency bands between about 11 GHz and 15 GHz that accommodate a variety of fixed services using intermediate hop lengths.

Fixed service deployment progresses towards higher frequencies depending on the available frequency spectrum, service requirements, and technological progress. Recommendation ITU-R F.746 provides summary information on the ITU recommended radio-frequency channel arrangements for radio-relay systems including the frequency bands 17.7 - 19.7 GHz ("18 GHz"), 21.2 - 23.6 GHz ("23 GHz"), 24.25 - 29.5 GHz ("27 GHz"), 31.0 - 31.3 GHz ("31 GHz"), 36.0 - 40.5 GHz ("38 GHz") and 54.25 - 58.2 GHz ("55 GHz"). Local access service deployment is accelerating in all of these bands. Spectrum congestion is already evident in parts of the 18 GHz and 23 GHz bands. The fastest rate of deployment is currently in the 38 GHz band, due in part to the marketplace attractiveness of compact terminals for end user applications. The number of fixed service subscribers in the bands above 17 GHz is currently close to 200 thousand. Based on the accelerating rate of growth it is expected to triple within the next 2-3 years and again over the subsequent 2-3 year period.

7.5.2 The growing variety and high-density deployment of local access systems

Recommendation ITU-R F.1102 covers characteristics of radio-relay systems operating in frequency bands above about 17 GHz. It includes a variety of applications, hop length considerations, and digital radio implementations. The companion Recommendation ITU-R F.1101 supplements it in several important aspects, including a comparison of current and advanced modulation and coding methods. Additional relevant aspects are covered in Recommendations ITU-R F.756 on TDMA point-to-multipoint systems, ITU-R F.1104 on requirements for point-to-multipoint radio systems in the local grade portion of an ISDN connection, and ITU-R F.750 on SDH-based networks. In addition, the March 1996 meeting of Working Party 9B adopted Document 9B/TEMP/15 (Rev.1), a Draft New Recommendation on Radio

Local Area Networks (RLANs) that are listed in Recommendation ITU-R F.1102 as an important new application category in the bands above 17 GHz. The band-specific radio-frequency channel arrangements are provided in Recommendations ITU-R F.595 (18 GHz), F.637 (23 GHz), F.748 (25, 26 and 28 GHz), F.749 (38 GHz), and F.1100 (55 GHz).

This group of ITU-R Recommendations provides a solid framework for local access radio system deployment in the bands above 17 GHz, in general, and in the bands above 30 GHz, in particular. The rapid development of local access radio systems is further documented in more recent publications, e.g. in the ITU TELECOM 95 Technology Summit, Volume 2 of Speakers' Papers (H. P. Petry, Design Aspects of a Flexible Radio System in Access Networks, pp. 325-329, and K. Kohiyama, Advanced Wireless Access Systems, pp. 341-345). The following deployment summary is derived from Recommendation ITU-R F.1102 and from the quoted publications.

Example Current Deployments	Example Future Deployments (near-medium term)
Local access	Radio local area networks (RLANS)
User to user building LAN interconnection	Multimedia capability
End office to user building multiplexed links	Transmission rate and bandwidth on demand
Inter-cell links for cellular and PCS systems	ATM compatibility
Transportable radio for optical fiber backup	Expanded portability of user terminals
SDH access network links	Local distribution of television programs

The densest current deployment is in urban and suburban business areas and in industrial areas. Future dense deployment is expected to extend to residential areas, spearheaded by local distribution of television programs in competition to Cable TV and other new broadband service offerings to the home. The variety of network configurations includes: conventional point-to-point (P-P), conventional point-to-multipoint (P-MP), and combinations thereof, e.g. P-P systems deployed in multisectored P-MP configurations. High-density deployment of independent P-P links similarly results in clusters that assume the essential characteristics of P-MP deployment. The densest deployment cases have reached the range of 1 to 10 fixed terminals per square kilometer; they are expected to increase several fold within a few years.

7.5.3. The evolutionary shift includes inter-service frequency band sharing conditions

All of the fixed service allocations above 17 GHz are presently shared on a co-primary basis with satellite services, mostly with the fixed satellite service. Fixed service deployment started without any sharing restrictions in effect, and there is as yet no satellite deployment in the bands above 17 GHz, except experimental. Fixed satellite service planning for these bands started on the premise that the established sharing conditions in the 4/6 GHz and 11/14 GHz bands can be replicated above 17 GHz. However, the evolutionary shift from below to above 17 GHz introduces in both the terrestrial and satellite fixed services entirely new conditions which greatly reduce mutually tolerable sharing above 17 GHz. At the core of the problem is the increase in either actual or potential deployment densities in the two services. This is due in part to the substantial reduction of the physical size of both fixed satellite service and fixed service antennas allowed by the use of higher frequencies that results in a dramatic expansion of viable end user service applications. This is also due to the increased deployment densities made possible by higher signal attenuation in the higher frequency bands.

The critical sharing aspect is the coordination between satellite Earth stations and fixed service stations. Geographical separation is facilitated in the 4/6 GHz and 11/14 GHz frequency bands by the predominant

long distance and regional fixed service deployment, and by the comparatively low density deployment of satellite service Earth stations. In addition, frequency separation is facilitated by the comparable radio channel bandwidths of terrestrial and satellite services in those bands. Nevertheless, the proliferation of 4 GHz Earth stations in some parts of the United States has made it virtually impossible to add new fixed service links in this band through coordination.

In the bands above 17 GHz the fixed satellite service proposals aim at even higher densities of compact new Earth stations, the predominant number of which are intended to be placed directly at customer premises. While this is attractive in offering a complementary service to the existing and future fixed service subscribers, it is highly restrictive in the case of band sharing because it would require either collocation of terminals of the two services or placing them closer than the required separation distance. Since the planned deployment densities of satellite Earth stations are comparable to those of the fixed service, the extent of effective geographical separation is marginal at best. The effective use of frequency separation is also critically reduced by the large channel bandwidths of the proposed satellite services in the bands above 17 GHz, which are in many cases are many times larger than the channel bandwidths of the existing and planned fixed service links. Accordingly, band sharing between fixed service and fixed satellite service systems by coordination becomes largely ineffective for practical purposes in most frequency bands above 17 GHz.

7.5.4 Impact on WRC-97 agenda item 1.9.6

Propagation conditions, available technology and business conditions focus the WRC-97 agenda item 1.9.6 on the 30 - 50 GHz frequency range that includes two major bands allocated to fixed terrestrial and satellite services on a co-primary basis: 37.5 - 40.5 GHz and 47.2 - 50.2 GHz. ITU-R sharing studies that are being carried out for affected bands above 17 GHz provide sufficient indication that high-density fixed terrestrial and satellite services with collocated or closely spaced subscribers are in principle incompatible for band sharing purposes.

The underlying reason is two-fold: (i) the required inter-service separation distances are large in comparison with the intra-service distances; and (ii) inter-service frequency separation is rendered ineffective or impossible due to the comparatively very large radio-frequency channel bandwidths of the proposed fixed satellite services. This means that, if band sharing were imposed, either one or both services would become operationally and economically unjustifiable.

In the specific cases of the 38 GHz and 48 GHz bands the straightforward solution consists of band segmentation which would allow each service to be deployed to its full potential in terms of subscriber density, system capacity, service quality, cost effectiveness and spectral efficiency. This solution is readily available because in each case a 3 GHz bandwidth is allocated on a co-primary basis. The feasibility of this solution is demonstrated by the extensive and rapidly expanding high-density fixed service deployment in the 38 GHz band, which currently utilizes only one half or less of the 3 GHz wide co-primary band allocation. Near-term future fixed service deployments in the 48 GHz band are very likely to follow the same or a similar pattern.

As a result of the studies in response to WRC-97 Agenda item 1.9.6 it is clear that there currently exists a sound technical basis for remedial action at WRC-97 through appropriate changes to the Table of Allocations in the range of 30 - 50 GHz. Extant issues relating to Agenda item 1.9.6 concerning the bands above 50 GHz appear to require a follow-up WRC-99 agenda item.

DOCUMENT #2

Teledesic

1150 Connecticut Avenue, N.W., Suite 200, Washington, D.C. 20036
Tel: 202-296-8047 - Fax: 202-296-8953

TO: Steve Sharkey

FROM: Larry Williams

DATE: January 7, 1997
4:02 AM

FAX NO.:

NO. OF PAGES: (including cover)

We asked Endgate, an RF manufacturer that we worked with in the LMDS proceeding, to give us their best estimates on the amount of time necessary to develop 24 GHz point-to-multipoint equipment. Attached is their response. I thought it might be of interest to you.

Look forward to the meeting next week. It might be useful for us to talk before then.

Thanks.

To: Russ Daggatt
President
Teledesic Corporation

From: Doug Lockie
Executive Vice President and Founder
Endgate Corporation

Russ,

This letter documents microwave wave radio capabilities at 24 GHz.

There are standard radio bands at 23 GHz and at 26 GHz. A very straightforward modification of these radios will result in a 24 GHz product. The only things that need to be redesigned are diplexers and oscillators. The preamps, power amps, IF amps and mixers are all typically broadband in nature and essentially already have the performance needed for a 24 GHz radio.

If a telecommunication band becomes available in the 24 GHz range, modified radios could be made available within 6 months to 1 year. (Six months for prototypes and 1 year for qualified units.)

Several companies have radios at 23 and 26 GHz and any one of these could be candidates for suppliers of 24 GHz units. Endgate would be pleased to supply modified RF front ends to any of these companies. There are a number of other RF component suppliers who would also probably be willing to supply the 24 GHz front ends to the radio system integrators.

The cost for making modifications and qualification is on the order of $500 K to $750 K. Typically a radio manufacturing company will make this investment for a sale of on the order of $6 Million to $10 Million.

If there are any questions, please contact us here at Endgate.

Best regards,

6 JAN 1997

Doug Lockie
Endgate Corporation

DOCUMENT #3

ASSOCIATED COMMUNICATIONS, L.L.C.

11 Canal Center
Alexandria, Virginia 22314
Phone 703-299-4400 Fax 703-299-4580

TO: Mr. Steve Sharkey, FCC

FAX #: (202) 418-0765

DATE: 1/13/97 PAGES INCLUDING COVER: 9

RE:

☐ Urgent ☐ For Review ☐ Please Comment ☐ Please Reply ☐ Recycle

Message:

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ASSOCIATED COMMUNICATIONS, L.L.C.

January 13, 1997

Laurence E. Harris

Senior Vice Presid

General Counsel

11 Canal Center Plaz

Suite 300

Alexandria

Virginia 22314

703-299-4434

Fax 703-299-4580

Mr. Steve Sharkey
Acting Chief
Satellite Engineering Branch
Federal Communications Commission
2000 M Street, Room 512
Washington, DC 20554

Via Facsimile

Re: Digital Electronic Message Service

Dear Steve

Per your request, enclosed is some detail regarding the implementation of the dynamic with allocation for the ERICSSON INC. DEM System.

This information is proprietary to Associated Communications, L.L.C. and its affiliates. It is being provided to you to help the FCC resolve these issues and should be held in confidence.

Very truly yours,

Laurence E. Harris

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4.2.2 Dynamic Bandwidth Allocation

The radio system supports Dynamic Bandwidth Allocation (DBA) to facilitate - over the air - concentration of customer traffic. The DBA system efficiently allocates transmission carrier frequencies and transmission bandwidths for QPSK, 8PSK and 16PSK modulation schemes in response to dynamically varying customer traffic loads.

(38) DBA ensures that no customer call is blocked if sufficient unallocated spectrum segments exist to support the call type requested by the customer. Operation of DBA will cause no disruption to calls in progress.

(39) It is possible to download DBA software to the CPE over the air interface.

4.2.2.1 Commissioning, Cell Management and Interference

The DBA function is performed within the frequency band and polarization dedicated to this section.

4.2.2.2 Approach for DBA

(40) The modem is able to transmit and receive two carriers in parallel. For the case of change in the data rate of the user data, an additional carrier is set up between the same pair of modems. This carrier uses a free frequency slot within the available spectrum band. In order not to interfere with already established carriers, the choice of frequency, modulation, FEC-rate, data rate, EIRP etc. of the new carrier is defined by the RASCO. The parameters of the new carrier can be chosen independently from those of the original carrier.

(41) Switch-over from the original carrier to the new carrier will take place only after total synchronization of both carriers in order to maintain bit-error-free performance. After successful switch-over, the original carrier is switched-off, its previously occupied frequency slot can be used by other modems.

The period from call request up to successful switch-over and switching-off the original carrier is specified in Section 5.3.2.

4.2.3 Capacity Per Cell

The following figures indicate the capacity per cell, described as number of CPEs with certain traffic data rates. These figures are based on the following assumptions:

1. The cells are allocated in a rectangular grid on a flat surface, not overlapped.

2. Within the grid, randomly distributed reflectors are distributed. These reflectors are modeled as buildings with quadratic ground area, having dimensions of 50m x 50m. The sidewalls of these buildings are regarded as ideal reflectors. The height of these buildings is anticipated as equal to the

height of the base station. The rotation of those reflectors with respect to the base station is randomly chosen.

3. In order to take into account the results of a properly performed cell planning, the inner circle around the base stations, whose radius is less than 0,2 of the total cell radius, is regarded as being free from those reflectors. (Large reflectors within this inner circle will lead to an excessive view angle as seen from the base station, and therefore to an excessive shadowed area behind the reflector. Those situations will be avoided by proper cell planning)

4. Under these assumptions of randomly distributed reflectors, a coverage of 2% of the overall cell area by the ground area of the buildings results in an average of 40% of shadowed area behind the reflectors for 90-deg and 45-deg sectored cells in an average of 10% of area disturbed by reflections generated from other sectors of the same cell for 15-deg sectored cells in an average of 15% of area disturbed by reflections generated from other sectors of the same cell in an average of 10% of area disturbed by reflections generated from other cells.

5. The shadowing effect is anticipated also for reflected beams, i.e. the impact of reflections decreases with larger transmission path via the reflector. The beams by double reflection are not taken into account.

6. Shadowed reflectors are discounted

7. One broadcast carrier per sector is required

8. CPEs are assessed as being randomly distributed over the area. Therefore the affected area by reflections or direct interference is proportional to the number of affected CPEs.

9. Direct interference from neighboring cells is taken into account as affected areas with certain degrees of interference levels. This percentage of interfered area is directly correlated as a portion of the available spectrum, having a certain interference level, and requiring therefore a certain modulation scheme in order to allow operation.

10. 70% of the remaining spectrum is used. The rest is maintained as margin e.g. for overlapping.

11. For DBA-mode, the spectrum to allocate one typical carrier at QPSK-3/4 is kept free in order to provide sufficient spectrum for the DBA-algorithm.

12. Carriers with data rates less than 512 kbit/s cannot be operated with 16-TCM, carriers with data rates less than 256 kbit/s cannot be operated with 8-TCM.

13. To evaluate the number of lines in DBA-mode, an average traffic of 0,2 Erlang per line is anticipated. In FBA-mode one line corresponds to 64 kbit/s.

The following calculation gives an example for 45-deg-sectorization. 30 MHz of allocated bandwidth, and FBA-mode with a CPE of typical 10 Erlang traffic capacity:

1. At 45-deg-Sectorization, 4 broadcast carriers are needed for the sectors with the same polarization. Each broadcast carrier requires 135 kHz of bandwidth:

   Available bandwidth per sector: 30 MHz - 4 x 0,135 MHz = 29,46 MHz

2. 10% reflections from other sectors within the cell reduce the bandwidth to 26,78 MHz

3. 10% reflections from other neighboring cells lead to a bandwidth of 24,35 MHz

4.	70% of this spectrum is used for further calculations:	17,04 MHz
5.	Due to direct interference from other cells, the following spectrum can be used only for QPSK 1/2:	2,12 MHz
	Due to direct interference from other cells, the following spectrum can be used for QPSK 3/4 or QPSK 1/2	0,76 MHz
	Due to direct interference from other cells, the following spectrum can be used for QPSK 7/8, QPSK 3/4 or QPSK 1/2	0,91 MHz
	Due to direct interference from other cells, the following spectrum can be used for 8-TCM 2/3, QPSK 7/8, QPSK 3/4 or QPSK 1/2	6,04 MHz
	The remaining spectrum can be used for all modulation schemes:	7,23 MHz
6.	Number of CPEs operated in QPSK 1/2 used bandwidth (modulation efficiency 0,833)	2 1,73 MHz
	Number of CPEs operated in QPSK 3/4 used bandwidth (modulation efficiency 1.2)	1 0,60 MHz
	Number of CPEs operated in QPSK 7/8 used bandwidth (modulation efficiency 1,4)	2 1,03 MHz
	Number of CPEs operated in 8-TCM 2/3 used bandwidth (modulation efficiency 1,6)	13 5,85 MHz
	Number of CPEs operated in 16-TCM 3/4 used bandwidth (modulation efficiency 2.4)	24 7,20 MHz
	Total number of CPEs per sector	42

7. **Total number of CPEs per cell** **336**

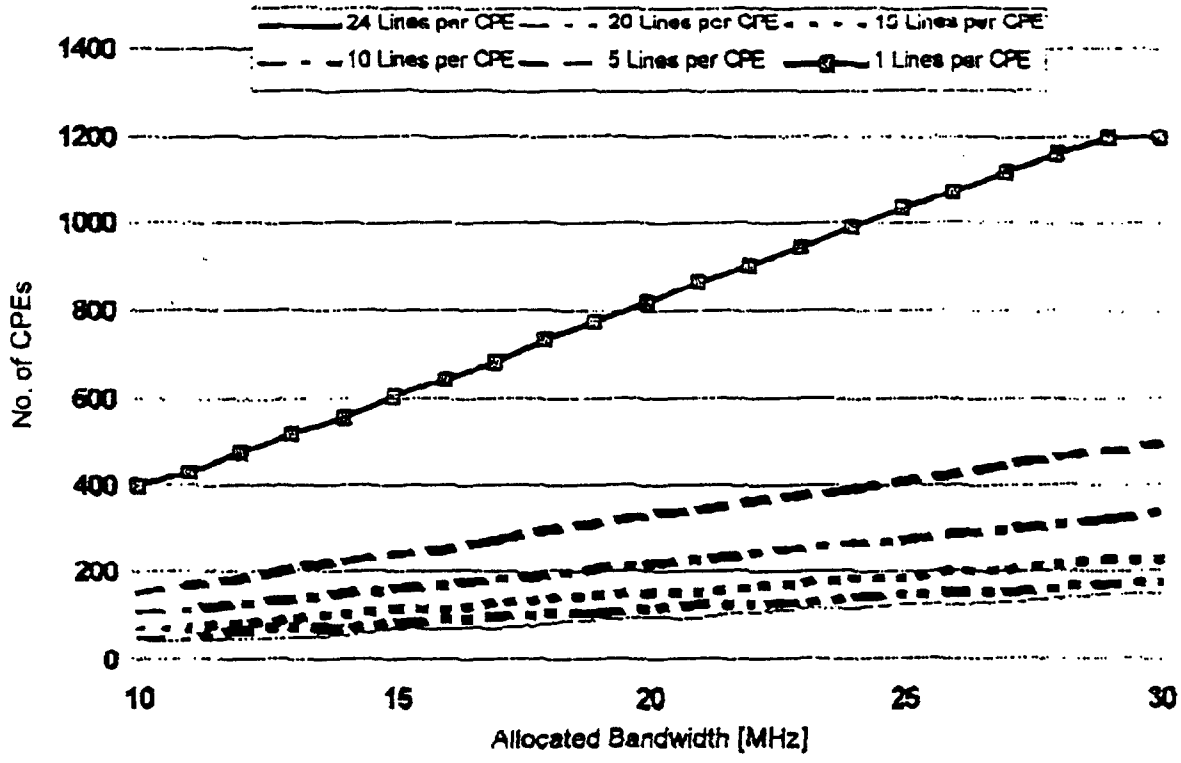

Figure 20 - No. of CPEs Per Cell with 45-Deg-Sectors in FBA-Mode

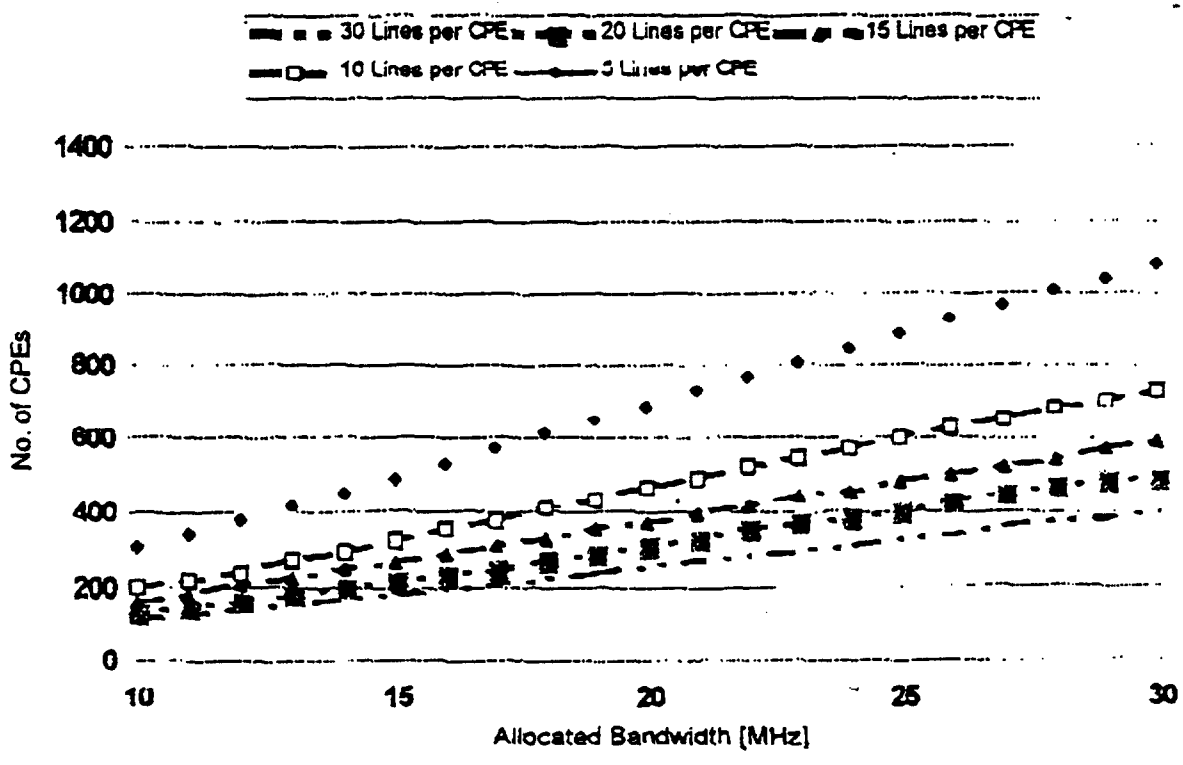

Figure 21 - No. of CPEs Per Cell with 45-Deg-Sectors in DBA-Mode

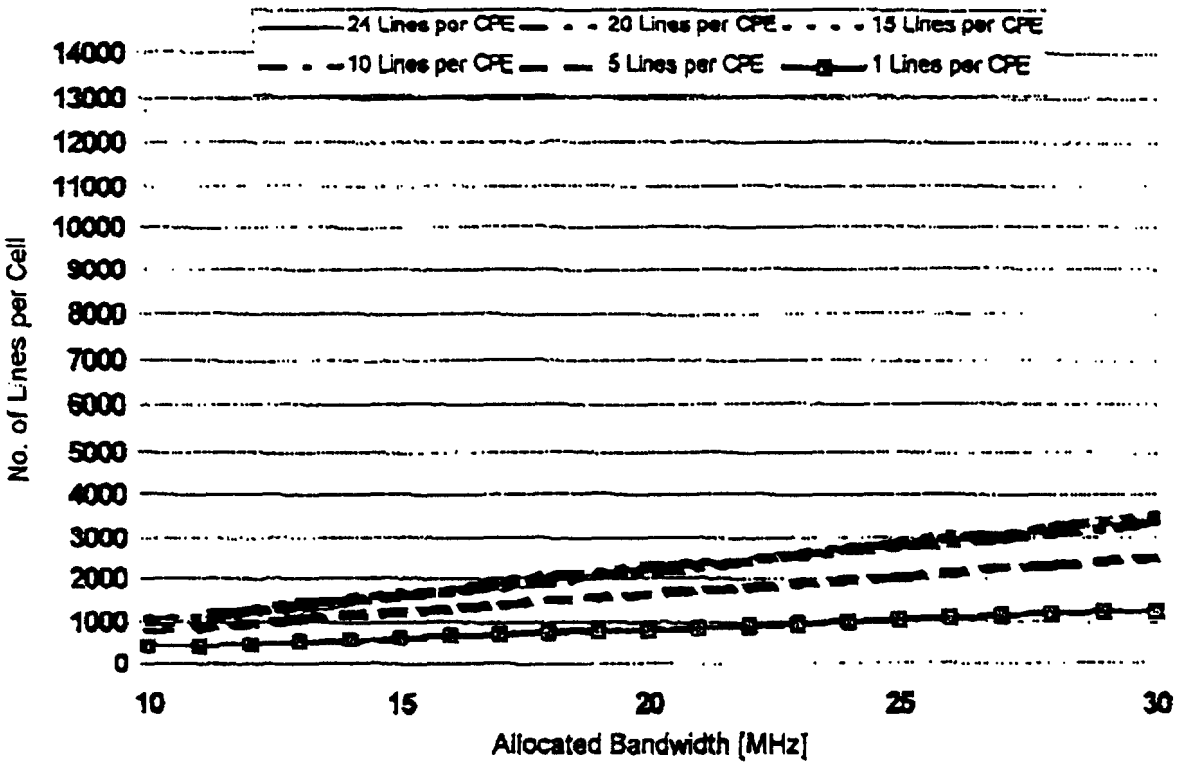

Figure 22 - No. of Lines Per Cell with 45-Deg-Sectors in FBA-Mode

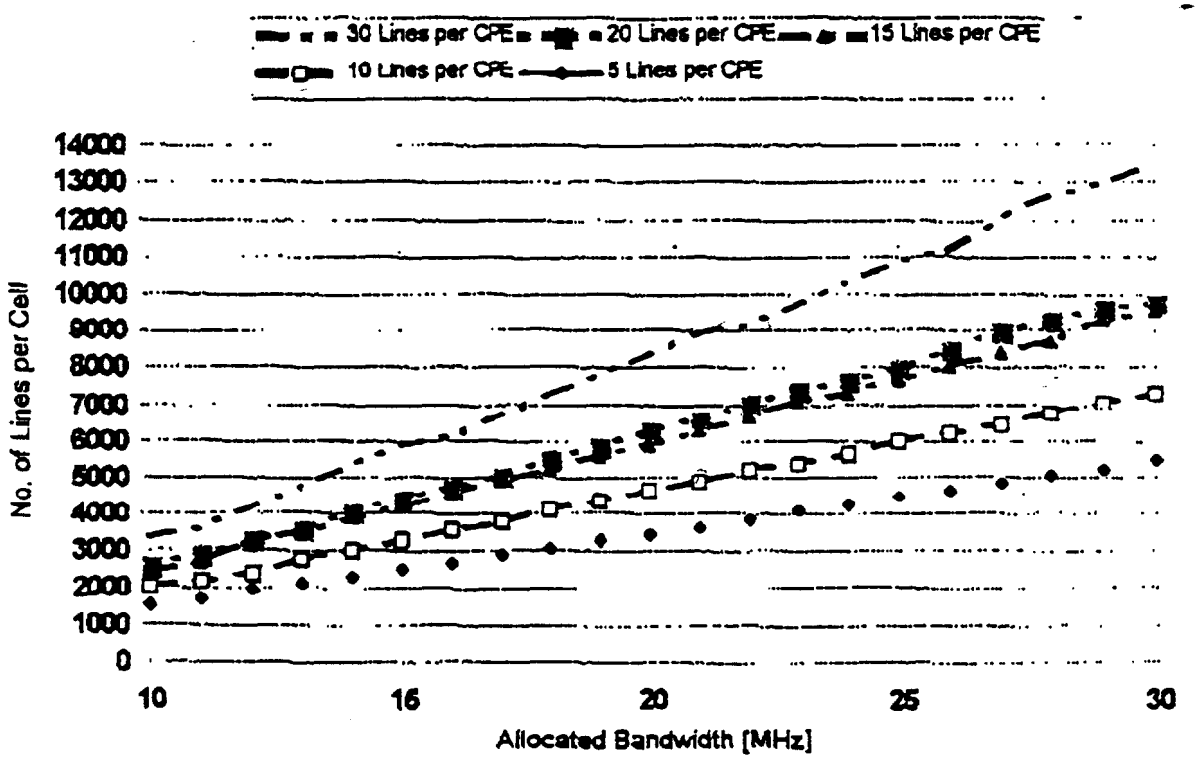

Figure 23 - No. of Lines Per Cell with 45-Deg-Sectors in DBA-Mode