Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In re Consolidated Application of **ECHOSTAR COMMUNICATIONS CORPORATION** **GENERAL MOTORS CORPORATION** **HUGHES ELECTRONICS CORPORATION,** Transferors, and **ECHOSTAR COMMUNICATIONS CORPORATION,** Transferee, For Authority to Transfer Control.	)	CS DOCKET 01-348

DECLARATION OF RICHARD G. GOULD

1. Background and Qualifications

My name is Richard G. Gould. I am the principal in Telecommunications Systems, Professional Consulting Engineers in Washington, D.C. I have been a graduate professional telecommunications engineer since 1949, and I have been active in the field of broadcasting satellites since 1960, beginning with projects for the U.S. Army Signal Corps Development Laboratories and NASA while at Stanford Research Institute. I did the technical design of the USSB satellite system that was included in the successful application of USSB to the FCC in 1985. I was also responsible for the Proposed Programming, Financial Qualifications and Public Interest portions of that application. For many years I have taught spectrum management at the George Washington University, and I developed and conducted a proprietary course in Broadcasting-satellites. I was a member of the U.S. delegations to the 1977, 1983 and 1985 ITU

Conferences that developed and adopted the Allotment Plans for Broadcasting-satellites, as well as the ITU Administrative Radio Conferences of 1987, 1988, 1992, 1995 and 1997, which dealt with the spectrum management aspects of other services. In 1985, I was elected a Fellow of the Institute of Electrical and Electronic Engineers, and I am now a Fellow of the Washington Academy of Sciences. I am a Registered Professional Engineer in the District of Columbia. A copy of my curriculum vitae is attached as Exhibit A.

2. Introduction and Summary

Based on technologies currently available and already proven to work, including techniques that DirecTV, EchoStar, or both are already deploying, DirecTV and EchoStar each have ample capacity to carry standard-definition television signals (also known as "NTSC" signals) from all of the local television broadcast stations in every one of the 210 Designated Market Areas (DMAs) as well as all their existing standard CONUS ("national") and pay-per-view (PPV) programming. These 210 DMAs include all U.S. TV households, and the 1467 local stations in those markets that are eligible for carriage under SHVIA. ("Local markets" are the Designated Market Areas, or "DMAs," defined by Nielson Media Research.)

Improvements in current techniques, technology, and spectrum management that will be available in the near future will provide further increases in capacity that could be used for additional national, regional or local television programming.

3. Use of DBS Ku-Band Capacity

A. Frequency Re-Use with Spot-Beam Satellite Transmitting Antennas

With the exception of DirecTV's recently-launched spot-beam satellite (D-4S), DBS satellites operated by EchoStar and DirecTV have CONUS beams. That is, the antennas of the satellites, much like a searchlight beam, concentrate the transmitted power that would otherwise be radiated in all directions like an unshielded light bulb. Such beams are shaped so that almost all of their power is directed towards the CONUS: the Contiguous United States. Another way to state this is to say that the "footprint" of the beam covers the CONUS and that DBS receiving equipment within that footprint will receive usable signals.

A frequency in such CONUS beams can be used only once with the same polarization. (By "frequency," I mean one of the 32 frequency bands or channels assigned by the FCC at each Ku-band orbital slot.) If two transponders used the same frequency for transmitting two different programs, the home receiving antennas ("dishes") of subscribers would pick up both transmissions, and each transmission would completely interfere with the other.

Spot-beam antennas, which have been used for decades by Intelsat and by many other satellite systems around the world, concentrate the transmitted satellite power much more, resulting in a much smaller footprint on the Earth. DIRECTV launched its first spot-beam satellite, D4-S, in November 2001. The D4-S reuses frequencies an average of 7.33 times. DirecTV has ordered another spot-beam satellite, D7-S, which is scheduled to be launched in the second half of 2003. EchoStar has ordered two spot-beam DBS satellites, EchoStar VII and VIII.[1]

But the re-use factor of 7.33 that DirecTV obtained with its design for the D4-S is far from the limit that can be achieved with the small spot-beams typical of those that can be produced by antennas on contemporary telecommunication satellites. The same frequency with the same polarization can be used from the same orbital slot several times throughout the CONUS, resulting in frequency re-use factors of 10 or even higher. But the size of the DMAs, and their geographical separation from each other, can reduce the average re-use factor to a number slightly less than 10. When DMAs are closely spaced, as in the Eastern United States, for example, frequencies cannot be re-used as often because of the need to avoid interference to other DMAs in the area.

Between them, EchoStar and DirecTV control all of the high-power Ku-band frequencies at the orbital locations (or "slots") most nearly centered on the United States, which are at 101 degrees west longitude ("WL"), 110 degrees WL, and 119 degrees WL. The FCC has assigned DirecTV all 32 frequencies at the 101-degree WL orbital location, three at the 110-degree orbital slot, and 11 at the 119-degree slot. Until the launch of D4-S, DirecTV had offered local-to-local service at all three slots, but moved all local stations to 101 degrees when D4-S became operational. Both EchoStar and DirecTV offer home receiving dishes with more than one feed that can pick up signals from two (or in the case of DirecTV, even three) orbital locations, and make available set-top boxes that can sort out the different programs and send them to the subscribers' TV sets.

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1 EchoStar VII and VIII were (initially) designed to re-use frequencies much less efficiently, namely an average of five times. EchoStar/DirecTV Joint Engineering Statement at 5, 6. The Engineering Statement does not disclose what steps EchoStar is taking to correct this much less efficient design, now that EchoStar is aware of what DirecTV was able to accomplish.

The use of satellites at three orbital locations provides another kind of frequency re-use that increases the capacity of DBS systems. Since the typical home DBS receiving dish has a beam-width of about three degrees, the antenna that picks up the signal from one DBS satellite does not "see" or receive the signals from a satellite nine degrees away. Therefore, the same transponder frequency can be used from each of the three DirecTV orbital slots, even with CONUS beams.

B. Digital Compression

Digital compression is another technology that can greatly increase the capacity of a DBS system. Digital compression is based on the fact that there is a great deal of redundancy in typical television signals. Much of a scene often does not change at all from frame to frame, while other portions of the scene may change only slowly. However, there will be much more change from frame to frame during fast-moving, rapid action programs such as football or basketball games, and at scene changes in all types of programs.

Digital transmission is usually preferred over analog for satellite transmissions. Therefore, compression techniques and technology that take advantage of the redundancy in TV signals have been developed for processing digital signals for DBS systems. The current worldwide industry standard for reducing the redundancy of a TV signal (both its color video and its audio components) is termed MPEG-2, one of a series of standards developed by the Motion Picture Experts Group. Without compression, an NTSC TV signal requires as much as 270 Megabits per second (Mbps) for faithful rendition. After MPEG-2 compression, an NTSC signal may be transmitted with a digital bit rate that can vary between 2 and 8 Mbps depending on the program content, that is, on the amount of change in the picture from one frame to the next. Another application of this coding concept, familiar to music fans, is "MP3" (also known as MPEG Audio Layer 3), which was developed by the same group and is used for storing music and other audio files in much less space.

After compression, several digital signals are combined ("multiplexed") into a single digital carrier. In that process, each of the digitized, compressed signals is assigned a certain portion of the total bit stream. The digitized signal of a fast-action program would be assigned more of the bits than a slowly changing signal such as a "talking heads" program. But even the fast-action program does not have fast action at every instant. To take advantage of this fact, statistical multiplexing ("stat mux") with variable bit rate ("VBR") encoding is used. The VBR "stat-mux" examines the several incoming signals to be combined, and assigns the necessary number of bits per second to each of the signals, depending on how fast the scene is changing at that instant.

The combination of digital compression, statistical multiplexing (with VBR encoding), efficient modulation, error-correction coding, and noise reduction currently results in a single frequency being able to carry several standard TV signals. That overall process will be referred to in this report as the "compression ratio."[2] A compression ratio of 10 represents a dramatic improvement over just four to five years ago, when only six to eight TV signals were carried in a single frequency. But compression ratios significantly higher than 10:1 are now technically, economically, and operationally feasible. Both DIRECTV and EchoStar have stated that they expect compression ratios to be 12:1 with existing hardware, and DirecTV stated in late 2000 that it was already carrying 500 channels on 46 CONUS frequencies (a compression ratio of

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2 Strictly speaking, compression refers only to the encoding of an NTSC analogue signal into a digital signal, with much of the redundancy removed. The resulting digital signal has a much lower bit rate than would otherwise be required to reproduce the picture satisfactorily. The overall process, including multiplexing could be termed increasing the "program-to-channel" ratio, that is, the number of NTSC programs than can be carried in one of the 32 DBS frequencies.

nearly 11:1). However, Harmonic, Inc. (formerly known as DiviCom), the manufacturer of the MPEG-2 encoders most widely used for DBS in the United States, now states that their current hardware, the MV-50, allows compression ratios of up to 14:1 with the same high quality and high availability of DBS systems in operation now.

This operational capability is based on accepted signal processing theory. The transponder capacity can be shown to be between 12 and 14 NTSC channels using standard methods of modulation and coding. With more robust modulation methods, such as 8PSK (discussed below), at least a 30 percent increase in capacity can be attained, yielding roughly 15-18 NTSC channels per transponder. These conclusions are based on the following analysis.

The total data rate that can be supported by a satellite transponder depends on the transponder bandwidth, the type of modulation, and the type of coding.

According to ITU regulations, the standard bandwidth for a DBS satellite transponder is 24 MHz. Thus the total data rate is determined by the choice of modulation and coding.

The required average data rate per channel depends on the compression, filtering, and dynamic multiplexing methods. The transponder NTSC channel capacity is the ratio of the total data rate and the required average data rate per channel.

Until recently, the industry standard for modulation has been Quaternary Phase Shift Keying (QPSK). With this type of modulation, there are four possible phase states, such that each phase state represents a symbol comprising two bits. Thus with coding at rate 3/4 and 20 percent bandwidth margin, the total data rate capacity of the transponder is 30 Mbps.

With modern forms of compression, filtering, and multiplexing, the required average data rate for MPEG-2 video is between 2.1 and 2.5 Mbps. Thus with QPSK modulation and rate 3/4 coding, the transponder capacity is between 12 and 14 NTSC channels, according to the compression equipment manufacturer that DirecTV already uses. With more modest coding, the data rate and capacity might be even higher.

A new form of modulation that is becoming more widely used is 8PSK modulation. With this form of modulation there are 8 possible phase states and each symbol comprises 3 bits. Thus, since the number of bits per symbol is increased in the ratio of 3/2 compared to QPSK, 8-PSK in principle permits a 50 percent increase in data rate. (I will conservatively assume that only a 30 percent increase would be achieved in actual practice.) Under similar compression, filtering, multiplexing, and coding techniques, the transponder channel capacity also increases to the same extent and becomes 15 to 18 NTSC channels. This form of modulation requires more power than QPSK modulation. However, current satellites have significantly more power than satellites of the past and power is no longer a major communication satellite system design limitation.

Another technology that is emerging is the combination of modulation and coding (Turbo Trellis Coded Modulation). This sophisticated technique has been permitted by the possibility of increased computer processing speeds. As a result, the bandwidth can be used more efficiently without requiring substantial increases in power.

Therefore, assuming the use of well known methods now being applied by one or both of the DBS firms and allowing for some conservatism, one can conclude that a DBS satellite can support up to 12-14 NTSC channels per transponder using the industry standard form of modulation (QPSK) and up to about 18 NTSC channels per transponder using 8PSK, a more robust form of modulation. With still further advanced methods of modulation that can be expected to be introduced in coming years (as discussed below), these numbers are likely to go still higher.

C. Capacity of DIRECTV and EchoStar to Carry Local Stations

This section will calculate the number of local stations DIRECTV and EchoStar could carry using their individual frequency assignments based on techniques already being used in the DBS industry.

DIRECTV

Since DIRECTV publicly stated in late 2000 that it was already carrying 500 channels on 46 CONUS frequencies (a compression ratio of approximately 11:1), I will use that figure for purposes of these calculations, although it is extremely conservative. (DirecTV and EchoStar have already said that they "expect" to achieve a higher compression ratio of 12:1, Joint Engineering Statement at 13.)

This calculation will use the frequency re-use factor for spot-beam satellites that DirecTV has quoted for its D4-S satellite, namely 7.33. Joint Engineering Statement at 6. Since that satellite was designed some time ago, and since engineers typically improve their techniques over time, the assumed 7.33 figure, like the assumed 11:1 compression ratio, is highly conservative.

This means that, at a minimum, 11 times 7.33, or about 80 local stations can be carried on one frequency. Therefore, all 1467 local stations could be carried in 19 frequencies (1467 divided by 80 = 18.4). That would leave DIRECTV with 46 - 19 = 27 frequencies for its national and pay-per-view (PPV) programming. Currently, DIRECTV carries 179 national plus 40-50 PPV channels depending on the season, for a total of 219-229 standard TV channels, which would require only 21 frequencies (assuming the same conservative 11:1 compression ratio). Thus, using only technologies that DirecTV has already shown can work, it could carry all local stations in all 210 DMAs plus all of its standard-definition national and PPV programming, with six frequencies left over for HDTV or other uses within its current FCC assignment of 46 full-CONUS Ku-band frequencies. For example, DirecTV could use those frequencies to carry 6 x 11 = 66 new national or PPV channels, or at least six (and perhaps more) HDTV channels.

If one merely assumed the compression ratio that DirecTV and EchoStar have said they "expect" to achieve, namely 12:1, the companies could pack 88 local stations onto a single frequency (12 x 7.33 = 88). Therefore, all 1467 eligible TV stations could be carried using only 17 frequencies, opening up two additional frequencies for other uses (1467 divided by 88 = 16.7), for a total of eight frequencies left over for DirecTV to use for HDTV or other purposes.

EchoStar

EchoStar has four more full-CONUS Ku-band frequencies than DirecTV: 50 rather than 46, and therefore has more capacity than DirecTV to deliver television programming from those slots. For the reasons just shown, if EchoStar simply uses techniques that DirecTV is already successfully using, it can carry all local channels on 19 frequencies, and could do so using only 17 frequencies if it achieves the compression ratio (12:1) that it has said it expects to achieve. That would leave 31 (or 33) frequencies available for other programming, which is much more than EchoStar would need to deliver all of the programming it currently offers from its CONUS slots. Currently, EchoStar carries 235 national plus 33 PPV channels on its CONUS satellites, for a total of 268 standard TV channels. (EchoStar does not now offer any high-definition programming from its CONUS satellites.) If we make the extremely conservative assumption of an 11:1 compression ratio, these 268 channels can be delivered using fewer than 25 CONUS frequencies. If we instead assume the 12:1 compression ratio that EchoStar has said it expects to achieve, it could carry these 268 channels using fewer than 23 CONUS frequencies. Thus, if EchoStar simply uses techniques that DirecTV is already successfully using (or that EchoStar has said it expects to use), it could carry all eligible local television stations and all of its current CONUS programming while leaving at least 10 CONUS Ku-band frequencies available for HDTV or other programming (33 - 23 = 10).

4. Increases in DBS System Capacity Achievable with New Technologies

An alternative to getting or using more spectrum for broadcasting satellites is using existing allocations and existing satellites more efficiently.

As discussed above, compression ratios of 12-14 are achievable now, and higher frequency re-use factors (between the 7.33 figure already achieved by DirecTV and 10) can also be assumed for satellites to be launched in the future.

A. Reverse Band

Yet another way to increase the amount of spectrum usable by the DBS carriers is to permit the current Ku-band DBS allocation to also be used in the reverse direction of transmission. The frequencies between 17.3 to 17.8 GHz, now used for feeder links (that is, uplinks), would be used for downlinks. Similarly, the frequencies between 12.2 to 12.7 GHz, now used for the downlink, or another FSS band, would be used for feeder links. This would effectively double the spectrum available to DBS in the Ku-band while requiring somewhat more satellite power (or somewhat larger home receiving dishes) to overcome the somewhat higher rain attenuation around 17 GHz as compared with 12 GHz.

For some years, the United States has been on record at international meetings as being in favor of the principle of reverse band working. DirecTV has asked the FCC to permit the use of the current DBS uplink allocation (17.3-17.8 GHz) for new downlinks. Satellites using the new downlink allocation would be placed between the existing satellites (which are nine degrees apart), thereby doubling the number of prime orbital locations for DBS satellites.

B. Higher-Order Modulation and Coding

Modulation is the process by which information is impressed on an electromagnetic carrier wave by varying the amplitude, frequency, or phase. Amplitude Modulation (AM) and Frequency Modulation (FM) are familiar techniques from commercial broadcast radio.

In digital satellite communication, the phase of the carrier wave is varied by a method called Phase Shift Keying (PSK). In this method, each phase state represents a different symbol. Binary Phase Shift Keying (BPSK) is a form of PSK modulation, in which there are two phase states, representing the symbols 1 and 0. QPSK modulation is another form of PSK modulation in which there are four phase states, representing the symbols 00, 01, 11, and 10. With BPSK modulation, there is only one bit per symbol; with QPSK modulation, there are two bits per symbol. Since for a given data rate the required bandwidth decreases proportionately with the number of bits per symbol, QPSK requires half the bandwidth as compared with BPSK. Consequently, for the same transponder bandwidth, QPSK permits twice the data rate. QPSK is currently the most commonly used form of modulation for satellite communication.

All of the calculations above have assumed that DirecTV and EchoStar have continued to use QPSK modulation technology rather than moving to higher order modulation, such as 8PSK, which has already been developed for use with satellites in other satellite services. It is possible to reduce bandwidth requirements further by adopting forms of modulation higher than QPSK at the expense of a need for somewhat greater power. Modern spacecraft are capable of providing the greater power that is needed in order to achieve the higher spectral efficiency afforded by 8PSK modulation discussed earlier, and by other, higher-order, modulation methods discussed below.

The use of forward error-correction methods also increases the available data rate with the same total power. Recent improvements in coding techniques, such as turbo codes, permit a substantial increase in data rate for a given total power and bit error rate (BER). These methods can combine coding and modulation, such as in Turbo Trellis Coded Modulation (Turbo TCM), and have been made possible by improvements in decoding techniques and increases in processing capabilities. With TCM, separate modulation and coding steps are combined in a single operation. The consequence is significantly higher data rates using the same bandwidth and power.

Another possibility is Quadrature Amplitude Modulation (QAM). With 12QAM there are an average of 3.58 bits per symbol. With 16QAM there are four bits per symbol, so the bandwidth needed to transmit a single TV channel is one-half that of QPSK for a given data rate. Thus, for the same total bandwidth, the total data rate is twice that of QPSK.

Since all of DirecTV's and EchoStar's existing and planned spot-beam satellites are non-processing ("bent pipe") satellites, their planned spot beams are compatible with 8PSK technology. If DirecTV and EchoStar decide to use 8PSK technology in connection with their spot-beam satellites, they could increase their capacities by at least 30 percent in practice, enabling a TV compression ratio of at least 15:1 instead of the current 12:1; or 18:1 instead of 14:1.

Even higher order modulation techniques, such as 16-PSK TCM, are also in development. These techniques will provide additional increases in capacity through smaller bandwidth requirements for a given data rate and correspondingly higher TV channel-to-transponder ratios.

C. Techniques to Improve Digital Compression

As mentioned above, digital compression reduces the data rate required to reproduce a TV signal accurately by exploiting spatial and temporal redundancy patterns in the transmitted signal. With MPEG-2 current compression technology, the required data rate is between 2 Mbps and 8 Mbps, depending on the picture content and the effectiveness of the encoder. For example, a detailed, rapidly changing picture, such as a sporting event, might require nearly 8 Mbps, whereas a slowing changing picture with a uniform background, such as a news broadcast, might require 2 Mbps to 4 Mbps or less.

The achievable compression has increased (lower bit rate for the same perceived picture quality) substantially over the past few years and will continue to increase as new techniques are developed to make better use of MPEG-2 technology. Examples of these new techniques and technologies include: dual-pass "look ahead" CBR/VBR encoding; motion-compensated temporal filtering; non-linear spatial filtering; impulse noise reduction; edge adaptive texture filtering; border processing; and intelligent priority control.

Moreover, new generation algorithms such as MPEG-4 are being designed and implemented to provide even more digital compression than is available now with MPEG-2. With greater compression, the required data rates will decrease and the number of TV channels that can be supported on a single transponder will increase beyond the assumptions made above.

D. Improved Statistical Multiplexing

As discussed above, multiplexing is the process by which independent data streams are combined onto a single data stream. Individual TV channels are combined onto a single carrier when they are transmitted by DirecTV or EchoStar so that they do not interfere with one another within the satellite transponder. The customer's set-top box receives this combined data stream and de-multiplexes the signal into the individual TV channels.

The required data rate depends on the TV channel program content. Instead of assigning a fixed data rate to each channel, it is possible to vary the data rate dynamically over time to accommodate the changing complexities of the transmitted picture and to use the available data bits where they are most needed. This technique, statistical multiplexing, takes advantage of the differences in the bit rate needs of different TV signals to apportion the available overall bit rate dynamically among all the signals carried together.

A major source of improvement in TV compression ratios over the past two or three years has been the improvement in statistical multiplexing. As statistical multiplexing methods continue to improve over the next few years, TV compression ratios are likely to increase as well.

E. Shared Use of Ku-Band DBS Capacity

Instead of each company uplinking and downlinking programming individually, DirecTV and EchoStar could share this function by providing their customers with equipment that enables them to access programming from the satellites of both companies. This would achieve the "avoidance of duplication" that EchoStar and DirecTV have described, without the need for a merger. To make this possible, certain equipment changes might be necessary, but the technical challenges can be addressed through available engineering techniques. In fact, EchoStar reported several weeks ago that it has already designed a set-top box will enable its subscribers to receive DirecTV programming; the one remaining step is for DirecTV to download certain software by satellite to the EchoStar's set-top box, which has a reprogrammable "flash memory" feature.[3]

Although the two companies use different encryption systems, EchoStar and DirecTV's Joint Engineering Statement indicates that the two companies are considering transmitting programming using "simulcyrption," which -- without the need for a uniform set-top box across all customers -- would enable "subscribers owning either set top box platform [to] receive their existing programming." Joint Engineering Statement at 3.[4] This technique could equally be employed by a joint venture.

5. Use of Additional Spectrum.

A. FSS Ka-Band

Frequencies have been allocated to the FSS in the Ka-band: 18.35 to 18.8 GHz and 19.7 to 20.2 GHz for downlinks (space-to-Earth). These bands could also be used for DBS service. This allocation of almost 1 GHz in each direction of transmission -- that is almost 1,000

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3 *EchoStar Gears up For Takeover*, Communications Daily (Jan. 10, 2002) ("As EchoStar gears up for proposed acquisition of Hughes Electronics and DirecTV, it expects to have set-top box (STB) by spring capable of receiving rival's service. Pro 301 will ship as EchoStar receiver but will contain 4 MB of memory for DirecTV's advanced program guide and it will be modified to handle its satellite switching, Senior VP Mark Jackson said at CES here. Final detail, should $26 billion deal be approved, would be for DirecTV to transfer source code to box via software download to receiver's flash memory . . . .").

4 *See* Harmonic, Inc., Web site, *SimulCyrpt Synchronizer*, http://www.divi.com/content/view_csd_product_group.cfm?classID=1080# (visited Feb. 2, 2002) ("SimulCrypt Solution allows customers to choose from among seven different conditional access vendor solutions, and has proven compatibility with a wide variety of set-top boxes . . . .").

Megahertz -- is almost twice the spectrum available in the FSS Ku-band, or in the DBS Ku-band. (A limitation of this band is that only 750 MHz can be used without coordination with terrestrial users.) The FCC has authorized some 73 Ka-band satellites to be spaced two degrees apart throughout the orbital arc capable of serving the United States. Among those authorizations are three for Hughes (which owns DirecTV) at 99, 101, and 103 degrees WL, and two for EchoStar at 113 and 121 degrees WL. DirecTV and EchoStar could use this spectrum as a supplement to their high-power Ku-band spectrum, for example by providing customers with dishes and set-top boxes capable of receiving both Ku-band and Ka-band signals.

6. Conclusion

I have worked in the field of satellite engineering since the 1960s. At every point during that period, scientists and engineers have been finding ways to use satellites more efficiently and intelligently than in the past. In this respect, the satellite industry is like the computer industry: past performance records are constantly being shattered as engineers design better and better hardware and software.

The trend towards more and more efficient use of satellite technology has, if anything accelerated in the past few years. For example, digital signal compression technology has improved sufficiently in just the past three years to permit DBS companies to expand the number of programs per channel from about 6 to the 12 that DirecTV and EchoStar "expect" to achieve, and to 14 according to DirecTV's compression equipment manufacturer. Better signal modulation and coding techniques, such as 8PSK and Turbo TCM are already available and are clearly the wave of the future; use of these techniques alone will greatly expand the capacity of satellites to deliver content. These new technologies have been made possible by dramatic increases in the processing power of solid-state components.

For all of those reasons, I am confident that DirecTV and EchoStar have ample capacity, using only techniques that one or both companies is already successfully using, to offer all of the eligible TV stations in all local markets in the United States, while continuing to deliver all of the national programming they currently deliver from their full-CONUS Ku-band slots and substantial amounts of new national programming (including HDTV) from those same slots. Using available techniques that they have not yet exploited, such as 8PSK, the two firms could separately deliver still more programming using these CONUS frequencies. And by developing equipment that would enable subscribers to receive programming from the satellites of either company -- equipment that the companies are already developing today -- the two companies could achieve the same "avoidance of duplication" that the merger would accomplish, while leaving the two companies as separate businesses.

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge.

Executed on February 4, 2002.

R G. Gould

Richard G. Gould

RICHARD G. GOULD

Richard G. Gould is a communications system engineer with over 50 years of theoretical and practical experience in government and industry, with special emphasis on fixed-satellites, broadcasting and broadcasting-satellites (both television and sound), mobile-satellites, digital telephone systems and CATV systems. Positions of responsibility with the FCC and the OTP, and long service as a member of U.S. delegations to Radiocommunication Sector (the former CCIR) meetings and ITU World and Regional Radio Conferences, have given Mr. Gould special insight into both government policy-making procedures and the regulatory process. In 1993 he was a member of the FCC's MSS Above 1 GHz Negotiated Rulemaking Committee.

Mr. Gould has been involved in the study and analysis of communications systems from their beginning, his first paper on Broadcasting Satellites having been written in 1962. He served for eight years at Stanford Research Institute as Project Engineer or Manager for studies of satellite systems, ionospheric sounders, air defense systems, large-scale HF communications systems, and the analysis of missile guidance systems.

Mr. Gould holds a Master of Science degree in Electronic Engineering from USC and has taken additional graduate work throughout his career, including the Advanced Propagation Course of NBS, and courses on computers, television systems, and Administrative Law. He was for six years an Instructor of graduate courses in electrical engineering for the University of California Extension, Berkeley, and has taught courses in Spectrum Management, Satellite System Design and Telecommunication Policy at the George Washington University.

Mr. Gould spent four years in government service, first as Chief of the Advanced Technology Division of OTP in the Executive Office of the President, and subsequently at the FCC as Special Assistant to the Chief of the Common Carrier Bureau, where he was responsible for the technical and economic aspects of the domestic communications satellite determination which resulted in the "Open Skies" policy. As Vice President of Satellite Systems Engineering, Inc. Mr. Gould was responsible for technical studies and programs as well as for general corporate management.

At the Communications Satellite Corporation, Mr. Gould was first responsible for engineering and economic studies of special-purpose satellite systems. Later, he presented technical contributions to the Interim Communications Satellite Committee and participated in its Technical Subcommittee meetings. As assistant to the first Director of Comsat Labs, he participated in the preparation of the Laboratory's program and its presentation to COMSAT management and the Interim Committee.

An active member of several professional groups, Mr. Gould served as the General Chairman IEEE's EASCON, and was Chairman of the Satellite Systems Panel of the AES Society of the IEEE for seven years. He served as the AES representative on the technical program committee of many IEEE conferences, including the yearly ICC's and NTC's. For many years he was a member of the IEEE Committee on Communication and Information Policy, and served as its Vice Chairman for several years. He has published many professional papers, and books of the IEEE Press and Horizon House. He was a Guest Editor of the Special Issue of the IEEE Transactions on Communications devoted to the 1979 WARC and of a Special Issue of the Journal on Selected Areas in Communications of the IEEE Communications Society, devoted entirely to Broadcasting Satellites.

Mr. Gould is a continuing and active participant in Radiocommunication Sector (ex-CCIR) Study Groups on both Fixed-, Mobile-, and Broadcasting-satellites, as well as the Group on Radio Relay Systems. He has participated in and been chairman of groups comprising the FCC-sponsored Committees preparing for the 1977, 1983, 1985, 1987, 1988 and 1992 Administrative Radio Conferences. Subsequently, he was a member of the delegation of the

United States to many of those conferences. Mr. Gould has also been a member of U.S. delegations to international preparatory groups which prepared the technical bases for these conferences. He is currently a member of the State Department's U.S. National Committee for the Radiocommunication Sector.

He is a Registered Professional Engineer in the District of Columbia, and was elected a Fellow of the IEEE in 1985. Mr. Gould is a Fellow of the Washington Academy of Sciences.

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Telecommunications Systems is a consulting engineering firm established to provide analysis and design of communications systems and to offer consulting and engineering services in the technical, economic, marketing, regulatory and frequency management aspects of complex telecommunication systems and networks. Telecommunications Systems was founded in 1976 by Richard G. Gould, a Registered Professional Engineer in the District of Columbia, named a Fellow of the Institute of Electrical and Electronic Engineers in 1985, and a Fellow of the Washington Academy of Sciences in 1999.

The goal of Telecommunications Systems is to provide an independent and comprehensive treatment of complex problems in the areas of system design, analysis, and operation for international organizations, government agencies, carriers, manufacturers, and industry associations.

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The work of Telecommunications Systems is objective and multidisciplinary. The firm does not manufacture nor does it represent manufacturers or communications carriers in the market-place.

REPRESENTATIVE PROJECTS

- *Engineering* of complete systems in the broadcasting-satellite (television), broadcasting-satellite (sound), fixed-satellite, and mobile-satellite services for prospective operators. These design efforts included the preparation of applications to the FCC, and Advance Publication information and Requests for Coordination to the ITU's Radiocommunication Bureau (the former IFRB).

- *Analysis* of systems in the land mobile-satellite, broadcasting-satellite (television and sound), fixed-satellite and fixed (terrestrial) services, and of international radiopaging systems, for technical contributions to RadioCommunication Sector (formerly the CCIR) meetings and Assemblies, and World Radio Conferences of the ITU. These analyses proposed recommendations on conditions of use, interference and noise criteria, and preferred frequency allocations. This work has been performed for commercial organizations and for U.S. government agencies including NASA, the FCC, the Office of Technology Assessment and the Department of Defense.

- *Design* of earth station complexes and their interconnecting microwave or fiber optic facilities, including specification of equipment; negotiation with equipment suppliers, contractors, regulatory agencies, and Civil, Structural and Soil Engineers; and preparation of applications to the FCC for earth station and radio relay system construction permits.

- *Economic and Marketing Studies*: marketplace forces applied to spectrum management; the economic impact on the terrestrial broadcasting industry of satellite transmission of TV programming; the economic and technical aspects of providing both aeronautical and maritime satellite services with a common spacecraft; the competitive environment of eight generic telecommunication services (for a major common-carrier); the technical and economic feasibility of extending "syndicated exclusivity" to home satellite dishes; the technical and economic feasibility of digital compression of television signals; the effects of legislative and regulatory changes on the use--and the efficiency of use--of the orbit and spectrum by communication common carriers;

- *International Spectrum Management:* Participation in the work of the ITU, including membership in many Delegations to World and Regional Administrative Radio Conferences, to many meetings of several of the Study Groups of the Radiocommunication Sector (the former CCIR), including meetings preparatory to Radio Conferences, and in submissions to the Radiocommunication Bureau (the former IFRB).

- *Preparation* of submissions to the FCC: for rulemaking proceedings, including those pertaining to construction permits for small earth stations, and protection of radio astronomy.

- *Applications* for earth station construction permits, including two-degree spacing interference and radiation hazard studies.

- *Design and Procurement Assistance* to the National Science Foundation for an unattended satellite earth station for operation under the adverse environmental conditions of the Antarctic winter.

- *Feasibility Studies* for the U.S. Trade and Development Agency of telecommunications systems in Asia and Eastern Europe, on subjects such as the Thailand TV broadcasting network; an integrated, (satellite and terrestrial) radio and television program distribution network for Indonesia; and a telecommunications network improvement program (digital overlay network, transit exchanges, fiber optic cable and radio relay systems, a satellite earth station and a mobile cellular radio system) for Bulgaria.

- *Studies* for the Office of Technology Assessment of the United States Congress (OTA): the results and consequences of WARC-79; Allocation of the Radio Frequency Spectrum (in preparation for WARC-92); and an analysis of the outcomes of WARC-92.