CABLE T.V. SATELLITE DISTRIBUTION C OR KU BAND

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ABSTRACT

Satellite distribution of cable television programming has been a key element in the overall success of the industry. Conversely our continued success is reliant upon uninterupted availability of adequate satellite capacity. Commercial domestic communications satellites generally have a 10 year lifetime. We are therefore given the opportunity from time to time to reflect on our experiences and make decisions about replacement satellite capacity. The cable industry is now at such a point in time. Decisions made now will be with us into the 21st century.

TODAY

Within 12 years of its beginnings satellite distribution of cable television programming is using third generation C-band satellites and a ground segment estimated at over 15,000 TVRO sites serving multiple customers and over 1,500,000 TVRO sites used by individual customers. It would be an understatement to characterize this system as anything but highly successful. Commercial quality TVRO's have shrunk from 10 meters in size to 3 meters due to more powerful C-band transponders and better understandings about adjacent satellite interference. Locations of TVRO's in urban centers, once thought impossible, are now routine because of a better understanding of terrestrial microwave interference. The installed based of commercial TVRO's receiving cable programming has a replacement value well over $250 million, more than the cost of a modest satellite system in orbit.

TOMORROW

Currently two operational satellite types are in orbit for use by domestic communiations users. One, first launched in 1975 operates in the C-band and the other first launched in 1980 operates in the Ku band. Each of these satellites uses similar technologies and are made up of receivers and transponders which together with antennae, power supplies, station keeping systems, and other equipment retransmit signals received from uplinks to the area of coverage, or footprint.

The difference between them is not so much the equipment but the band of frequencies used. This difference compells us to make a choice between C-band or Ku-band for distribution of programming to the cable industry. To make that choice a careful comparison of the characteristics of each frequency band and the constraints placed on both space and ground segment is necessary. In addition, as in any high stakes decision such as the building and launching of future satellite systems, issues not purely based in technology must be evaluated, such as business climate and launch availability.

THE LAUNCH CRISIS

Today there are no operational commercial launching systems available in the Western world. Regularly scheduled commercial launch availabilities are not expected to be back with us until the early 1990's. The insurance industry has also been severely affected by the recent spate of launch failures. Until regular launches begin to create a steady stream of premiums the insurance underwriters cannot generate the revenue necessary to spread risk. Further compounding the insurance crisis is an unwillingness on the part of any U.S. governmental agency to hold harmless, as NASA had, commercial launch operations, from liability of all sorts, including damage to governmental facilities and civilian property. All these factors make it impossible to forecast the cost and date of replacement satellite capacity.

It is therefore crystal clear that capacity must be secured which is currently in orbit and can outlast the launch crisis with enough margin to safely ensure uninterupted distribution.

It is also necessary to arrange for backup satellite capacity already in orbit that can stand ready to replace the prime satellite if a single point failure occurs, such as loss of stationkeeping or power supply. Doing otherwise is not prudent.

There is today not enough medium power Ku-band capacity aloft to supply the total cable industry with reliable distribution; as measured by transponders or spacecraft. Because of the launch/insurance crisis more capacity is unavailable until the 1990 time frame.

By arranging for the use of Hughes Communications Galaxy III satellite, with backup provided by its sister Galaxy II Viacom will have uninterupted service on a constellation whose end of life is currently predicted as late 1994/early 1995.

Viacom's decision bridges the launch crisis, but we are still faced with making a decision for the next constellation that will serve us through the year 2005.

THE BUSINESS CLIMATE

Building and launching satellite constellations is a costly and risky business. The first round of commercial satellite launches in this Country were totally speculative. No orders were written or deposits taken for over a billion dollars worth of spacecraft launched in the first epoch of that new industry. Each endeavor backed by such companies as RCA Americom, Western Union, and SBS hoped that space traffic would develop around the traditional terrestrial traffic models of message, data, and video. But as in many speculative ventures changing conditions, overbuilding in a highly competitive atmosphere, and competing technologies such as fiber optic cable, created a huge oversupply. Today approximately half of all U.S. commercial transponders aloft generate revenue insufficient to return satisfactorily on investment. One would expect that satellite operators would be wary on the next round of launches. However, the list of FCC grants for new satellites reveals that speculation continues although a subtle shift has occurred. 8 equivalent C-band satellites have been granted construction and launch permits and 14 equivalent Ku-band spacecraft have been granted.

The ratio of C-band and Ku-band is a sign at once of new realism and continued speculation in the market place. C-band has become a well understood business, suited primarily to Broadcast and Cable Network video program distribution. As such the market size for C-band can be more accurately guaged. Ku-band on the other hand is the only potential growth satellite industry and, just as C-band was in 1975, shows evidence of speculative activity by its high number of launch commitments. The C-band licenses for future launches in the early 1990's are held by such companies as Hughes Communications, AT&T, and RCA Americom. In addition, recently John Koehler, President of Hughes Communications has stated his desire to apply for additional construction permits to replace the current Galaxy constellation.

The established carriers are sending a clear signal that follow on C-band capacity will be available in the 21st century if firm orders materialize. Indeed, it is becoming clear even among Ku-band satellite operators that follow on capacity will on the whole only be available if there are firm orders Therefore, no matter what type of capacity is needed by the industry, that type will be launched.

THE EARTH SEGMENT

The total investment in commercial TVRO's receiving Viacom's cable program services is at least $250 million. This equipment will be serviceable into the 21st century. Virtually none of that equipment is transferrable to Ku-band use. The main reflectors employed in most dish antennae are not smooth enough to achieve adequate gain. The Low Noise Amplifiers, or Block converters and feedhorns are totally unusable. Of the total video receiver universe installed over the last ten years only a small minority are able to switch to Ku-band. Making obsolete such a large installed and operating investment can be justified only with the most compelling arguments.

THE DIFFERENCES

There are differences between the C and Ku-bands. Some arise from physical laws, others from laws passed by governments.

Rain Antenuation is the most well known difference between Ku and C-band. Indeed this is the primary reason Ku-band satellites followed C-band by so many years. In order to provide adequate power levels to be received through rain by reasonably sized antennae the development of large solar power arrays and high power transponders had to be awaited. Early Ku-band transponders included 20 watt traveling wave tubes while the first C-band transponders were 3.5 watts. Current generation Ku-band transponders have 45 watt traveling wave tubes. This represents a 3.5 db improvement in EIRP for footprints of similar size. An additional 1.3 db improvement has been requested by RCA Americom of the FCC for its future spacecraft K-3. For adjacent satellite interference reasons the Commission has yet to approve that request and so we cannot count that improvement. To put these improvements in power level in perspective it is interesting to note that good practice for most of the United States is that rain fade margin should be at least 10db. Unfortunately the rain fade during heavy thunderstorms can be 15 to 20 db. As the cable industry's experience with CARS band reminds us there is no economical way to protect a link under such severe conditions.

Antenna Size has absolutely nothing to do with which band is in use, given the same transponder power and footprint. For instance an excellent signal can be received from Galaxy III on C-band with a 3 meter antenna. Galaxy III employs 9 watt transponders. If a Ku band transponder's signal of 9 watts were received by a 3 meter antenna an equally good signal would be received. Unfortunately in that case the least amount of rain or snow would reduce the quality of the signal, eventually obliterating it entirely. It is for this reason that Ku-band transponders must be higher powered, to overcome rain attentuation. Using this comparison RCA Ku-band satellites such as K-1 achieve a rain fade margin of approximately 9db with like antenna size to Galaxy III type C-band satellites. The suggestion here is that for truly reliable service which the cable industry today enjoys on C-band larger antennae will be required for Ku-band.

Spacecraft Reliability is always a concern when unexpected outages deprive customers of programming. Because of the aforementioned need to overcome rain attentuation Ku-band spacecraft must rely on high power vacuum tubes and their companion high voltage power supplies. The latest generation of C-band spacecraft utilize solid state power amplifiers in their transponders. Transitors operate at much lower voltages, putting less strain on components in their power supplies. It should be noted that high voltage power supplies have accounted for more transponder failures than any other single cause of outage. Higher signal powers also puts a strain on other satellite components, including waveguide networks and cooling systems. As a result of these factors calculated reliability for current Ku-band spacecraft is materially inferior to solid state C-band spacecraft.

Cost of spacecraft, including launch are much higher for Ku than C-band. Regardless of frequency band the more powerful a transponder the more weight which will be required. Several systems' weights are affected, including the transponder itself, cooling equipment, eclipse batteries, solar cells, power supplies and waveguide components. Weight in the launch business means expense. Indeed some launch vehicles restrict the total number of transponders per launch because of their total weight. As a result the cost per transponder of constructing and launching a number of Ku-band spacecraft to form a constellation of similar capacity and backup to Galaxy's is much higher - up to three times as high.

Cost of an uplink for Ku-band is more than double that of C-band. One thunderstorm over the uplink can disrupt service to the entire Country. It is not practical to build enough margin into the uplink to compensate for such rain fades. Therefore two widely separated uplinks need to be built. In addition a very high reliability microwave or cable link must be established between the two locations.

Terrestrial Interference on Ku-band does not exist in any material amount. The band has been held exclusively for the use of satellites. This is the only enhancement Ku-band delivers to satellite communications beyond C-band. C-band satellites share the band with terrestrial microwave links carrying primarily message traffic. As a result and as long as there is line of sight to the satellite a Ku-band link can be established to the customer's premises. Two applications specifically made possible because of this feature are Direct Broadcast service to homeowners and Private Business networks to coorperate headquarters in downtown urban areas.

In the early 1970's terrestrial microwave interference was expected to limit C-band TVRO's to extremely rural environments. Over the last decade the art of coordinating TVRO sites in the C-band has become much more sophisticated. Engineering models now take into account terrain and man made shielding while interference models have become much more realistic. Filter techniques and hardware have also added significntly to the body of knowledge and tools which has resulted in thousands of TVRO's throughout the United States in urban and suburban areas. Indeed in most cases the limiting factor for coordination is line of site, not terrestrial interference.

An interesting possiblity for the future of C-band is that greater reliance on fiber optic cable for terrestrial traffic will cause coordination to be easier as fewer and fewer microwave links are in use.

Adjacent Satellite Interference is an effect which will have increasing importance on Ku-band and less on C-band. Because of the increased speculative launches on Ku-band it is more likely to experience such interference than on C-band, where fewer satellites will be operational, and most likely farther apart.

CONCLUSION

Viacom has taken several factors into consideration in choosing what type of satellite shall distribute its program services to the cable television industry. Above all our decision was driven by the most reliable, cost-effective technique, now and for the foreseeable future. We have found that Ku-band has nothing in its favor except the ability to reach directly into the customer's premises. Its inferior reliability, greater cost, and uncertain availability in the near term stand in stark contrast to today's functioning C-band system.