CABLE SATELLITES : THE NEXT GENERATION
Issues Facing Cable Operators and Programmers

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ABSTRACT

The deployment of next-generation satellites in compliance with the FCC's uniform 2-degree spacing plan, together with the movement of cable programming, will occur during the next two years. A discussion of the transition scenario, the technical differences in the new satellites, and ground station requirements reveals that Cable TV and SMATV facilities will require reconfiguration and in some cases replacement may be necessary. The satellite movement and programming transfers in the early nineties compel the cable industry to examine the future performance of existing facilities.

o Introduction

C-Band satellites have become a reliable means of delivery for cable television programs and have played an important role in the phenomenal growth of the industry. We have seen numerous operational, technical and regulatory changes together with technological advances in satellite and ground station equipment that led to significant reduction in overall costs. The cable industry has demonstrated its ability to successfully deal with such changes over the years.

A development that will impact the cable industry is the FCC mandate to phase-in a uniform 2-degree spacing between U.S. domestic satellites. The intent of the plan is to alleviate overcrowding in the U.S. orbital arc. It times the deployment of next generation satellites with improvements in ground station receiving characteristics in order to control the ensuing increase in adjacent satellite interference.

This paper discusses the satellite and orbital changes that are expected to occur during the next two years, and presents some critical issues and challenges facing satellite programmers and cable operators .

o Time of Replacements

In the early days, 4-degrees of separation within the two segments assigned to U.S. domestic communication satellites -- 70 to 104 degrees and 117 to 143 degrees West Longitude (°WL) -- consisting of 15 satellite slots were found adequate. (The central portion from 104° to 117° has been reserved for Canadian and Mexican satellites.) But as the popularity and importance of satellite delivered services increased, the separation provided in the usable orbital arc for U.S. domestic satellites was found inadequate for planned spacecrafts.

Hence, in 1983, the FCC adopted a plan to essentially double the number of orbiting domestic communications satellites by gradually reducing the

Figure 1. Next Generation Satellites

CARRIER/ SATELLITE	FREQ BAND	ORBIT	LAUNCH DATE	
ALASCOM				
Aurora II (Satcom C5)	C	139	May 1991	
AT&T				
Telstar 401	C	97	May 1993	
Telstar 402	C/K	89	Mar 1994	
CONTEL ASC				
ASC II	C/K	101	Apr 1991	
ASC 1R	C/K	129	Sep 1993	
GE AMERICOM				
Satcom C4	C	135	Sep 1992	o
Satcom C3	C	131	Nov 1992	o
Satcom C1	C	137	Nov 1990	▪
Satcom H1	C/K	79	1994	
GTE SPACENET				
GStar 4	K	64	Nov 1990	
Spacenet 1R	C/K	103	May 1993	
Spacenet 2R	C/K	69	Sep 1993	
GStar 1R	K	121	Jun 1994	
HUGHES				
SBS 6	K	72	Oct 1990	
Galaxy V	C	125	1991	o
Galaxy 1R	C	133	1993	o
Galaxy VII	C	91	1992	
Galaxy VI	C	91	Oct 1990	▪
Galaxy IV	C/K	99	1992	
Galaxy IIIR	C	95	1994	
NATIONAL EXCHANGE				
Spotnet I	C/K	93	Mar 1993	
Spotnet II	C/K	127	Sep 1993	

o Cable Satellites
▪ In-orbit Backup for Cable Satellites

spacing between satellites, so that over approximately ten years, a uniform 2-degree spacing would be achieved. This evolutionary approach was chosen because: It prevented early obsolescence of existing satellites; it granted manufacturers sufficient time to design and construct antennas that can better discriminate between adjacent satellites; and, it permitted cable operators to amortize their existing facilities. The FCC's 2-degree spacing plan guided most of the technical, regulatory and economic developments that we experienced during the past decade.

In the early nineties, Alascom, AT&T, Contel, GE Americom, GTE Spacenet and Hughes communications will construct and launch next-generation satellites as shown in Figure 1. The cable industry has committed to basically two satellite vendors -- Hughes and GE Americom -- involving four satellites. HBO and Turner Broadcasting are anchoring Hughes' Galaxy V and Galaxy IR, while Viacom Networks and a group of other programmers including HBO have chosen Satcom C3 and Satcom C4.

o TRANSITION

The preparations for launching the next generation cable satellites and the accompanying movement of programming actually began in 1988, as Galaxy I and Satcom 3R approached their designed end-of-life terms. Recognizing that approximately three years of lead time is required to design, construct and launch satellites, the FCC and satellite vendors developed a transition strategy with the goals of ensuring uninterrupted service and minimize inconvenience to users.

The transition timetable for the deployment of satellites is illustrated in Figure 2. Note that Satcom 3R (131°WL) has been temporarily replaced by Satcom 1R in 1991 and will remain there until Satcom C3 (131°WL) becomes operational in 1993. Satcom 1R (originally at 139°) moved its traffic to Satcom C1 (139°W) and then Satcom IR was

repositioned to 131°W to take over traffic from the retiring Satcom 3R (131°W). Satcom C3 will take over when

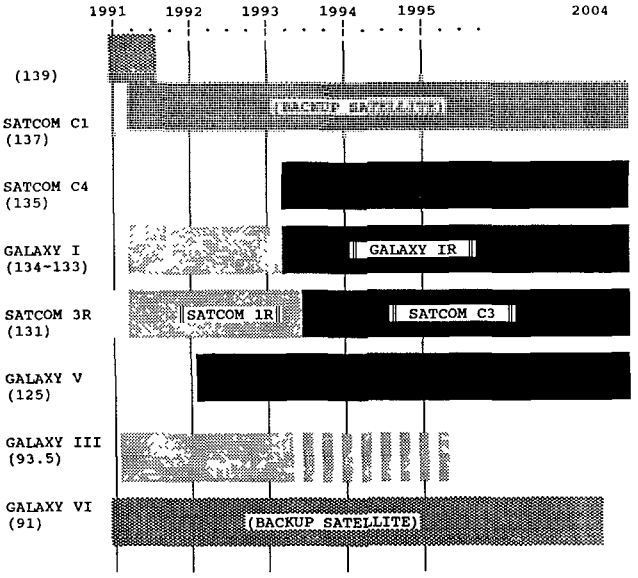

Fig. 2 Deployment of Next Generation Cable Satellites

Satcom 1R retires. Although the changeover and spacecraft maneuvers between Satcom 3R, 1R and C3 are complicated, most transfer activities will be transparent to cable operators because antenna repointing would not be required. Minor polarization skew adjustments needed to be performed when Satcom IR was relocated due to the finalization of the orthogonal interleaving of adjacent satellites, which was not supported by Satcom 3R.

Galaxy I will be moved by one degree from 134°WL to 133°WL during May or June of 1991 in compliance with the FCC uniform 2-degree spacing plan. This movement will require antenna repointing. The schedule will be announced to the industry ahead of time so that multiple-beam antenna feeds unable to be used in the 2-degree spacing plan can be replaced or new antennas with better specifications can be installed.

The move will most likely occur during a 7-day period, beginning on Monday. To minimize service disruptions, the bulk of the satellite movement would occur on weekdays. Only one or two repointing procedures would be normally required, depending on antenna size, antenna directivity and system noise margin.

Galaxy V (125°WL) will be launched during the last quarter of 1991 and will become operational in early 1992.

In the middle of 1993, Galaxy IR (133°WL) will replace the retiring co-located Galaxy I (133°WL) and remain there until its end of life in 2005

Another cable satellite, Galaxy III (93.5°WL) will remain in its current orbital location until its end of life in 1995. The broken line in Figure 2 depicts a possible transition of programming from Galaxy III to other satellites as transponder leases expire in 1993.

While these transfers are happening, both GE Americom and Hughes will maintain two C-Band fleet spare satellites Satcom C1 (137°WL) and Galaxy VI (91°WL) respectively. These in-orbit spare satellites were launched in advance (1990) to provide restoration in case of launch failures of the four primary cable satellites. The spare satellites will contain pre-emptible programming to accommodate protected cable services in the event of fleet satellite failures.

Figure 3. **PROGRAMMING ON CURRENT AND NEXT GENERATION SATELLITES**
(January 1991)

PROGRAMMING ON CURRENT SATELLITES

GALAXY 1	SATCOM IR (Formerly IIIR)	GALAXY III
HBO E	HBO W	MTV E
Comedy Channel	BET	MTV W
Headline News	Request TV 1	Nick E
ESPN	USA W	HA!
Showtime W	CNBC	Viewer's Chce 1
TMC W	Lifetime W	Viewer's Chce 2
Disney E	TNT (to G1 3/91)	Weather Cha
A&E	Cinemax W	C-Span II
TNT (3/91)	Bravo	VH-1
CNN	E!	Lifetime E
Cinemax E	Learning Channel	C-SPAN I
WTBS	FNN/Source	Nick W
Showtime E	AMC/AVN	Family Net
TMC E	Request TV 2	Nustar
USA E	Fashion	MEU
Disney W	TBN	EWTN
Discovery/video Mall	Shop TV	CVN
TNN	Univision	HSN
Family Channel	QVC	ACTS
WGN	VISN	CVS/PPV
ESPN Blackout	CNN/feeds	ESPN Blackout
CMTV	Travel	
WWOR	Home Shop 2	
Inspirational	Inspirational(4/91)	
Galavision		

POSSIBLE PROGRAMMING ON NEXT GENERATION SATELLITES

GALAXY V	GALAXY IR	SATCOM C3	SATCOM C4
HBO E	HBO E	Showtime	Nickelodeon
TBS	Cinemax E	Movie Channel	C-SPAN 2
TNT	Turner Bdcst	VH-1	QVC
Headline News	Disney W	E!	Nustar
CNN	USA W	QVC	Discovery
ESPN	ESPN	A&E W	Prevue Guide
USA E	Eternal Word	C-SPAN 1	Family Chan W
A&E E	Univision	Family Chan E	Sci-fi Chan
Disney E	Nostalgia	Home Shopping 1	Home Shop 2
Mind Ext. U	Group W	Learning Channel	Viewer's Choice
FNN	Inspirational	Lifetime E	Lifetime W
BET		Viewer's Choice	WOR-TV
Monitor Channel		Weather Channel	
Group W-Nashville		Cinemax W	
United Video-WGN		HBO W	
Trinity			
Viacom			

o Where will programming windup?

As the new fleets of next generation satellites become fully operational, the programming lineup will transition as well. The transfer of programming will take place in 1992 and 1993.

HBO and Turner Broadcasting, joined by USA, ESPN, Disney and others will anchor Galaxy V and Galaxy IR. Viacom, joined by other programmers will anchor Satcom C3 and Satcom C4. HBO and Cinemax West feeds will be on Satcom C3. After the switchover to the next generation satellites, the cable programming lineup will most likely appear as in Figure 3.

To minimize service interruptions, the programming networks will most likely dual-feed each of their services for a certain period. Cable operators are encouraged to keep in touch with programmers to keep abreast with developments and to determine the exact timing and location of simultaneous feeds. It is imperative for cable operators to find out where the programs currently carried will wind up. In order to determine how the transition will impact individual cable system operation, you should become familiar with the future satellite plans of each programmer.

o 2° Spacing-Timing and Implications

The process of retiring satellites and launching new ones has been carefully planned to ensure a smooth transition. Actually, the space segment procedures have already started. For example, the two spare in-orbit satellites

have already been launched and now operational; new generation satellites are now either approaching final design stages or under construction; and, some spacecraft maneuvers have been accomplished. There are more activities that are planned to take place during the next two years, and more ground segment activities can be expected.

The eventual reduction of satellite spacing to two degrees will require careful examination of several ground segment technical issues. Of utmost importance is the earth station's ability to avoid interference from signals coming from undesired adjacent satellites. The parameters that affect interference are: Satellite transmit power (EIRP), antenna directivity, receiver sensitivities, signal formats, type of modulation, frequency offset, IF Bandwidth and filtering techniques. Of these, satellite EIRP and antenna directivity are major factors that determine acceptable or objectional levels of interference.

The majority of C-Band satellite receiving antennas currently serving the cable industry are of parabolic design, and pick up signals from a single satellite. Since 1983, antenna manufacturers have been improving their designs in anticipation of the 2-degree spacing scenario. Cable operators should find out from antenna manufacturers which designs need modification or replacement. In addition, proof-of-performance tests should be undertaken to ensure that antennas currently meet design specifications after many years of use. Corrosion, warping and misalignment degrade antenna performance.

Smaller diameter antennas such as those serving SMATV or smaller cable systems are particularly susceptible to increased interference from adjacent satellites due to their wider beamwidths.

Other antenna configurations such as those having multiple feed horns could be seriously affected if each individual C-Band feedhorns can not be physically moved closer to one another. To correct this problem, some antenna manufacturers devised new assemblies and/or feedhorn designs that are claimed to function under the 2-degree spacing plan.

In some cases, parabolic antennas that were retrofitted with dual or triple feeds might have to return to single feed configurations.

There is still sufficient time to identify potential problems and deal with them accordingly.

o <u>Technical Differences in the New Generation Satellites</u>

The technical parameters of next generation C-Band satellites have improved significantly. Traveling Wave Tube Amplifiers (TWTAs) have progressed from 5 Watts to 8 Watts, up to its new capability of 16 Watts. The latest in antenna beam-shaping techniques also allow a more uniform concentration of power to desired coverage areas. Furthermore, other spacecraft improvements such as better power subsystem design, better heat management, decreased intermodulation

distortion (IMD), and improved transponder protection schemes ultimately yields a significantly improved next generation C-Band satellite system.

Figure 4. Comparison of Signal Quality

Ant. Size	Retiring Satellites	Next-Gen. Satellites
3.0 (M)	C/N=11.4 C/I=23.1 C/N+I=11.1 VSN=48.3	C/N=14.4 C/I=19.7 C/N+I=12.4 VSN=49.6
3.7 (M)	C/N=13.2 C/I=24.9 C/N+I=12.9 VSN=50.2	C/N=16.2 C/I=21.5 C/N+I=14.2 VSN=51.4
4.5 (M)	C/N=14.9 C/I=26.6 C/N+I=14.6 VSN=51.8	C/N=17.9 C/I=23.2 C/N+I=15.9 VSN=53.1
7.0 (M)	C/N=18.8 C/I=30.5 C/N+I=18.5 VSN=55.7	C/N=21.8 C/I=27.1 C/N+I=19.8 VSN=57.0

Where:
C/N = Carrier-to-noise ratio
C/I = Carrier-to-interference ratio
C/N+I = Total carrier-to-noise plus interference, calculated as power summations and taking into account slight EIRP differences among adjacent satellites. The separation of 3-degrees were used for retiring satellites and 2-degrees for next generation satellites.
VSN = Weighted Video Signal-to-Noise Ratio

Given:
Antenna Efficiency= 65% Antenna Temp=25 °K
LNA Temp = 70 °K IF Bandwidth= 28 MHz
EIRP(retiring)= 34 dBW EIRP(next gen)=37dBW

These improvements are all well and good, but the forthcoming uniform 2-degree spacing environment will negate the benefits if appropriate steps at the ground segment were not taken.

Figure 4. shows how the signal quality would change if satellite spacing is reduced to 2-degrees using the next generation satellites. It can be seen that larger antennas (4.5M or larger) would be less affected by adjacent satellite interference and therefore would yield signal to noise ratios in the mid to upper fifties (dB) of video signal to noise ratio. These high values are desirable when feeding television to cable distribution systems, even more so as fiber reduces its distribution plant degradation and improves video signal-to-noise in subscriber delivery.

o Summary: What is the Impact on Cable Operators?

Satellite and cable operators are now faced with the inevitable challenges that next generation C-Band cable satellites, 2-degree spacing mandate, and the accompanying movement of cable programming present. Cable operators using antennas smaller than 4.5-meters or those using multiple beam feeds could be affected. Everyone will experience the inconvenience of antenna repointing, so break out the Liquid Wrench! Some will face equipment reconfiguration and perhaps in some cases, replacement. The transition plan is set, but there is ample time to prepare. The industry needs to work closely with each other to raise awareness of the need to ascertain the future performance of existing facilities. Specifically, there is a need to:
1) Determine the migration plans of programmers currently carried by the system;
2) determine the impact of 2° spacing on

existing facilities; and then,
3) come up with a system-specific technical plan and transition timetable.

By doing so, we will ensure a successful transfer of services to the next generation satellites and maintain the excellent signal quality that we strive to provide to all our subscribers.

* * *

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