SATELLITE SERVICE PROTECTION

ANDREW F. INGLIS
PRESIDENT

RCA AMERICAN COMMUNICATIONS, INC.

INTRODUCTION

Satellite common carriers face a special problem -- their basic communications facility cannot be repaired once in orbit. If a single transponder or a complete satellite fails, it is gone forever. But most customers have a need for continuity of service. Fulfillment of this need by satellite carriers requires that they provide backup facilities or "protection."

Satellite carriers have responded to this requirement in various ways. The purpose of this article is to describe RCA Americom's plan for service protection, to discuss the relative need for protection by various classes of customers, and to describe an alternate plan which might be adopted.

SATELLITE RELIABILITY

The best form of protection is to minimize the need for it. Current communications satellites have been more reliable than expected, and future developments should make them even more so.

A whole series of evolutionary improvements is being made in battery systems, solar arrays, component and circuit designs, and operating practices. In addition, beginning with the launch of SATCOM V in October 1982, all RCA Americom satellites will employ solid-state transponders; these will eliminate the system component with the greatest potential for unreliability -- the travelling wave tube and its high voltage power supply. The cumulative effect will be a further improvement in reliability. Communications satellites launched in the 1980's should be highly reliable, indeed.

Nevertheless, the consequences of loss of service are so severe for most customers, that the risk of loss is unacceptable, even though small. These customers should demand protected service, and their carriers should plan their systems to provide it.

PROTECTION FOR INDIVIDUAL TRANSPONDER FAILURE

RCA Americom is planning a "belt and suspenders" system for protection against individual transponder failure. This is illustrated in Figure 1.

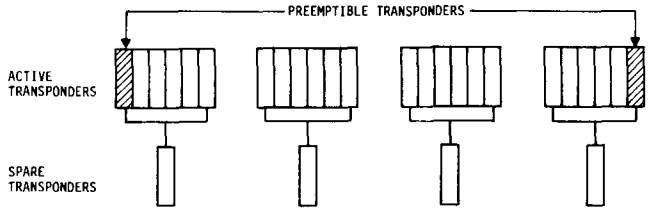

Figure 1

TRANSPONDER PROTECTION PLAN

Each bank of six transponders is provided with a spare which can be placed in service to replace any one of the six in the event of a failure. If two transponders in a single bank fail, traffic is restored on one of the preemptible transponders. This requires, of course, that any traffic on the preemptible transponder be bumped.

With this arrangement, and given the inherent reliability of second generation satellites, the probability that the carrier can offer protected service on 22 transponders during the entire life of the satellite is extremely high.

PROTECTION FOR SATELLITE FAILURE

Protection for satellite failure requires that sufficient preemptible transponders be provided in the system so that traffic on all of the protected transponders on any failed satellite can be restored. These can be grouped on a single satellite or distributed among the satellites in the system.

A superficial perception might indicate that the grouped configuration is inefficient in its use of orbital slots. It

portrays the image of an "in-orbit spare" floating empty in space occupying a valuable orbital slot. But an examination of these two configurations in Table 1 shows that the difference in the total number of preemptible transponders in a five-satellite system is small -- 25 vs 30. Furthermore, as will be seen later, there is a market need for preemptible service, and it is expected that the in-orbit spare will receive considerable utilization.

Table 1

GROUPED PROTECTION CONFIGURATION

Preemptibles Distributed

Satellite	A	B	C	D	E	Total
No. of Transponders						
Protected	19	19	19	19	19	95
Preemptible	5	5	5	5	5	25
						120

Preemptibles Grouped

Satellite	A	B	C	D	E	Total
No. of Tranponders						
Protected	22	22	22	22	2	90
Preemptible	2	2	2	2	22	30
						120

RCA Americom has chosen the grouped configuration because customers in two of its markets, Alascom and the cable TV program suppliers, require that all protected transponders be restored on the same satellite. In each case there is a large number of earth stations, all communicating through transponders from a single satellite, which must continue to communicate with a single satellite after traffic is restored.

In the event of a satellite failure, service will not be protected from a second failure until another satellite is launched and in orbit. In order to minimize this time interval, RCA Americom plans to construct a ground spare which will be kept in readiness for launch. In an emergency situation, it is expected that NASA would make every effort to expedite an unscheduled launch. The expected time for this would be six months from the date of the failure.

GRADES OF SERVICE

RCA Americom offers three grades of service for transponder lease: protected, unprotected and preemptible.

Protected service is restored in the event of either satellite or transponder failure.

Unprotected service is not restored but cannot be preempted to protect other services.

Preemptible service is not only not restored but, as its name implies, is subject to preemption by protected service.

TARIFFED RATES

The rates for these services reflect their grade with protected service having the highest rate and preemptible the lowest. From the carrier's standpoint, the cost of providing unprotected service in a multi-satellite system is nearly as high as the cost of protected service. Hence the difference in Americom's tariffs for protected and unprotected service is small.

The rate for a protected transponder is equal to the basic cost for that transponder plus a proportionate share of the net cost of the preemptible transponders in the system (the gross cost of these transponders less any preemptible revenue received). An examination of Table 1 discloses that the cost of protection will diminish as the number of satellites in the system increases. In the five-satellite system shown with preemptible transponders grouped, 30 preemptible transponders provide protection to 90 protected transponders, or a ratio of 1:3. Thus, each protected transponder need bear only one-third the net cost of a preemptible transponder. In a two-satellite system, on the other hand, this ratio would be approximately 1:1 and each protected transponder would have to bear the total net cost of a preemptible transponder.

SATELLITE SERVICE PROTECTION -- WHO NEEDS IT?

Having described the means and the cost of satellite service protection, the key question, "Who needs it?" can be considered.

A preliminary answer would be, "Everybody!" One could make a case that communications is so vital a function that no one can afford a significant risk of service interruption. And for most applications and customers this is true. There are, however, important exceptions -- situations where the use of a preemptible

service is reasonable and prudent. These include the following:

- Alternate transmission routes are available.

  A customer might lease preemptible service from two carriers -- or from a single carrier on separate satellites. The risk that both services would be interrupted would be small.

  Or, terrestrial routes might be available and the only penalty would be higher costs.

- Non-real time communication.

  Communications which are not on real time, i.e., batch data transmission on TV commercial distribution could, in an emergency, be handled by mail or other means.

- Cost of service is critical.

  There are applications where cost is so critical to their economic justification that the lower rates of preemptible transponders makes them attractive even with the added risk. Examples are teleconferencing or the start-up period for an entrepreneurial TV program service.

In summary, protected service is basic and will be required by most customers. Nevertheless, there are few specific situations in which the lower costs of preemptible service make it an attractive and reasonable alternative.

ALTERNATE PROTECTION CONFIGURATION

The FCC on December 3, 1980 issued a satellite decision in which it authorized the construction of 25 satellites and the launch of 20. Launch of the remaining satellites would be authorized when need was demonstrated. Closely related to the demonstration of need was the question, should a valuable orbital slot be devoted to an in-orbit spare? The Commission stated that further study of this was required and established an inquiry for this purpose.

As noted above, the total number of preemptible transponders required in a satellite system is nearly the same, whether they are grouped on an in-orbit spare or distributed throughout the system. The real issue, then, is not whether orbital slots should be devoted to in-orbit spares but whether preemptible transponders should be permitted anywhere in the system -- whether grouped or distributed.

There is an alternative configuration that could be adopted which would permit most of the transponders in a system to be designated as "protected." In this configuration the in-orbit spare would be inactive and would be co-located in the same orbital slot with an active operating satellite. If any of the satellites in the system failed, the spare would be moved to the location of the failed satellite where it would be put into operation. The time required for this could vary from a few days to a few weeks, depending on the distance and the amount of fuel consumed in the movement. This configuration is given in Table 2.

Table 2

ALTERNATE PROTECTION PLAN

Satellite	A	B	C	D & E (spare)	Total
No. of Transponders					
Protected	22	22	22	22	88
Preemptible	2	2	2	2	8
					96

This configuration reduced the amount of orbital capacity devoted to preemptible service, but has serious disadvantages:

- There would be an interruption of service for customers utilizing a failed satellite while the spare was being moved into position.

- Protected service would be more costly because there would be no revenue available from the spare to offset a portion of its cost.

- The supply of preemptible transponders available for lease would be limited, probably below the level of demand.

In view of these disadvantages, it is not believed that this configuration offers the most effective and efficient use of the orbital arc.

SUMMARY

RCA Americom's plan for satellite service protection has been developed as the result of six years experience in providing satellite service to a variety

of customers with a wide range of service requirements. It has important advantages which make it near optimum both with respect to customer service and efficiency in the use of the orbital arc:

- For the majority of customers who require a high degree of service protection, it provides total restoration capability for both transponder and satellite failure.
- For customers requiring a lower degree of service protection, it provides preemptible service at reduced rates.
- Protection is provided at a reasonable cost, since the cost of the preemptible transponders is shared by all of the protected transponders in a five-satellite system.
- The use of a five-satellite system also increases the efficiency of the use of the orbital arc because of the sharing of the preemptible transponders.