

BELLCOMM, INC.

SUBJECT: Reliability of Microwave Radio
Relay Facilities for Apollo
Launch Data System (ALDS)
Circuits Between Orlando and
Cape Kennedy. Case 320

DATE: June 9, 1966

FROM: G. H. Speake

ABSTRACT

The possibility of simultaneous fading of geographi-
cally diversified microwave radio relay communications routes
in the Florida area serving the Cape Kennedy complex and
providing for the ALDS channels between Houston and the Merritt
Island Launch Area (MILA) has been of some concern. Although
such concern may have been justified in early 1965, signi-
ficant improvements have been made in these links since that
time. These improvements have resulted in a measured performance
that makes it improbable that installing coaxial cable for the
Orlando - Cape Kennedy section would result in additional
improvement.

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(NASA-CR-152924) RELIABILITY OF MICROWAVE
RADIO RELAY FACILITIES FOR APOLLO LAUNCH
DATA SYSTEM (ALDS) CIRCUITS BETWEEN ORLANDO
AND CAPE KENNEDY (Bellcomm, Inc.) 5 P
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MEMORANDUM FOR FILE

The ALDS consists of teletype, voice, data, and television channels between Houston and Cape Kennedy. These are provided over geographically diversified communications facilities for reliability reasons. The northern facility route consists of coaxial wideband cable between Houston and Orlando via Atlanta and microwave radio relay between Orlando and Cape Kennedy. The southern route via Lake City, Florida and across Louisiana consists entirely of microwave radio relay. Although the Lake City-Cape Kennedy and the Orlando - Cape Kennedy routes are geographically separated, there has been some concern over the possibility of simultaneous microwave fading on both routes during a critical time period resulting in the disablement of a high percentage of the ALDS circuits. Severe microwave fading apparently did occur during December 1964 and March 1965. Also significant circuit outages occurred during Gemini - Titan GT-3 mission simulations. The situation was reported by NASA to the common carriers and studies were instituted by the telephone companies.¹

An engineering study of the Orlando - Cape Kennedy TD-2 system had concluded that improved performance was desirable. The measured and calculated received carrier levels in the three microwave hops were about -40 dbm resulting in fade margins of 36 db (with FM breaking of -76 dbm). Such received carrier levels are generally quite satisfactory from a design standpoint for commercial message service where good maintenance practices are followed. It was felt, however, that the importance of the NASA ALDS circuits, and the somewhat higher probabilities of microwave fading in the Florida area due to weather and terrain factors justified higher fade margins. Consequently, recommendations were made which included 1) five watt power output amplifiers, 2) horn antennas, and 3) the new 100A protection channel switching system with two protection channels. The work required was completed in late 1965 and the entire system carefully checked by the maintenance forces.

1. Trip Report - Visit to Cape Kennedy on May 19, 1965, to discuss Communication Facilities between MCC-H and Cape Kennedy, by G. H. Speake, June 7, 1965.

This writer met with Southern Bell Telephone and Telegraph Co., engineering representatives for the Florida area, Messrs. W. B. Baker and J. T. Wallace and maintenance forces representative Mr. E. F. Carr at Jacksonville, Florida on May 25, 1966 for the purpose of discussing the recent performance of the microwave radio relay communication systems serving the Cape Kennedy complex. At the present time, received carrier levels are $-25 \text{ dbm} \pm 2 \text{ db}$ with fade margins of approximately 51 db. The resultant reliability of the system, based on the Rayleigh Distribution and assuming that -60 dbm is the minimum satisfactory received carrier level, is better than 99.999 percent.

Recording of AGC voltage at the Christmas repeater station with the recorders calibrated to read received carrier levels has been conducted on 4 RF channels since January 1966. The recorders count the number of fades that are 20 db, 30 db, or 40 db down from the nominal carrier received levels and accumulate the total time that RF carrier is received at the reduced levels. The RF channels under test are 3750 mc and 3990 mc from Orlando and 3750 mc and 3990 mc from Cocoa (see Figure 1). This gives a 240 mc separation between the channels which are utilized for either a protection channel or the NASA wideband data service. According to the results to date, 40 db fading occurred simultaneously on all 4 channels for a total time of 0.06 minutes in 32 occurrences between 3:15 PM EST January 19, 1966, and 3:00 PM EST March 24, 1966. The average length of each fade would be approximately 0.1 seconds. Fading occurred simultaneously on two channels for a total accumulated time of 0.1 minutes in 35 instances. The average length of fading for this case would be approximately 0.2 seconds. The corresponding reliability is better than 99.999 percent, and supports the previously calculated performance. The above data indicates that simultaneous fading of more than one microwave channel does, in fact, occur. However, the occurrences are relatively few in number and the duration of such fades are relatively short.

According to the maintenance forces records, there have been no simultaneous fading for time intervals sufficient to inhibit full channel protection on the microwave route since January 1, 1966. Normal protection channel switching had occurred, but in no case had a protection channel been called for and a switch fail to take place because of simultaneously faded channels. The test data and calculations indicates a high degree of system performance and reliability, and is supported by the maintenance forces records.

Orlando is the nearest point from Cape Kennedy for access to a coaxial wideband cable system. The new Bell System L4 coaxial route will pass about 20 miles west of Orlando with a leg into that city, and will thus not provide a closer access point for Cape Kennedy. The cost of a coaxial system from Cape Kennedy to Orlando would be in the order of several million dollars.

A few drop-outs, transients, hits, or other interruptions are inevitable on any communications system. The long Lines Department of A. T. & T. Co., and the Southern Bell Tel. & Tel. Company are maintaining close supervision of communication facilities serving Cape Kennedy, and it is planned to continue their testing programs on these routes. In view of this and the present information on the performance of the microwave radio relay routes, it is not believed that an expenditure of the required magnitude to provide coaxial wideband cable between Orlando and Cape Kennedy can be justified.

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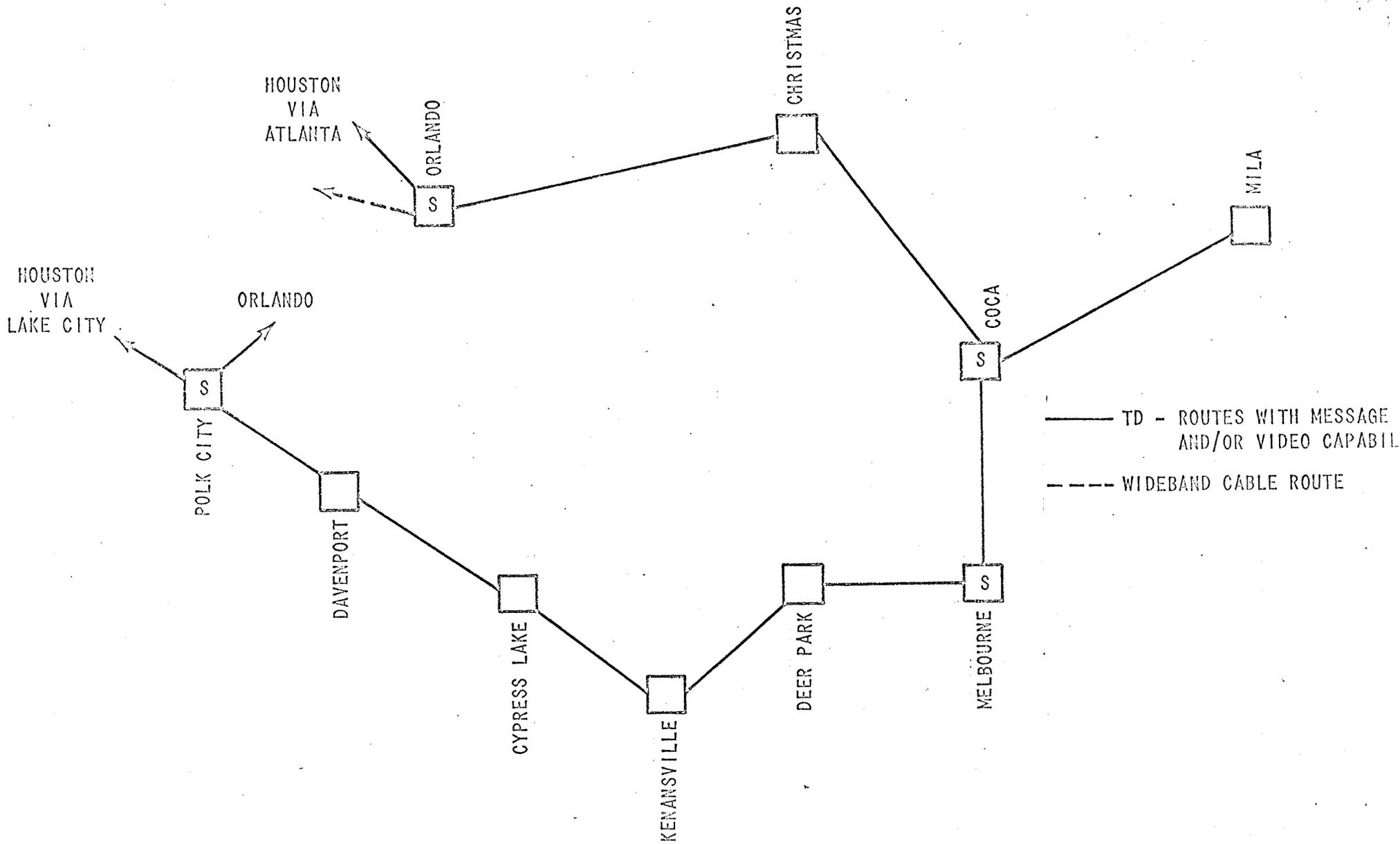


FIGURE 1 - MICROWAVE RADIO RELAY MESSAGE AND VIDEO FOR CAPE KENNEDY