Provision of 9.6-kbps Wideband Data Rate Capability in the DSN

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This article provides an overview of the new 9.6-kbps wideband data rate capability in the DSN. A functional description of the completed implementation is presented, together with a plan to upgrade the JPL Central Communications Terminal for additional 9.6 kbps operational flexibility.

I. Introduction

In the latter part of 1981, budget constraints caused the NASA Communications Network (NASCOM) to reevaluate the service it provides to the NASCOM users. JPL, being a major user of the NASCOM network, was approached by NASCOM to evaluate the feasibility of replacing the overseas 56-kbps wideband (WBD) data circuits with 9.6-kbps WBD data circuits. JPL recognized that NASCOM would achieve major cost savings if this could be accomplished. JPL therefore conducted studies to evaluate whether its ongoing projects could be adequately served by utilizing 9.6-kbps WBD service.

JPL completed its studies in January 1982. JPL concluded that its projects could be adequately supported by the new 9.6-kbps WBD data rate with occasional supplementary use of overseas NASCOM 56-kbps circuits. The 56-kbps circuits would be time-shared by both NASCOM and JPL on a scheduled basis.

II. Results of JPL's Project Assessments to Replace 56-kbps Circuits with 9.6-kbps Circuits

The Voyager Project and the DSN's Very Long Baseline Interferometry (VLBI) differential one-way range (DELTA DOR) data transfer were the only users affected by the WBD rate change.

A. Voyager

The Voyager Project concluded that 56-kbps WBD service could be replaced on a day-to-day basis by 9.6-kbps WBD service while Voyager is in its post-Saturn cruise mode in the 1982-85 era. Eighty percent of its telemetry requirements are for 7.2-kbps spacecraft data rates. Real-time data requirements in excess of 7.2 kbps could be forecast one to two months in advance to aid in scheduling available overseas NASCOM lines on a shared basis. The high-volume Voyager navigation DELTA DOR data could be scheduled in the same manner.

B. VLBI

Both the VLBI Mark I System and the VLBI Mark II System concluded that they could schedule the NASCOM overseas 56-kbps WBD circuits on a shared basis for their high-volume data. The VLBI Mark I System provides for time synchronization, Universal Time One, and polar motion data requirements. The VLBI Mark II System provides delta differential one-way range (DELTA DOR) capability data for flight project navigation support.

III. Significant Functional Differences Between Old and New Overseas DSN Wideband Subsystems

Refer to Figs. 1 and 2, which depict the DSN/NASCOM 9.6-kbps wideband configurations.

A. Old Overseas DSS 42/43 and DSS 61/63 56-kbps Wideband Data Assembly (WBDA)

The WBDA received block-formatted, serial data from the on-site computers (OSC) and conditioned the data for transmission by WBD equipment. The block-encoded data was applied to a 303-type data set which converted it to a baseband signal and inputted it to an LWM-6 type modem. The modem translated the baseband signal into vestigial sideband (VSB) signal in the range of 60-108 kHz. This form of signal is known as group-band. The group-band signals were then applied to a 56-kbps NASCOM line to the Madrid or Canberra Switching Centers for retransmission over satellite communication links to the Goddard Space Flight Center (GSFC). From GSFC, the signals were retransmitted via a 56-kbps satellite link to the JPL Central Communications Terminal (CCT) WBD assembly terminal equipment.

B. New DSS 42/43 9.6-kbps Wideband Equipment

The old 56-kbps equipment remains unchanged. NASCOM has provided new 9.6-kbps 209-type data sets and current-to-voltage (I/V) signal converters to serve the 9.6-kbps circuits described in Section III-A above.

The block-encoded data is now applied to the I/V converters for conversion to a voltage-mode signal that can be interfaced to the 9.6-kbps 209-type data sets. The data set converts it to an analog signal which is routed, via voice/data switching equipment, onto a NASCOM voice/data circuit for transmission to the Canberra Switching Center. The Canberra Switching Center has been configured by NASCOM to allow for two methods to route the signal to GSFC. It can either regenerate the signals with 9.6-kbps 209-type data sets for transmission to GSFC via voice/data circuits, or it can multiplex the signals onto a 56-kbps Time Division Multiplex (TDM) System for transmission via a satellite link to GSFC. GFSC transmits the signals to JPL via a 56-kbps satellite link or by discreet D-1 conditioned voice/data lines using 9.6-kbps 2096 data sets.

C. New DSS 61/63 9.6-kbps Wideband Data Equipment

The old 56-kbps equipment remains unchanged. NASCOM has provided line drivers capable of driving the new 9.6-kbps signals to the Madrid Switching Center. The line drivers accept the block-encoded data described in Section III-A and converts the data into balanced current-mode signals for transmission, via existing NASCOM cable facilities, to the Madrid Switching Center. The Madrid Switching Center has the same capabilities as the Canberra Switching Center for alternate data transmission to GSFC as described in Section III-B.

IV. 9.6-kbps Implementation Completed in the JPL CCT Central Wideband (CWB) Assembly

NASCOM has provided three new 9.6-kbps 2096 data sets, on a leased basis, and I/V converters. The analog sides of the 2096 data sets have been interfaced via the CCT voice/data switcher to two D-1 conditioned lines to receive transmission from GSFC. GSFC receives the signals from the overseas switching centers and stations as previously described.

The RS-232 digital sides of the data sets at JPL are applied to I/V converters where the signals are converted to balanced current mode signals for input to the CWB terminal equipment, and thence to the CCT computers and Mission Control and Computer Center (MCCC) users.

V. Plan for Upgrading the 9.6-kbps Wideband Capability in the JPL CCT

The following plan will provide the capability to either multiplex 9.6-kbps signals onto a 56-kbps line, or to route them directly to 9.6-kbps 2096 data sets for transmission over discreet D-1 conditioned Voice/Data lines.

(1) Convert the existing NASCOM-provided WBD prime and backup TDMs to enable them to multiplex 9.6-kbps circuits. Presently, the TDMs multiplex seven 7.2-kbps high speed data (HSD) channels onto a 56-kbps circuit. The planned conversion will allow multiplexing three 7.2-kbps HSD channels and three 9.6-kbps channels. All six of these channels will be interfaced to the line side (data communications equipment side) of the Error Correction and Switching (ECS) Assembly HSD switch.

(2) Interface the existing 9.6-kbps 2096 data sets to the line side of the HSD switch.

(3) Interface the equipment side (data terminal equipment side) of the HSD switch directly to the existing unused RS-232 ports of the WBD Network Encoders/Decoders (NEDs) which, in turn, are cabled directly to the existing WBD terminal equipment. The WBD terminal equipment interfaces both the CCT computers and MCCC customer equipment.

VI. Summary and Conclusions

JPL, being a major user of the worldwide NASCOM Communications Network, is successfully supporting the data requirements of its projects at a new nominal data rate of 9.6 kbps. JPL and NASCOM have planned the time-shared use of the NASCOM overseas 56-kbps circuits when high-volume Voyager Project or VLBI data require their use.

To sum up, NASCOM and JPL have achieved major cost savings in an era of increased budgetary restraints.

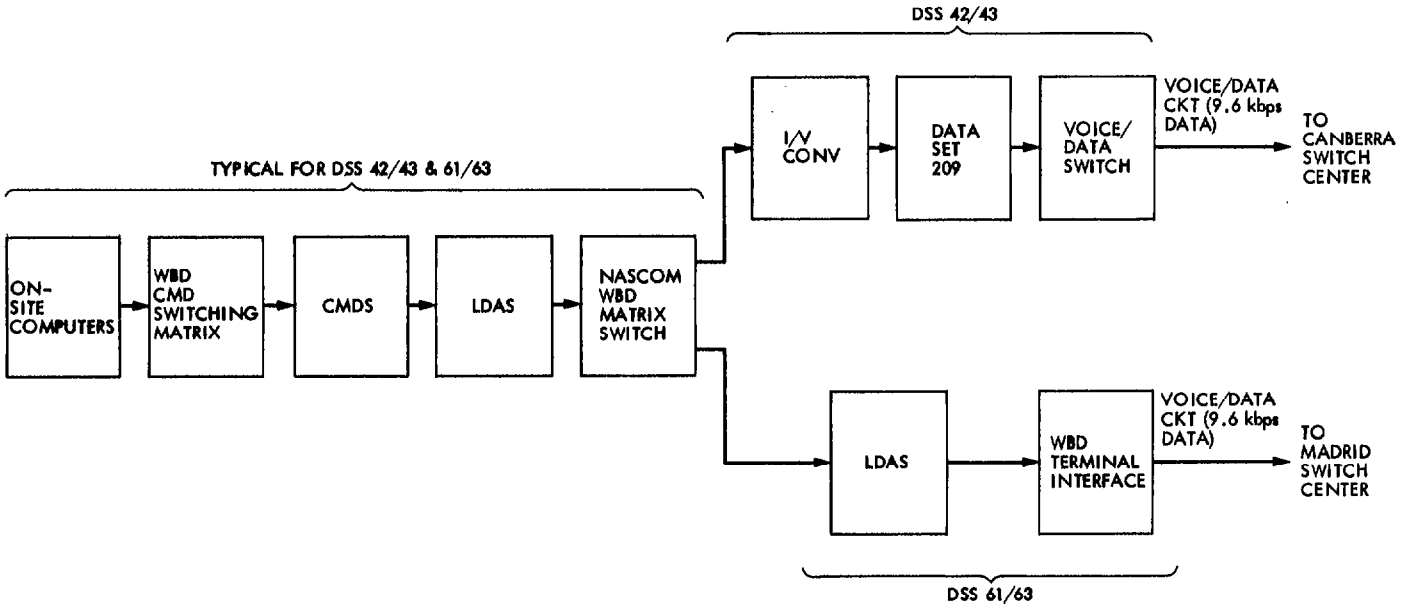

Fig. 1. Overseas station 9.6-kbps wideband configuration

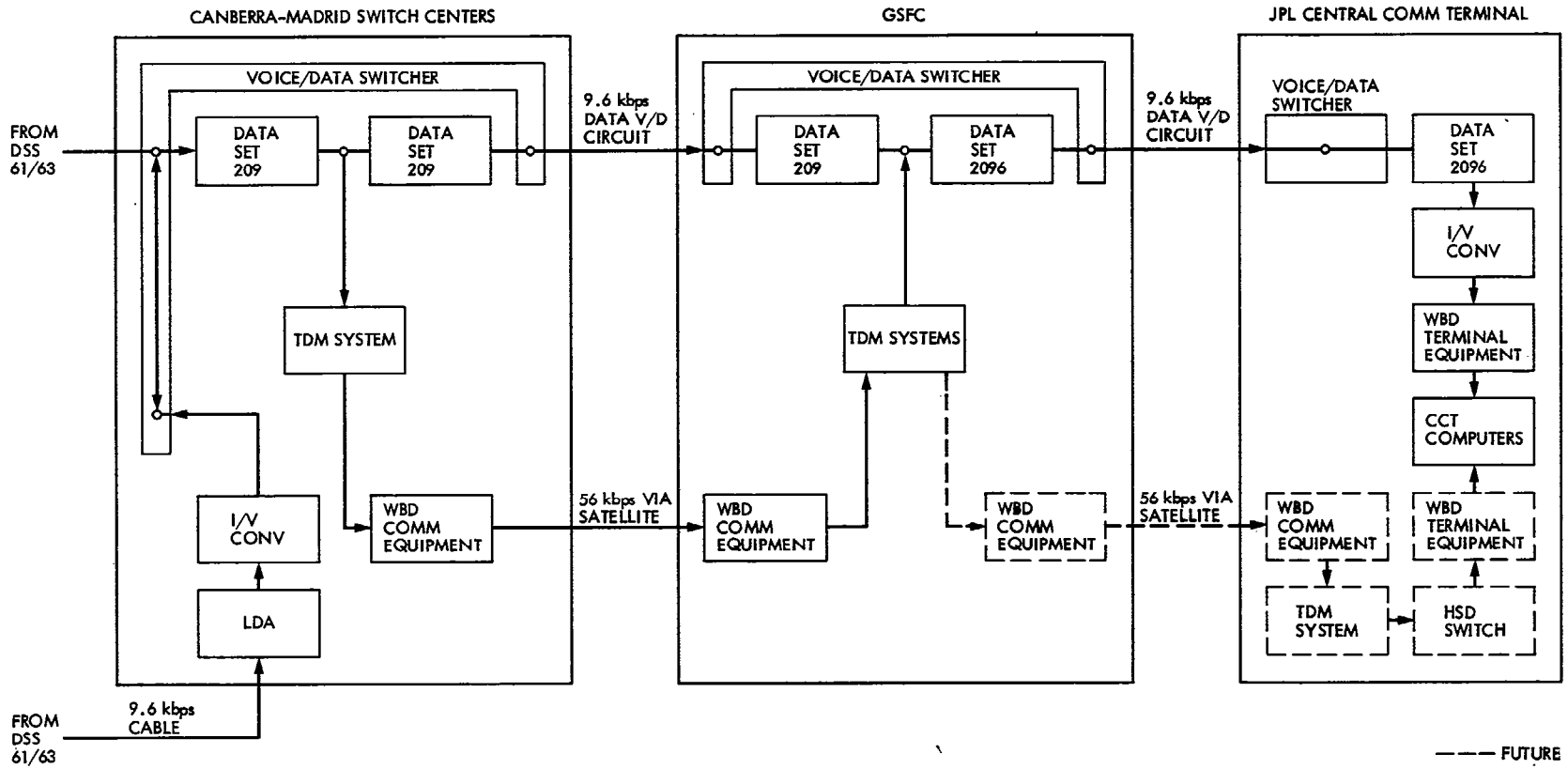

Fig. 2. 9.6-kbps wideband configuration switching centers/GSFC/JPL