DSN Radio Science System Mark III-78 Real-Time Display Capability

A. L. Berman
TDA Engineering Office

This article describes the current plan to provide radio science real-time display capability in response to multimission radio science requirements. The implementation occurs in two phases, as follows:

Phase I: Provides display of doppler frequency and high-resolution graphical display of all closed-loop radio metric parameters.

Phase II: Provides spectrum displays of open-loop receiver output.

I. Introduction

The Radio Science System was recently instituted as a Deep Space Network (DSN) data system. A review of Radio Science System functional requirements was held on February 4, 1977 (see Ref. 1 for a detailed description of the review). At the review, the question of real-time radio science data display capability was broached and designated as requiring subsequent resolution. This article describes the plan generated to provide radio science real-time data display capability during the Voyager era.

Radio science data is conveniently categorized as either originating from the closed (phase-locked)-loop receiver assembly ("closed-loop data") or the open-loop receiver assembly ("open-loop data"). Data acquired by the closed-loop receiver assembly consists of the following major types of radio metric data:

(1) Single-frequency doppler.

(2) Dual-frequency doppler.

(3) Single-frequency range.

(4) Dual-frequency range.

(5) Differenced range minus integrated doppler (DRVID).

These data are utilized by both Navigation and Radio Science; although Navigation is the prime user, the data is nonetheless extremely important for its radio science content. Open-loop data, primarily acquired during signal transit through the solar and planetary atmospheres, is dedicated to and solely used by Radio Science. Real-time (tracking system) displays of closed-loop data are scheduled for implementation in early 1978, in

concert with implementation of the DSN Tracking System Mark III-77. These displays will consist of tabular digital television (DTV) displays of all closed-loop radio metric data types available from the DSS Tracking Subsystem metric data assembly (MDA), with the notable exception of doppler frequency.[1]

Multimission Radio Science real-time display requirements were compared to planned Tracking System display capability; Radio Science requirements not satisfied by the planned Tracking System capability were as follows:

(1) Closed-loop radio metric data

   Doppler frequency.

   High-resolution graphical displays of all parameters.

(2) Open-loop radio science data

   Spectrum displays of the open-loop receiver bandwidth.

To provide these capabilities, a phased implementation program was planned as follows:

Phase I: Provide doppler frequency and high-resolution graphical display of all closed-loop radio metric parameters.

Phase II: Provide spectrum displays of the open-loop receivers.

These phases are described in detail in Sections II and III, which follow.

II. Phase I — Real-Time Display of Closed-Loop Radio Metric Data

In Phase I, the following additional capability (to that already provided by the tracking system) will be made available to NOCC and Project Radio Science:

(1) Computation of doppler frequency. This will be performed in the tracking real-time monitor (RTM) of the NOCC Tracking Subsystem.

(2) High-resolution graphical display of radio metric closed-loop parameters. Graphical resolution will be approximately 240 × 640, full screen.

(3) Display channels. Three full (quad) channels will be made available for Radio Science displays. Current NOCC users of these channels will be supplied with single-channel, dual-format display devices.

Phase I implementation is scheduled to commence in October 1977 and is planned for delivery to operations in August 1978, in accordance with Voyager Radio Science requirements. Fig. 1 illustrates the Phase I functional data flow.

III. Phase II — Real-Time Display of Closed-Loop Radio Metric Data and Open-Loop Spectrum Data

Phase II of the Radio Science real-time display implementation provides the capability to display in NOCC and for Project Radio Science spectrum displays of open-loop receiver output, for the primary purpose of ascertaining signal presence in the open-loop receiver bandwidth during critical operations. Key to the Phase II implementation is the addition of a second Video Assembly Processor (VAP) and associated RAMTEK television distribution device, which will:

(1) Contain the necessary software to process and display the spectrum displays.

(2) Serve as a backup for the NOCC Display Subsystem.

Digitized spectrum displays from the Spectral Signal Indicator Assembly[2] of the Receiver-Exciter Subsystem will be provided to the Occultation Data Assembly (ODA) of the DSS Radio Science Subsystem, where the data will be formatted for immediate high-speed data (HSD) transmission to the NOCC. When received by the NOCC Display Subsystem, the data is prepared for display by software residing in the (second) VAP. It is expected that the capability will exist to update the spectrum displays as often as every 5-30 seconds. Phase II implementation is currently scheduled to commence in October 1978 and is planned for delivery on June 1, 1979. The goal is to have the capability available to support the Voyager second Jupiter occultation. Phase II functional data flow is seen in Fig. 2.

Acknowledgments

Reference

1. Mulhall, B. D. L., "DSN Radio Science System Description and Requirements," in *The Deep Space Network Program Report 42-39*, pp. 119-129, Jet Propulsion Laboratory, Pasadena, Calif., June 15, 1977.

DSS

METRIC DATA ASSEMBLY (MDA)

RADIO METRIC DATA

GCF COMM MONITOR AND FORMATTER

HSDL

COMM BUFFER

DISPLAY SUBSYSTEM

DIGITAL DISPLAY PROCESSOR (DDP)

STAR SWITCH CONTROLLER (SSC)

NETWORK COMM EQUIPMENT (NCE)

WBDL

NETWORK LOG PROCESSOR (NLP)

STAR SWITCH CONTROLLER (SSC)

RADIO METRIC DATA

TRACK RTM

VIDEO ASSEMBLY PROCESSOR (VAP)

RAMTEK

DTV

BUILDING 202

BUILDING 230

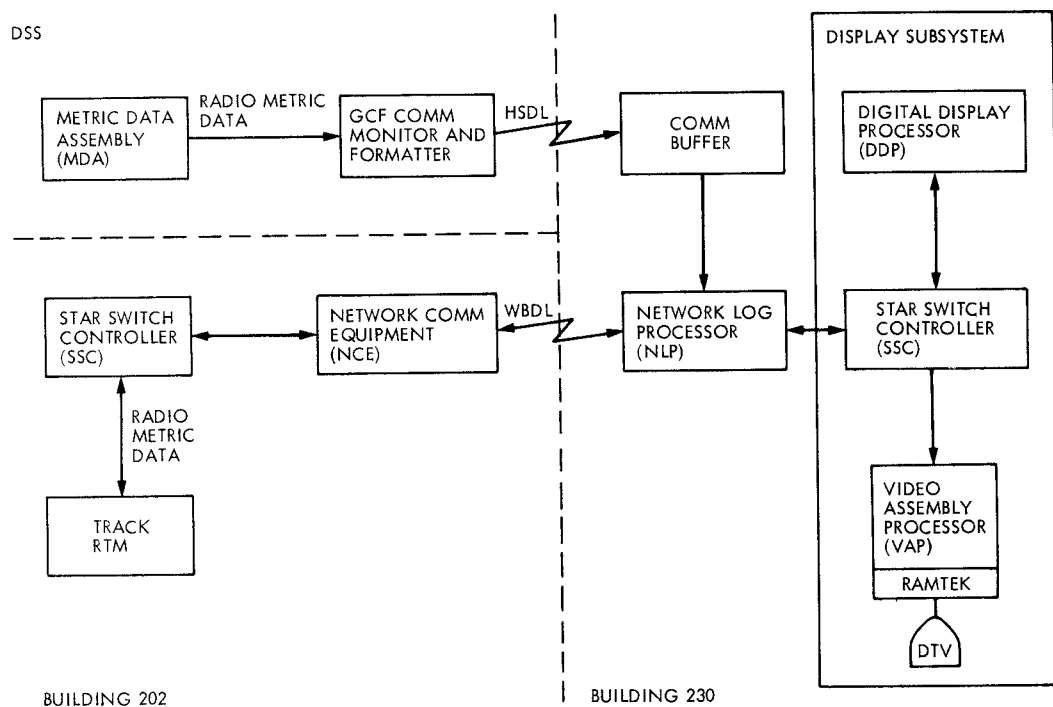**Fig. 1. DSN Radio Science System planned implementation Phase I: NOCC real-time display of closed-loop radio metric data**

DSS

SPECTRAL SIGNAL INDICATOR (SSI) → DIGITIZED OPEN-LOOP SPECTRAL DATA → OCCULTATION DATA ASSEMBLY (ODA)

DIGITIZED AND FORMATTED OPEN-LOOP SPECTRAL DATA

METRIC DATA ASSEMBLY (MDA) → RADIO METRIC DATA → GCF COMM MONITOR AND FORMATTER → HSDL → COMM BUFFER

DISPLAY SUBSYSTEM

DIGITAL DISPLAY PROCESSOR (DDP)

STAR SWITCH CONTROLLER (SSC) ↔ NETWORK COMM EQUIPMENT (NCE) → WBDL → NETWORK LOG PROCESSOR (NLP) ↔ STAR SWITCH CONTROLLER (SSC)

RADIO METRIC DATA

TRACK RTM

VIDEO ASSEMBLY PROCESSOR (VAP)

RAMTEK

DTV

VIDEO ASSEMBLY PROCESSOR (VAP)

RAMTEK

DTV

LEGEND:

BUILDING 202

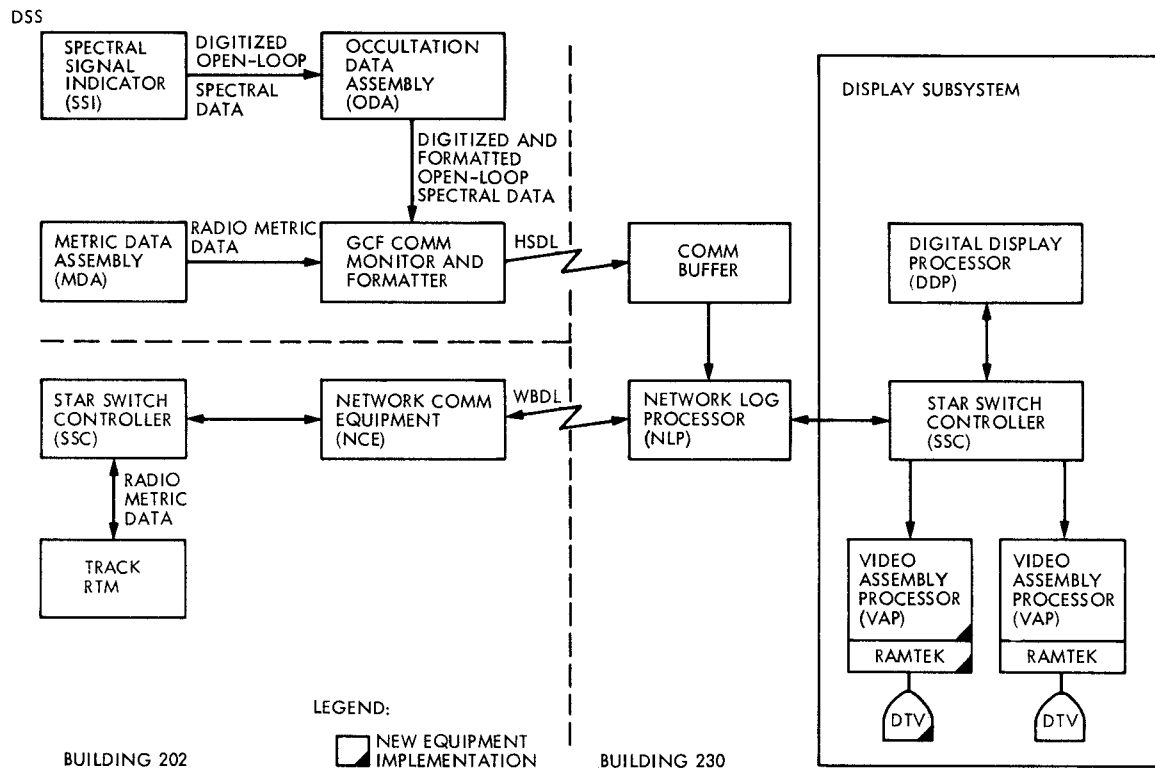NEW EQUIPMENT IMPLEMENTATION

BUILDING 230

Fig. 2. DSN Radio Science System planned implementation Phase II: NOCC real-time display of closed-loop radio metric and open-loop spectrum data

145