MAINTENANCE SYSTEM
DMS-100/200

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FIGURES

1. GENERAL

1.01 The purpose of the Maintenance System for the DMS 100
Family of Digital Multiplex Switching (DMS) systems is to provide
complete maintenance by detecting, analyzing, correcting and
reporting errors in DMS software and hardware.

1.02   The Maintenance System consists of a number of functional
areas, each having hardware elements and software resources,
which interact through internal messages to perform the tasks
involved in automatic maintenance.

1.03   Each functional area, referred to as a maintenance
sub-system (SS) contains the software necessary for maintaining
its own hardware.   The functional areas correspond to the
hardware and software components of DMS which are described in
NTP 297-1001-100.   Each maintenance SS locates and diagnoses
errors occurring within the area of responsibility assigned to
it.

1.04   The maintenance sub-systems are accessible to maintenance
personnel through the Maintenance and Administration Position
(MAP) or other terminal devices such as TTY.   The MAP provides a
Man-Machine Interface (MMI) through its Visual Display Unit (VDU)
screen and keyboard.   The VDU screen displays DMS status
information in response to requests from maintenance personnel
entered manually via the VDU keyboard.   Refer to NTP
297-1001-110 for a detailed description of the MAP and its
operating instructions.

2. MAINTENANCE SUB-SYSTEMS

2.01   Refer to Figure 2-1, which shows a block diagram of the
DMS maintenance sub-systems and their connection with the other
elements of the maintenance system.   The maintenance sub-systems
and their areas of responsibility are:

Software_(SWERR)_Maintenance_SS

2.02   The Software   maintenance SS   is responsible   for
periodically checking the CC software to ensure that logical
rules are followed (software sanity). The SWERR SS monitors the
number of timeouts, the density of message flow, the amount of

available system resources, and the percentage of memory used.

Central_Control_(CC)_Maintenance_SS

2.03 The CC maintenance SS is responsible for maintaining the
hardware on the Central Processor Unit (CPU), Data Store (DS),
and Program Store (PS) shelves.   This includes cards, such as
the data port extenders and the associated control and interface
cards. Also monitors the power converters and cooling unit. DS
maintenance includes the memory extension (MEX) frame if such is
in use.   Reports changes in CPU status (active or inactive).
Maintains links up to, but not including the Central Message
Controller (CMC).

Central_Message_Controller_(CMC) Maintenance_SS

2.04   Responsible for maintaining all hardware on the CMC
shelves, plus the links to   the Network Modules (NM) and
Input-Output Controllers (IOC).

Input-Output_Devices_(IOD)_Maintenance_SS

2.05   Responsible for maintainting all hardware on the IOC
shelves, including the device controller (DC) cards for the local
IO devices (tape drives, TTY, VDU, etc.), the remote IO devices
(Via modems), and the common control cards. Also monitors the
performance of the IO devices themselves and the power converter
cards.

Network_Module_(NET)_Maintenance_SS

2.06   Responsible for maintaining all Network Modules (NM) and
the links to the Peripheral Modules (PM).   Also maintains the
power converters, and cooling units of all NM frames.

Peripheral_Module_(PM)_Maintenance_SS

2.07   The PM maintenance SS is responsible for all types of
peripheral modules such as; Trunk Module (TM), Line Module (LM),
and Digital Carrier Module (DCM).   In each type of PM, the
common control cards, the interface cards to the NMs, and the
power converters, are maintained.   Not included, are the
transmission interface cards to the trunks (TM), lines (LM), or
digital carrier equipment (DCE).

Trunks_(TRKS)_Maintenance_SS

2.08   Responsible for maintaining the trunk interface cards in
the TM and the transmission facilities to the distant office.
In a DCM, the TRKS SS maintains the DCE interface cards and the
transmission facilities via the digital carrier equipment to the
distant office.

Lines_(LNS)_Maintenance_SS

2.09   Responsible for maintaining the line interface cards in
the LM and the transmission facilities to the subscriber's
station equipment.

Traffic_(TRAF)_Maintenance_SS

2.10   Responsible for detecting abnormal traffic and overload
conditions. Generates data on traffic patterns for display on the
VDU. Permits manual overload control.   Applies automatic
high-priority line.

External_(EXT)_Alarms_Maintenance_SS

2.11   Monitors the alarm circuits of any equipment outside the
DMS system. Sends alarm indication to alarm hardware and VDU.

2.12   MAINTENANCE SUB-SYSTEM INTERFACES

.13   Each of the maintenance sub-systems just described has
three kinds of interfaces with other elements of the maintenance
system.

    (a) _____.   From other maintenance sub-systems, from the
        Inputs
        I/O system and the alarm detection system.

    (b) Outputs.   To other maintenance sub-system and to the
        routing and reporting sub-system.

    (c) Manual. Via the VDU or TTY, as mentioned in para. l.

Input-Output_(I/O)_Message_System

2.14   The I/O Message System handles the reception and routing
of internal messages between components of the DMS.   All
messages contain an error indicator.   If no error indicator is
present the message proceeds without the maintenance system being
involved.   If an error is present, the error indicator is routed
to the maintenance SS whose area of responsibility covers the
source of the error.   The I/O System is a major source of error
detection inputs to the maintenance sub-systems. Refer to NTP
297-1001-104 for details of the I/O Message System.

Alarm_Detection_Sub-System

2.14   The alarm detection SS is a software/hardware entity which
performs the following functions:

    (a) Receives hardware-detected alarms from within the DMS
        system via alarm scan points.

    (b) Receives software alarms via error information from the
        I/O system

    (c) Interprets the type of alarm and its level of severity.

(d) Routes alarm messages to the responsible maintenance SS
            for action.

        (e) Sends messages to the routing and reporting SS for
            status display update (VDU, TTY).

        (f) Resets alarm conditions when   a problem has been
            resolved, or on a manual input from the VDU keyboard.

Routing_and_Reporting_Sub-system

2.16   The routing and reporting SS provides an interface between
the maintenance sub-systems, the VDU and the alarm hardware
(visible and audible alarm devices). The action of the routing
and reporting SS is described later.

3. MAINTENANCE CONCEPT

3.01   The basic concept of the DMS Maintenance System is that
each maintenance SS has the responsibility to locate and diagnose
an error condition which is presented to it.   The maintenance SS
must determine first if the error lies within its own area of
responsibility.   If the error is within the responsibility of
the maintenance SS, the error is diagnosed to determine what item
is causing the error, and a message is sent to the routing and
reporting SS.   If the error is not within the maintenance SS
tself, the error message is passed to the next appropriate SS
which takes similar action until the error is finally located.

3.02   MAN-MACHINE INTERFACE (MMI)

3.03   Maintenance personnel can access each of the maintenance
SS via the VDU keyboard and obtain status information as a
display on the VDU screen. An additional or alternative MMI can
also be provided by TTY.

3.04   TELESCOPING

3.05   The MAP maintenance function uses the technique of
'telescoping' to examine the operation of the DMS.   Telescoping
permits ever-increasing details about system status or troubles
to be obtained, starting at the maintenance sub-system level and
descending to lower levels until the fault is eventually traced
to a replaceable component level.

3.06   Refer to Figure 2-2.   The screen of the VDU displays
various levels of status information in the System Status and
Command Interpreter areas.   The Command Menu Area displays a
list of possible functions or commands which the maintenance
personnel can perform at each level of interrogation.   The use
of menus minimizes the necessity for memorizing the commands or
refering to documentation.   Commands entered are repeated in the
Input Echo area.

4. ROUTING AND REPORTING SUB-SYSTEM

4.01   Refer to Figure 4-1.   The routing and reporting SS
provides an   interface between the VDU, the readout and storage
devices, and the maintenance sub-systems. The following lists the
main functions of this sub-system:

    (a) Assigns priorities to   messages incoming from the
        maintenance sub-systems, based on the type and severity
        of the fault.

    (b) Assigns output routes based on the message type and
        routing information contained therein.

    (c) Drives software and hardware alarms based on the
        severity of the fault information contained in the
        message.

    (d) Retrieves information from a message logging mechanism.
        The request for this information is usually originated
        by the maintenance personnel.

    (e) Monitors the number of instances of a specific message
        and then, outputs either successive instances of that
        message and/or a 'threshold message'.

    The routing and reporting sub-system is divided into three
parts as follows:-

    - Routing mechanism
    - Logging Mechanism
    - Software/hardware Alarm

OUTING MECHANISM

4.02   The core of the routing and reporting sub-system is the
routing mechanism which interfaces with the VDU, the maintenance
sub-systems, the alarm sub-system and the logging mechanism.

    The main function of the routing mechanism is to receive
messages from the different sub-systems and decide whether the
message should be:

    (a) Routed immediately to one or more VDUs.

    (b) Stored in the logging mechanism for future retrieval.

    (c) Routed for status update; i.e. if a sub-system reports a
        change in its resource status or organization, the
        routing mechanism will decide which VDU requires the
        level of status change.

    (d) Routed to the alarm sub-system in order to take
        appropriate action based on the type and severity of the
        alarm message.

    (e) Re-routed to an alternative I/O device if the intended
        device is out of service.

4.03   The routing mechanism also checks the threshold of alarms
which are   not associated with any   particular maintenance
sub-system.

LOGGING MECHANISM

4.04   The logging mechanism can display and store data in any of the following forms:

   (a) Hardcopy on printer.

   (b) Storage device.

   (c) Memory device at a remote terminal capable of performing system correlation.

4.05   The routing mechanism determines whether the alarm message hould be directed to a printer or to a storage device. Maintenance personnel can at any time request retrieval of all he information pertaining to a particular alarm.   This method prevents the maintenance personnel from being flooded with irrelevant data on topics other than the problem at hand.

SOFTWARE/HARDWARE ALARM

4.06   The software/hardware alarm receives the status messages from maintenance sub-systems and acts as follows, depending on the severity of the alarm:

   (a) Activates the proper audio and visual alarm (e.g. bell and light).

   (b) Updates the top level status display of the appropriate man machine terminal.   This is done on a continuous update basis.

   (c) Resets alarm conditions whenever a problem has been cleared.

5.   MESSAGE TYPES

INTER-MAINTENANCE SUB-SYSTEM MESSAGES

5.01   See Figure 2-1.   Transient errors always stay in the maintenance sub-system where they occured.   It is ONLY when these errors persist that, if not resolved, they will be communicated to another maintenance sub-system via inter-maintenance sub-system messages.

5.02   There are two reasons for communication to take place between two maintenance sub-systems:

   (a) A sub-system is giving an error indication to another sub-system. These are termed fault messages.

   (b) A sub-system is notifying another sub-system that a component is no longer available for service.   These are termed status messages.

5.03   The receiving sub-system is responsible for taking the appropriate action on the message.   Furthermore, it is responsible for communicating information concerning its activity to the routing and reporting SS.   Note that the transmitting

sub-system's responsibilities concerning problems related to other sub-systems terminate as soon as it has disposed of the information.

MESSAGES FROM THE MAINTENANCE SUB-SYSTEMS TO THE ROUTING AND REPORTING SUB-SYSTEM

5.04   Refer to Figure 4-1.   Any maintenance sub-system can find it necessary to send one of four types of messages to the routing and reporting sub-system. In the usual order of occurrence, the four types of messages are:

    (a) Error - an abnormal event has occurred in the sub-system.

    (b) Diagnostic - results from an attempt by the sub-system to test a given aspect.

    (c) Action - an alteration has occurred in the status or organization of the sub-system's resources.

    (d) Exception - a report that a threshold has been exceeded.

    (e) Information - a report on the instantaneous status of a sub-system.

5.05   These messages are passed to the routing and reporting ub-system in packed (i.e. internal) format. There are two kinds of messages involved:

    (a) Specific responses to requests from   the command interpreter.

    (b) Unsolicited messages which are submitted to the routing and   reporting   sub-system   without   any   specific destination from the sub-system's point of view.

MESSAGES BETWEEN THE VDU AND THE ROUTING MECHANISM

5.06   Input from the VDU moves through the command interpreter (CI). This process is responsible for interpreting the common language definitions of system components into internal form. This translated result and the request or command is then passed on to:

    (a) The relevant maintenance sub-system, or:

    (b) the routing mechanism, or:

    (c) the logging mechanism.

.07   In case (b) above, the input either performs routing and eporting functions such as setting thresholds, or is passed on to the logging mechanism or the software-hardware alarm system. In (c) the input is used to retrieve stored information for display.

5.08   Output to the VDU always emerges from the routing and reporting sub-system. This includes responses to requests or ommands from the command interpreter to the maintenance

sub-system.

5.09   Output and inputs to any other devices (i.e. printer) are
organized in the same way as the VDU.

MESSAGES   BETWEEN   REMOTE   MAINTENANCE   CENTERS   AND   TRUNKS
MAINTENANCE SS.

5.10   An external interface to the trunk maintenance SS is
provided. It is through such a facility that messages will pass
between DMS and remote maintenance and administration centers.

MESSAGES BETWEEN THE I/O MESSAGE SYSTEM OR ALARM DETECTION
SUB-SYSTEM AND THE MAINTENANCE SUB-SYSTEMS

5.11   Major sources of indications to the maintenance sub-system
are the messages from the I/O message system or the alarm
detection sub-system. Problems detected by these two systems are
routed to the relevant maintenance SS.

MESSAGES FROM THE CC MAINTENANCE SS TO SOFTWARE MAINTENANCE SS

5.12   When anomalies in the CC Maintenance SS, relating to the
software environment itself, occur the CC passes a message to the
SW maintenance SS. This is the only type of communication
between the SW maintenance SS and any other sub-system.

6.   INTERACTION PROTOCOL

6.01   This section defines maintenance sub-system interaction
protocol and man-machine protocol. Refer to Figure 6-1.

MAINTENANCE SUB-SYSTEM INTERACTION PROTOCOL (MSIP)

6.02   MSIP is initiated by a detection of a fault (FD). When
the I/O system, alarm detection SS, or any of the maintenance
sub-systems, detect a fault, the maintenance sub-system in whose
area the problem falls, is responsible for running a diagnostic
rocedure. Should the diagnosis be sucessful and the problem is
not transient, then an error message is sent to the routing and
reporting SS. Should the diagnosis fail, a diagnostic message is
sent to the routing and reporting SS. The maintenance sub-system
is capable of initiating an action when it can determine the
cause of the failure. If so, an action message (followed
possibly by a status message) is sent to the routing and
reporting SS.

6.03   MSIP as initiated by a manual request (MR) from the VDU.
Three types of messages can be requested by the VDU:

     (a) Action request (AR) - which may result in a status
         change and hence a status update on the VDU.

     (b) Status request (SR) - which is a simple request for
         information.

(c) Diagnostic request (DR) - which is a simple request to
　　　　　　run a diagnostic.　No action is taken as a function of
　　　　　　the result of the diagnosis when the request comes from
　　　　　　the MAP.

MAN-MACHINE PROTOCOL

6.04　Refer to Figure 6-2.　Having observed a status change on
the system VDU display, the maintenance personnel can request
sublevel information, showing overall sub-system status.　Further
information is retrievable from the logging mechanism on
diagnostic, error and status messages stored therein.　Based on
this information the fault is repaired and the maintenance
personnel then request that the component be returned to service.
This request results in a diagnostic being run, which if
successful, then performs the action of returning the repaired
component to service. The associated action and status messages
are also generated at this time.　If the diagnostic fails, a
diagnostic message is sent resulting in a repetition of the
repair attempt and a re-run of the diagnostic. The fault will
continue to be displayed as an alarm on the VDU, even if the
audible alarm is off, until the diagnostic is successful.

7.　REFERENCES

System Description.　DMS 100 Family of
Digital Multiplex Switching Systems.　　　　　NTP 297-1001-100

Maintenance and Administration Position　　　NTP 297-1001-110

I/O Message System　　　　　　　　　　　　　NTP 297-1001-104

8.　ABBREVIATIONS

AF-　　　　- Access Fault
AR-　　　　- Action Request
CC-　　　　- Central Control (CPU, DS, PS)
CI-　　　　- Command Interpreter
CMC-　　　- Central Message Controller
CP-　　　　- Call Processing
CPU-　　　- Central Processor Unit
DC-　　　　- Device Controller cards (part of IOC)
DR-　　　　- Diagnostic Request
DS-　　　　- Data Store
FD-　　　　- Fault Detection
IOC-　　　- Input-Output Controller
LM-　　　　- Line Module
MAP-　　　- Maintenance and Administration Position
MMI-　　　- Man-Machine Interface
MR-　　　　- Manual Request
MSIP-　　　- Maintenance Sub-system Interaction Protocol
NM-　　　　- Network Module
NMC-　　　- Network Message Controller
ODM-　　　- Office Data Modification
PM-　　　　- Peripheral Modules (LM, TM)
PS-　　　　- Program Store
SR-　　　　- Status Request
SS-　　　　- Sub-system
TL-　　　　- Trunk/Line Maintenance
TM-　　　　- Trunk Module

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TTY-       - Teletype or printer
VDU-       - Visual Display Unit
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