DEEP SPACE NETWORK EQUIPMENT PERFORMANCE, RELIABILITY, AND OPERATIONS MANAGEMENT USING THE DISCREPANCY REPORTING MANAGEMENT SYSTEM (DRMS)

AUTHORS

MARK CHATILLON (Process Development and Testing Engineer)

JAMES LIN (System Architect and Programmer)

TONJA COOPER (Team Lead)

AFFILIATIONS

Mark Chatillon, BAE SYSTEMS AUSTRALIA at CANBERRA DEEP SPACE COMMUNICATIONS COMPLEX (CDSCC)

James Lin, CHASE COMPUTING at JET PROPULSION LABORATORY (JPL), CALIFORNIA INSTITUTE OF TECHNOLOGY

Tonja Cooper, JET PROPULSION LABORATORY (JPL), CALIFORNIA INSTITUTE OF TECHNOLOGY

OVERVIEW

The DRMS is the Discrepancy Reporting Management System used by the Deep Space Network (DSN). It uses a web interface and is a management tool designed to track and manage:

- data outage incidents during spacecraft tracks against equipment and software known as **DRs** (Discrepancy Reports),
- to record "out of pass" incident logs against equipment and software in a **Station Log**,
- to record instances where equipment has be re-started or reset as **Reset** records, and
- to electronically record **equipment readiness status** across the DSN.

Each of these record types is managed in separate sections of the system

Tracking and managing these items increases DSN operational efficiency by providing:-

- the ability to establish the operational history of equipment items,
- data on the quality of service provided to the DSN customers,
- the ability to measure service performance,
- early insight into processes, procedures and interfaces that may need updating or changing,
- the capability to trace a data outage to a software or hardware change.

The DRMS uses a three tiered pick list structure common to each record type. The lowest level is called the Assembly level - this is the most common level of usage - and assemblies can be either dedicated to an antenna or assignable across a range of antennae. A group of assemblies combine together to make up a Subsystem and a group of related Subsystems combine to make up a System. The pick list for recording equipment resets is further constrained to those Assemblies that can actually be reset or re-started. Users originating records commonly do so at the assembly level, often combined with an antenna.

The DRMS makes use of stringent business logic to control via roles the "work flow" of the processing and analysis of an incident. It makes use of targeted e-mail messages and includes a built in "To Do List" (TDL) to focus attention on matters awaiting a user's input. Entered data is validated where necessary. The on-line help including pop up suggestions assist the user to operate the system properly. The usefulness of the collected data is significantly improved by the capability to attach files and link URLs to records, and by the robust reporting capability.

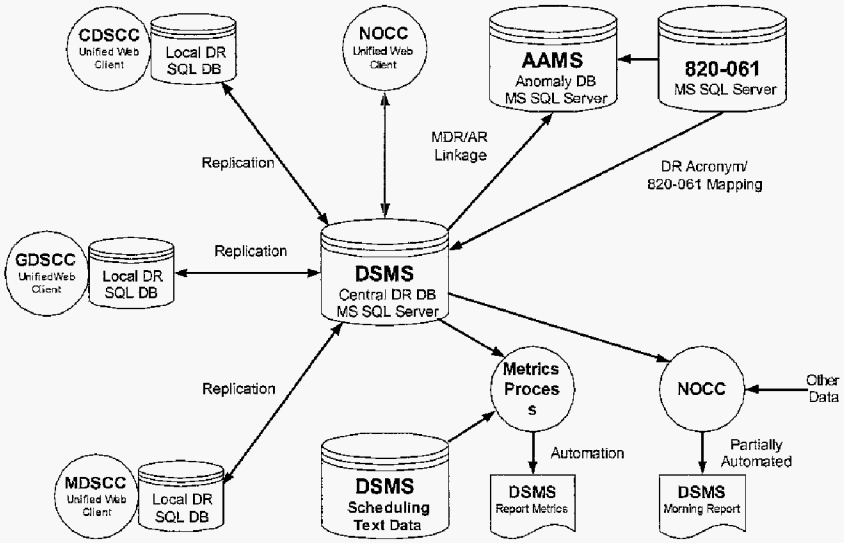
The tool provides the DSN Operations Managers across the network with enhanced visibility of their Station performance and data output. As a result the Stations are able to provide a better service to their flight project customers with the provision of improved data quality.

THE WEB INTERFACE and DATA REPLICATION

The DRMS is compatible with both mainstream web browsers Netscape and Internet Explorer (IE). It includes remote scripting to dynamically populate pick-lists within the system, thus requiring the later versions of the browsers. Additional functionality that makes use of some IE features not available in Netscape has been incorporated into the DRMS. These extra features do not impact the data but assist in making the system user-friendly.

All DR, Master DR, and Reset data is replicated to a master server, Master DR data is replicated to all the DSN sites, Station Logs are internal to each of the DSN sites and are not replicated.

DRMS Data Replication



COMPONENTS, BUSINESS LOGIC AND PROCESSES

The DRMS in the broadest terms, includes the following components:

- DR records
- Station Log records
- Reset records
- Electronic Equipment Status records

DISCREPANCY REPORTS (DRs)

The DRs segment of the DRMS provides the capability to collect, distribute, process, and communicate discrepancy information. The DRMS is also used for performance analysis; data accountability; and the generation of reports for engineering, operations, maintenance, and management personnel. A DR record contains all pertinent information regarding a DSN system deficiency that occurred during committed or scheduled support. A DR is opened by real-time operations personnel at the Signal Processing Centers (SPCs) or the Network Operations Control Center (NOCC), and contains information related to the failure. This information is distributed within the DRMS for others to view and take action accordingly. When the discrepancy has been corrected or the capability has been restored, the DR information is updated and the DR is closed. A closed DR record will contain the full history of the discrepancy, including the corrective or restorative action and problem analysis in a single record.

THE STATION LOG

The Station Log (the Log) enables users within each DSN site to record and manage informal "events" and incidents. The Log is site specific and is NOT replicated back to the central database. It provides the capability of recording site events or incidents against the same equipment item list as is used for the DRs. It is a simple system, yet includes very useful capabilities for sites, in particular as an internal communication medium and event logger, however the individual sites are not required to use it to its full capability. Log entries are also used to "declare" a piece of equipment or an antenna's availability status. Whilst not as stringent as is the case with a DR, the Station Log and Electronic Status records incorporate a history of activities and actions.

RESETS

Resets are simple originate only actions that record on a non interference basis the details of equipment resets that have been required to be made (other than scheduled reset activity). The information is often useful in pointing towards possible emerging problems that could thus be avoided or in troubleshooting. The information recorded is minimal, simply an Assembly (a subset of the DR pick-list – only those items that can be reset), a number of times the item was reset, and the "phase" of the pass. A timestamp is recorded in the background however with only an originate action do not require a history.

ELECTRONIC STATUS

The Electronic Status Board details equipment status on both a site and global basis. Items may be declared to have a status of Red, (out of service), Orange (reduced capacity and /or not operating to expected specifications), or Blue (removed from service to allow for other work to be undertaken), in addition to the nominal Green. The records are managed with e-mail notifications and Estimated Time of Return to Operation (ETRO) adjustment capability.

THE BUSINESS PROCESSES

The DRMS has built-in business rules and processes to enable a systematic work flow in the relevant DR, Station Log and Equipment Status records. When such a record is originated against an item of equipment, roles tables are used to advise the relevant site Maintenance and Installation (M&I) personnel by e-mail of the problem. There are no limits to how many personnel that can have the role for an item allowing for teams of maintenance technicians or for a prime and backup scenario. The e-mail message contains useful abbreviated details of the incident, indicates the action required and includes a hyperlink to the full incident record. Concurrently an entry is also placed on the maintenance personnel's TDL. Whenever a user logs on to the DRMS, if there are any items on their TDL, it is automatically displayed.

It is considered important to segregate the input of the incident observers from the problem analysis entries made by the technical personnel. Observers are restricted to a problem description and details of corrective actions attempted and any relevant outcomes of these attempts. The engineering and technical maintenance personnel provide the incident technical analysis in a separate analysis field. Third parties have the ability to add comment and all users may add file attachments or URL links. Records are numbered to identify their origination site and in the case of the Station Log, Resets and electronic Equipment Status records their year of origination.

The ability to extract information from both the DR and the Log record streams offers maintenance users in particular a full chronological history of all recorded incidents and events attributed to an equipment item or group of items. Users can of course also make use of Reset information to further expand on the equipment history. This constantly growing and developing corporate knowledge is thus available in a consistent format that is efficiently retrievable.

WORK FLOWS FOR THE VARIOUS RECORDS

The DRMS uses defined actions linked to roles to "enforce" proper processing of the data contained within it. These processes differ depending on the record type and are described in detail below. There are some "global" actions available to DRs and Logs. Any user may add comment against DR and Log records (there are some notifications in the case of the Station Logs when this occurs) and users may attach files or URL links to these records. The attachment capability enables screen dumps and other graphical or textural material related to the record to be associated with it. Attachments can only be removed by the user who attached them.

DR WORK FLOW

DRs are originated primarily by link operators and shift leaders. The data collected includes required fields Cause, Spacecraft, Antenna, Incident Duration and Description. Additionally available are Assembly, Error Message, Data Outages, and Corrective Action. The originator may temporarily hold the DR (to a maximum of 12 hours), and participate in the closure process by indicating that they want to concur with the closure. The originators are required to concisely and precisely describe the incident / outage detail, what corrective actions were attempted and what outcomes were achieved. They determine the cause and equipment involved to the best of their ability and experience. On origination the notification process commences (except for held DRs).

The originator may modify the DR record or withdraw it prior to any access by the maintenance personnel. Once analysis commences, this action is no longer available to the originator.

The maintenance personnel are expected to provide DR analysis and have several actions available to them:

- Engineer Review
- Engineer Review and Close
- Link to a Master DR (MDR)
- ReAssign Assembly

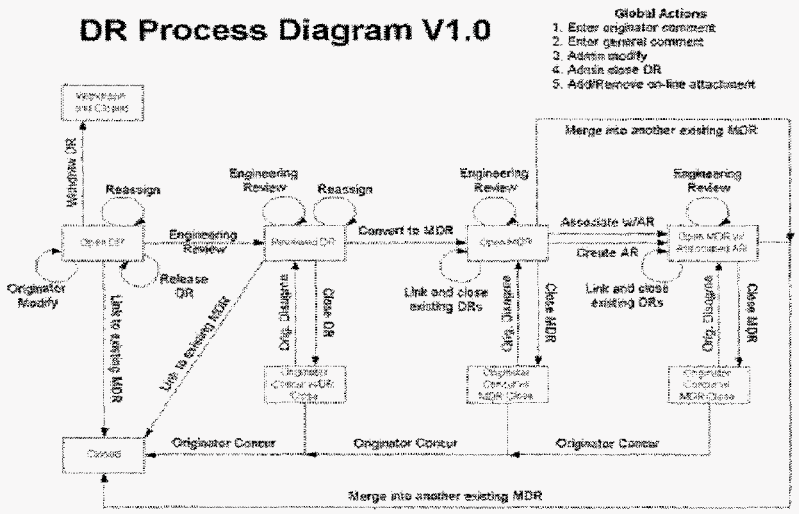
Problems requiring a higher degree of analysis and investigation are commonly initially "reviewed" by the relevant maintenance personnel whilst incidents that are "cut and dried" are reviewed and closed in the one action. The ability to close out an incident as another instance of a problem recorded as a Master DR enables users to see all such instances from the one location as such instances are included in the "parent" Master DR as "child" DRs, (a link from the child to the parent is also established).

The maintenance personnel initially advised of an incident may determine that the true cause is an alternative equipment item and use the ReAsssign action to update the record. The reassignment triggers another notification process (e-mail and TDL) to the maintenance personnel responsible for the updated equipment item.

For DRs with a cause of SW (software), HW (hardware) and UN (unknown), the notification processes continues once the "local" site maintenance personnel have provided their initial reaction/response. The DR record is then brought to the attention of the cognizant development engineer (CDE) and the Operational Engineer, (OE) for the equipment item again via an e-mail and a TDL entry.

The CDE / OE now aware of the incident have the opportunity to add their own input. They can provide advice and assistance to the remote site staff or they may determine that the problem is one that will recur and requires some form of formal action to correct the situation, such as a software fix. In such a scenario the CDE / OE can raise the status of the DR to that of a Master DR. The actual corrective process can then be tracked through the related Automated Anomaly Management System (AAMS). If this path is followed the records within both systems are interlinked allowing users to switch backwards and forwards through either system. The creation of a Master DR results in the MDR being replicated to and thus available to ALL DSN sites to report incident recurrences against. The system is designed in such a way that if a master DR is raised from a DR against one of several similar assemblies (sites commonly have 6 or 8 receivers for example), similar recurrences against these other "like" items can also be linked to the master DR.

Further business logic is applied in respect of incidents where there is no possible intervention, for example incidents caused by weather. In such cases, the record is created but is it automatically closed out. Such incidents do not require the originator to identify an equipment item because in reality the cause affects many assemblies (and being specific in such an instance is not useful) although an antenna is identified.



STATION LOG WORK FLOW

The minimum requirement for a user to generate a Log entry is a simple descriptive text, the author and the origination time are also inserted as part of the record. Typically, such entries are of general interest to the entire site or are of an informational nature. A good example is that each change in tracking schedule received is "logged" to alert site personnel that there has been a change. Extending the functionality of the Log is accomplished by increasing the scope of the content, particularly by the author selecting from equipment and spacecraft pick lists, and "manipulating" defaulting assignees.

Selecting an assembly or antenna / assembly combination from the pick lists automatically places all the site maintenance personnel responsible for that assembly (excluding the author) in the "Inform" field of the Log form as assignees. The author is then able to move the defaulted Inform assignees to the "Action" field – signifying that the author expects that one or more of these assignees to perform an action as a result of the Log entry. Once submitted, the Log entry is created with the "Log Opened" action being the first entry in the Chronological Activity field of the record.

On origination, the notification actions occur. All assignees receive a "View New Log Entry" e-mail and an appropriate entry on their TDL. The TDL process for Action and Inform assignees differs in that once an Inform user views the Log entry, it is removed from their TDL list, whilst the entry remains on the Action assignees TDL until a Log Closure action occurs. In a similar fashion to DRs the originator may make modifications to a Log entry within 2 hours of origination, provided no response has been made.

The next logical action is that the Log entry is received and read by one of the assignees . There are two scenarios dependant on if there are Action assignees:

- If there are no Action assignees then the time that the first Inform assignee views the entry is entered into the chronological activity field as a "Noted" action.
- If there are Action assignees this "Noted" action is entered when the first of the Action assignees reads the entry.

There are a number of next actions possible for a Log entry. The most common is an assignee responds or an assignee responds and closes. In each case a new entry is made in the chronological activity field of the record with suitable headings. The possible options are detailed below

- **An Action assignee user adds comment / response**. This common action results in a "View Log Response from Action Assignee" e-mail is sent to all assignees except the responding user, and their TDLs are updated in a similar manner.

- **An Inform assignee or other (third party) user adds comments to an <u>Open</u> Log entry**. If it is a third party commenting then the third party is added to the Inform assignees. A "View Log Comment" e-mail is sent to all assignees except the responding user, and TDLs are updated accordingly.

- **An Inform assignee or other (third party) user adds comments to a Closed Log entry.** The Log entry is Re-Opened by this action. If it is a third party commenting then the third party is added to the Inform assignees. A "View Log Comment – Log ReOpened" e-mail is sent to all assignees except the responding user, and TDLs are updated accordingly.
- **A user starts a related Log entry.** In the newly created Log entry the usual log Opened chronological activity line is created with the text altered to "Related Log started from Log N###". The log number part of the text is a link to the related Log and the assignees and equipment details are carried forward to the new entry. E-mail and TDL actions for this related log are the same as for any new Log entry. On origination there is a "Started Related Log N### " entry placed in the original Log chronological record, however there are no new e-mail or TDL actions.
- **An Action assignee responds and closes a log entry.** This action is only available to Action assignees (and db administrator). A "View Log – Log Closed" e-mail is sent to all assignees except the responding user and their TDLs are updated in a similar manner.

As mentioned previously informational Log entries do not have these actions. Station Log entries declaring equipment status have additional actions and notifications. For consistency the processes mirror those of the Station Log where possible.

Station Log Example[1]

Comment/Respond Respond/CLOSE Add/Remove Attachment Start Related Log

Log No	**CL021234 (Closed)**	Ops Chiefs Advised: N	
Author	Mark Chatillon	Originated at: 2002 033 22:10	
Antenna	DSS43		
Assembly	UGC – Microwave Group Controller		
Assigned Users			
Action		**Inform**	
Ric Gutierrez	Kevin Piechowski	Basilio Ormeno Alan Robinson	Len Ricardo
Chronological Activity			

Mark Chatillon **Opened Log** at 2002 033 22:10
Please check the Rain Blower as it appears to have no air flow. This was noticed during the VGR2 pass.

Kevin Piechowski Read / Noted at 2002 034 23:12

Kevin Piechowski at 2002 034 23:20
Rain blower will be checked in maintenance period commencing 035 21:00.

Ric Gutierrez at 2002 035 21:52
Blower checked, found intermittent fault with XYZ. Blower left on for continued monitoring.

Ric Gutierrez at 2002 035 21:54
Attachment added: Related Log entry
http://cmmaster2.jpl.nasa.gov/dr/view.asp?no=NL020007

Ric Gutierrez **Log Closed** : 2002 037 23:12
Monitoring completed – blower performing to specifications.

[1] Data displayed in this log is fictional

ELECTRONIC STATUS RECORDS WORK FLOW

Station Logs that declare an equipment status also generate an Electronic Status record. This record is replicated back to the central database to facilitate a global view of equipment at the DSN control center. Effectively, all e-mail notifications and To Do Lists relevant to an items equipment status point to this status record, rather than the Log record that "wraps" the process. The "wrap" Log entries created are automatically updated by status changes effected at the Status record and the normal respond or respond and close actions are not available. Commenting and attachment actions are provided.

A change in an items status, i.e. a change from Red to Orange or Orange to Green for example is treated as the closure of that status. This allows the measurement and tracking of the duration that an item was either out of service (red) or not fully functional / operating at a reduced capability (orange). Managerially, these durations are important to evaluate equipment and personnel performance.

The system performs a daily analysis of the Electronic Status records (at a different time at each site to tie in with their normal working hours) and assesses the ETRO time (Estimated Time of Return to Operation), in each record with the current time. Where an ETRO is within 12 hours of the current time a "reminder" email is sent to the assignees involved, with copies to the originator of the record and the site DRMS system administrator(s). Once the ETRO is passed, a similar "ETRO expired" message is sent until the item's status is updated. This helps manage maintenance technicians' time by suggesting they perhaps re-evaluate their work priorities.

HOW HAS VALIDATION BEEN IMPLEMENTED?

The scope of the industry and the rapid technical changes inherent within it, necessitates that data validation be of a very high order. The output from the system like any other, is subject to the GIGO (garbage in, garbage out) principle. Data must be consistent to instil confidence in the decision makers at the DSN sites. The DRMS approaches validation in a variety of manners.

Naturally there are the standard validations performed at the field level to ensure such things as negative durations or negative data losses do not occur. These are predominantly in the DR records and suitable conflict warning messages are provided to the user who errs against one of these validation rules. Validation is taken past the simply numeric by the implementation of a suitable table schema that provides the capability to validate cause and assemblies, e.g., you cannot write a software cause DR against an assembly that is an item of hardware (and vice versa). Complimenting these validations are ones for those selections that are made less frequently where the system validates "suggestively" by prompting the originator to confirm their selection, and offering potential alternatives. Even some query parameter fields have validation built into them, enhancing query construction.

Aiding the validation built into the system is the context help available which is augmented by the use of links to provide further details of items or acronyms and their place in the hierarchy.

REPORTING & METRICS CAPABILITIES

The reporting capability starts with canned reports that enable users to instantly see recent originations over the last 24, 72, 96 hours, the last 10 days, and since the users last login to the system. By using these canned reports the user is able to quickly catch up with what has occurred in the relevant period. Each of these canned reports / queries displays the DRs, Station Log entries, Equipment Status declarations and Resets. The output can be displayed in either most recent to oldest or the reverse at the users choice. These capabilities are expanded by the ability to select either originations or activities as a basic filter, and by the provision of from / to time fields to allow the user to specify a precise period for their query. This allows personnel to quickly see what took place on the previous shift or during a holiday period.

Capability to query each record type – DRs, Logs, Resets and Equipment Status as well as a combination of the Log and DRs is provided. Important from a managerial standpoint, the capability to filter and extract data is a strong point of the system design. Recognising that there are complex relationships between the equipment items and how the assemblies, subsystems and systems inter-react, special attention has been given to the user interface utilized to extract information. Because of this complexity, the parameters relating to the equipment, sites and antennas is identical in format for all the record type queries. This assists users to be confident in using the parameter queries.

The parameters available for querying are extensive in the case of the main record type (DRs). Whilst the query parameters are not as extensive for other record types (the records themselves are simpler in nature), all components (fields) of a record can be queried. The DR query parameters are summarised in the list below:

Equipment	**"Time" durations**	**Keyword Text Search**	**Other**
Facility	Number range (from-to)	All text fields	Originator
System	Outage period (from-to)	MDR Title	Status
Subsystem	Outage duration (from-to)	Description	Cause
Assembly	Originated date (from-to)	Corrective Action	Phase
Antenna type	Closed date (from-to)	Analysis	Lost data type
Antenna	Pass number (from-to)	Comment	Data category
	Record type		Spacecraft/User
			Error message

Powerful time variables are included for use with most of the time-duration parameters. The variables are $TDY (Today), $FTW / $FLW (first day of this week / last week), $FTM / $FLM (first day of this month / last month), $FTY / $FLY (first day of this year / last year) and $LLG (since time of last login). The user simply enters the desired variable into the relevant field and the variable is interpreted by the system automatically (they are also validated when entered into the field). To further refine these capabilities the user is able to also use offset days from –99 to 365. Thus by selecting $TDY in the origination date with –25 will extract data based on records originated in the past 25 days.

Query output is also comprehensive. The user is able to output in the basic formats of tables with and without borders, Tab delimited and as a chart. The output can have a two dimensional data outage matrix at the group and / or total level. Query output can be grouped by items that grouping makes sense for, and output can be sorted by multiple items. A set of output fields and sort order is defaulted to the user when specifying a query however the user can select the sort and output "fields", and can promote or demote them in precedence. The system cleverly allows the user to update the pick list options by moving rows up or down the lists to alter the sort priority of output position. Ascending and descending sorts are provided.

The user can further format their output by including a report title and if they so wish a report header that provides a simplified SQL version of what has been specified. This plain English header is useful in jogging users memory of how a result set was specified.

Users can save their query specifications which then become listings on that users specific query menu. Queries saved can be edited by the query owner to make minor alterations and these can be saved as the current query or as a new query. By combining the use of time variables with saved queries users can have a "management watch" set of report queries that keep them informed about relevant activities specific to their needs. A user can delete a query at any time. Future plans include the ability for users to "publish" users defined queries so that other users might make use of them should they so wish.

FILE ATTACHMENT AND URL LINKS

The functionality and capacity to store incident related data of the system is enhanced by the ability to attach any form of file to a record (DR or Log) and by being able to also attach or link to a URL. Typically equipment logs and support products such as antenna pointing and telemetry predicts might be attached to assist in the problem evaluation by maintenance. Related records across the system can be linked to each other for example there may be 2 or 3 Log entries that relate to a DR and the user can place URLs to these 2 or three records within the DR record.

Any user can add an attachment to a record; however, only the attaching user can delete the attachment.

UTILITIES

The system contains a broad set of utilities for both the everyday user and the system administrators. In addition to a password change utility, there are the standard lists of assemblies and spacecraft and two sets of personnel lists available to users. Each utility has a search capability to compliment the lists that make use of wildcards to narrow down the result sets returned. The assembly listings also show which site maintenance staff are responsible for the item as well as the cognizant development and operational engineers. The subsystem involved is also available. For spacecraft the flight teams are available with each position identified.

From a user standpoint one of the most useful utilities is the proxy capability. Users can assign their rights and roles to others to allow for ongoing responses during vacation periods etc. A user can assign several persons to act as their proxy. The To Do List (TDL) screen of the person(s) acting as proxy will have the name of the individual(s) who designated them, clicking on that individuals' name will bring up that persons' TDL. The user would then use the utility to act as proxy, choosing who to act for from the list of individuals who designated them. (a user might have proxies from more than one person). Once invoked the user is able to perform all actions for that individual. In each case the historical record clearly indicates that the action was performed by a proxy.

From an administrative point of view the DRMS administrator can use another set of utilities to update the user capability. They can add a new user, update a user's profile allowing the user originate rights, deactivate a departed user and reset a forgotten password. In recognition of the fact that roles change, the administrators can assign roles at the assembly, subsystem or system level to match site requirements. Generally administrators will allocate a role to two persons, a prime and a backup however there is no limitation or restriction in the numbers permitted.

CONCLUSION

Since the introduction of the DRMS, sites have benefited from the availability of data that has been collected and maintained with great integrity. This has led to more efficiency in addressing incidents, more effective communication between the partners resulting in improved outcomes. As time passes and the corporate knowledge contained within the DRMS increases further efficiencies will be achieved.

From a management perspective the DRMS is also used at the Canberra site to assess some components of the performance of the site management contract. The capability to similarly assess performance can also be used by the mission / spacecraft teams to monitor performance.

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MANAGEMENT USING THE DISC
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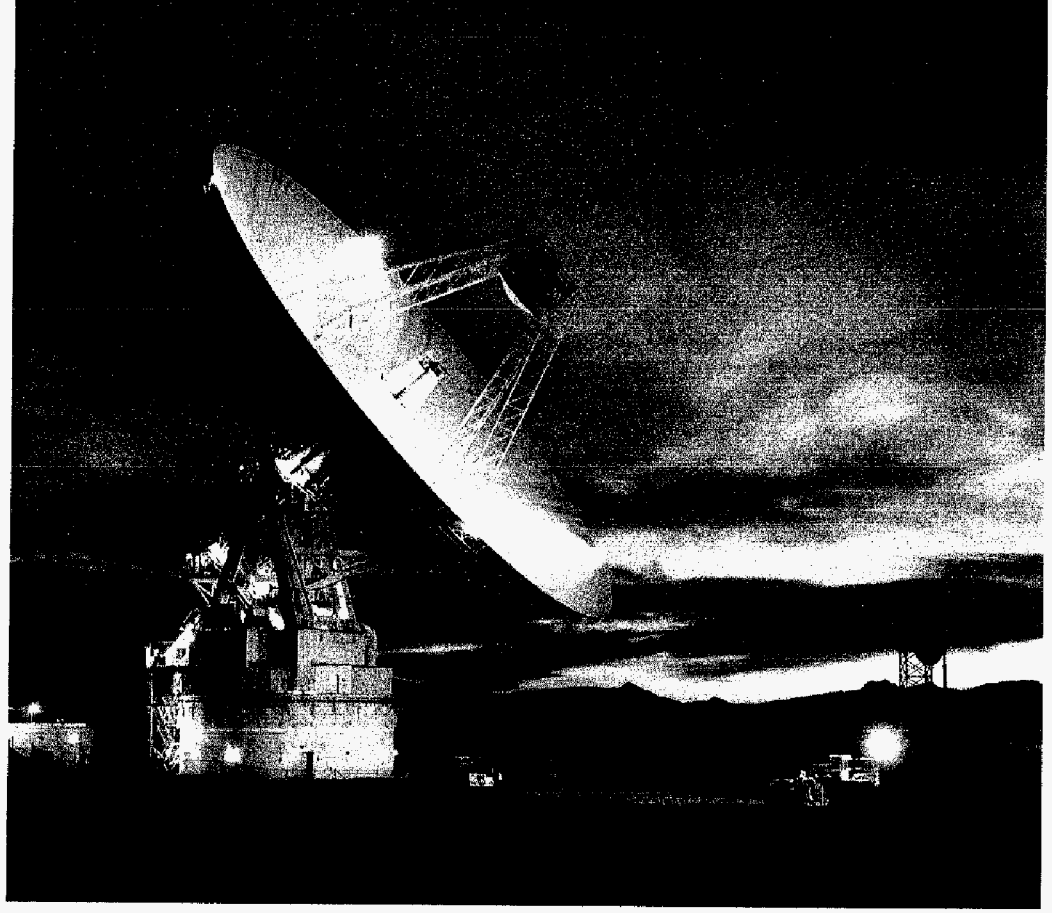

Mark Chatillon, James Lin,
Tonja Cooper

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Introduction

- The Discrepancy Reporting Management System (DRMS) collects, processes, communicates and manages data discrepancies, equipment resets, physical equipment status, and maintains an internal Station Log.
  - Commenced project in 2000, first release June 2001, 4 releases since then.
  - Latest release concentrated on managerial capability – metrics and charting.
- It is a web-based system featuring a distributed database design and replication feature to achieve location specific autonomy, while maintaining high data quality consistency.
- It manages a role-based process of logical actions.

Developers

- Developed by a Deep Space Mission Systems international team residing at the Jet Propulsion Laboratory in Pasadena, California and the Canberra Deep Space Communications Complex in Australia.
- Key Members:
  - James Lin of Chase Computing, System Architect and Programmer.
  - Mark Chatillon of BAE Systems, Process Development and Testing Engineer.
  - Tonja Cooper, DSMS JPL, Team Lead

Widely Distributed User Roles

- Deep Space Network Personnel on 3 continents (at Goldstone, Madrid, and Canberra):
  - Are the principle observers of problems
  - Provide initial engineering review, comment & analysis
  - Undertake site specific managerial analysis, metrics, charting.
- Network Operations & Control Center and JPL in Pasadena:
  - Are the observers of "centralized" problems
  - Provide review and analysis of some specific problems
- JPL Operations Management in Pasadena:
  - Undertake "global" managerial analysis, metrics, statistics and charting.

Basic Utilization

- Record discrepancies (DRs), (a condition that negatively impacts the quantity or quality of committed data or service), relating to:
  - Equipment problems or faults,
  - Spacecraft operations or management,
  - Operational procedures,
  - Other external factors (e.g. weather).
- Recording "Station Log" entries:
  - "Informal" chronological log against equipment and/or spacecraft, or general operational site information.
- Recording equipment status electronically.
- Recording (on a non interference basis) equipment resets.

TOOL SCENARIOS

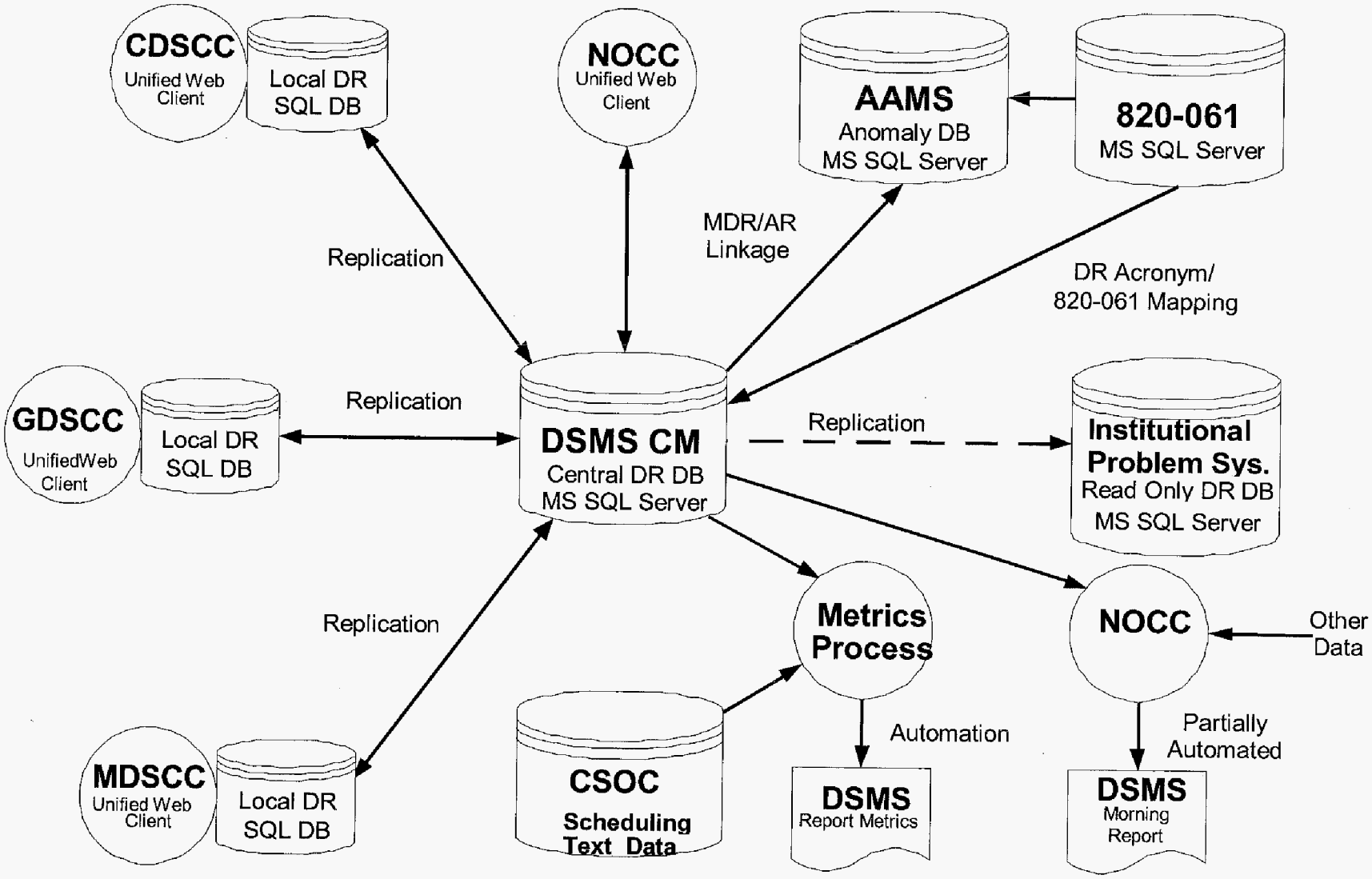
- Problems occurring during a spacecraft track result in a "DR" (Discrepancy Report).
- Observations or comments on, or problems with equipment and/or spacecraft outside of a track, are recorded in the "Station Log".
  - Non equipment related matters may also be entered into the Station Log.
- Unserviceable equipment is "declared":
  - Red (no capability), Orange (not functioning as specified), Blue (out of service) and Green (OK).
- If an item of equipment or software is "reset" we record the instance and circumstances.

REPLICATION

- Most Records (DRs, Resets and Equipment Status) are replicated to JPL, from each of the 3 DSN sites. To Do List and Emails flow between sites as required.
- The pick lists of equipment and spacecraft common to all locations (the same set is used by DR, Log and Resets), replicate to sites from JPL.
- Only limited records are replicated between the DSN sites (Master DRs).
- The Station Log is private to each site and is not replicated.

Discrepancy Reporting Management System

Replication Diagram



BUSINESS RULES - DRs

- Processing of DRs is dependent on cause of the DR and the equipment assembly involved.
- Business Rules control who can perform updates (actions) based on the cause and equipment.
  - Software, hardware, unknown, cause DRs must relate to equipment. The DR is worked by persons responsible for the equipment item involved.
  - Some DR causes are independent of equipment (e.g. weather, low elevation). These close automatically and the system sends out appropriate notifications.
  - Problems attributed to a spacecraft or management thereof are worked by the project support team.
  - Procedural problems are addressed by operations.

BUSINESS RULES – DR ACTIONS

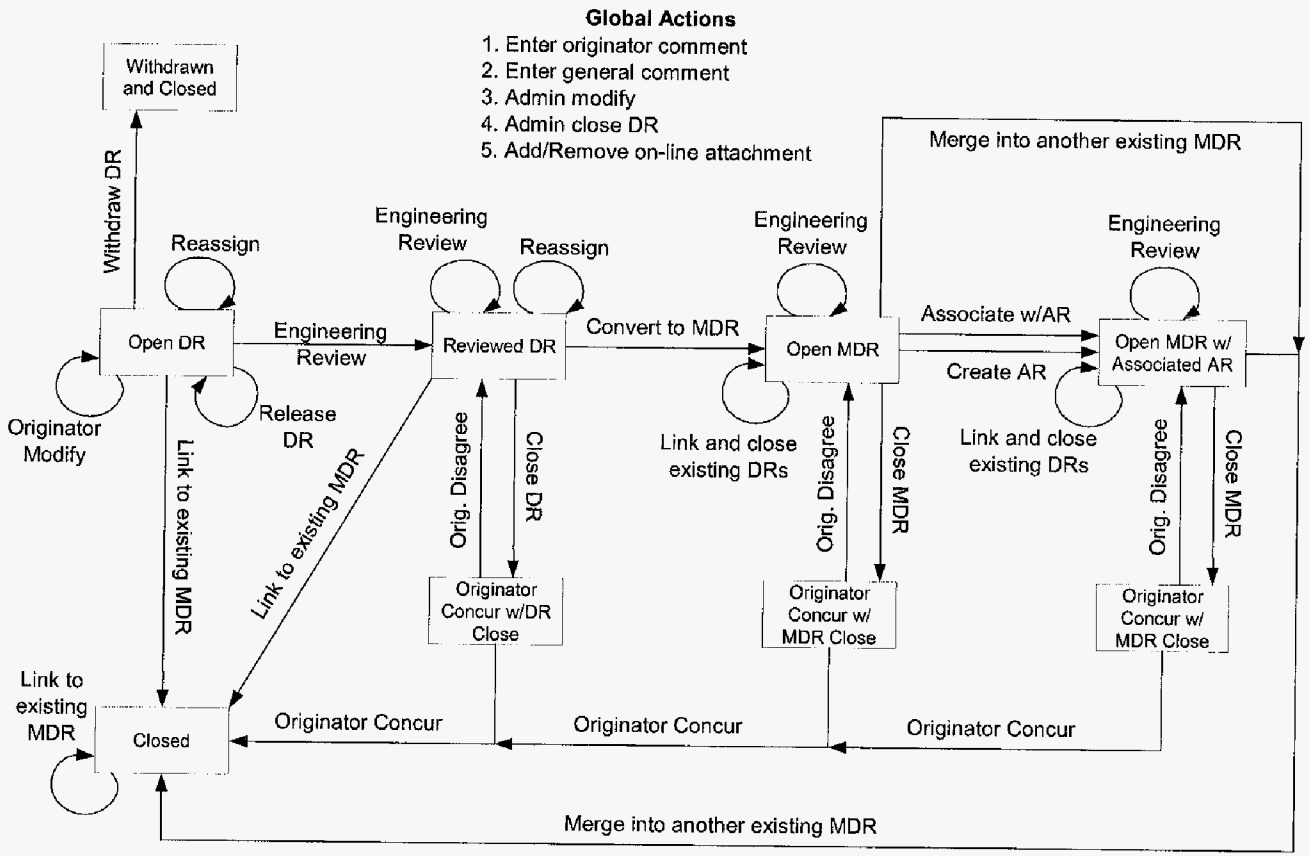
- Business Rules provide the following "Actions" for DRs (and similar for Station Log entries) with roles used to allow/disallow these actions:
  - Originator modify (within limits), hold and release, add originator comment, concur / disagree with closure.
  - Engineer Review, or Engineer Review and Close,
  - Close a DR,
  - Link to a Master DR, or Convert to a Master DR,
  - Re-Assign Assembly / Cause.
- Global Actions include:
  - Enter general comment,
  - Add/Remove on-line attachments and/or URLs.
- Administrative functions are also provided:
  - Users, passwords, roles, equipment availability.

WHO ARE THE USERS AND WHAT ARE THEIR ROLES?

- Problem "Observers" - usually the Antenna Operators at the three complexes:
  - Record incident, attempted corrective action(s) and their outcome(s).
- Problem "Rectifiers" - Maintenance Personnel:
  - Analyze, repair and document the fix.
- Equipment "Design Teams" - generally at JPL Pasadena:
  - Improve product, assist with work-arounds.
- Operational Managers (at each site and JPL):
  - Drive redesign, revised procedures, training, metrics and performance monitoring.

Discrepancy Reporting Management System

Discrepancy Report Process Flow Diagram



DISCREPANCY REPORT - PROBLEM "OBSERVERS"

- "Observers" originate discrepancy records by:
  - Recording details of the incident and any data loss,
  - Detailing the corrective action(s) attempted and their outcome(s),
  - Extracting the Pass Catalogue (set of files containing planned sequence of events, predictions etc) for inclusion with the DR.
- The observer's selection of cause and equipment directs the DR to the correct Maintenance & Installation (M&I) personnel via Email and a user specific To Do List.
  - On logging in, if a user has items on his To Do List the TDL screen is defaulted to the user.

Address http://cdrms/dr/view.asp?dr=C101324&q=1&h=/2&order=D

C101324

View

DR No.

Update

Current Information

Update

DR No.	C101324	Current Status	**Entered**
Current Phase	Open DR		
Originated by	Robert Quick **at**: 2002 161 07:39	Current Owner	Robert Quick
SC/User	M01O - 2001 Mars Odyssey		
Cause	**HW** - Hardware	Pass Number	430
Antenna	**DSS43** (SPC40 - Canberra)	Workorder No.	
Assembly	ASC - Antenna Servo Controller Assembly		
Duration	2002 161 07:09 - 2002 161 07:25 (16 mins)		

	ANG	CMD	DOP1	DOP2	DOP3	MON	RAD	RAS	RNG	RS	SPEC	TLM	VLBI	Mins
LOST	0	0	0	**16**	0	0	0	0	**16**	0	0	**16**	0	**48**
DEG	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	**16**	0	0	0	0	**16**	0	0	**16**	0	**48**

Description	Lost Comms with SRC during no downlink period. Unable to acquire good receiver lock during scheduled downlink.
Corrective Action	Tried SRC reset several times with no success. Also lost comms with ASC. Reset ASC and ACS. Downloaded predicts again and eventually the antenna status improved where SRC position angle looked OK but were not updating. Antenna was again tracking at drive on time however at RTLT, receiver signal was marginal and could not lock the TLM prior to scheduled LOS. SRC declared RED.

Note: Data displayed is fictional for example purposes

Done

Local intranet

DRMS To Do List - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Discrepancy Reporting Management System

Home Login Originate Query To Do List Help Logout Utilities

2002 184 00:36
John Murray

Enter No.

View

DR No.

Update

To Do List

Name: John Murray
Proxies of: Kevin Piechowski

Enter Engineer Review

DR No.	Cause	SC/Usr	DSS	Assembly	Since	Action
C101377	HW	M01O	43	X20KW	175	Update
C101373	HW	CLU1	43	UGC	174	Update
C101371	HW	M01O	43	X20KW	174	Update
C101364	HW	CAS	45	X20KW	171	Update

Station Log

Log No.	DSS	Assembly	Since	Action
CL021676	43	S20KW	177	Update

Home | Originate | Query | To Do List | Log Out

Note: Data displayed is fictional for example purposes

Local intranet

STATION LOGS - INCIDENT "OBSERVERS"

- "Observers" originate Log Entries by:
  - Detailing their comments, often but not always against an equipment item and/or spacecraft.
  - If an equipment item is selected, the personnel assigned the M & I role for that item default as "Inform" assignees (except originator).
  - Originator may move "Inform" assignees to "Action" assignees (requiring a response), and/or choose to inform the Operations Chief.
- Appropriate To Do Lists are updated and Emails are sent.
- Logs can have attachments, are chronological and if "Action" Logs have a closure process.

Document2 - Microsoft Word

File Edit View Insert Format Tools Table Window Help

Comment/Respond Respond/CLOSE Add/Remove Attachment Start Related Log

Log No	**CL021234**	Ops Chiefs Advised: N
Author	Mark Chatillon	Originated at: 2002 033 22:10
Antenna	DSS43	
Assembly	UGC – Microwave Group Controller	

Assigned Users

Action	Inform
Ric Gutierrez Kevin Piechowski	Basilio Ormeno Len Ricardo Alan Robinson

Chronological Activity

Mark Chatillon **Opened Log** at 2002 033 22:10
Please check the Rain Blower as it appears to have no air flow. This was noticed during the VGR2 pass.

Ric Gutierrez at 2002 034 23:12
Noted

Kevin Piechowski at 2002 034 23:20
Rain blower will be checked in maintenance period commencing 035 21:00.

Ric Gutierrez at 2002 035 21:52
Blower checked, found intermittent fault with XYZ. Blower left on for continued monitoring.

Ric Gutierrez at 2002 035 21:54
Attachment added: Related Log entry
http://cmmaster2.jpl.nasa.gov/dr/view.asp?no=NL020007

Ric Gutierrez **Log Closed** : 2002 037 23:12
Monitoring completed – blower performing to specifications.

Note: Data displayed is fictional for example purposes

Page 1 Sec 1 1/1 At 2.5cm Ln 1 Col 53 REC TRK EXT OVR

RECORDING EQUIPMENT STATUS

- "Observers" post equipment status by:
  - Declaring an system or items status as red, orange, blue or green through a Station Log entry.
- A separate "linked" status record is created and replicated to Network Control at JPL.
- At Network Control the Operations Chiefs can view all sites equipment status and take action regarding upcoming passes as required.
- Equipment status metrics are available as an aid to M&I and design engineering.
- Users may update status to logical outcomes.
  - Creates a status transition record showing history.

DRMS Electronic Status Board - Microsoft Internet Explorer

File Edit View Favorites Tools Help

2002 184 01:44
Mark Chatillon

Electronic Status Board

by Condition by DSS

Enter No.

View

DR No.

Update

All Sites GDSCC CDSCC MDSCC

All Sites by Condition

Note: Data displayed is fictional for example purposes

Site	DSS	Assm.	Text	Log#	St Time	ETRO	Action
G	14	TWM-SP	Declared Red. LNA warmed up after station pow	GL020335	183 01:00	184 23:00	
G	14	UPS	Declared Red. Oscillations when under a load.	GL020336	182 01:00	185 23:00	
G	14	ZZZ	DECLARED RED : Pure water storage at DSS 14 i	GL020327	351 18:58	189 23:00	
G	27	UPS	Declared Red. Needs batteries replaced.	GL020337	182 01:00	183 23:00	
M	63	HEMT-X	DECLARED RED : Due to cooldown	ML020258	183 15.08	184 15:30	
M	63	MEC	DECLARED RED : MEC Red. Unable to track in P	ML020255	172 15:30	185 12:00	
G	14	TSA2	Ref: [GL020161] - Declared ORANGE : ETRO upda	GL020329	086 19:00	189 23:00	
G	14	X20KW	Ref: [GL020280] - Declared ORANGE : Channels	GL020330	161 03:30	189 23:00	
G	15	ACS	Declared Orange. Loss of interface intermitte	GL020331	161 18:00	189 23:00	
G	15	HEMT-X	Ref: [GL020323] - Declared Orange : LNA chang	GL020328	179 23:00	183 23:00	
G	16	TIZRP	Ref: [GL020270] - Declared Orange. : Current	GL020333	144 23:00	189 23:00	
G	25	KS00W	Ref: [GL020324] - Declared Orange : ETRO upda	GL020326	174 02:00	185 23:00	
G	27	ASD	Declared Orange. Azimuth drive rate set to .8	GL020334	118 12:00	189 23:00	

Done

Internet

RECORDING EQUIPMENT RESETS

- "Observers" record equipment resets by:
  - Recording the details of the equipment that has been reset on a non interference basis.
- There are no enforced reset actions however the originator may also choose to originate a Log entry with assignees from the reset screen should they so wish.
  - This enables them to direct the "Reset" to the attention of selected individuals.
- Equipment designers "CDE/OE" (Cognizant Design Engineer / Operational Engineer) can access global and selected reset data.

DRMS View - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address http://cdms/dr/view.asp?reset=CR020762&q=1&h=72&order=D

Links »

Discrepancy Reporting Management System

Home Login Originate Query To Do List Help Logout Utilities

2002 163 01:35
Mark Chatillon

Enter No.
CR020762

View

DR No.

Update

View Reset

☑ Preserve Text Format ☑ Form Style Refresh

Reset No.	CR020762
Initiator	Robert Quick Recorded at: 2002 161 08:56
Antenna	DSS43 (SPC40 - Canberra)
SC/User	M01O - 2001 Mars Odyssey
Assembly	APA1 - Antenna Pointing Assembly 1*
Tracking Phase	P - During Pass / Other
Number of Reset	3

Home | Originate | Query | To Do List | Log Out

Note: Data displayed is fictional for example purposes

Done

Local intranet

PROBLEM "RECTIFIERS" - DRs

- "Rectifiers" – M&I personnel detail DR incident progress (where applicable – i.e. not automatically closed) by:
  - Entering incident analysis, any repair or fix activity,
  - They may allocate the incident to a different cause and/or equipment item (redirects it to relevant M&I team),
  - They may "Review & Close" the DR or may review and leave it open pending further investigation.
- Once they have entered initial analysis, CDE/OE are advised of the incident and initial local "reaction" via their To Do List and Email.

SITE M&I SEEK DESIGN ENGINEER'S INPUT

- Site M&I personnel may invite CDE/OE to become more involved in a DR by:
  - If the problem is consistently repetitive, requesting that a Master DR is created.
  - Requesting input, comment or assistance from them into the record,
- Master DRs are replicated back out to all sites and subsequently:
  - M&I personnel can then close out repeat instances to the Master DR.
    - Records are linked to/from the Master DR
    - Repeat instances are flagged to the "design engineers".

DESIGN AND OPERATIONAL ENGINEER TEAM

- Equipment "Design Teams" at JPL Pasadena:
  - Are kept fully informed of pertinent equipment information and this data should assist them to improve the product, assist with work-arounds,
  - Can link Master DRs with a known anomaly in the Anomaly Management System (active link to/from) OR create a new anomaly from within the DRMS system,
    - AAMS manages and records the corrective processes
      - Acceptance of problem,
      - Redesign, reworking, recoding,
      - Testing,
      - Implementation, and
      - Closure

OPERATIONAL AND SITE MANAGERS

- Operational, Engineering and Site Managers:
  - Assess the wide range of data, utilizing it to manage their operations,
  - Identify trends in performance and activity,
  - Monitor performance over time (and across sites) to,
    - Direct and focus resources, (personnel and physical) to better address the problems,
    - Target training to improve the outcomes and aim for best practice,
    - Provide site input to centralized management at the planning and budgetary level.

THE POWER OF THE QUERY CAPABILITY…

- The "Canned" queries provided:
  - Originations (or activities) in last:
    - 24 hours,
    - 72 hours,
    - 96 hours,
    - 10 days, or
    - SLL (since the users last login).
  - Daily Morning Report (with daylight saving option)
  - Current Equipment Status **
  - Monthly Statistics **

  - ** - restricted to eligible users

THE POWER OF THE QUERY CAPABILITY…

- Users can create "User defined" queries
  - Query DRs,
  - Query Station Log,
  - Query DR & Station Log (chronological events),
    - Based on common data items in each record type.
  - Query Resets,
  - Query Equipment Status.
- Users can "Save", and "Edit" owned Queries.
- Set of time variables available.
  - $FT & $FL Week, Month, Year, $ToDaY, +/- days
- Query output formats include tables, with / without border, tab delimited and charting.

QUERY OUTPUT CAPABILITY...

DRMS Query DR - Microsoft Internet Explorer

File Edit View Favorites Tools Help

2002 164 06:13
Mark Chatillon

Query DR

Query Equip. Status | Query Log | Query DR+Log | Query Reset

Enter No.

View

DR No.

Update

The Query Selections below operate on the Boolean **AND** principle. Take care with your choices.

Facility
- (ALL)
- NOCC
- SPC10 - Goldstone
- SPC40 - Canberra
- SPC60 - Madrid

System
- (ALL)
- ANT - Antenna
- CMD - Command
- COMM - Communications
- DTT - Downlink

Sub-System
- (ALL)
- AIS - Admin Information Services Infrastructure
- ANT - Antenna Control (Multi Antenna)
- ANT11 - 11M Antenna
- ANT26 - 26M Antenna

Assembly
- (ALL)
- AAC - Antenna Air Conditioning
- ABC - Aberration Correction Assembly
- ACC - Antenna Control Console
- ACG - Air Condition Group

Antenna Type
- (ALL)
- 11 - 11 Metre
- 26 - 26 Metre
- 34B - 34M BWG
- 34H - 34M HEF

Antenna
- (ALL)
- 00 - NOCC
- 12 - SPC10
- 14 - SPC10
- 15 - SPC10

Search For ◉ All ○ MDRs ○ MDRs w/ARs ○ DRs

DR Number Between
From To

Outage Period UTC Time (Year, DOY, Hour, Minute)
From
To

Outage Duration (minutes)
From To

DR Originated Date UTC Time (Year, DOY)
From $FLW 3 To $FLW 9

Search Keyword in All Text Fields

Search Keyword in MDR Title

Search Keyword in Description

Search Keyword in Corrective Action

Search Keyword in Analysis

Done | Local intranet

QUERY OUTPUT CAPABILITY...

DRMS Query DR - Microsoft Internet Explorer

File Edit View Favorites Tools Help Links

Originator
- (ALL)
- MDSCC-CrewA
- MDSCC-CrewB
- MDSCC-CrewC
- MDSCC-CrewD

DR Status
- (ALL)
- Entered
- Reviewed
- Closed
- Withdrawn

Current Phase
- (ALL)
- Origination
- Open DR
- Reviewed DR
- Originator Concur w/DR Closure

Cause
- (ALL)
- SW - Software
- HW - Hardware
- UN - Unknown
- P2 - Procedural 2

Lost Data Type
- (ALL)
- TLM - Telemetry
- CMD - Command
- DOP1 - Doppler 1
- DOP2 - Doppler 2

Data Category
- (ALL)
- Recoverable
- Degraded
- Not Recoverable

SC/User
- (ALL)
- ABRX - ABRIXAS
- ACE - Advanced Composition Explorer
- ACRIMSAT - Active Cavity Radiometer Irradiance Monitor Sat.
- AFRI - Afristar

Error Message
- (ALL)
- BVR - 012 - FAILED TO CONNECT TO xxx
- BVR - 014 - xxx COMMUNICATION DOWN
- BVR - 016 - UNEXPECTED CONNECTION FROM xxx
- BVR - 017 - DUPLICATE CONNECTION FROM xxx

Output Option

Type of Output
- Table with Border
- Table w/o Border
- Tab Delimited

Max Rows (Default=1000)
1000

☐ Show Group 2D Outage Matrix
☑ Show Total 2D Outage Matrix

Group By
- (None)
- Facility
- Assembly
- Cause
- SC/User
- DSS ID
- DR Status
- Originator
- Error Message

Sort By
- DR Status
- Facility
- Cause
- SC/User
- Assembly
- DSS ID
- Outage Start Time
- Outage End Time
- Error Message
- Originator

Display
- DR Number
- Date Originated
- DR Status
- SC/User
- Assembly
- DSS ID
- Cause
- Description
- Corrective Action
- Analysis

A/D | Up | Down | A/D | Up | Down

Done | Local intranet

Discrepancy Reporting Management System

QUERY OUTPUT CAPABILITY...

DRMS Query DR Result - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Mark Chatillon

Query DR

Query DR | Query E. Status | Query Log | Query DR+Log | Query

Reset

Enter No.

View

DR No.

Update

Weekly DRs / with Matrix

Note: Data displayed is fictional for example purposes

Report Date: **2002 164 04:30** Total Records Found: **4**

DSS ID: 45

DR No.	Orig. Date	SC/Usr	Assm.	Description
C101319	2002 158 18:06	VGR2		Loss of TLM due to heavy rain. Four instances, 0952 to 0958, 1012 to 1052, 1140 to 1145 and 1214 to 1253.
C101329	2002 163 08:41	VGR2	RCP1	Unable to lock receivers. Receivers would not acquire using selected predict subset (1way).
C101330	2002 163 15:36	VGR2		Heavy Rain caused TLM to drop lock. AGC=-170, rcv ssnr=-7
C101331	2002 163 20:18	VGR2	TGC3	Lost telemetry lock due to heavy rain.

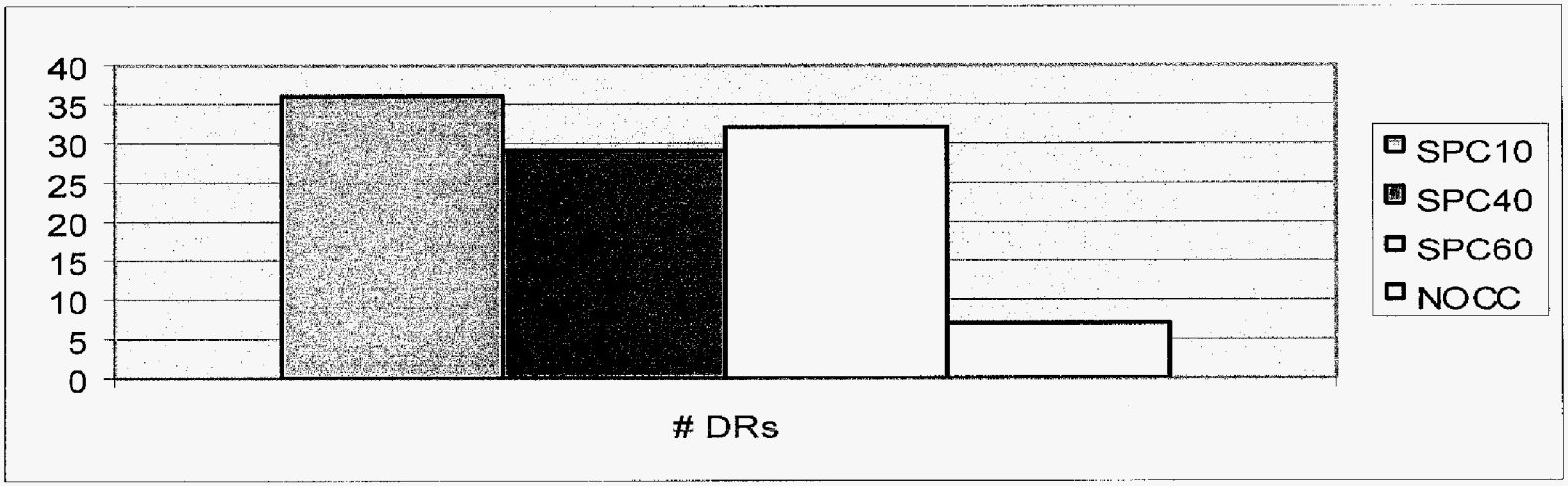
Subtotal: 4

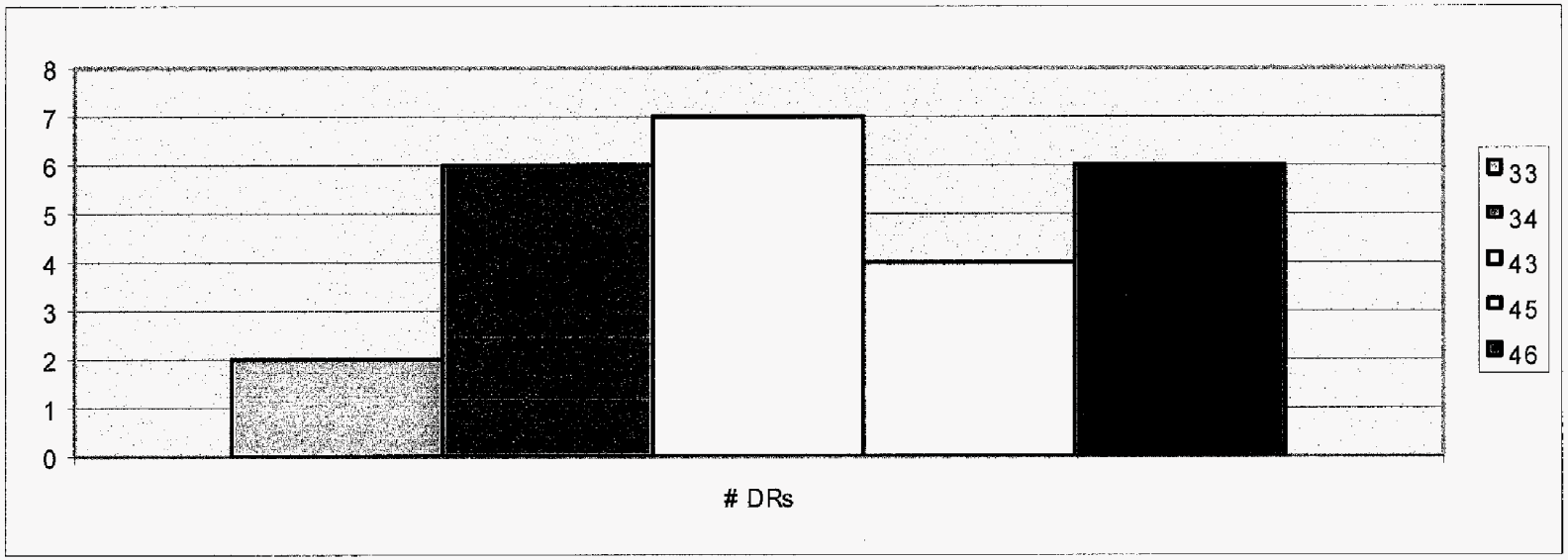
Total Number of Records Listed: 4

	ANG	CMD	DOP1	DOP2	DOP3	MON	RAD	RAS	RNG	RS	SPEC	TLM	VLBI	Mins
LOST	0	0	**6**	0	0	0	0	0	0	0	0	**158**	0	**164**
DEG	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	**6**	0	0	0	0	0	0	0	0	**158**	0	164

Local intranet

CHARTING POWER AND CAPABILITY...





Note: Data displayed is fictional for example purposes

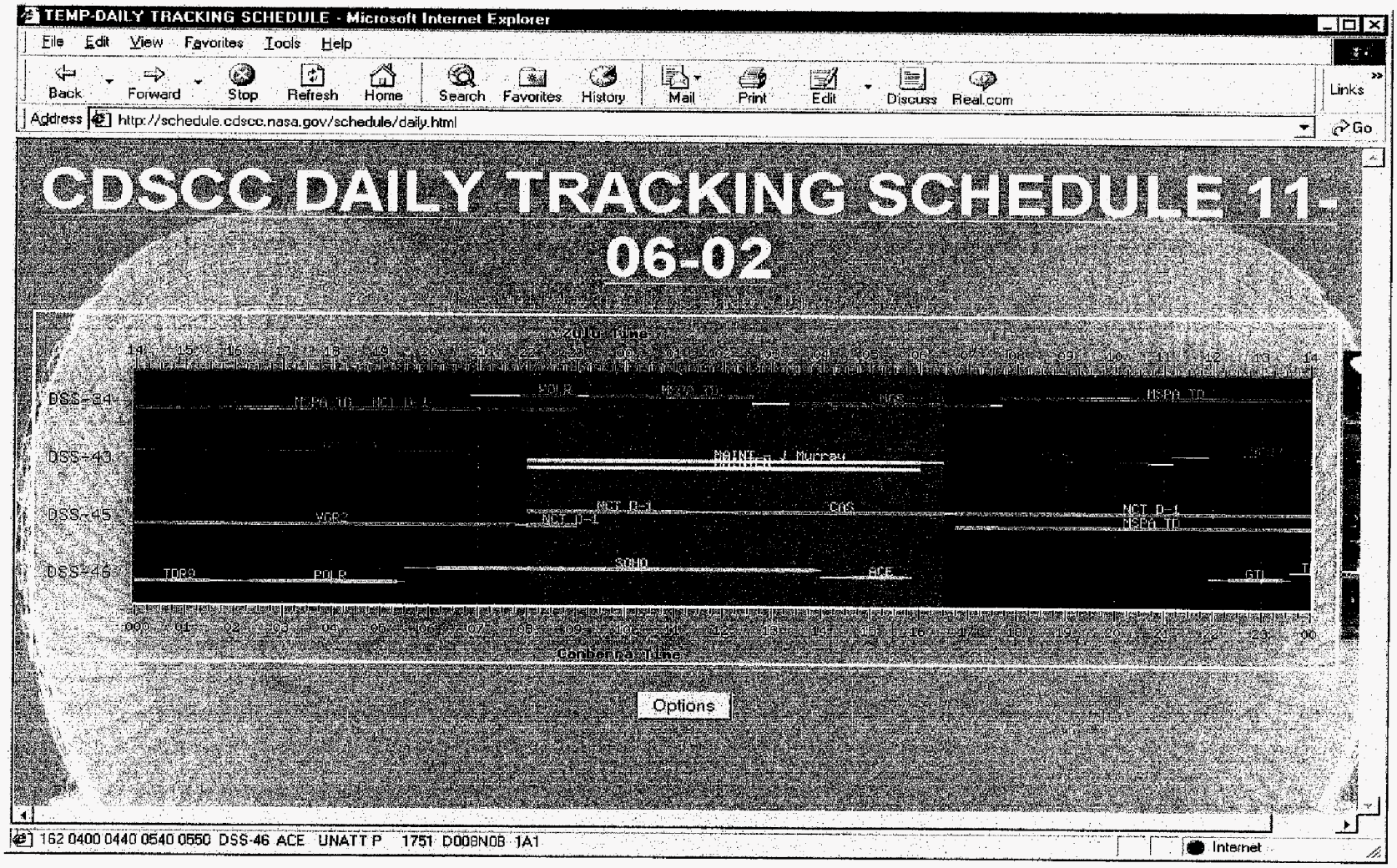
THE TOOL SOFTWARE ENVIRONMENT…

- Web browser interface
  - IE 5 and later Netscape – remote scripting for IE users
  - The system utilizes the web (ASP/IIS) and database (SQL Server 2000) technology from Microsoft.
  - HTML w/JavaScript,
  - Microsoft Visual Basic Scripting Edition
  - Other tools include:
    - Persists ASPEmail
    - SoftArtisans SA-File Up
    - Opalis Robot
- Hardware
  - Dual Compaq 8500 8X550 CPU/4G/100G (central)
  - Dual Compaq ML750 933 CPU/256M/18G (sites)

THE FUTURE...

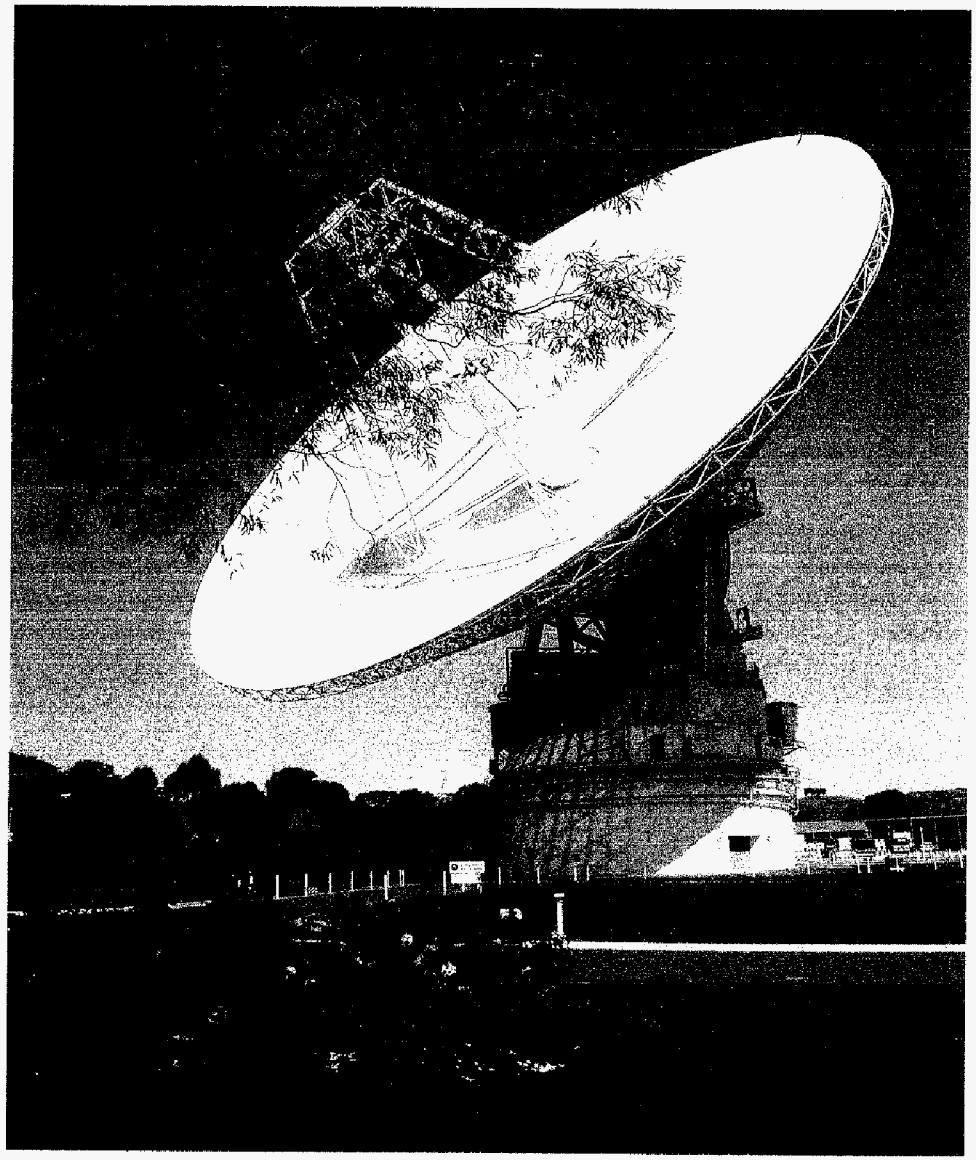
- Future planned major developments include:
  - Interface with scheduling to provide:
    - A graphic depiction of scheduled tracking including the ability for M&I staff to "reserve" maintenance time.
      - This is available at CDSCC already.
    - Increased assistance to originators to ensure DR data is consistent with items actually in use for a pass.
  - Automated interface with Pass Tracking Logs:
    - Use spacecraft, pass, antenna, time fields to query the Log file server retrieving complete Logs of a track as an aid to investigation.
  - Provide interactive link to and compatibility to Maximo preventative maintenance system.

SCHEDULE GRAPHIC…



The End

- DSS43 the 70M dish at Canberra, DSS46 in the background.
- Thank you for your attendance.
- Any questions?



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