Some Data Relationships Among Diverse Areas of the DSN and JPL

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A logical-level data model is used to represent real-world relationships among diverse areas of the Deep Space Network (DSN) and non-DSN areas. The possibility for reduction of data redundancy is addressed.

I. Introduction

Section 377 (Deep Space Network Support) maintains an operational database containing data for managing equipment used in Deep Space Network operations. The types of data maintained are: description, identification, location and several kinds of status including data on failures, modifications and shipments. During the past few years, work conducted on the database has revealed and emphasized the existence of relationships in the data domain among diverse elements of the DSN and JPL.

II. Data Relationships

This article presents a cursory analysis of some of the data relationships that exist among various DSN (and JPL, non-DSN) activities. The data elements used in this article are representative of existing real-world attributes. Data element sets, representing existing real-world entities, are presented in this article in the form of third-normal-form relations (defined in Ref. 1). The relations and data elements are not necessarily used as-is in existing databases, rather the intent of these representations is to show the existence of real relationships in the data domain; hence the possibility for communication and coordination among the databases of apparently diverse organizations. The lists of data elements and relations are not exhaustive.

Seven separate functions in the DSN and two non-DSN functions are represented by collections of relations to illustrate interrelationships within and beyond the bounds of the DSN.

Table 1 lists all the data elements used in this article and defines each, as used in the article. Tables 2 through 10 depict relations applicable to the functions indicated by the table titles. Each table may be viewed as a separate, limited logical database or the entire collection may be viewed as representative of a larger, global logical database.

Within each table can be seen one or more data elements used repeatedly, as common keys, among the relations. These common keys provide logical links among *relations*. Were these relations properly established in a database, a user could make use of the existence of the common keys to produce useful information. For instance, using relations 3 and 27 with CON NUMBER as a common key a user could determine the location of an item of equipment with a specific JPL Property

Number *or* he could obtain a listing of all property-controlled equipment at a given location.

Similar logical links exist among *tables* (therefore, between JPL activities). For instance, CON NUMBER is common to Tables 2, 6 and 7; JPL DWG is common to Tables 2, 3, 7 and 4 (where DOCUMENT is equivalent to JPL DWG). As a final example of the existence of logical links: If the relations were integrated in a database, the location of all equipment authorized under a given ADP (Automatic Data Processing) Plan could be determined; using ADP ID as an access key in relation 98; using PO NUMBER as a common key between relations 98 and 1; using CON NUMBER as a common key between relations 1 and 3; deriving resultant location data from LOCATION in relation 3. Casual inspection will reveal other, similar relationships.

III. Redundancies

It is interesting to note the amount of redundancy that exists throughout Tables 2 through 10. By integrating all 99 of the relations in Tables 2 through 10, 26 duplicate relations may be deleted. An additional 7 relations may be removed because of the existence of multiple inferred relationships. This amounts to approximately 33 percent reduction in redundancy as a result of integrating the diverse data sets. This is probably typical of the degree of reduction that could be achieved in an actual integration.

Reference

1. Date, C. J., *An Introduction to Database Systems*, Addison-Wesley Publishing Company, Inc., Reading, Mass., 1975.

Table 1. Definitions of data elements used in tables 2 through 10

DATA ELEMENT NAME	DATA ELEMENT DEFINITION
1-ACCEPTANCE	ACCEPTANCE STATUS OF ECO FIRST INSTALLATION
2-ACQ DATE	DATE ON WHICH PROPERTY WAS ACQUIRED BY JPL
3-ADDRESS	ADDRESS OF A MANUFACTURER
4-ADP ID	ADP PLAN IDENTIFICATION
5-APPLIC FAC	FACILITY TO WHICH AN ENGINEERING CHANGE IS APPLICABLE
6-CATEGORY	USAGE CATEGORY OF EQUIPMENT
7-CDE	COGNIZANT DEVELOPMENT ENGINEER
8-CERT STATUS	EMPLOYEE QA TRAINING STATUS
9-CERT SUBJECT	SUBJECT IN WHICH AN EMPLOYEE IS CERTIFIED
10-COE REC DATE	DATE ON WHICH A COE RECEIVED AN ECO KIT
11-COE SHIP DATE	DATE ON WHICH A COE SHIPPED AN ECO KIT
12-COE	COGNIZANT OPERATIONS ENGINEER
13-CON NUMBER	DSN EQUIPMENT CONTROL NUMBER
14-COST	COST OF AN ITEM
15-CSE	COGNIZANT SUSTAINING ENGINEER
16-DATE FUNCTIONAL	DATE ON WHICH MODIFIED EQUIPMENT IS FUNCTIONAL
17-DATE	DATE OF AN EVENT OR CONDITION
18-DELEGATION	FACILITY TO WHICH EQUIPMENT MAINTENANCE IS DELEGATED
19-DESCRIPTION	DESCRIPTION OF AN ITEM
20-DESIGN FINISH	DATE THAT ECO DESIGN IS FINISHED
21-DEST FAC	FACILITY TO WHICH AN ITEM IS BEING SHIPPED
22-DISCREPANCY	DISCREPANCY DISCOVERED DURING INSPECTION
23-DISPOSITION	FINAL DISPOSITION OF MATERIAL AFTER INSPECTION
24-DOCUMENT	CONTROLLING IDENTIFICATION OF A DOCUMENT
25-DUE DATE	DATE ON WHICH AN EVENT OR CONDITION IS DUE
26-EC COST	ESTIMATED TOTAL COST TO IMPLEMENT AN ECO
27-EC EXCEPTION	EXCEPTION TO AN ECO FIRST INSTALLATION
28-EC STATUS	EC STATUS OF AN ITEM OF EQUIPMENT
29-ECI	ENGINEERING CHANGE INSTRUCTION
30-ECO	ENGINEERING CHANGE ORDER
31-ECR	ENGINEERING CHANGE REQUEST
32-EMP NUMBER	JPL EMPLOYEE NUMBER
33-EMP ORGANIZATION	NUMERIC DIVISION-SECTION IDENTIFIER
34-EST DESIGN FINISH	ESTIMATED ECO DESIGN FINISH DATE
35-EST FAB FINISH	ESTIMATED ECO FABRICATION FINISH DATE
36-FAB FINISH	DATE THAT ECO FABRICATION IS FINISHED
37-FAC COMP DATE	DATE OF ECO COMPLETION AT A FACILITY
38-FAC EST COMP	ESTIMATED DATE OF ECO COMPLETION AT A FACILITY
39-FAC REC DATE	DATE OF ECO KIT RECEIPT AT A FACILITY
40-FACILITY	DSN OPERATIONAL OR SUPPORT FACILITY
41-FAIL DATE	DATE OF EQUIPMENT FAILURE
42-FAIL TIME	TIME OF EQUIPMENT FAILURE
43-ICE	IMPLEMENTATION COORDINATION ENGINEER
44-INSP DATE	DATE ON WHICH AN INSPECTION WAS COMPLETED
45-INSP NUMBER	UNIQUE NUMBER ASSIGNED TO AN INSPECTION ACTIVITY
46-INSP STATUS	STATUS OF AN INSPECTION

Table 1 (contd)

47-INSP TYPE	TYPE OF INSPECTION
48-ISSUE UNIT	UNIT OF ISSUE FROM SUPPLY
49-JPL DWG	JPL DRAWING NUMBER
50-LANGUAGE	NAME OF A PROGRAMMING LANGUAGE
51-LEAD TIME	LEAD TIME FOR RECEIPT OF MATERIAL AFTER ORDER
52-LOCATION	DSN OPERATIONAL OR SUPPORT FACILITY
53-MA NAME	NAME OF A MAJOR ASSEMBLY
54-MFR	MANUFACTURER
55-MODEL	MODEL IDENTIFICATION
56-NAME	NAME OF A MANUFACTURER
57-NOMENCLATURE	DESCRIPTIVE EQUIPMENT NAME
58-NSE	NETWORK SYSTEMS ENGINEER
59-NSN	NATIONAL STOCK NUMBER
60-OPSTAT	OPERATIONAL STATUS OF EQUIPMENT
61-OWNER	FACILITY TO WHICH EQUIPMENT IS ASSIGNED
62-PART NUMBER	MANUFACTURER'S PART NUMBER
63-PO NUMBER	PURCHASE ORDER NUMBER
64-PRIORITY	PRIORITY OF AN ENGINEERING CHANGE ASSESSMENT
65-PROCEDURE	CONTROLLING IDENTIFICATION OF A PROCEDURE
66-PROGRAM	CONTROLLING IDENTIFICATION OF A COMPUTER PROGRAM
67-PROJECT	FLIGHT PROJECT
68-PROP NUMBER	JPL PROPERTY NUMBER
69-QUANTITY	QUANTITY OF SPARES REQUIRED
70-RACK	SUBSYSTEM RACK IDENTIFIER
71-REC DATE	DATE OF RECEIPT AT A FACILITY
72-REF DES	SUBSYSTEM REFERENCE DESIGNATOR
73-REFER TO	PARTY TO WHICH AN ECR IS REFERRED FOR REVIEW
74-RELEASE DATE	DOCUMENT OR PROGRAM RELEASE DATE
75-REPAIR TIME	TIME EXPENDED IN REPAIRING AN ITEM
76-REQ COMP DATE	REQUIRED COMPLETION DATE
77-REVISION	REVISION LETTER OF A JPL DRAWING
78-SCOE	SYSTEM COGNIZANT OPERATIONS ENGINEER
79-SERIAL NUMBER	MANUFACTURER'S EQUIPMENT SERIAL NUMBER
80-SERVICE DATE	DATE ON WHICH EQUIPMENT WAS SERVICED
81-SERVICE FAC	FACILITY THAT PERFORMED SERVICE ON EQUIPMENT
82-SERVICE INTERVAL	PRESCRIBED TIME INTERVAL BETWEEN SERVICES
83-SHIP DATE	DATE OF SHIPMENT
84-SHIP FAC	FACILITY THAT SHIPPED AN ITEM
85-SS NAME	SUBSYSTEM NAME
86-SSE	SUBSYSTEM ENGINEER
87-SSMA	SUBSYSTEM-MAJOR ASSEMBLY CODE
88-STADIR	STATION DIRECTOR
89-SUBSYSTEM	SUBSYSTEM CODE
90-SYSTEM NAME	SYSTEM NAME
91-SYSTEM	SYSTEM CODE
92-TA EXCEPTION	TRANSFER AGREEMENT EXCEPTION
93-TA STATUS	TRANSFER AGREEMENT STATUS
94-TEST TIME	TIME EXPENDED IN TESTING AN ITEM
95-TITLE	TITLE OF A DOCUMENT OR COMPUTER PROGRAM
96-VENDOR	NAME OF AN EQUIPMENT VENDOR

Table 2. Examples of relations pertinent to DSN operations

	RELATION NAME	DATA ELEMENTS
1)	ACQUISITION	(CON NUMBER,COST,PO NUMBER,ACQ DATE)
2)	AS DESIGNED	(FACILITY,SSMA,RACK,REF DES,NSN)
3)	ASSIGNMENT	(CON NUMBER,OWNER,LOCATION,OPSTAT,REC DATE)
4)	CDE	(SSMA,CDE)
5)	COE	(SSMA,COE)
6)	CSE	(SSMA,CSE)
7)	DELEGATION	(NSN,SERVICE INTERVAL,DELEGATION,PROCEDURE)
8)	DESCRIPTION	(CON NUMBER,NSN,CATEGORY)
9)	EC APPLICABILITY	(ECO,APPLIC FAC,SSMA,REQ COMP DATE)
10)	EC COST EST	(ECO,EC COST)
11)	EC DESCRIPTION	(ECR,DESCRIPTION)
12)	EC EXCEPTION	(ECO,FACILITY,EC EXCEPTION)
13)	EC PROCEDURE	(ECO,PROCEDURE)
14)	ECI	(ECI,JPL DWG)
15)	ECO DWG	(ECO,JPL DWG)
16)	ECO ECI	(ECO,ECI)
17)	ECO MILESTONES	(ECO,COE REC DATE,COE SHIP DATE,DEST FAC,FAC REC DATE FAC EST COMP,DATE FUNCTIONAL,FAC COMP DATE)
18)	ECO EQUIPMENT	(CON NUMBER,ECO,EC STATUS)
19)	ECR OPEN	(ECR,DATE,PRIORITY)
20)	ENROUTE	(CON NUMBER,SHIP DATE,SHIP FAC,DEST FAC)
21)	FAILURE	(CON NUMBER,FAIL DATE,FAIL TIME,FACILITY)
22)	FIRST INST	(ECO,DATE,ACCEPTANCE)
23)	IMPLEMENTATION ENG	(FACILITY,ICE)
24)	MAJOR ASSEMBLY ID	(SSMA,MA NAME)
25)	MANUFACTURER	(MFR,NAME,ADDRESS)
26)	NSN	(NSN,MFR,MODEL,JPL DWG)
27)	PROPERTY	(CON NUMBER,PROP NUMBER)
28)	REFER ECR	(ECR,REFER TO)
29)	SERVICE DUE	(CON NUMBER,DUE DATE)
30)	SERVICE HISTORY	(CON NUMBER,SERVICE DATE,SERVICE FAC,TEST TIME, REPAIR TIME)
31)	SPARES REQ	(NSN,QUANTITY,FACILITY)
32)	SSE	(SUBSYSTEM,SSE)
33)	STATION DIRECTOR	(FACILITY,STADIR)
34)	SUBSYST COORD	(FACILITY,SSMA,RACK,REF DES,CON NUMBER)
35)	SUBSYSTEM ID	(SUBSYSTEM,SS NAME)
36)	SYST TA STATUS	(SYSTEM,TA STATUS)
37)	SYSTEM CDE	(SYSTEM,SCDE)
38)	SYSTEM ENGINEER	(SYSTEM,NSE)
39)	SYSTEM ID	(SYSTEM,SYSTEM NAME)
40)	TA EXCEPTIONS	(SSMA,TA EXCEPTION)
41)	TA STATUS	(SSMA,FACILITY,TA STATUS)

Table 3. Examples of relations pertinent to DSN engineering change management

	RELATION NAME	DATA ELEMENTS
42)	EC APPLICABILITY	(ECO,APPLIC FAC,SSMA,REQ COMP DATE)
43)	EC COST EST	(ECO,EC COST)
44)	EC DESCRIPTION	(ECR,PROJECT,DESCRIPTION,REQ COMP DATE)
45)	EC EXCEPTIONS	(ECO,FACILITY,EC EXCEPTION)
46)	ECO MILESTONE	(ECO,COE REC DATE,COE SHIP DATE,DEST FAC,FAC REC DATE, FAC EST COMP,DATE FUNCTIONAL,FAC COMP DATE)
47)	EC PROCEDURE	(ECO,PROCEDURE)
48)	EC SUBSYSTEM	(ECR,SUBSYSTEM)
49)	ECI	(ECI,JPL DWG)
50)	ECO DWG	(ECO,JPL DWG)
51)	ECO ECI	(ECO,ECI)
52)	ECO FORECAST	(ECO,EST DESIGN FINISH,EST FAB FINISH)
53)	ECO KIT	(ECO,DESIGN FINISH,FAB FINISH)
54)	ECR OPEN	(ECR,DATE,PRIORITY)
55)	FIRST INST	(ECO,DATE,ACCEPTANCE)
56)	REFER ECR	(ECR,REFER TO)

Table 4. Examples of relations pertinent to DSN maintenance and operation documentation

	RELATION NAME	DATA ELEMENTS
57)	COST	(DOCUMENT,REVISION,COST)
58)	RELEASE DATE	(DOCUMENT,REVISION,RELEASE DATE)
59)	TITLE	(DOCUMENT,TITLE)

Table 5. Examples of relations pertinent to the DSN program library

	RELATION NAME	DATA ELEMENTS
60)	APPLICABILITY	(PROGRAM,SSMA)
61)	PROGRAM ID	(PROGRAM,LANGUAGE,TITLE)
62)	RELEASE DATE	(PROGRAM,RELEASE DATE)
63)	TA STATUS	(PROGRAM,TA STATUS,DATE)

Table 6. Examples of relations pertinent to DSN logistics

	RELATION NAME	DATA ELEMENTS
64)	COST	(NSN,COST)
65)	IDENTIFICATION	(NSN,MFR,MODEL,PART NUMBER,NOMENCLATURE)
66)	LEAD TIME	(NSN,LEAD TIME)
67)	LOCATION	(CON NUMBER,LOCATION)
68)	SERVICE DELEGATION	(NSN,DELEGATION)
69)	SOURCE	(NSN,VENDOR)
70)	UNIT OF ISSUE	(NSN,ISSUE UNIT)

Table 7. Examples of relations pertinent to DSN workmanship assurance

	RELATION NAME	DATA ELEMENTS
71)	DISCREPANCY	(INSP NUMBER,DISCREPANCY)
72)	ECO INSPECTION	(INSP NUMBER,ECO,INSP STATUS)
73)	EMP CERT STATUS	(EMP NUMBER,CERT STATUS,CERT SUBJECT)
74)	EQUIPMENT ID	(CON NUMBER,MFR,MODEL,NOMENCLATURE,SERIAL NUMBER)
75)	EQUIPMENT DWG	(CON NUMBER,JPL DWG)
76)	INSPECT DATE	(INSP NUMBER,DISPOSITION,DATE)
77)	INSPECTION	(CON NUMBER,INSP DATE,LOCATION,INSP NUMBER,INSP TYPE)
78)	SUBSYSTEM APPLIC	(INSP NUMBER,SUBSYSTEM)

Table 8. Examples of relations pertinent to DSN subsystem status and assignments

	RELATION NAME	DATA ELEMENTS
79)	CDE	(SSMA,CDE)
80)	COE	(SSMA,COE)
81)	IMPLEMENTATION ENG	(FACILITY,ICE)
82)	MAJOR ASSEMBLY ID	(SSMA,MA NAME)
83)	SSE	(SUBSYSTEM,SSE)
84)	STATION DIRECTOR	(FACILITY,STADIR)
85)	SUBSYSTEM ID	(SUBSYSTEM,SS NAME)
86)	SYST TA STATUS	(SYSTEM,TA STATUS)
87)	SYSTEM COE	(SYSTEM,SCOE)
88)	SYSTEM ENGINEER	(SYSTEM,NSE)
89)	SYSTEM ID	(SYSTEM,SYSTEM NAME)
90)	TA EXCEPTIONS	(SSMA,TA EXCEPTION)
91)	TA STATUS	(SSMA,FACILITY,TA STATUS)

Table 9. Examples of relations pertinent to JPL property control

	RELATION NAME	DATA ELEMENTS
92)	ACQUISITION	(PROP NUMBER,COST,ACQ DATE,PO NUMBER)
93)	EMP RESPONSIBILITY	(PROP NUMBER,EMP NUMBER)
94)	EMPLOYEE ORG	(EMP NUMBER,EMP ORGANIZATION)
95)	EQUIP SERIAL	(PROP NUMBER,SERIAL NUMBER)
96)	EQUIPMENT ID	(PROP NUMBER,MFR,MODEL,NOMENCLATURE)
97)	LOCATION	(PROP NUMBER,LOCATION)

Table 10. Examples of relations pertinent to the management of automatic data processing equipment

	RELATION NAME	DATA ELEMENTS
98)	ADP PLAN	(ADP ID,PO NUMBER)
99)	LOCATION	(PO NUMBER,PROP NUMBER,MFR,MODEL,LOCATION)