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SATELLITE AND MISSILE DATA GENERATION FOR AIS

Operating Systems, Inc.

Dr. Georgette M. T. Silva
Dr. Christine A. Montgomery

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ROME AIR DEVELOPMENT CENTER
Air Force Systems Command
Griffiss Air Force Base, New York 13441

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This final technical report describes a 12 month R&D effort under Contract F30602-78-C-0274, "Satellite and Missile Data Generation for AIS". Extended abstract included in the Report. All examples of messages and message fragments (sentences) in the report are based upon facts and events described in the daily press, specifically the Los Angeles Times (July 1979), Aviation Week (February 1978 - July 1979), American and Soviet Military Trends since the Cuban Missile Crisis by John M. Collins, published by the Center for Strategic and International Studies, Georgetown University, Washington DC, 1978 (Cont'd)

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and Jane's All the World's Aircraft, 1976 - 1977. The messages used as examples resemble the actual messages only in their grammatical structure. Most objects, attributes, and time/location parameters used refer to the events connected with the launch, mission, deorbit, breakup and impact of Skylab.

ABSTRACT

This final report presents the results of work performed under RADC contract No. F30602-78-C-0274. The effort described specifically addressed the problem of deriving indicator and descriptor data from the narrative text portions of a class of intelligence messages dealing with events related to missile and satellite launchings used for input to the Advanced Indicator System (AIS) data base.

The introductory section briefly discusses the intelligence problem which OSI's event processing technology intends to solve, summarizes the technology developed under this contract, and presents the conclusions drawn on the basis of the results obtained.

Section 2 offers a summary of OSI's methodological approach to the analysis and description of event reports. This methodology, initially developed on the basis of messages dealing with air activities, was, under this contract, extended to cover reports of events involving missile and satellite launchings and related events. Subsection 2.2 presents the characteristics of the maximal unit of analysis: the EVENT REPORT, while subsection 2.3 discusses the characteristics of messages from the point of view of their conceptual organization and that of their linguistic organization, and gives details of the analytical procedures adopted for their analysis. Subsection 2.4 discusses two representational constructs of fundamental importance in event processing: the Template, and the Event Record. Subsection 2.5 outlines some issues involved in the problem of reference, while subsection 2.6 provides guidelines for the establishment of a research corpus.

Section 3 describes the Missile and Satellite domains, and presents the results of their analysis in terms of a domain definition. The discussion includes a characterization of the event report in terms of its component messages; a list of the message types encountered in the domains under consideration; a list of the event types identified together with their descriptor system, and a definition of the sublanguage in terms of its vocabulary and syntax.

Section 4 focuses on the implementation of OSI's message text analysis system, MATRES II. It briefly reviews the principles underlying OSI's event processing techonology and offers an overview of MATRES II. The computer programs which embody OSI's approach to the automated analysis of message text are written in FORTH, Prolog, and SNOBOL4, and run on a PDP 11/45 under the RSX 11D operating system. Finally, the analytical processes utilized by MATRES II are illustrated by means of examples.

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EVALUATION

The objective of this effort consists in augmenting and extending the capabilities of the existing message text processing methodology to the subject domain of satellite and missile sightings. The work described deals with the analysis of textual reports of events and the synthesis of relevant information elements in a format suitable for automated input to the AIS database.

The effort is directed at providing computerized aids to the I&W analyst in distilling the contents of incoming text messages into compact, formatted, computer processable content representations in support of his mission to predict the future on the basis of information describing past and present events. The analyst's difficulties result from the fact that the volume of message traffic is normally very high and increases sharply in a crisis situation. This prevents efficient handling and full exploitation of the enormous amount of variables contained in the message traffic under both normal and critical operating conditions. Since a computer experiences no difficulty in processing large numbers of variables, the notion of automating this task provides a logical solution in the context of information explosion.

The significance of the subject effort consists in computer modeling of the analyst's cognitive activities in reading and understanding message text, transforming its contents into information items of interest, and building a conceptual model of the information conveyed in the message. In order to accomplish this task, the computer must be equipped with representations of both linguistic and extra-linguistic knowledge inherent in cognitive faculties of the analyst. The approach to computer modeling of understanding relies heavily on the recent and current theoretical advances in computational linguistics, language theory, artificial intelligence and cognitive psychology.

ZBIGNIEW L. PANKOWICZ
Project Engineer

1.0 INTRODUCTION AND SUMMARY

1.1 Introduction

This final report presents the results of work performed under RADC contract No. F30602-78-C-0274. The effort described specifically addressed the problem of deriving indicator and descriptor data from the narrative text portions of a class of intelligence messages dealing with events related to missile and satellite launchings used for input to the Advanced Indicator System (AIS) data base. The following sections briefly discuss the intelligence problem which OSI's event processing technology intends to solve (1.1.1.), and summarize the development of the technology thus far (1.1.2.)

1.1.1 Problem Statement. The task of an intelligence analyst is to predict the future on the basis of information describing what has happened in the past and what events are currently taking place.

At the global level, the questions the analyst asks himself are: "What is happening?" "What does it mean in terms of my knowledge about similar events in the past?", "What is going to happen next"? He is concerned with certain states of affairs, and events signifying changes in these states of affairs.

When working with a single message, the analyst seeks answers to at last the following questions:

1. What is its information content?
2. How reliable is the source?
3. How "credible" is the data?

His evaluations of incoming information are based on his cognitive models of certain kinds of situations, the personalities, entities, and processes involved, and the potentialities and constraints associated with changes in an existing state of affairs.

Given the volume of information he must sift, and the complexity of the cognitive models involved, the difficulties of the analyst's task are obvious. Aids to support his analytical processes clearly must involve means for distilling the content of incoming information into a form which is compact, usable, and compatible with his view of the world.

Information on the world situation comes to the I&W analyst mainly in the form of intelligence messages, which are electrically received in an I&W center 24 hours a day. The messages come from many different originators, and are largely in the form of narrative text. The volume of message traffic is extremely high, and in a crisis situation, increases dramatically. Even under normal operating conditions it is very difficult for an analyst to isolate items of information from message text and to assimilate and correlate these items into a pattern of events of indications significance. In a crisis situation, the analyst is completely saturated with data, and the performance of his task demands superhuman capabilities for handling the enormous number of variables which are contained in the message traffic.

A computer, on the other hand, can process large numbers of variables. Thus, the notion of offloading some of the variable processing functions onto the machine seems to provide a logical solution to the information problem.

One of the interesting developments in this direction is the Advanced Indications System (AIS), which currently has the capability to statistically analyze intelligence data and to display such data in a logical and useful form.

Briefly, the AIS provides the following:

a. A structure for continuous objective and systematic monitoring of selected indicator time series.

b. Computer based logic for detecting the significant patterns in current data, comparing them to past activities, and quantifying the departure from normally observed activity.

c. The capability to interact at a single point with a comprehensive data base to assimilate, investigate, present and resolve the unusual situations detected.

At the current stage of development, the messages to be analyzed by the AIS are manually sorted into functional threat focused indications categories. Data elements called 'indicators' and 'descriptors', which are n-ary structures of various types*, are then derived from relevant segments of certain messages, and subsequently entered into the system's data base for the daily update. Due to the experimental and developmental status of the AIS, update of the descriptor/indicator data base is currently performed manually by contractor personnel. When the system achieves operational status, update of the AIS data base will be performed by an I&W analyst. Despite the considerable benefits he will derive from the AIS, maintaining the AIS data base constitutes still another task for the overburdened analyst.

1.1.2 Toward a Solution. For the past several years RADC has been sponsoring an exploratory and developmental program related to the design and development of a general methodology for the efficient and effective exploitation of the content of electrically transmitted intelligence messages. The long term goal of this work is to develop a system which would assist the analyst in creating and maintaining formatted data bases derived from natural language text, and thus offload some of the processing functions from the analyst to the computer. Such a system should provide the analyst with information which is needed for the attainment of his particular goal, i.e., information which is

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* These are described in detail in a classified appendix to the OSI Final Technical Report RADC-TR-77-194, June 1977.

relevant to his task, is of high epistemic standing, and therefore useful to solving his problems.

Figure 1-1 shows the components of a total system for message exploitation and highlights the focus of the RADC program.

As mentioned above, the work described in this report is concerned with the analysis of textual reports of events and the synthesis of relevant information elements in a format suitable for automated input to the AIS data base.

Specifically, the program addresses the problem of automating the analysis of the narrative text portions of intelligence messages describing events, with the aim of transforming them into succinct, formatted, computer processable content representations.

The automated generation of information elements from narrative message text requires that the computer in some sense "understand" natural language text. Within the context of the work described here, we say that a computer system understands an input text insofar as it can construct an adequate representation of the information content of that text. Specifically, we require that the output of the computer understanding process, when applied to some message text, furnish the analyst with at least those information elements that he would himself have extracted from that particular text.

OSI's approach to the problem of computer "understanding" leans heavily on theoretical advances in several disciplines, including theoretical linguistics, computational linguistics, artificial intelligence, text linguistics, and cognitive psychology. A survey of the field as related to the work reported here can be found in Silva and Montgomery (1978) and Silva et al. (1979).

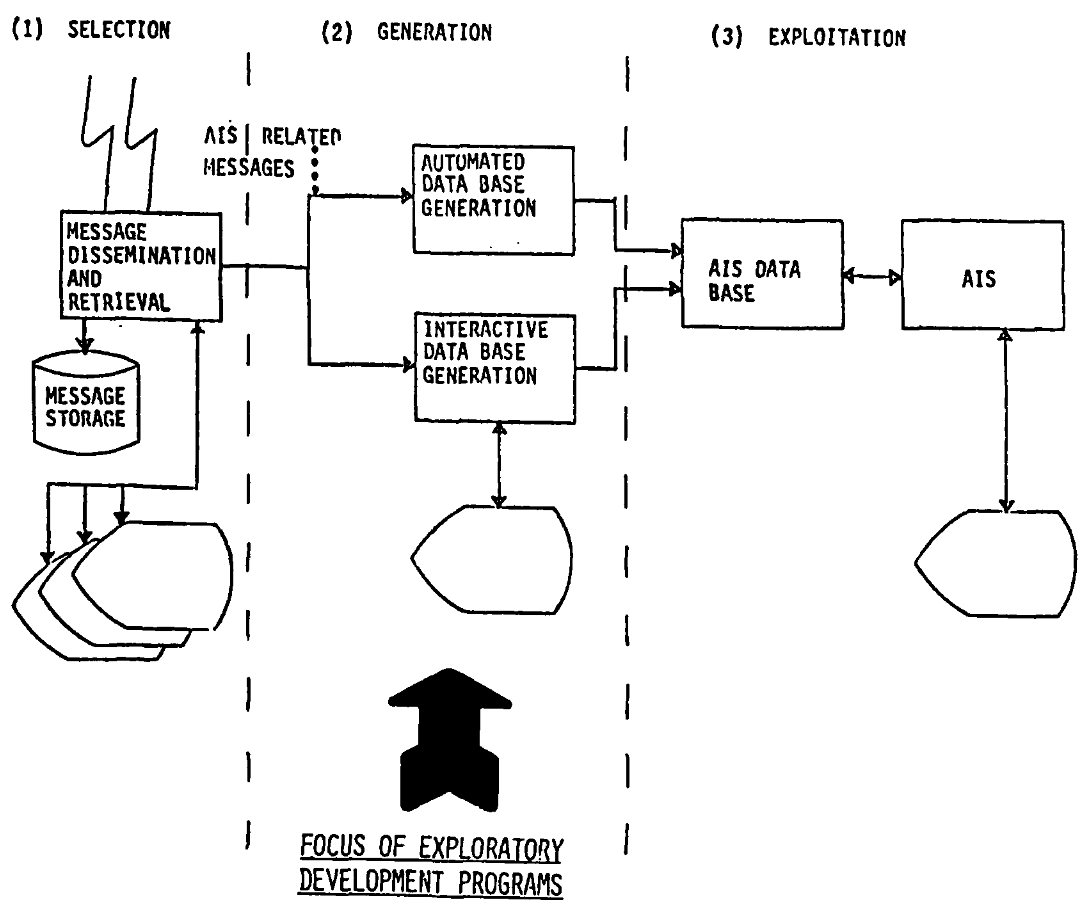

Figure 1-1. Components of an Experimental Message Exploitation System

The aim is to model the cognitive activities of the human analyst as he reads and understands message text, distilling its contents into information items of interest to him, and building a conceptual model of the information conveyed by the message.

In order to model this human cognitive activity, the computer must be equipped with representations of both linguistic and extra-linguistic knowledge, and a means of manipulating such representations for the analysis of text and synthesis of information elements. The elements must then be presented in a clear and useful format suitable for the task at hand.

1.2 Summary

1.2.1 Scope of Current Effort. The scope of the effort described here included extending and augmenting the capabilities of the message text processing methodology originally developed under previous contracts to the missile and satellite subject domain.

Briefly, the work involved the establishment of a research corpus; the development of a transcription scheme for the sanitization of messages; extensions to the linguistic methodology; extensions and additions to the ATN grammar constructed under a previous contract to accept a wider range of linguistic structures; the refinement of the notion of "template" -- the fundamental information structure developed for the organization and representation of knowledge about events; the development of templates for the missile and satellite domains; and finally, additions and extensions to the existing algorithms for the interpretation of narrative text and its subsequent transformation into formal content representations.

A major effort was devoted to the development of additional program modules to accommodate new syntactic construction types in the missile and satellite domains, and to the provision of adequate system control.

1.2.2 Current Capabilities of OSI's Message Text Processing System. **The OSI message text analysis system has the capability to digest narrative text and systematically transform it into concise, machine processable content representations called 'event records', in which a message can be viewed from several perspectives: time, location, organization involved, activity type, etc.**

Specifically, the current capabilities of the system are:

a. It determines the key event described in a message on the basis of an analysis of its first sentence and presents it to the analyst in a form that answers the basic "what is happening?" question (1.1.1.).

b. It provides information useful for determining the reliability of the source by recognizing and displaying the reported source of an event. For example, if an event is reported by a foreign news agency, the name of that news agency is displayed in the event record under the heading Infosource.

c. It provides information helpful to evaluate the credibility of the source data, by highlighting the probabilistic information associated with a report of an event. Words such as 'possible', 'probable', 'successfully' constitute judgments of the originator of a message as to the reliability of the data reported. Such words are preserved during processing and remain associated with the term they modify in the text. For an example see Table 1-1 below, where the word 'successfully' indicates certitude of the successful completion of the deorbit event described.

Table 1-1 shows a hypothetical (partially transcribed) input sentence describing a major event and the corresponding event record produced by MATRES II.

Table 1-1 Example Input and Output by MATRES II

```
+-----------------------------------------------------------------+
|                                                                 |
|     THE NEWSAGENCY PRESSNAME ANNOUNCED THAT THE TWO             |
|     UNIDENTIFIED SATELLITES WHICH WERE LAUNCHED                 |
|     FROM PLACENAME1 ON 09 MARCH 1973 AT ZULUTIME WERE           |
|     SUCCESSFULLY DEORBITED INTO THE PLACENAME2  ON 09 APR 1978  |
|     BY THE POLITNAME ON REVOLUTION 3NMBR                        |
|                                                                 |
|     Infosource= THE NEWSAGENCY PRESSNAME                        |
|     Event:  DEORBIT                                             |
|     Action= SUCCESSFULLY DEORBITED                              |
|     Agent= BY THE POLITNAME                                     |
|     Object:  SATELLITE                                          |
|     ...Equipment= UNIDENTIFIED SATELLITES                       |
|     ...Number= TWO                                              |
|     ...Relative= LAUNCHED FROM PLACENAME1 ON 09 MARCH 1978 AT   |
|                  ZULUTIME                                       |
|     Location= INTO THE PLACENAME2                               |
|     Revolution= ON REVOLUTION 3NMBR                             |
|     Date= ON 09 APR 1978                                        |
+-----------------------------------------------------------------+
```

The report is divided into four major sections.

Section 2 offers a summary of OSI's methodological approach to the analysis and description of event reports. This methodology, initially developed on the basis of messages dealing with air activities, was, under this contract, extended to cover reports of events involving missile and satellite launchings and related events. Subsection 2.2 presents the characteristics of the maximal unit of analysis: the EVENT REPORT, while subsection 2.3 discusses the characteristics of messages from the point of view of their conceptual organization and that of their linguistic organization, and gives examples of the analytical procedures adopted for their analysis. Subsection 2.4 discusses two representational constructs of fundamental importance in event processing: the Template, and the Event Record. Subsection 2.5 outlines some issues involved in the problem of reference, while subsection 2.6 provides guidelines for the establishment of a research corpus.

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Section 5 contains a list of references to books, journal articles, conference papers, doctoral dissertations, and other publications of relevance to the work described here. Much of the information contained in these publications has inspired and guided the RADC-sponsored developmental work on automated data base generation since its inception several years ago.

Appendices A-E contain a listing of sanitized message text (A), a listing of the combined lexicons for the air activities, missile, and satellite domains (B), a listing of the ERL templates and their ancilliary procedures as encoded in Prolog (C), a listing of the FSA character processing algorithm (D), and a set of examples of system input/output (E).

1.3 Conclusions

OSI's message text analysis methodology, while initially developed on the basis of a restricted subject domain -- reports of air activities -- has successfully been applied to two new subject domains -- those of missile and satellite reports. It has been demonstrated to be general in its applicability to different subject areas and therefore extensible in a non-trivial manner to reports of events involving the physical movement of objects such as aircraft, ships, missiles, and satellites.

It is shown that the automated analysis of event data needs to take into account all aspects of event reporting and requires a truly interdisciplinary approach. Several levels of analysis are identified, each involving a different aspect of event reporting, and each based upon different considerations.

The three sublanguage domains studied thus far consist of descriptions of events involving aircraft activities and launchings of missiles and satellites, and related events. In all three cases, the source data are contained in the text portions of military messages typical of these subject domains, consisting of a report title summarizing a given event, followed by one or more declarative sentences describing that event (and optionally, other related events).

In all three cases, the semantics and the syntax of event descriptions are constrained by two factors. One, by the particular subject domain, and two, by the fact that the events described are limited to what is observable and what should be reported according to a reporting procedure. This results in a substantial number of participial constructions of various types, complex nominalizations and agentless passives, as well as a range of types of quantification, conjunction, complementation, ellipsis, and anaphora.

The sublanguages, although less extensive in their inventory of syntactic constructions than event reports in journalistic narrative, nevertheless contains certain constructions which present challenging semantic problems. Such problems include the treatment of "respectively" constructions, as well as certain types of definite anaphora which not only transcend sentence boundaries and, in some cases, even message boundaries, but often are of the kind that have no explicit referent in the previous discourse.

Of the three languages studied thus far, the discourse structure of the satellite reports is considerably more complex than that of missile reports or reports in the air activities domain. While in air activities reports the description of a given event is often completed within a single sentence (e.g., a particular aircraft penetrated enemy airspace at a specific location and a specific time), in missile and satellite reports the complete specification of the properties of an event and of the object(s) involved more frequently requires several sentences, and not uncommonly, several messages. Thus, a report on some launch operation can consist of an initial, rather skeletal statement, followed by one or more messages received over a period of time which update the previous report, adding to and sometimes changing previous specifications.

Although event reports in the air activities domain may also involve several messages, the update problem is much simpler, since the attributes of a flight event are fewer and less complex than those of satellite events. In any case, the boundaries of a discourse relevant to a single event can range from a single sentence to several messages. The problem of assembling the total mental "picture" relating to any given event can only be approached on the discourse level.

The major impact of adding a new subject domain to the system's repertoire was felt in two related areas: vocabulary analysis and template construction. Although there exists a core of overlapping vocabulary for the three subject domains, domain-specific usage of event-related terms necessitates the construction of separate templates for each domain, even in those cases where they share the central concept.

To see this, consider the FLIGHT concept, which is shared by the three domains. In the air activities domain, it happens to be the key concept, and therefore it has a complex internal structure. In the missile and satellite domains, it is referred to only tangentially to express the duration of a mission: "THE MISSILE IMPACTED AFTER A FIVE MINUTE FLIGHT".

The syntax of the three sublanguages, on the other hand, exhibited a large number of similarities, so that the addition of the new domains only required development of a small number of new constructions, specifically, relative clause constructions and appositive postmodofication, which was relatively rare in the air activities reports and had therefore not been sufficiently developed.

MATRES II is still at an early stage of development. No attempt has been made to represent a complete set of semantic structures for the interpretation of the whole range of linguistic expressions occurring in the messages studied.

On the contrary, the aim was to find a small set of structures that would describe as many event types as possible, but still be simple and compact enough to be the basis of a manageable and understandable computer system.

This goal has to a great extent been achieved. By limiting the scope of the system's knowledge, it has been possible to model a complex domain of practical significance, and to implement algorithms that "understand" this domain in a limited sense.

From the theoretical point of view, it is important to stress that the development described in this report is only a first step toward a formal characterization of the relationship between knowledge-based language understanding and the generation of indicator and descriptor data.

However, from the pragmatic point of view, the work carried out under the current contract has demonstrated that OSI's initial design concept was sound, and can be developed into an automated support system for I&W functions. The timeframe of an operational development is obviously a function of the degree of automated versus interactive processes - - the more interaction, the less is required of the knowledge base.

The concepts underlying the MATRES II design and implementation appear sufficiently useful that the system has already aroused considerable interest both within and outside the intelligence community. With some additional developmental effort, it should be possible to field an experimental MATRES system in the near future, allowing interested users the possibility of hands-on evaluation of the I&W data base generation concept.

2.0 METHODOLOGICAL APPROACH

2.1 Preliminary Notions

The method of approach which OSI has adopted since the inception of the RADC exploratory and developmental program for Automated Data Base Generation has been to look ahead to the potential capabilities of a future system for both interactive and fully automated exploitation of the narrative text of intelligence messages, and to develop a methodology that will remain valid for applications of considerably greater scope than the one currently under development.

This section offers a summary of OSI's methodological approach to the automated generation of indicator and descriptor data from the narrative text portions of intelligence messages reporting on events related to movements of physical objects such as aircraft, ships, missiles and satellites.

This methodology, initially developed on the basis of messages dealing with air activities, was, under this contract, extended to cover reports of events involving missile and satellite launchings and related events.

OSI's methodological approach is centered around the notion of "event", which is adopted as the logical unit of analysis, and thus becomes the basis for describing intelligence information. Although the concept of an event is fundamental to many research endeavors, no standardized terminology for describing or classifying events seems to exist. In many cases, the definition of an event is arbitrary and tailored to a particular field or purpose. Thus, in physics, the term 'event' usually refers to a point in the space/time continuum, while in mathematical statistics it has the broadest meaning, that of any proposition, whether true or not. The philosopher Russell (1956), regards the event concept as a primitive (i.e., as undefined) and then uses it to define a series of time points. In another usage, 'event' refers to a fact. In a related approach, the event concept encompasses the parameters of 'action/time/location,' and is used to refer to a type of activity. For a detailed treatment of the event concept as initially developed by OSI, the reader is referred to Kuhns (1974), or Silva et al., (1979).

For the purpose of the work described in this report, we have expanded the definition of an event as previously stated, to encompass all the states, processes, and activities associated with an object or a set of objects from the inception to the termination of its/their mission. The term used for the aggregate of these states, actions, activities, and processes is "global event", symbolized as EVENT.

To illustrate this usage of the term EVENT, consider the story of Skylab, as reported in the news media (Los Angeles Times, Newsweek, and Aviation Week between 1973 and 1979).

Briefly, Skylab was the orbital workshop which was launched from the Kennedy Space Center on the 14th of May, 1973. It incurred serious damage at lift-off time and was later repaired by the astronauts previously scheduled to rendezvous with it. The astronauts, launched in a modified Apollo service module, attached themselves to Skylab by "umbilical" cords (connections to life support systems), and salvaged the ailing spacecraft. Subsequently, Skylab was used for experiments, and was later abandoned. Recently, it caused much concern, because it was obvious Skylab was going to deorbit and crash to earth. It did indeed reenter the earth's atmosphere, upon which it began to break up into pieces, some of which burned up on reentry. Others impacted in the Indian Ocean, and yet others landed in Western Australia.

From a global perspective, the Skylab story constitutes an EVENT and all the various news items which informed us of the state of Skylab over the last six years constitute an EVENT REPORT.

A global event has a complex internal structure composed of smaller interrelated units: the launch, the deorbit, the impact, etc. These smaller units are referred to as 'events', or 'atomic events'. An 'atomic event' is roughly either a property that an object has at a point in time or over a time interval, or a relation that holds among a set of objects or locations at a point in time or over a time interval.

Descriptions of atomic events take two forms: *intensional* descriptions, and *extensional* descriptions.

An intensional description is an abstract description of a class of *individuals* in terms of a set of invariant properties common to all members of the class. Thus, the intensional description of the class of launch events would state that all such events are associated with an object that can be launched. In the satellite domain, the object is a satellite. It usually has some specified mission, and is associated with an orbit, which itself is described in terms of several parameters such as apogee, inclination, perigee, and period. Other entities associated with a satellite launch are the launch system used for injecting the satellite into orbit, the launch site, and the time and date of the launch.

An *extensional* description involves one individual, i.e., a unique member of a class of individuals in the world being modeled. A simple example is the description of a specific launch event involving a particular spacecraft (e.g., Skylab), launched from a particular launch site (the Kennedy Space Center), by a particular launch system (a Saturn-5 type launch vehicle), into a particular orbit (the Skylab orbit had an inclination of 50 degrees to the equator), at a particular time and date (1300 hours on 14 May 1973).

The representational construct for intensional descriptions of events and their associated concepts is the "template" (see subsection 2.4.1), while that for the extensional description of events and their associated concepts is the "event record" (see subsection 2.4.2). The relation between a template and its corresponding event record is roughly the same as that which holds between an intensional description of a concept and its extension. Thus, the set of event records describing events of the same class, i.e., event records related to a particular template, constitute the *extension* of the concept described by the template.

The collection of reports describing an EVENT constitute an EVENT REPORT. In the military environment, an EVENT REPORT comprises a variable number of discrete intelligence messages, which are often received hours, days, weeks, or even years apart.

The messages fall into definable classes which have important methodological implications for event processing. Each message type has an internal conceptual organization reflected in the linguistic organization of the message text. The next few subsections describe the major characteristics of EVENT REPORTS, and the internal conceptual and linguistic organization of message text.

2.2 Characteristics of EVENT REPORTS

One of the fundamental properties of an EVENT REPORT is that it is coherent with respect to a global theme. Thus, if the central theme of an EVENT REPORT is the mission of a particular spacecraft, the atomic events described by individual messages, including the comments offered and the inferences stated, are all in some intuitive way related to that theme.

Precise rules for establishing coherence at this level, however, are very difficult to formulate. Although it is clear that determining coherence involves domain-specific knowledge of objects, their properties and their behavior in the real world, as well as knowledge of conventions governing reporting procedures, the inferential procedures for establishing coherence cannot be explicitly formulated at this time.

An attempt was made to identify some of the factors which might enter into the establishment of links between messages in the missile and satellite domain. Two notions emerged as crucial in this area: the time reference of a reported event, and the discourse referent, i.e., the entity discussed. (For further discussion, see subsections 2.3.4.3 and 2.5).

It is clear that the procedures involved in event processing at the level of the EVENT RECORD must be based upon a cognitive theory of discourse comprehension utilizing real world knowledge of how the objects, facts, processes and events are organized in a particular subject domain.

2.3 Characteristics of Messages

As mentioned above, the individual messages in message sequences constituting EVENT REPORTS usually fall into several identifiable classes. From the point of view of automated computer analysis, a distinction must be made between those messages that contain new event descriptions (i.e., descriptions of events reported for the first time), and those that either confirm previously reported events, request changes in the parameters of some previously reported event, add information to previously underspecified parameters, or provide summaries of global events. From an operational point of view, a first report involves creating a new data element, while elaborations, requests for change and updates involve changes and/or additions to an already existing structure.

Messages have a complex internal structure comprising header information, followed by either formatted, semi-formatted, and/or unformatted (narrative) text portions, before ending with some special symbols signalling the conclusion of the message.

Since this work is concerned mainly with the narrative text portions of messages, the latter are described in terms of three components: a 'pre-text' component, the 'text' component, and a 'post-text' component. The next two subsections focus on the characteristics of the 'text' component of messages.

2.3.1 The Conceptual Organization of Message Text. This subsection focuses on the conceptual organization of message text. In general. the 'text' component of a message contains information as to the time and location of a given atomic event, and may contain additional data giving the context of the event sequence or chain of related events, properties of objects involved, the source of the information, and some interpretation of the event.

The majority of event-related messages have a characteristic structure which may be represented by the following formula, where the parentheses enclose optional elements, and curly brackets enclose alternatives:

$$(S)\ E\ L\ (T)\left(\begin{Bmatrix} E'(I) \\ I \end{Bmatrix}\right)$$

S represents references to the source of the information, and is an optional element. The following single-sentence message contains a source reference represented by the string THE SOVIET NEWS AGENCY TASS:

> THE SOVIET NEWS AGENCY TASS ANNOUNCED
> THAT IMPACT OF COSMOS-954 TOOK PLACE
> NEAR YELLOWKNIFE, CANADA.

E symbolizes the key event being reported in the message, while L represents the location and T the time of the given event. In the above example, the key event is the impact of Cosmos-954, and the location is Yellowknife, Canada. The time of the impact is not mentioned. When time information is omitted, it can be derived from the header of is not mentioned. When time information is omitted, it can be derived from the header of the message, or from a combination of other factors, including the tense of the main verb. The latter procedure often involves complex inferential processes which are difficult to implement.

E' symbolizes further information on the key event, e.g., properties of the objects involved, and other occurrences in the chain of events reported.

I represents further information on the event. The latter often takes the form of evaluative comments on surrounding circumstances or consists of sentences describing relevant historical background. Interpretative comments are often absent from messages, but in those cases, more detailed information on the key event itself is usually given.

Messages containing more than one paragraph are generally structured along the same lines, where each additional paragraph reports a related event, with associated time and location data, details, and interpretive comments.

In event-related messages, a description of the key event and its parameters occurs in the first sentence of the text. Thus, it is always the first sentence of the message text which introduces the TOPIC of the message.

2.3.2 The Description of Message Content. In order to describe the information content of message text, we utilize the "Text Grammar" approach as developed in the writings of Petofi (1971), Petofi and Rieser (1973), van Dijk (1972, 1979), van Dijk and Petofi (1977), and Dressler (1978a, 1978b).

As the name implies, the unit of analysis of a text grammar is a text, in our case, the message text. The aim of a text grammar is to provide an abstract linguistic description of a text -- including a description of the structure of its individual sentences --

utilizing as many levels of analysis as necessary to make explicit the content structure of the text.

Our approach to this problem is to describe the meaning content of the message in terms of a "Message Grammar" in which the "primitives" are event classes, and the relations are text-level relations. The latter may be optional or obligatory and determine the connectivity or non-connectivity between events.

The definition of the Message Grammar is based upon a systematic study of the language used in a particular subject domain. The results of the study for the missile and satellite sublanguage are pesented in Section 3 of this report.

The formulation of a message grammar for event data requires a multi-level approach, beginning with the description of the text at the level of words and sentences and concluding with a description of the information content of the message in terms of higher-level abstract units. Each level of description involves its own units and principles of analysis.

2.3.3 The Linguistic Organization of Message Text. At the linguistic level a message text is characterized in terms of a sequence of propositions. It is important to note, however, that a message text is not just an arbitrary, unrelated set of propositions; it is a coherent, structured conceptual unit, whose individual propositions are linked by means of text-level relations including coreference, temporal relations, causal relations, entailments and presuppositions.

The formulation of conditions for textual coherence is an essential part of the linguistic characterization of a message text and plays an important role in message text analysis. Some of these relations are explicitly expressed in the surface structure of the text; others are inferred during the interpretation process on the basis of contextual and real world knowledge. In addition, it is important to note that for a text to be coherent, its propositions need not necessarily be connected in an explicit manner at the text level, since much of the information conveyed by a text is implied. It is sufficient that a text be coherent at a higher level of abstraction with respect to the TOPIC of the message, i.e., the entity discussed.

The next higher level of analysis is the Event Level. The linguistic level is related to the Event level by a set of mapping rules which transform the individual propositions of the text into event representations. The mapping rules are based upon a study of the correspondences between form and content in a given domain. Examples of such correspondences taken from the domains under consideration are given in the next section.

2.3.4 Description at the Event Level. This level involves the description of atomic events in terms of their properties, including time, location, action, objects, and related facts. For each subject domain, the description of message content at this level requires that the set of characteristic event classes be identified together with the set of operations and relations on events that hold within the domain. This, in turn, requires a thorough analysis of the vocabulary of the sublanguage, and lexical analysis, and a study of text-level relations. The following sections sketch OSI's approach to these requirements.

2.3.4.1 Vocabulary Analysis. A KWIC concordance of the message sentences is first prepared to serve as a basic analytical tool for development of the dictionary and grammar (see subsection 2.6.3). The vocabulary yielded by the initial KWIC index, is partitioned into those items which are entered into the system's dictionary and those that are members of open sets and must be treated heuristically.

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* A dictionary, or lexicon, is a file of information about the words of the language.

The first category is made up of natural language words (nouns, pronouns, adjectives, verbs, adverbs, conjunctions, subjunctions, etc.). The second category comprises number strings, date time groups, regiment numbers, division numbers, and other alphanumeric strings such as designations of equipment types and launch systems. Furthermore, this category also includes geographic designations, names of countries, areas, zones, cities, rivers, etc., which require the use of special dictionaries for their recognition.

Heuristics for automatically recognizing and labelling lexical items which are members of open sets (e.g., types of equipment, place names, geographical coordinates) involves writing specific recognition routines involving anything from pattern-matching to syntactic prediction.

In addition to a common core of English language words utilized across subject domains, each individual subject domain requires its special dictionary reflecting domain-specific nomenclature and usage.

Since the lexicon has to mesh both with the parser and the interpretive routines, the task of building the lexicon is a continuous effort extending over the entire period of development.

2.3.4.2 Lexical Analysis. The results of the vocabulary analysis form the basis of the *lexical analysis*, which in turn underlies the definition of new templates.

The goal of lexical analysis is the description of the concepts expressed by words and the identification of their conceptual relations to other words*. All key concepts, their

---

Each word entry is accompanied by information regarding its syntactic category, in what syntactic environments it can occur, and what some of its semantic properties are.

* Note that the term "word" is used loosely to refer to single words or combinations of words generally considered to form a unit of meaning.

attributes, their internal argument structure, and their external relations to other concepts must be determined for each subject domain. The following paragraphs provide some background on OSI's approach to lexical analysis.

Information on words is characteristically acquired by experience. It is generally accepted that such information includes spelling, pronunciation, inflected and derived forms, major syntactic category, knowledge about how words combine with other words to form grammatical phrases and sentences, knowledge about semantic relations between words (e.g., synonymy, antonymy, hyponymy), knowledge about semantic fields, rules for appropriate use in a given situation, and other encyclopedic facts. Knowledge about words underlies a person's faculty to produce and comprehend language and to communicate with other people in a manner appropriate to a given situation. The meanings of many words depend upon functional and perceptual attributes, as well as the place that word occupies within a system of concepts.

One of the goals of lexical analysis is to define the boundaries of the lexical universe for the domain under study. Within a given subject domain, representations of concepts expressed by words need only include what is relevant to the particular domain.

To illustrate the kinds of issues involved in formulating hypotheses about concepts expressed by words, their internal relations and their links to other concepts, we offer the following two examples.

2.3.4.2.1 Example 1: Hyponymy. Hyponymy is generally considered to be one of the most important principles underlying the organization of nominal concepts. It has been the subject of many linguistic investigations -- especially in connection with kin terms, color terms, and plant and animal taxonomies.

According to Lyons (1968), hyponymy is the relation which holds between a more specific, or subordinate, lexical unit and a more general, or superordinate, lexical unit, as exemplified by the pair of words 'Skylab' and 'spacecraft', where 'Skylab' is a hyponym of 'spacecraft'. Under this definition, Pioneer 11, Voyager, and Viking are co-hyponyms of the superordinate term 'spacecraft'. Hyponymy has sometimes been defined in terms of the logical relation of class-inclusion (see, for example, Carnap, 1956). According to Lyons (1977), however, there are problems attaching to the definition of hyponymy in terms of the logic of classes. He proposes that hyponymy be defined in terms of unilateral implication, as follows:

> Word Wi is a hyponym of word Wj if, for any x, the sentence
> "x is a Wi" entails the sentence "x is a Wj".

The relation of hyponymy imposes a hierarchical structure upon a vocabulary and upon particular fields within a vocabulary. Knowledge of hyponymy relations is essential to the resolution of discourse reference, and plays an important role in information retrieval. In Library Science, it underlies the assignment of "See also" references.

Hyponymy is an external relation between concepts. Example 2 below illustrates a class of internal relations which are often referred to as "case" relations (Fillmore, 1968).

2.3.4.2.2 Example 2: Case Relations. Natural language cases are widely recognized as an important organizing principle in the analysis and description of natural language data. Many of the advanced projects for natural language understanding in the U.S. as well as abroad embody some sort of case system.

A "case" is a binary relation which holds between the predicate (usually, but not necessarily, realized as a verb) and one of its arguments. A case analysis determines the semantic roles of the components of an expression with respect to a central concept.

Consider, for example, the sentence:

A SATURN-5 TYPE LAUNCHER WAS USED TO PLACE THE SPACECRAFT INTO ORBIT.

The main predicative concept "USE" denotes an action, and as such determines the roles of the other components of the sentence with respect to it. Thus, "A Saturn-5 type launcher" fulfills the role of "instrument", and "to place the spacecarft into orbit" the role of "purpose" in relation to "USE". These roles are purely semantic and describe the internal relations of the concept USE to other constructs in its immediate, syntactic environment. Continuing our analysis, we note that the "purpose" argument can be further decomposed into the predicative concept "place", the noun phrase "the spacecraft", and the prepositional phrase "into orbit". The noun phrase "the spacecraft" fulfills the role of "object", while the prepositional phrase "into orbit" fulfills the role of "locational goal" in relation to "place".

Correlations between the text of our example and its logical argument structure are expressed by what linguists refer to as the "selectional restrictions" or the "selectional preferences" of a particular verb. Some of the selectional preferences for the verb "use" are given below:

(a) The Agent, if expressed in surface structure, corresponds to the "logical" subject.

(b) The Instrument is expressed by the object noun phrase denoting any object which can be "used".

(c) The Purpose, if expressed in surface structure, is a "to" complement, or a "for" complement.

Internal relations may be obligatory or optional. For example, with the predicate USE, the purpose for which something is used need not always be explicitly expressed in surface structure. The verbal gerund "Using Message Spooling Processors in a Non-Interactive Network" does not spell out the purpose. It does, however, give an indication of the environment ("in a non-interactive network"). Both Purpose and Environment are optional arguments of USE. Mention of the Instrument argument, is, however, mandatory.

In conclusion, this brief analysis of the two examples given above identifies only a small number of the semantic relations which can hold among words. An in-depth lexical study must come to grips with issues relating to polysemy and lexical disambiguation, including the problem of core senses and the way a core sense can be extended to provide other senses; with morphological relations, including inflectional and derivational word formation, as well as with the meaning of compounds, with the notion of "semantic field", and with issues of representation. In addition, the role of presupposition must be clarified.

Presuppositions and entailments are of particular importance for event data analysis, because they make predictions about possible sequences of events. If any of these predictions are violated, they must be brought to the attention of the analyst.

2.3.4.3 The Study of Text Level Relations. By "text-level relations" we mean those relations that connect atomic propositions in a running text. They include such relations as synonymy, hyponymy, part/whole relations, causal relations, temporal relations, pronominal reference, noun phrase reference, and temporal reference.

Factors that enter into text level relations are implications in the semantic content of constituent propositions, lexical equivalence, and syntactic devices such as time and place relators, logical connectors, and the use of proforms.

For example, consider the following message fragment, which consists of two clauses, each describing an atomic event:

THE SATELLITE DEORBITED AFTER COMPLETING A 28 DAY MISSION.

The event described by the main clause (the satellite deorbited), stands in the time relation of succession to the event described by the subordinate clause: the deorbit of the satellite is understood to have taken place after a mission which lasted for 28 days.

This time relation is explicitly stated in the text, and can be derived from the semantics of the two clauses, including the meaning of the subordinate conjunction 'after'. The semantic interpretation of the time relation between the two propositions is defined as follows:

BEFORE(P,P')

where P represents the 28 day mission, and P' the deorbit of the satellite.

In other cases, links between propositions of a text can be established by means of the hyponymy relation holding between words contained in the text. To illustrate this, consider the following pair of consecutive sentences:

(a) SPUTNIK 1 WAS OBSERVED IN ORBIT
OVER THE INDIAN OCEAN ON FEBRUARY 11.

(b) THE SATELLITE LATER REENTERED THE EARTH'S ATMOSPHERE
AND BROKE UP UPON REENTRY.

Here the noun phrase "the satellite" is a more general term for "Sputnik 1", the relation between the two terms being one of hyponymy (subsection 2.3.4.2). The link between the two sentences is one of noun phrase reference.

Equivalence between two noun phrases is sometimes explicitly stated in a text as in (c) below:

(c) THE FIRST EARTH SATELLITE, ALSO KNOWN AS SPUTNIK 1...

In the previous example, the information which permitts the resolution of the noun phrase reference is present in the immediate context. At times lexical connection between sentences may not be given overtly, but may depend upon factual knowledge that the originator of the text assumes on the part of the reader. Consider the following pair of sentences where the definite noun phrase refers to a concept not mentioned in the previous context, but is conceptually linked to it.

(d) A FLIGHT OF TWO AIRCRAFT WAS ACTIVE OVER PLACENAME DURING THE LATE ZULUTIME HOURS.

(e) THE PILOTS WERE IN COMMUNICATION WITH AN UNIDENTIFIED CONTROL AND REPORTING CENTER.

The problem here is to establish the referents of the definite noun phrase "the pilots", which has not been mentioned in the previous context. In cases such as these, the disambiguation may be handled by what Chafe (1972) describes as "foregrounding". Chafe argues that whenever a new concept is introduced into a communication, that concept introduces a number of related concepts into the local context or foreground. For example, once the concept of "aircraft" has been mentioned in a text, we can use definite reference for its engine, fuselage, wings, and even its pilot. Thus, in the pair of sentences above, sentence (d) introduces the concept of "aircraft" which then automatically brings into focus closely associated concepts including the notion of "pilot", which is referred to by a definite noun phrase in (e).

In an automated system, the fact that aircraft have pilots is stored in the permanent knowledge base of the system and is thus readily accessible to the routines for anaphora resolution.

2.4 Representational Issues

This section discusses two representational constructs of fundamental importance to event processing: the Template and the Event Record.

2.4.1 The Template. Taking the event as the primary unit of analysis, OSI has developed the concept of a "template" as an organizing principle for the uniform representation of information on events and event-related entities, as viewed from the perspective of the user/analyst in the context of a particular task domain.

Events and event-related entities are described as n-ary relations, where the n-ary relationships is named by a predicate symbol and the arguments of the relation correspond to the "roles" of case theory (see subsection 2.3.4.2).

An important part of the information encoded in templates consists of what linguists call the "selectional restrictions" or "selectional preferences" in a particular domain. In essence, the latter express the correspondences between syntax and semantics, and play a fundamental role in semantic interpretation. They form the basis for constructing the procedures which map syntactically analyzed input sentences into event records and thus have the function of reducing the many ways a concept can be expressed in natural language to a systematic representation of the information content of the input sentence.

Although most correspondences between syntax and semantics hold across subject domains, each domain seems to present some idiosyncratic usage. It is important, therefore, that the correspondences between syntax and semantics be studied in depth for each subject domain before they can be translated into algorithms and incorporated into templates.

In the domains under investigation there are templates for classes of objects (aircraft, missiles), classes of events (flights, launchings), classes of relations (temporal, causal), and other concepts such as the date time group. For example, a template describing the class of flight events in the context of the air activities domain includes parameters such as time of flight, the aircraft involved in the flight, the purpose of the flight (its mission) , the point of departure, the destination, the current location, the farthest point reached, direction, altitude, and path. The aircraft involved in a flight are in turn described in terms of aircraft-related parameters such as equipment type, nationality, organizational subordination, and so on. These are all parameters which can enter into a flight event and are therefore part of the cognitive model of the analyst, i.e., of his view of what a flight involves.

Table 2-a provides an informal description of the LAUNCH template as developed for the Missile and Satellite domains. The template embodies a set of descriptors selected from a small set of descriptor types. Each descriptor has a procedure attached to it which incorporates the information necessary to relate abstract descriptions of concepts to syntactic structures. They are essentially mapping rules which effect the transformation of parsed sentences into event records.

In a sense a template is like a class declaration, a structure naming the attributes (descriptor slots) which are optionally or obligatorily associated with instances of that class, and specifying the values those attributes can have.

Templates integrate procedural knowledge with a richly structured declarative representation. In this sense, templates have a lot in common with both Wilks'(1977) recursive semantic formulas and Bobrow and Winograd's (1977) KRL Specialization Units.

Table 2-a. Informal Description of the LAUNCH Concept in the Missile and Satellite Domain.

Descriptive Elements			Procedural Elements
Descriptor	Filler Specification	OBL/ / /OPT	Procedures for filling slots
Agent	If expressed, then logical subject of sentence. Head noun with feature NATION	OPT	If conditions hold, fill Agent slot with subject noun phrase
Object	If no Agent, then Object in logical subject position; otherwise in object position. Allowable features: MISSILE and SATELLITE	OBL	According to which conditions hold, construct Object template from either subject nounphrase or object nounphrase
Launchsys	Either subject nounphrase with headnoun with feature BOOSTER, or PP with prep BY and headnoun with feature BOOSTER	OPT	Test headnoun of subject for feature BOOSTER Search VMODS list for specified prepositional phrase
Launchsite	PP with headnoun (+LOC)		Search VMODS list for specified constituent
Inclination	PP with headnoun (+INCL)		Search VMODS list for specified constituent

Table 2-a (contd)

Destination	PP with Preps TO or INTO and headnoun with feature LOC		Search VMODS list for specified constituent
Time	1. ADV (TYME REF) or 2. PP with TYME prep and headnoun with feature TYME	OPT	Search VMODS list for specified constituent
Date	PP with DATE-node	OPT	Search VMODS list for specified constituent

Each subject domain yields its own template inventory corresponding to the events and objects and their internal and external relations -- optional or obligatory -- which have informational significance within that domain. In the Missile and Satellite domain, some of the key concepts for which templates have been constructed are: "launch", "deorbit", "reentry", "breakup", "impact", "missile", "satellite", and "DTG". (For a complete listing of the template inventory and the auxiliary procedures as encoded in the language Prolog, see Appendix C).

In summary, the template is an information structure which provides the means for coding the analyst's cognitive models in terms of logical data structures which are susceptible to automatic processing. In other words, templates provide a framework for the representation of higher-level conceptual information approximating that which a human reader has of a given subject matter.

Logically, templates can be viewed as relational network models of memory in which primitives are relations, words, and word senses. Procedurally, they can best be described as the fundamental knowledge structures which mediate the correlations between syntactic structures and their corresponding information content.

Each template describes a class of entities in terms of those properties which are normally associated with that class in a particular task domain. A template thus reflects the information user's conceptualization of the domain, i.e., his view of what that class of entities involves.

2.4.2 The Event Record. While templates are abstract data structures for the representation of event classes, Event Records are concrete data structures for the representation of individual events. An event record is the description of a single individual, i.e., a unique member of a class of individuals in the world being modeled. A simple example is the description of a specific spacecraft (e.g., Skylab) which was launched from a specific launch site, at a given time and date. Table 2-b illustrates the event record corresponding to the LAUNCH sentence below:

> THE SKYLAB ORBITAL WORKSHOP, A CONVERTED S-4B
> THIRD STAGE FROM A SATURN-5 LAUNCH VEHICLE,
> WAS LAUNCHED FROM THE KENNEDY SPACE CENTER
> AT 1300 HOURS ON 14 MAY 1973.

Table 2-b. Event Record for LAUNCH Sentence

```
+------------------------------------------------------------+
|                                                            |
|   Event:  LAUNCH                                           |
|   Action: LAUNCHED                                         |
|   Object: SATELLITE                                        |
|   ... Equipment= SKYLAB ORBITAL WORKSHOP                   |
|   ... Number=                                              |
|   ... Relative= A CONVERTED S-4B THIRD STAGE FROM A        |
|                 SATURN-5 LAUNCH VEHICLE                    |
|   Launchsite= FROM THE KENNEDY SPACE CENTER                |
|   Time = AT 1300 HOURS                                     |
|   Date = ON 14 MAY 1973                                    |
+------------------------------------------------------------+
```

Notice that the above sentence does not provide values for all the descriptors associated with the LAUNCH template. Templates represent an aggregate of all the possible parameters and attributes which can be associated with an event or object in the context of a given domain. Many of these parameters or attributes are optional and therefore need not be present in any one actual description in a text.

Note also that the appositive "a converted S-4B third stage from a Saturn-5 launch vehicle" is analyzed as a relative clause and stored in the "Relative" descriptor slot. For a discussion of the current treatment of relative clauses the reader is referred to the subsections on relative clauses and appositive postmodification in Section 3 of this report.

Event Records have several important properties which render them particularly useful as a support tool for the I&W analyst:

- They reflect the analysts view of the world, and are thus compatible with their cognitive models of objects, events and states of affairs in their area of expertise.
- They are discrete representations of events, objects, and their properties and are usable for the construction of a data base.
- They are so designed as to allow flexible retrieval of information not only by event type, but also by other associated parameters, such as object(s) involved in the event, and time and location indicators.
- The information stored in these data structures is in a format which lends itself readily to further processing. This processing may be related to storage and retrieval functions, may be statistical in nature, or may be part of the inference making mechanisms to be developed for a future system (e.g., a system for event prediction).

The next section deals primarily with discourse reference. The section begins by briefly defining the problem of reference, and then goes on to discuss several forms of reference common in our sublanguage.

2.5 The Problem of Reference

A more complete computer 'understanding' of narrative text requires the machine to have the ability to deal with anaphoric language in a perspicuous and systematic way. This ability is especially important for the analysis of larger texts characteristic of intelligence messages.

Two of the major surveys discussing the problems of anaphora are Nash-Webber (1977) and Hirst (1979).

Computer-based attempts to handle anaphoric expressions are described in Baranovsky (1970), Burton (1976), Charniak (1972, 1973), Deutsch (1975), Hobbs (1976), Rumelhart (1975), Wilks (1975), Winograd (1972), Woods (1972), and others.

Information contained in a message falls into two distinct categories. At each point in a message text some of the information is "new": i.e., it is being introduced into the text by the sentence being analyzed at that point. Other information is "given", or "old", i.e., it has previously been introduced in the text and we assume, stored in memory, much as the human processes sequential text. Interpreting a text requires identifying given concepts in memory and attaching the new information to them. In the following discussion, the term "referring expression" is used to denote those parts of a sentence that communicate given information.

The problem of reference, then, is the problem of identifying the concepts referred to in a text. Such concepts need not explicitly be expressed as segments in a text; they very often are entities which are assumed to be in the reader's mind.*

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* For a discussion of the general problem of reference see RADC-TR-77-194, Vol. I, Part I, Section 2.1.

Anaphoric expressions comprise pronouns, pro-verbs, some definite noun phrases and ellipses. The ensuing remarks are restricted to definite referring expressions.

2.5.1 Definite Referring Expressions. For the purposes of discussion it is useful to distinguish two kinds of definite referring expressions: pronouns and non-pronominal definite noun phrases. The reason for this distinction is that the processes needed to identify the concepts referred to by pronouns differ from those needed for the resolution of non-pronominal definite noun phrases.

The test data used under this contract contains both pronominal and non-pronominal definite noun phrases (e.g., it, their, they, the spacecraft, the three missiles launched from PLACENAME).

2.5.1.1 Pronominal Reference. Pronouns carry little information in themselves. Consider the following sentence:

IT IMPACTED IN THE AUSTRALIAN OUTBACK.

The pronoun "it" in the above sentence only tells us that the subject of "impacted" must be singular. To help identify the referent of "it" we must determine its functional role in the sentence -- its "case" in the sense of Fillmore (see subsection 2.3.4.2 -- and make use of the syntactic and semantic restrictions on the slot occupied by the pronoun. Then the previous context can be searched for a concept that satisfies those restrictions. In the given example the restrictions are first, that the referent of "it" must be singular, and second, that it must be a physical object capable of impacting. In the given subject domain, such an object is either a missile or a satellite.

The following paragraphs suggest a method for handling pronoun references of the kind illustrated above.

The above sentence would first be syntactically analyzed into a propositional structure, and subsequently undergo case assignment; the pronoun 'it' is assigned the role of Object. As mentioned above, 'it' carries the lexical information that it is definite and singular. The fact that it was assigned the Object role indicates that its referent must belong to either the missile or the satellite class. This information is included in the restrictions specified in the intensional description of the IMPACT event concept. Once the program determines the restrictions on the referent for "it", it proceeds to examine all descriptions recently stored in memory to find one which meets the semantic feature tests for the pronoun's case slot. If such a description is found, the program will ensure that it agrees in number with "it" before it is accepted as a possible referent. If the test is positive, the program creates a link from the Object slot of the event record representing the sentence under discussion to the description just identified.

When pronouns refer back over longer portions of a text the resolution process is more complicated, since the larger the previous context, the more numerous are the potential referents of the pronoun and the more complex the inferential processing that has to be performed.

The next section examines definite noun phrases which are used anaphorically, i.e., the noun at the head of the construction refers to a specific object or concept.

2.5.1.2 Definite Noun Phrases. The major difference between pronouns and definite noun phrases is that the latter carry more information. Thus, the phrase 'the four SS-11 missiles' contains information specifying both the general class (missiles) and the type (SS-11) of the objects referred to.

The resolution of such noun phrases is basically a problem of finding a matching description in memory. The methods required to decide whether a given entity fits a given description are often very complex and include all kinds of inferential processes.

In the simplest cases are those which involve matching a definite description with an object that has been described in the same way previously in the text. Other cases may involve complex routines using the semantics of descriptors as well as their syntactic form, the immediate linguistic context, the world knowledge stored in the system, external data files (special dictionaries, glossaries, etc.), and sometimes even the extensional event data base in order to decide whether two descriptions match.

Sometimes a definite noun phrase may refer to an entire chain of events. In such cases it is necessary to appeal to structures made up of units defined at a higher conceptual level than that customary in traditional linguistic analyses.

For a computer program to do this, it must be able to refer not to the individual sentences of the message, but to the chain of events represented by these sentences expressed in higher level conceptual categories appropriate for event description, thus making use of the "Message Grammar".

One of the areas into which this research might profitably be extended is exploring the possibility of resolving anaphora not only within the limited context of a single message, but also within the larger context of an EVENT REPORT.

2.6 Guidelines for the Establishment of a Research Corpus

Because of the nature of the data for which this system is developed, a special approach is taken to the establishment of a research corpus.

2.6.1 Data Collection. For any given subject domain, the first task relates to the collection, "sanitization", and organization of a representative sample of intelligence messages to serve as the source data for the analysis and characterization of the reporting language.

Data should be gathered in cohesive units which form a conceptual whole in the given domain. Thus, in the missile and satellite domain, messages were collected in sets constituting EVENT REPORTS. Only if so organized can a systematic study of the domain be undertaken.

A sufficient amount of data needs to be collected for each subject domain. The notion "sufficient data" can only be quantified by a step by step collection of data in each subject domain. It is a well known fact that each new batch of data collected for any given domain yields less and less new information. At a certain point the graph of additional new items vs. total information levels off. It is at that point that further data collection becomes unproductive.

2.6.2 Data Sanitization. The source data gathered for purposes of development is usually classified. It can therefore not be used in its original form for in-house development of computer programs for the analysis of message text. Such developmental work can be accomplished far more easily with unclassified test data than with actual messages, provided the test data has the same grammatical structure as the original material.

To achieve this, a procedure to generate unclassified message text from classified data was developed. The procedure consists of two steps.

- Step 1. Narrative message text is transcribed according to a set of transcription rules, according to which all proper names of objects, their attributes, and time/location parameters are replaced by placeholders. For example, names of political entities (e.g., USA, UK) are replaced by the string "politname". Specific geographic placenames (e.g., Cape Kennedy, Florida) are replaced by the string "placename". Names of persons (e.g., Pete Conrad, Valery Bykovsky) are replaced by the string "personname, while times and dates are replaced by appropriate placeholders. A complete list of the sanitization rules developed for the Missile and Satellite domains is given in subsection 3.2.1. The resulting text is used for the study of the grammatical structure of the reporting language and for system development.

- Step 2. For purposes of demonstrating the system, the transcribed text is input to a special routine which places all events in the future and randomly replaces the placeholders by either totally ficticious names or by names referring to objects in outer space.

This method preserves the syntactic structure of the original language for linguistic analysis. At the same time, it provides some appearance of verisimilitude.

Thus, the transcribed sentence (a) below, might be changed into sentence (b):

a. MISCLASS LAUNCHED FROM PLACENAME1 TO PLACENAME2, DAYNO NMTH 4NMBR.

b. UM-67 ICBM LAUNCHED FROM BETELGEUSE TO RIGEL 23 JULY 1987.*

2.6.3 The KWIC Concordance. Next, the sanitized data is put into a machine readable form and processed by a standard KWIC index program, which yields a key-word-in-context concordance, orthographic type counts, and some limited statistics. The utility of KWIC concordances and associated frequency lists both as an aid to linguistic analysis and for determining priorities in the parser need hardly be stressed. An excerpt from a KWIC concordance produced for the Missile and Satellite domains is shown in Table 2-1.

A listing of each word form in its context permits a more precise charactorization of the sublanguage under investigation than would be possible otherwise. By its very form, the

* Note: M-67 is the name of a galactic cluster in the Cancer constellation. UM-67 is a fictitious name. Betelgeuse and Rigel are stars in the Orion constellation.

KWIC index facilitates the determination of the word classes and relations characteristic of a particular sublanguage, and thus forms the basis for defining both the scope and the vocabulary specific to a reporting language and the scope of the sublanguage grammar to be used by the parser.

The three procedural steps described above lay the foundations for the conceptual analysis of the source data.

Table 2-1   Concordance Program Output

TOKEN	MESG. NO.	SENT. NO.
TED ON THE PLACENAME PENNISULA ABOUT NMBR MINUTES AFTER LAUNCH	34	3
RE-ENTERED IN THE ACRONYM AREA ABOUT NMBR MINUTES AFTER LAUNCH AT ZULUTIME	32	3
ENERAL VICINITY OF COORDINATES ABOUT NMBR MINUTES AFTER LIFT-OFF	13	4
AME REACHIVATED SATELLITENAME ON DAYNO MONTHNAME AFTER NMBR DAYS OF SPACECRAFT INACTIVITY	14	2
RANSPONDER FREQUENCIES WILL PROBABLY BE ACTIVATED AFTER SATELLITENAME IS FINALLY STABLIZED	14	7
THE ORBIT OF SATELLITENAME WILL AGAIN BE FAVORABLE FOR GEOPOSITIONING WITHIN THE N	14	8
AT ZULUTIME, NAME -- THE COUNTRYNAME NEWS AGENCY -- ANNOUNCED THE LAUNCH OF SPACECRAFTNAME,	4	2
A ROUTINELY WORDED STATEMENT THE COUNTRYNAME NEWS AGENCY NAME ANNOUNCED THE LAUNCHING OF SPACECRAFTN	19	2
1. AT ZULUTIME TODAY, NAME, THE COUNTRYNAME NEWS AGENCY, ANNOUMCED THE LAUNCH OF SPACECRAFTNAME	6	2
STATEMENT AT ZULUTIME TODAY, THE COUNTRYNAME NEWS AGENCY, NAME, ANNOUNCED THAT SPACECRAFTNAME WAS LA	-	2
THE COUNTRYNAME NEWS AGENCY, NAME, ANNOUNCED THE LAUNCH OF SPACECRAFTNA	11	2
THE FOLLOWING DEPICTS THE RIGHT ASCENSION ALIGNMENT OF THE SECOND-GENERATION NAVSAT NETWORK	13	10
ALL LAUNCHES SINCE MONTHNAME YEARNO HAVE BEEN TO T	30	7
WAS THE NMBRTH MISSILECATEGORY LAUNCH THIS YEAR, ALL MOD NMBR'S	21	11
ALL THE SIGNALS INTERCEPTED WERE ON NOMINAL MISSIL	21	8
ENAME WAS EVIDENTLY TEMPORARILY ABANDONED AND WAS ALLOWED TO CONTINUE ITS ORIGINAL WESTWARD DRIFT IN	14	4
NMBR DEGREES FROM THE EXISTING NETWORK AND IS ALMOST NMBR DEGREES OUT-OF-PHASE WITH SPACECRA	13	8
RESOLUTION PHOTOGRAPHIC SATELLITE (PROBABLY IN THE ALPHANMBR SERIES)	2	3
THE PLACENAME MISSILE TEST RANGE (ACRONYM) BY THE ALPHANMBR SPACE BOOSTER AND INSERTED INTO AN ORBIT	7	2
ED FROM PLACENAME MISSILE AND SPACE CENTER BY THE ALPHANMBR SPACE BOOSTER AT ZULUTIME HAS BEEN CONFI	18	2
OM THE PLACENAME MISSILE AND SPACE COMPLEX BY THE ALPHANMBR SPACE BOOSTER AT ZULUTIME THIS DATE HAS	10	2
FROM THE PLACENAME MISSILE AND SPCE CENTER BY THE ALPHANMBR SPACE LAUNCH SYSTEM	12	2
ROM THE PLACENAME MISSILE AND SPACE CENTER BY THE ALPHANMBR SPACE LAUNCH SYSTEM AND WAS INJECTED INT	9	2
LAUNCHED ON AN INCLINATION OF NMBR DEGREES BY THE ALPHANMBR SPACE SYSTEM, WAS APPARENTLY INTENDED TO	13	5
ED AS AN UNIDENTIFIED MILITARY SUPPORT SATELLITE (ALPHANMBR) OF THE SPACECRAFTCLASS NMBR, NMBR, NMBR	10	2
A MANNED COUNTRYNAME SPACECRAFTCLASS FERRY CRAFT (ALPHANMBR) WAS LAUNCHED FROM THE PLACENAME MISSILE	7	2
CRAFTNAME, THE UNIDENTIFIED MILITARY SUPPORT ESV (ALPHANMBR) WHICH WAS LAUNCHED FROM THE PLACENAME M	4	2
ALTHOUGH THE EXACT MOD OF THE VEHICLE CANNOT BE DE	26	4
CHED FROM PLACENAME ON DAYNO MONTHNAME, AND AFTER AN APPARENT UNSUCCESSFUL ATTEMPT TO STABLIZE THE S	14	3
LAUNCHES PER YEAR IN THE YEARNO-YEARNO PERIOD AND AN AVERAGE OF NMBR PER YEAR THEREAFTER	30	6
NOTE: THIS IS FOLLOWED BY AN EVENT HISTORY IN TABULAR FORMAT	21	12
THIS SPACECRAFT, LAUNCHED ON AN INCLINATION OF NMBR DEGREES BY THE ALPHANMBR SP	13	5
HNAME, HOWEVER, THIS INITIAL MANEUVER RESULTED IN AN INSIGNIFICANT REDUCTION IN THE SPACECRAFT'S ORB	16	3
TH LAUNCH COMPLEX A SUGGESTS THAT THE MISSILE WAS AN MISSILECATEGORY	28	6
AT APPROXIMATELY ZULUTIME, AN MISSILECATEGORY (POSSIBLY DUAL) WAS LAUNCHED FR	38	2
1. AN MISSILECATEGORY ICBM WAS LAUNCHED FROM THE STRA	26	2
AN MISSILECATEGORY ICBM WAS LAUNCHED FROM THE PLAC	34	2
AT APPROXIMATELY ZULUTIME ON DAYNO MONTHNAME, AN MISSILECATEGORY INTERMEDIATE RANGE BALLISTIC MI	33	2
DAYNO MONTHNAME YEARNO, THE COUNTRYNAME LAUNCHED AN MISSILECATEGORY IRBM FROM THE OCEANNAME	36	2
1. AN MISSILECATEGORY MOD NMBR ICBM WAS LAUNCHED FROM	21	2
DAYNO MONTHNAME YEARNO, THE COUNTRYNAME LAUNCHED AN MISSILECATEGORY MOD NMBR ICBM FROM THE PLACENAM	35	2
AT ZULUTIME, AN MISSILECATEGORY SIMULATION WAS LAUNCHED FROM TH	38	5
AN MISSILECATEGORY SLBM WAS LAUNCHED FROM THE OCEA	22	2
AN MISSILECATEGORY VERTICAL WAS LAUNCHED FROM THE	32	2
AT ZULUTIME, AN MISSILECATEGORY WAS LAUNCHED FROM PLACENAME MIS	37	2
AT THE SAME TIME, AN MISSILECATEGORY WAS LAUNCHED FROM THE SRF SITE	23	3
AN UNIDENTIFIED SURFACE-TO-AIR MISSILE, POSSIBLY AN MISSILECATEGORY, WAS LAUNCHED POSSIBLY FROM	29	2
PHANMBR SPACE LAUNCH SYSTEM AND WAS INJECTED INTO AN ORBIT INCLINED NMBR DEGREES TO THE EQUATOR	9	2
BY THE ALPHANMBR SPACE BOOSTER AND INSERTED INTO AN ORBIT INCLINED NMBR DEGREES TO THE EQUATOR	7	2
AFT, IF SUCCESSFUL, WOULD HAVE BEEN INSERTED INTO AN ORBIT SIMILAR TO PREVIOUS NAVSATS	13	9
STER AT ZULUTIME THIS DATE HAS BEEN IDENTIFIED AS AN UNIDENTIFIED MILITARY SUPPORT SATELLITE (ALPHAN	10	2

3.0 MISSILE AND SATELLITE DOMAIN DEFINITION

This section begins with a brief introduction of the missile and satellite worlds, and continues with a detailed description of the two domains in the form of a domain definition.

3.1 The Missile and Satellite Worlds

The missile and satellite worlds have a large number of properties in common.

Both worlds contain political entities (e.g., U.S., USSR, Uganda), which carry out intentional actions (e.g., they launch satellites, or missiles).

Both worlds are characterized by certain human actions whose instigators normally remain unidentified. Thus, objects are identified; missions are assessed or confirmed; events are expected, announced or confirmed; actions are attempted.

In both worlds time and location indications are of crucial importance.

There are, however, some significant differences, due to the differences in function between missiles and satellites. Satellites but not missiles are launched into a given orbit; satellites but not missiles perform orbital maneuvers; satellites but not missiles have well-defined missions; some satellites perform manned flights, in which case they may rendezvous and dock with other spacecraft; finally, satellites but not missiles are deorbited, abandoned, or reactivated.

Another important difference concerns the time span associated with the series of actions and events connected with a launch. Thus, while the duration of the chain of events associated with missile launchings is measured in minutes, that of events associated with satellite launchings is usually measured in days, months, or even years, as in the case of Skylab.

The characteristic objects in the satellite world are spacecraft. As mentioned above, the range of actions a spacecraft normally performs is wider than that of missiles. Spacecraft can be launched, placed into orbit, deorbited, and recovered; they can perform orbital maneuvers, rendezvous and dock with other spacecraft, they can deorbit themselves, reenter the earth's atmosphere, break up, burn up, crash to earth and impact. They can be manned or unmanned. They can have different kinds of missions. Their physical properties are varied.

Missiles are simpler to describe and the number of atomic events they can participate in, although similar, are much more restricted.

3.2 Domain Definition

3.2.1 Research Corpus. The test corpus used as a basis for the developmental work described in this report consists of 280 messages organized into EVENT REPORTS.

3.2.1.1 Source Data Sanitization. Approximately 20% of the messages collected were transcribed according to the sanitization rules discussed in subsection 2.5.2. For a listing of the sanitized message texts, see Appendix A.

The list of placeholders used for the transcription of the missile and satellite test corpus is given below.

Placeholder List

Note that all propernames used in this list are taken from the sources listed in the Foreword to this report.

- *SPANAME* (spacecraft name): COSMOS-724, COSMOS-651, VOYAGER, SOYUZ-21, MOLNIYA-2A PIONEER-11, etc.
- *SPATYPE* (spacecraft type): SOYUZ, COSMOS, PIONEER
- *SPACLASS* (spacecraft class): ESV
- *SPASTANAME* (space station name): SALYUT-4
- *MISNAME* (missile name): SS-N-10, SS-14, SS-N-6,

- *MISCLASS* (missile class): INTERMEDIATE BALLISTIC MISSILE, ICBM, SLBM, DRONE, SAM
- *LSTYPE* (launch system type): SS-4, SATURN-1B
- *PRESSNAME:* TASS
- *PLACENAME:* TYURATAM, PLESETSK, THE AUSTRALIAN OUTBACK
- *SEANAME:* INDIAN OCEAN, BLACK SEA
- *TRAC* (test range acronym):
- *POLITNAME:* SOVIET UNION, USSR, USA
- *POLITADJ:* SOVIET
- *NATNAME:* (Used for nationals of countries) SOVIETS, AUSTRALIANS
- *PERSONNAME:* CHARLES (PETE) CONRAD, YURIJ ROMANENKO, GEORGIJ GRECHKO
- *COORDINATES:* 68-28N 46-29E, 49-33N 160-24E, 70N 36E, (Note the variety of formats used for the expression of coordinates).
- *ZULUTIME:* 0940Z, 281600Z, (Note the different formats).
- *1NMBR:* 1, 2, etc.
- *2NMBR:* 10, 11, etc. (and similarly for 3NMBR, etc. Note that 1NMBR or 2NMBR might designate a day of the month, and that 2NMBR or 4NMBR might refer to a year.)
- *NMBRNAME:* SEVEN, SIX, etc.
- *1NMBRTH:* 1ST, 2ND, etc. (and similarly for 2NMBRTH, etc.)
- *NMBRNAMETH:* FIFTH, SIXTH, etc.
- *RNMBR:* used for Roman Numerals like I, II, V, VII.
- *NMTH:* used for name of month, e.g., JANUARY, NOVEMBER

The list of "placeholders" remains open-ended. New placeholders are incorporated as required by the material under study.

3.2.1.2 *Examples of Transcribed Text.* The following examples show sanitized versions of real message text.

Example 1

MISNAME LAUNCHED FROM PLACENAME 2NMBR MNTH 4NMBR.
AT ZULUTIME1, A MISNAME WAS LAUNCHED FROM PLACENAME1.
IT IMPACTED NEAR PLACENAME2 AT ZULUTIME2.

Example 2

PRESSNAME ANNOUNCES LAUNCH OF SPANAME.
AT ZULUTIME, PRESSNAME-THE POLITADJ NEWS AGENCY-ANNOUNCED THE LAUNCH OF SPANAME, THE UNIDENTIFIED MILITARY SUPPORT SPACLASS WHICH WAS LAUNCHED FROM THE PLACENAME MISSILE AND SPACE CENTER AT ZULUTIME TODAY.
ORBITAL PARAMETERS AS CONTAINED IN THE ANNOUNCEMENT ARE:
APOGEE NMBR KILOMETERS
PERIGEE NMBR KILOMETERS
INCLINATION NMBR DEGREES
PERIOD NMBR MINUTES

The transcription procedure is very time consuming. The exercise of developing a sanitization procedure, however, has proved useful. It has provided a means of partitioning the message vocabulary into those items which are common English words and those that are specific to the domain (nomenclature, specific ways of referring to times and dates, geographic locations, etc.) and therefore require special recognition procedures in an operational environment.

The set of messages sanitized according to the above procedure under this contract are contained in Appendix A.

3.2.2 The Structure of EVENT REPORTS. As one would expect, the structure of the EVENT REPORTS in the two domains reflects the state of affairs in the real world. EVENT REPORTS describing satellite-related activities consist of several messages, each describing one or more atomic events.

For example, in the satellite domain, a first message always describes a launch, and is invariably followed by a message confirming the launch. A subsequent message reports the announcement of the launch by a foreign press agency and usually provides details of orbital parameters. The foreign press announcement is optionally followed by one or more messages describing related events such as orbital maneuvers, stabilization maneuvers, a rendezvous, a docking, a deorbit, an impact and/or a recovery.

The last message in an EVENT REPORT is usually a summary statement describing the global event.

EVENT REPORTS describing missile launching and related events are much more compact. Often the launch, the reentry and the impact of a particular missile are described in a single message.

This structural difference has implications for the process models which will apply to the two domains; the model for the satellite domains will be much more complex than that for the missile domain.

3.2.2.1 Message Types. In order to characterize EVENT REPORTS at the global level, their internal composition in terms of message types was studied.

Individual messages were classified according to the type of information they contain. As pointed out in subsection 2.3, it is important to distinguish between those messages that refer to an event for the first time, and those that confirm events, elaborate on their properties, request changes, report on related events, offer comments, or provide global summaries of EVENTS.

Several distinct message types were identified:

a. Messages describing a new event.
b. Messages confirming an event.
c. Messages elaborating on the parameters of a previously reported event.
d. A report of a report, e.g., a message reporting on a foreign news agency press release concerning an event.
e. Data Summary Messages.
f. Closure Messages
g. Follow up Messages.
h. Requests for changes to previously reported facts.

The message types studied in detail under this contract include those listed under a-d. Types e-h are characterized by an abundance of evaluative statements, hypothetical statements, and statements expressing opinions or certain inferences. The current study was limited to statements describing events and therefore excludes message types e-h.

3.2.2.2 Event Types and other Concepts. The following major Event types were identified:

a. LAUNCH

b. DEORBIT

c. DOCKING

d. REENTRY (AND DECAY)

e. BREAKUP

f. IMPACT

A number of other concepts with a complex internal structure were identified:

a. Objects: Missiles and Satellites

b. The date time group (DTG)

c. Orbital Parameters: Apogee, Perigee, Period and Inclination.

The relations which hold between events in the missile and satellite domains, are mainly temporal relations of succession in time and relations of presupposition and entailment. A spacecraft which is in orbit now must have necessarily been launched some time previously. A spacecraft which is reentering the earth's atmosphere will break up, burn up, or crash to earth.

A complete listing of the templates developed for the event types and other concepts listed above, including their ancilliary procedures as encoded in Prolog is given in Appendix C.

The DEORBIT template, as encoded in Prolog, is explicated in subsection 4.3.3.

3.2.2.3 Descriptor System. The following descriptors were identified for the Missile and Satellite Domains:

Table 3-1. Missile and Satellite Descriptor System

A. Higher-Level descriptors	
Infosource	The source of a report of an event e.g., a foreign news agency
Status	Status of event (expected to happen; failed to happen; confirmed)
B. Event-related descriptors	
Agent	Animate instigator of an action.
Object	The entity that moves or changes or whose position or existence is being described.
Location	The location of the object at some point in time.
Destination	Projected or actual destination of the object at the end of the mission.
Mission	Mission of satellite
Revolution	Usually revolution on which
C. Orbit-related descriptors	
Apogee	
Perigee	
Period	
Inclination	
C. Launch-related descriptors	
Launchsite	Site from which a missile or satellite was launched
Launchsystem	System used for firing missile or satellite.
D. Date/Time Group Descriptors	
Time	Time of observed event
Date	Date of observed event
Duration	Duration of an event
E. Object-related descriptors	
Equipment Class	Spacecraft or missile class
Setspecification	Number of objects
Further description	Usually a relative clause or appositive clause

3.2.3 Language Definition. The reporting language used in the two domains has special grammatical and lexical properties which justify calling it a sublanguage.

3.2.3.1 Relationship between General English and the Reporting Language. The reporting language consists of declarative sentences. There are no questions or commands. Furthermore, the reporting language is characterized by grammatical constructions which deviate from those of "normal" English, (e.g., dropped articles, dropped prepositions). Although it might be possible to first recover the deleted material and then subject the expanded text to a general parsing grammar, it turned out more convenient to write a specialized grammar stating the allowable combinations of word classes directly. Our number of rules still is considerable smaller than those that would be required for general English.

As an example of idiosyncratic vocabulary usage, consider the verb "deploy". In ordinary discursive prose, this verb is normally used with an animate Agent: somebody deploys something. In our corpus, inanimate objects like aircraft more often than not deploy themselves. Constructions with the Agent expressed in surface structure occur less frequently.

3.2.3.2 The Grammar. In the MATRES II System, the linguistic structure is defined by means of an augmented transition network grammar in terms of familiar linguistic categories such as sentence, nounphrase, verbgroup, prepositional phrase and adverb.

In order to expedite processing, a number of language specific categories, not usually found in traditional grammars, were added. Thus, the familiar definition of prepositional phrase in (a) was augmented to encompass dates (b):

(a) pp → prep + nounphrase

(b) pp → prep + date

where 'date' is a non-terminal of the grammar with its own internal structure.

In this section we give an informal description of the major grammatical phenomena which are covered by the grammar, and of the analyses which are given them by the ATN parser.

3.2.3.2.1 The Declarative Sentence. The only class of sentences handled by the current version of the grammar are declarative sentences. As mentioned above there are no other sentence types in the corpus.

A declarative sentence may be a simple sentence as in (1), a complex sentence with embedded nominal clauses as in (2) and (3), or sentences with adverbial subordinate clauses as in (4) and (5). The current version of the grammar does not handle coordination.

1. SKYLAB DEORBITED OVER CANADA.
2. TASS ANNOUNCED THAT SKYLAB DEORBITED OVER CANADA.
3. SKYLAB FAILED TO IMPACT IN CANADA.
4. THE SATELLITE DEORBITED AFTER A 13 DAY MISSION.
5. THE SATELLITE DEORBITED FOLLOWING A 13 DAY MISSION.

The MATRES II grammar analyzes a declarative sentence as a list having as its first element a simple sentence, which may be followed optionally by a sentence conjunction, and either another simple sentence or a noun phrase.

3.2.3.2.2 The Simple Sentence. A simple sentence may have six components, of which only the main predicate is mandatory. The components are: voice (active or passive), subject (a noun phrase), a verb group, optionally followed by a direct object, a complement, and one or more post-verb modifiers.

The grammar analyzes a simple sentence as a six-branched node structure. The first branch points to the voice node, the second to the subject node, the third branch to the verb group, the fourth to the object, the fifth to a complement, and the sixth to a list of adverbial modifiers.

3.2.3.2.3 The Noun Phrase. In the simplest case, a noun phrase may consist of a pronoun or a proper noun optionally followed by an appositive construction. On the other extreme, a noun phrase may consist of a determiner followed by a list of pre-head modifiers, a head noun, and a list of post-head modifiers.

A determiner may consist simply of an article (e. g., 'THE'), a quantifier (eg. 'ALL'), or a number phrase (eg. 'AS MANY AS SIX'), or it may be a complex structure involving two or three of these constituents, as shown in the examples below:

ALL THE MISSILES

ALL SIX MISSILES

THE SIX MISSILES

ALL OF THE SIX MISSILES

Pre-head modifiers may include adjectives, nouns, past participles, and present participles. In both domains analyzed, head nouns are typically preceded by several modifiers referring to various attributes. Example (8) is taken from the aircraft domain, while example (9), is from the satellite domain.

(8) RETURNING UGANDAN UBBC SR-71 AIRCRAFT

(9) A FIRST GENERATION HIGH RESOLUTION PHOTOGRAPHIC SATELLITE

Possible post-head modifiers are relative clauses, reduced relative clauses, appositives, and prepositional phrases. An example of each is given in (10) through (13), respectively.

(10) SKYLAB, WHICH WAS LAUNCHED FROM THE KENNEDY SPACE CENTER ON 14 MAY 1973,....

(11) THE SATELLITE, LAUNCHED FROM THE KENNEDY SPACE CENTER ON 14 MAY 1973,.....

(12) THE SKYLAB ORBITAL WORKSHOP, A CONVERTED S-4B THIRD STAGE FROM A SATURN-5 LAUNCH VEHICLE, DEORBITED.......

(13) THE AIRCRAFT FROM ENTEBBE

A noun phrase is analyzed as a four-branched node. The first branch points to a determiner (possibly null, as in (10)), the second to a list of pre-head modifiers, the third to the head noun, and the fourth to a list of post-head modifiers.

The current version of the grammar only allows simple noun phrases (i.e., those without post-head modifiers) to occur as direct objects or prepositional objects.

3.2.3.2.4 Nominalizations. The following constructions, referred to as nominalizations, are very frequent in our research corpus:

a. THE DEORBIT OF SKYLAB

b. THE IMPACT OF SKYLAB

c. THE REENTRY OF SKYLAB

These nominalizations are parsed as noun phrases and are later converted into propositional structures in the ERL "machine" before semantic interpretation. Nouns like DEORBIT, IMPACT and REENTRY, which denote events, become the main predicates of their respective propositions, and the objects of the preposition 'of' become the logical subjects. Such nouns are marked by the feature EVENTIVE in the lexicon.

3.2.3.2.5 Relative Clauses. Among the post nominal modifiers, the relative clause is one of the most frequent constructions. A relative clause may start with a relative pronoun (e.g., which, that), in which case we refer to it as a "wh" relative (example a), or it may start with a past participle (b) or a present participle (c) optionally preceded by an adverb, in which case we refer to it as a reduced relative.

(a) THE UNIDENTIFIED MISSILE, WHICH WAS SOFTLANDED
NEAR THE SEANAME TODAY, WAS FIRED FROM PLACENAME.

(b) SATNAME, THE FIRST GENERATION HIGH RESOLUTION
PHOTOGRAPHIC SATELLITE LAUNCHED FROM PLACENAME
ON 2NMBR MONTHMAME, WAS DEORBITED DURING
ITS 3NMBRTH REVOLUTION.

(c) THE SPACECRAFT, CARRYING TWO ASTRONAUTS,
WAS SUCCESSFULLY INJECTED INTO AN ORBIT
INCLINED 2NMBR TO THE EQUATOR.

Relative clauses usually describe an event related to the main event of the sentence. As such they provide links to previous sentences or even messages.

In the current version of the system, relative clauses are parsed as sentences and stored in the postmodifier list of the head noun. The interpretive routines recognize relative clauses and store them as a unit in the "Relative" slot of event templates. A more sophisticated system, however, would break down relative clauses and build event records for them, which would be suitably connected to the main template. This was not done under this contract simply for lack of time.

The current version of the grammar also allows for relative clauses with a sentential antecedent as in the sentence below:

THE AIRCRAFT WAS APPARENTLY POSITIONED AT

0125N3470E, WHICH WOULD PLACE IT APPROXIMATELY

6 KMS INSIDE UGANDAN AIRSPACE.

Such relatives are stored in the post modifier list of the main verb. The following example illustrates how relative clauses are stored in templates:

(a) THE UNIDENTIFIED MISSILE , WHICH WAS SOFTLANDED NEAR
THE SEANAME TODAY, WAS FIRED FROM PLACENAME.

Event: LAUNCH
Action= FIRED
Object: MISSILE
...Equipment= UNIDENTIFIED MISSILE
...Number=
...Relative= SOFTLANDED NEAR THE SEANAME TODAY
Launchsite= FROM PLACENAME

3.2.3.2.6 Noun Phrase Apposition. Noun phrase apposition is very common in the sublanguages under study.

For two or more noun phrases to be appositives, i.e., in apposition, they must normally be identical in reference or else the reference of one must be included in the reference of the other. For example, in (a), THE SOVIET NEWS AGENCY and TASS refer to the same organization.

(a) THE SOVIET NEWS AGENCY, TASS, ANNOUNCED THAT........

The semantic relationship between the two noun phrases is one of "appellation", a subclass of the more general "equivalence" relationship (c.f., Quirk, 1972). With "appellation", both noun phrases are definite and the second is typically a proper noun.

The converse of "appellation" is "designation" also a subclass of the "equivalence" relationship. With designation -- as in the case of appellation -- both appositives are commonly definite noun phrases, but here the second appositive is less specific than the first, as illustrated in (b)

(b) TASS, THE SOVIET NEWS AGENCY, ANNOUNCED THAT..........

A third subclass of the equivalence relationship is that of "identification". With identification, the first appositive is typically an indefinite noun phrase and the second appositive is more specific as in (c) below:

(c) AN UNIDENTIFIED MISSILE, PERHAPS A DRONE,......

Here, there is no longer unique equivalence as there was with (a) and (b); the second appositive identifies -- often only tentatively -- what is given in the first appositive.

A second type of major semantic relationship in strict non-restrictive noun-phrase apposition is that of "attribution". "Attribution" involves predication rather than equivalence. The second appositive is commonly an indefinite noun phrase (although it can also be definite), and can be replaced by a relative clause:

(d) SPANAME, A LOW RESOLUTION PHOTOGRAPHIC SATELLITE,
LAUNCHED FROM TYURATAM AT 000Z ON 30 DEC 1955,...............

Figure 3-2 summarizes the semantic relationships in the types of appositives identified so far in the three subject domains analyzed thus far.

```
+--------------------------------------------------------+
|                      { APPELLATION                     |
| EQUIVALENCE          { IDENTIFICATION                  |
|                      { DESIGNATION                     |
|                                                        |
| ATTRIBUTION                                            |
|                                                        |
+--------------------------------------------------------+
```

Figure 3-2. Semantic Relationships in non-restrictive noun-phrase apposition.

Because all the subclasses of noun phrase apposition found in the aircraft, missile, and satellite materials to date are such that the second appositive can be replaced by a relative clause, it was decided to analyze them as relative clauses in the ATN grammar, and to shift the burden of distinguishing appositives from relative clauses to the interpretive component (the ERL "machine") -- if such distinctions were useful in an an operational environment.

The following example, taken from the the Missile domain, shows how a sentence containing an appositive is analyzed by the current version of the MATRES II system.

```
*>> AN UNIDENTIFIED MISSILE, PROBABLY A MISNAME,
*WAS FIRED FROM PLACENAME AT APPROXIMATELY ZULUTIME TODAY.
Event: LAUNCH
Action= FIRED
Object: MISSILE
...Equipment= UNIDENTIFIED MISSILE
...Number=
...Relative= PROBABLY A MISNAME
Launchsite= FROM PLACENAME
Time= AT APPROXIMATELY ZULUTIME TODAY
```

3.2.3.2.7 The Verb Group. The verb group may consist of an auxiliary followed by a verb, as in (14), or an auxiliary followed by a copula followed by an adjective, as in (15).

(14) HAVE BEEN CONDUCTING

(15) HAVE BEEN ACTIVE

In (14) the auxiliary is 'HAVE BEEN', while in (15) the auxiliary is 'HAVE', and 'BEEN' is the copula.

Some verbs (eg. 'CONDUCT', 'PENETRATE') must be followed by a direct object constituent, which is another noun phrase. Other verbs (eg. 'ARRIVE') never have a direct object, while for others (eg. 'OPERATE') the object is optional. Such verbs are marked TRANS, INTRANS or left unmarked in the lexicon.

3.2.3.2.8 Adverbials. Adverbial modifiers include prepositional phrases and adverbs, and may occur before the subject, as in (16), after the verb (and the object, if there is one) as in (17), or embedded within the verb group, as is the case with 'CURRENTLY' in (18).

(16) AT APPROXIMATELY 9 AM ON 25 MAY 1973,
AN APOLLO SPACECRAFT CARRYING THREE ASTRONAUTS
WAS LAUNCHED FROM THE KENNEDY SPACE CENTER.

(17) THE SATELLITE WAS LAUNCHED AT APPROXIMATELY
1330 HOURS ON 14 MAY 1973.

(18) THE SATELLITE IS CURRENTLY ORBITING OVER CANADA.

3.2.3.2.9 *The Concepts of Time and Space.* Two of the key concepts in intelligence reporting normally expressed as adverbials are the concepts of "time" and "space".

Knowledge of temporal patterns of given classes of events and time order relations between event classes, coupled with location data, can often assist the analyst in creating an overview of the current situation and in predicting possible outcomes. Knowledge of all events that occurred at about the same time or within a given time-span, in a given geographic area, can greatly enhance the analyst's capability to make accurate assessments of world situations.

Time references are particularly important, since in many cases they provide the only explicit link between the various messages constituting an EVENT REPORT (i.e., all messages referring to the same global event).

For example, consider an event referring to the launch of a new satellite. A first message may report the observed launching of an "unidentified" satellite. Although there is no name available for the satellite, such a message usually gives precise information as to the time, date and site of the launching. A subsequent message may state that the satellite launched at such and such a time from such and such a launchsite is now confirmed in orbit, but still lack information on the class of the satellite launched. The message identifying the satellite by name is sometimes not received until the foreign news agency announces the launch, or when the satellite is otherwise identified. Notice that up to that point the only available link between the received messages is the launch time and date and possibly the site.

The linguistic realization of time and location adverbials in our particular message domain often differs rather sharply from that in "normal" English.

Time phrases in the sublanguages under consideration tend to occur either at the beginning of sentences or at the end. In addition, they have special characteristics which render them easy to isolate from the rest of the sentence. First, they usually begin with certain prepositions (e.g., at, between, during, in, on, since, from ... to, until). Second, they necessarily contain one or more of a set of words designating the months of the year (including abbreviations); numbers, either spelled, in numeric form, or a form peculiar to intelligence reporting (zulutime); and third, expressions like "today", "this date", this year". The prepositions and the time expressions in the third group form closed sets and can be easily identified on the basis of a fairly restricted sample for any given class of messages.

The following are some examples of time and date expressions taken from the intelligence messages reporting on aircraft activities and missile and satellite launchings:

- AT 0940Z; AT 0940; AT 094000Z; AT APPROXIMATELY 0940Z; AT ABOUT 0940Z
- AT THE SAME TIME
- BETWEEN 0115 AND 0332Z; BETWEEN 0115-0332Z; BETWEEN 0115:0332Z
- BY 201600Z
- CURRENTLY
- DURING THE EARLY 0200Z HOUR
- DURING THE MORNING HOURS
- EARLIER; EARLIER TODAY

- FROM 1400-1625Z
- SINCE 0119; SINCE ABOUT 0119Z; SINCE APPROXIMATELY 0119

Corresponding date expressions are:

- DURING THE YEAR
- IN 1977; IN OCTOBER 1977; OCTOBER 1977
- ON 12 DECEMBER; ON 12 DECEMBER 1977; ON 12/13 DECEMBER
- ON THE 3RD; ON 3RD APR; ON THE 3RD APR
- 12 DECEMBER; 12 DEC 74; 12 DECEMBER 1974; DECEMBER 1977
- THIS DATE; ON THIS DATE; ON THAT DATE
- THIS YEAR
- TODAY; EARLIER TODAY

Date phrases are analyzed as three branched nodes. The first branch points to the day, the second to the month, and the third to the year (the third is often null).

3.2.3.2.10 Location References. Natural language expressions describing locations are far more varied than expression referring to time. While many such expressions may only be identifiable by means of linguistic analysis, there are nevertheless some classes that could be handled by a finite state character processing algorithm. Obvious candidates are references to location by means of coordinates (e.g., 5026N7138E, 50-26N 071-38E, and variations thereof).

3.2.3.2 11 Complementation. The current version of the grammar handles two types of complements: "that"-complements and "to"-complements, the only types found in the reporting languages under investigation.

Examples of 'that'-complements from the missile and satellite corpus are:

a. ...SUGGESTS THAT A MALFUNCTION MAY HAVE OCCURRED AS EARLY AS 2NMBR MNTH.

b. ...SUGGESTS THAT NMBRNAME WERE CARRIED.

c. ...ANNOUNCED THAT SPANAME WAS LAUNCHED FROM THE POLITNAME.

d. ...SUGGESTS THAT THE MISSLE WAS A MISNAME.

e. ...INDICATED THAT THE SECOND STAGE ENGINE FAILED TO IGNITE AS PROGRAMMED FOLLOWING FIRST STAGE SHUTDOWN.

f. ...INDICATIONS ARE THAT THE SECOND STAGE OF THE LAUNCH VEHICLE FAILED TO IGNITE.

g. ...INDICATES THAT THE SPACECRAFT HAS BEEN ABANDONED.

h. ...INDICATED THAT THE SPACECRAFT, IF SUCCESSFUL, WOULD HAVE BEEN INSERTED INTO AN ORBIT SIMILAR TO PREVIOUS NAVSATS.

i. ...INDICATES THAT THIS WAS A NOMINAL MISNAME MOD 1NMBR, ...

As the above examples show, 'that'-complements are complete declarative sentences preceded by the word 'that'. In our corpus, they are found in object position of verbs, as well as after certain nouns. The parser analyzes 'that'-complements as sentences and stores them in the 'Compl' register.

'To'-complements consist of the 'to' marker followed by the first verb of the predicate, which must be untensed. Examples of 'to'-complements from the missile and satellite corpus are:

a. ...FAILED TO ACHIEVE EARTH ORBIT AND REENTERED.

b. ...WAS TO BE INCLINED 2NMBR DEGREES TO THE EQUATOR.

c. ...WAS THE NMBRNAMETH MISNAME TO BE LAUNCHED FROM PLACENAME THIS YEAR.

d. ...APPEAR TO BE PRESENTLY CONDUCTING A SYSTEMATIC CHECKOUT OF THE ON-BOARD SYSTEMS.

e. ...WAS ALLOWED TO CONTINUE ITS ORIGINAL WESTWARD DRIFT IN SILENCE.

f. ...ATTEMPTED TO GEOPOSITION THE SATELLITE ON 1NMBR MNTH.

g. ...FAILED TO IGNITE.

h. ...FAILED TO IGNITE AS PROGRAMMED FOLLOWING FIRST STAGE SHUTDOWN.

i. ...IS EXPECTED TO RENDEZVOUS AND DOCK WITH THE ORBITING SPACE STATION SPASTANAME.

j. ...WAS APPARENTLY INTENDED TO REPLACE SPANAME.

k. ...SPANAME1 WAS LAUNCHED TO REPLACE SPANAME2.

l. ...WILL PROBABLY ATTEMPT TO SEPARATE THE NUCLEAR POWER SUPPLY FROM THE MAIN PAYLOAD.

m. ...ARE CONTINUING TO SHIFT WESTWARD AT ABOUT NMBR DEGREES PER DAY.

n. ...AFTER FAILING TO STABILIZE IT.

3.2.3.2.12 Passive Sentences. A form of "be" followed by a past participle form of a verb indicates the passive construction. Passive constructions are "inverted" so that passive and active forms of the same sentence result in the same "deep" structure. In the MATRES II grammar, a sentence such as (24) is restructured as in (25), where the surface subject becomes the object, and the surface object becomes the subject.

(24) THE SATELLITE WAS LAUNCHED BY NASA ON 14 MAY 1973.

(25) NASA LAUNCHED THE SATELLITE ON 14 MAY 1973.

3.2.3.2.13 Ambiguity. Because of the limited semantic domain, the possibilities for word-sense ambiguity are greatly reduced.

3.2.3.2.14 The Paraphrase Problem. Since we are dealing with a restricted subject domain, we are not confronted with the whole spectrum of difficulties one would expect in a system for general English. Nevertheless, we do have to deal with a certain amount of paraphrase.

Sentences with eventive nouns as logical subject and with verbs such as TAKE PLACE, OCCUR, or forms of the verb BE as main verb, are considered paraphrases of sentences with main verbs which correspond to the eventive noun. Two examples are shown in 26 and 27 below. Note the similarity of the corresponding event records.

Example 1: Impacted vs. Impact (occurred/took place/was...

26. (a) SKYLAB IMPACTED IN WESTERN AUSTRALIA JUST SOUTHEAST
OF KALGOORLIE ON 12 JULY 1979.

(b) IMPACT OF SKYLAB OCCURRED/ TOOK PLACE/ WAS IN
WESTERN AUSTRALIA JUST SOUTHEAST OF KALGOORLIE
ON 12 JULY 1979.

Table 3-3 (a) Event Record for Sentence 26(a)

```
+-----------------------------------------------------------+
|                                                           !
| Event:   IMPACT                                           |
| Action=  IMPACTED                                         |
| Object:  SATELLITE                                        |
| ...Equipment=  SKYLAB                                     |
| ...Relative=                                              |
| Location=  IN WESTERN AUSTRALIA JUST SOUTHEAST OF         |
| KALGOORLIE                                                |
| Date=  ON 12 JUL 1979                                     |
|                                                           |
+-----------------------------------------------------------+
```

Table 3-3 (b). Event Record for Sentence 26(b).

```
+----------------------------------------------------------+
|                                                          !
|                                                          |
| Event:   IMPACT                                          |
| Action:  IMPACT                                          |
| Object:  SATELLITE                                       |
| ...Equipment=  SKYLAB                                    |
| ...Relative=                                             |
| Location=  IN WESTERN AUSTRALIA JUST SOUTHEAST           |
| OF KALGOORLIE                                            |
| Date=  ON 12 JUL 1979                                    |
|                                                          |
+----------------------------------------------------------+
```

Example 2: Reentered vs. Reentry

27. (a) SKYLAB REENTERED THE EARTH'S ATMOSPHERE OVER CANADA ON 21 JUL 1979.

(b) REENTRY OF SKYLAB TOOK PLACE OVER CANADA ON 21 JUL 1979.

Table 3-4 (a) Event Record for Sentence 27(a).

```
+-----------------------------------------------------------+
|                                                           |
| Event:   REENTRY                                          |
| Action= REENTERED                                         |
| Object:  SATELLITE                                        |
| ...Equipment=  SKYLAB                                     |
| ...Relative=                                              |
| Location= THE EARTH'S ATMOSPHERE OVER CANADA              |
| DATA= ON 12 JUL 1979                                      |
+-----------------------------------------------------------+
```

Table 3-4(b) Event Record for Sentence 27(b).

```
+------------------------------------------------------------+
|                                                            |
| Event:  REENTRY                                            |
| Action= REENTRY                                            |
| Object:  SATELLITE                                         |
| ...Equipment=  SKYLAB                                      |
| ...Relative=                                               |
| Location=  OVER CANADA                                     |
| Date=  ON 12 JUL 1979                                      |
|                                                            |
+------------------------------------------------------------+
```

To achieve this, the sentences with the eventive noun as subject are first restructured in the ERL component. Thus, in (27b), the eventive noun IMPACT is recognized as expressing the main predicative concept and its parse tree is restructured to resemble that of (a): the surface verb "occurred", "took place" or "was" is replaced by the lexical entry for IMPACT.

3.2.3.2.15 Functional Synonyms. In each domain there are a number of verbs which are used interchangeably(e.g., "launch" and " fire"; "land" and "impact"). These are treated as functional synonyms, i.e., they are marked in the lexicon as members of the same class of event related concepts. Similarly, all terms identifying members of a missile class are marked in the lexicon by the superordinate term, and processed by the template, in this case, the MISSILE template.

Marking functional synonyms in the lexicon as members of the same class of concepts, allows retrieval in terms of event or object classes, rather than requiring the user analyst to think of all possible words for the members of the event or object classes.

The two examples below illustrate event records derived from two sentences using the functional synonyms "launch" and "fire". Note that both sentences are interpreted as "launch" events. The particular verb used is shown in the Action slot.

Table 3-4 (a). Launch vs. Fire

```
*>> THE SKYLAB ORBITAL WORKSHOP,
*A CONVERTED S-4B THIRD STAGE FROM A SATURN-5
*LAUNCH VEHICLE, WAS LAUNCHED FROM THE KENNEDY
*SPACE CENTER AT 1330 HOURS ON 14 MAY 1973.
Event:  LAUNCH
Action= LAUNCHED
Object: SATELLITE
...Equipment= SKYLAB ORBITAL WORKSHOP
...Relative= A CONVERTED S-4B THIRD STAGE FROM A
SATURN-5 LAUNCH VEHICLE
Launchsite= FROM THE KENNEDY SPACE CENTER
Location=
Time= AT 1330
```

Table 3-4 (b). Launch vs. Fire

```
*>> THE SKYLAB ORBITAL WORKSHOP, A CONVERTED
*S-4B THIRD STAGE FROM A SATURN-5 LAUNCH VEHICLE,
*WAS FIRED FROM THE KENNEDY SPACE CENTER AT
1330 HOURS ON 14 MAY 1973.
Event:  LAUNCH
Action= FIRED
Object:  SATELLITE
...Equipment= A CONVERTED S-4B THIRD STAGE FROM A
SATURN-5 LAUNCH VEHICLE
Launchsite= FROM KENNEDY SPACE CENTER
Location=
Time= AT 1330
```

We are aware that paraphrase rules may lead to enormous difficulties in a system for general English. However, in our restricted task domain, the problem seems manageable. We also are aware of the fact that there will always be the possibility of a paraphrase that was not anticipated, as well as other cases when the complexity of the experimental input exceeds the current capabilities of the model of the system. This is one of the reasons why MATRES I is interactive.

3.2.3.3 *The Lexicon.* The MATRES II lexicon is specifically designed to support the grammatical analysis procedure, and is therefore intended as an economical rather than an exhaustive inventory of feature descriptions. It consists of two parts: a listing of the features or attributes employed by the system, and a collection of lexical entries in the form of static declarations of lexical items and their attributes.

The attributes fall into several classes. Examples of each are given below.

(i) Major Grammatical Category Specifications.

ADVB (adverb)
ADJ (adjective)
ART (article)
CONJ (conjunction)
NUM (number)
N (noun)
VB (verb)

(ii) Examples of Lexical Features:
COPULA
DIR (directional)
EVENTIVE (marks eventive nouns)
INTRANS (marks intransitive verbs)
LOC (locational)
MODAL
PASTP (past particile)
PRESP (present participle)
ROBJ ("raise-object")
RSUBJ ("raise-subject")
SUBNUM (subordination number)
TENSED (marks tensed verbs)
TRANS (marks transitive verbs)
1NMBR, 2NMBR, etc. (marks one-digit, two-digit, etc., numbers

(iii) Event-Related Features:

EVENTS		OBJECTS	OTHER CONCEPTS
ACTIVITY	FLIGHT	ACRAFT	INCL (inclination)
ARRIVE	IMPACT	MISSILE	REV (revolution)
DEORBIT	LAUNCH	SATELLITE	COMM (communication)
DEPART	PENETRATE	BOOSTER	
DEPLOY	REENTRY		
ENROUTE	RETURN		

An excerpt from the current lexicon is given below:

```
:: DELTA-CLASS [ ADJ ] .;
:: DEORBIT [ N EVENTIVE DEORBIT ] [ VB DEORBIT ] .;
:: DEORBITED [ VB TRANS PASTP DEORBIT ]
              [ VB TRANS TENSED DEORBIT ] .;
:: DEPARTED [ VB TRANS PASTP DEPART ]
            [ VB TRANS TENSED DEPART ] .;
:: DEPLOYED [ VB TRANS PASTP DEPLOY ]
              [ VB TRANS TENSED DEPLOY ] .;
:: DEPLOYMENTS [ N EVENTIVE ] .;
:: DESTINATION [ N ] .;
:: DIVISION  [ N ] .;
:: DJIBOUTI  [ N LOC ] .;
:: DOWNED  [ VB TRANS PASTP ] [ VB TRANS TENSED ] .;
:: DOWNRANGE [ N LOC ] .;
:: DURING [ PREP EMOD TYME ] .;
```

The entire lexicon, comprising lexical entries for all three domains studied thus far, is contained in Appendix B.

4.0 IMPLEMENTATION

4.1 Principles of Discourse Processing

From the theoretical viewpoint, the primary goal of discourse processing is to arrive at the total information content of a text, where the total information content of a text is taken to be the aggregate of all the information communicated by that text, including that which is made explicit and that which can be inferred from the meaning of the words appearing in that text and their syntactic and semantic interrelations.

A human analyst, however, is selective. He does not seek to extract all the information a text may contain, but only that which is needed for the performance of his task. When reviewing a message, the human analyst uses his innate knowledge of English grammar, as well as his extra-linguistic knowledge of entities such as spacecraft, time, location, and actions -- including all the relevant concepts which can be attributed to or are implied by such entities -- and extracts only those information items which are relevant and useful to the attainment of his current goal.

To distill information elements from a text, the computer must in some sense model the cognitive processes of the analyst. It must take into account what is known about human linguistic behavior -- how the analyst interprets text, how he makes inferences, how he remembers, and how he communicates.

Fundamental to the approaches taken in this field is the assumption that a person interpreting natural language text uses much more than just the information contained in isolated words and sentences. The meanings which people attribute to words and sentences vary not only according to their linguistic context, but also with the subject matter being discussed and/or the situation in which they are used. A word or phrase is interpreted in terms of the total context in which it occurs; it is the knowledge of the total context which enables a person to understand language, and this knowledge includes all our knowledge about the real world.

Many of the subprocesses involved in language understanding are still largely unexplored and it is therefore not possible to construct a comprehensive model of language understanding. For example, no specification for the many and complex inferential processes involved in language understanding can be given at this stage, although the points in the understanding process at which they operate can be stated.

The OSI natural language processing system is based upon a process model of text understanding involving four sets of operations.

First, the sentences of a message text are parsed into a set of propositinal structures. The propositions are linked by various semantic relations which may be explicitly expressed in the surface structure of the text, or inferred during the interpretation process on the basis of contextual and/or real world knowledge.

Second, the resulting set of propositions are organized into higher-level conceptual categories, namely, event representations.

A third set of operations links the resulting event representations into a coherent whole, reflecting the meaning of the message text as a whole.

Finally, when all messages constituting an EVENT REPORT are processed in this manner, a set of constraints checks the coherence of the set of messages constituting an EVENT REPORT at the global level, i.e., at the level of the EVENT REPORT.

4.2 The MATRES II Text Processing System

4.2.1 General Remarks. The principles of message text processing discussed above are partially implemented in the MATRES II text processing system.

MATRES II is the result of the second cycle in the development of a system with full capabilities for deriving formatted records from the narrative text of intelligence messages. It represents a considerable advance on MATRES I, which provided only a rudimentary capability for testing algorithms for narrative text analysis.

The two subject domains of MATRES II are air activities and missile and satellite launchings. While in a fully developed system the unit of analysis would be the entire message, the scope of the current system is limited to the analysis of single declarative sentences.

The definition of the input language accepted by the system is embodied in a transition network grammar model based upon Woods (1970, 1973). The MATRES II parser has undergone considerable refinement and expansion and currently accepts a much wider range of syntactic constructions than was previously achieved.

In the current version of the system, English language words are entered into a linguistic dictionary, while strings with fixed patterns are recognized at the input stage by a finite state automaton (FSA) designed especially for this purpose.

The FSA recognizes strings denoting Zulutimes (e.g., 1907Z), geographic coordinates (e.g., 3674N4261E), integers (e.g.15, 1978), and ordinals (2nd, 3rd, 25th). Such strings are tagged with appropriate features at the input stage and added to the internal lexicon.

The major feature of MATRES II is its capability for semantic analysis. This is achieved by means of the Event Representation Language, which is a language specially developed for mapping the syntactic structures produced by the parser into template-derived content representations. The basic data structure of the Event Representation Language is the template.

The current version of the system takes single sentences as input and transforms each into one or more event records by combining a "bottom-up", data-driven analysis based upon linguistic and logical principles with a "top-down", conceptually driven domain-specific interpretation of the structures generated by the input analysis. The "bottom-up" analysis is effected by the augmented transition network (ATN) parser, which utilizes a dictionary and a grammar of the reporting language to produce a parse tree showing the syntactic composition of the input string and the hierarchical relationships between component structures. The output of the parser is input to the ERL "machine", which uses a set of prestored templates for the interpretation of the input, and produces event records as output. These event records constitute the primary elements for the construction of the "extensional" data base, whose purpose is to serve as a support tool for higher-level analytical functions in a decision-making environment.

Figure 4-1 illustrates how the program reorganizes the components of -- in this case -- a hypothetical sentence to give a clearer presentation of its information content.

The computer program which embodies this approach to natural language understanding is written in FORTH, Prolog, and SNOBOL4, and runs on a PDP 11/45 under the RSX 11D operating system. A flow diagram of the MATRES II system is shown in Figure 4-2.

Input: Unstructured Text

```
+--------------------------------------------------------------+
| The three unidentified heavy bombers which flew              |
| from London to Cairo on the 30 Apr 1975, refuelled           |
| in Naples at approximately 1300 hours the same day.          |
+--------------------------------------------------------------+
```

Output: Event Record

```
+--------------------------------------------------------------+
| Event Type: REFUEL                                           |
| Verb used: REFUELLED                                         |
| Object:                                                      |
| ...Equipment: UNIDENTIFIED HEAVY BOMBERS                     |
| ...Set specification: THREE                                  |
| ...Relative: WHICH FLEW FROM LONDON TO CAIRO                 |
|                         ON THE 30 APR 1975                   |
|                                                              |
| Location: IN NAPLES                                          |
| Time: AT APPROXIMATELY 1300 HOURS                            |
| Date: THE SAME DAY                                           |
+--------------------------------------------------------------+
```

Figure 4-1. Input/Output Representations

The major part of the system was built in the programming language FORTH, which is an interactive, incremental system with a low-level semantics which the user can easily and quickly extend. This allowed the rapid development of the ATN language and control scheme, as well as the support scheme for the execution of the Event Representation Language (ERL) algorithms, a formal language written for the purpose of analyzing text. The ERL algorithms are written in Prolog, a language that is well suited to the specification of templates and the algorithms for instantiating them in ERL. For ease of implementation, the compiler for the subset of Prolog utilized in this application was written in SNOBOL 4.

The use of FORTH and the Prolog formalism allowed fairly easy development of the system even without the powerful structure manipulation capabilities of a language like LISP.

Toward the end of the I&W III contract, it became clear that the combination of the grammar and template code compiled from ERL would take up almost all of the available space in the FORTH dictionary, leaving very little working room for sentence processing. In fact, it was necessary to partition the templates into separate files, and process sentences using different templates in different runs of MATRES; even then, only short sentences could be processed.

To remedy this difficulty, a scheme was developed to "overlay" the code for the grammar and templates, so that they would each occupy the same space, but at different times, since parsing and template matching do not overlap in time. To do this, it was necessary to design a scheme to allow a portion of the FORTH dictionary to be saved on disk, and the dictionary to be truncated. The saved segment could later be brought back into memory at the same locations, and linked into the dictionary in the same way as when it was saved. Several segments could be created and saved in this way, starting at the same location, and could be restored to memory one at a time as needed.

Several FORTH Words were defined to manage this operation. SEGBASE defines the starting location of a set of segments; every Word defined after an invocation of SEGBASE belongs to the first segment until an invocation of SEGSAVE. SEGSAVE takes as a parameter the name given to the SEGBASE, and stores the segment on disk starting at the block number given by the variable DYNBAS, which it updates to the next available block for the next segment; it also truncates the dictionary at the SEGBASE. Thereafter, Words are defined, making up the next segment, until the next call of SEGSAVE. In this way, several segments are defined. When it is in order to use a particular segment, SEGLOAD is called with the block number of the desired segment as a parameter; it loads the block starting just after the SEGBASE, making the Words in the segment available.

Using those commands, MATRES was rebuilt to store the finite-state automaton for lexical lookup and the ATN grammar in one segment, and the ERL machine and the template code in the other. A sentence is processed by loading the parse segment, parsing the sentence to create the parse tree, loading the ERL and template segment, then matching the templates with the parse tree. This resulted in a very slight slowdown from the earlier scheme, but has allowed more templates of greater complexity to be loaded, and much longer sentences to be processed.

The ultimate test of a computational system for understanding natural language is its success in performing some specific task. The goals set out for the current project have to a large extent been met.

4.2.2 Functional Description. An overview of the MATRES II system organization and data flow is shown in Figure 4-2. The main system components are: the Lexical Unit Recognizer, the ATN parser, and the ERL "machine". The direction of the arrows in Figure 4-2 indicates the general flow of information as a sentence is processed through the system. The main stages of event record generation are shown across the center of the figure. Feeding into this are the various analysis components, each compiled from a source text in a language appropriate to the component.

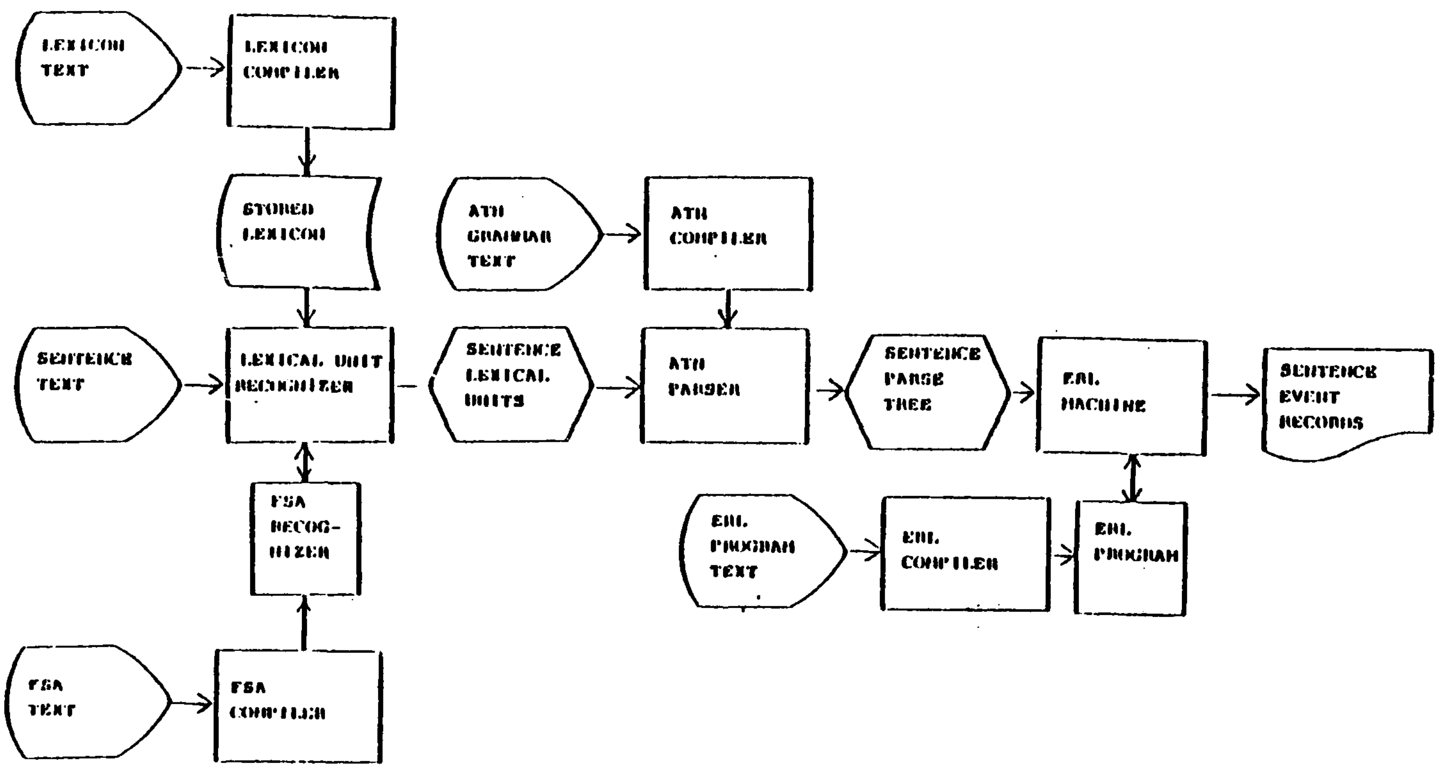

Figure 4-2. MATRES II System Overview

4.2.3 The Event Representation Language (ERL). The Event Representation Language is a formalism which was developed for the purpose of exploring the effectiveness of "templates" as a knowledge representation technique with which to build systems for message text analysis in support of I&W functions.

The main function of this language is to guide the mapping process which converts narrative text into formatted event records.

The basic data objects of the Event Representation Language are the templates. As mentioned in Subsection 2.2.3, we conceive of templates as active memory structures which embody hypotheses about objects, facts, events, processes, operations, procedures and computations required to characterize the links between form and content.

The Event Representation Language is implemented in a subset of Prolog, a formalism using a clausal form of logic restricted to "Horn" clauses (Warren et *al.*, 1977; Pereira et al., 1978). Horn clauses may be given both a declarative and a procedural interpretation and are therefore well suited for the expression of concepts in ERL. The basic computational mechanism of Prolog is a pattern matching process ("unification") operating on general record structures ("terms" of logic).

Prolog was initially developed at the University of Marseilles (Roussel 1975) as a practical tool for 'logic programming' (Kowalski 1974; Colmerauer 1975; van Emden 1975), and has since been used in several other centers (Stanford, Edinborough) for writing language analysis systems (Dahl 1977; Warren 1977a, Warren 1977b).

Prolog is a perspicuous and powerful language for the expression of the concepts of the Event Representation Language, and admits of an effective and reasonably efficient implementation. Clear, readable, concise programs can be written quickly and with few errors. Specifically, the following features make it particularly suitable for our purposes:

a. Pattern matching (unification) replaces the conventional use of selector and constructor functions for operating on structured data.

b. The arguments of a procedure can serve, not only for it to receive one or more values as input, but also for it to return one or more values as output. Procedures can thus be "multi-output" as well as "multi-input".

c. The input and output arguments of a procedure do not have to be distinguished in advance, but may vary from one call to another. Procedures can thus be "multi-purpose".

d. Procedures may generate (via backtracking, in the case of Prolog) a set of alternative results. Such procedures are called "non-determinate". Backtracking amounts to a high-level form of iteration.

e. Procedures may return "incomplete" results, i.e., the term or terms returned as the result of a procedure may contain variables, which are only filled in later by calls to other procedures. The effect is similar to the use of assignment in a conventional language to fill in fields of a data structure. Note, however, that there may be many occurrences of an instantiated variable, and that all of these get filled in simultaneously (in a single step) when the variable is finally instantiated. Note also that when two variables are unified together, they become identified as one. The effect is as though an invisible pointer, or reference, linked one variable to the other. We refer to these related phenomena as the "logical variable".

f. "Program" and "data" are identical in form. A procedure consisting solely of unit clauses is closer to an array, or table of data, in a conventional language.

4.2.4 The ERL Control Mechanism. Prolog provides a remarkably simple form of control, which suffices for many practical applications.

The declarative semantics of Prolog clauses is such that the order of the goals in a clause and the order of the clauses themselves are both irrelevant to the declarative interpretation. However, these orderings are generally significant in Prolog, as they constitute the main control information.

When the Prolog system is executing a procedure call, the clause ordering determines the order in which the different entry points of the procedure are tried. The goal ordering fixes the order in which the procedure calls in a clause are executed. The 'productive' effect of a Prolog computation arises from the process of 'matching' a procedure call against a procedure entry point.

Prolog has captured the imagination of many workers in natural language processing and advanced data base management, and promises to be one of the major languages of the future.

4.2.5 Advantages of Prolog Representation. This representation has several advantages, among which we might mention the following two: (1) if additional information needs to be associated with a particular predicate, this can be done simply by adding another clause; and (2), Prolog provides a uniform way of representing structures and processes at several levels of grammatical description: syntactic structures, syntactic normalization, description of objects, description of events, and description of text-level relations.

Recent investigations reported in the literature show that Prolog is not only used for grammatical description of structures and processes of natural language, but can also be used as a practical tool and unifying principle for the description and manipulation of data bases.

4.3 Illustration of the Understanding Process

The next three subsections give examples of the various procedural steps involved in the processing of narrative text, and show how the goals set out in Section 1 are approximated.

4.3.1 Inputting a Sentence. The understanding process begins when a sentence is input to the system. This is currently done either from a terminal, or from a disc file. A sentence is input in the format '>> Sentence.'. This is illustrated below:

(a) >> THE SKYLAB ORBITAL WORKSHOP,
A CONVERTED S-4B THIRD STAGE FROM A SATURN-5
LAUNCH VEHICLE, SUCCESSFULLY DEORBITED INTO THE
AUSTRALIAN OUTBACK ON 12 JUL 1979.

The input sentence is received by the Lexical Unit Recognizer, which uses a stored dictionary and the FSA Recognizer to transform the individual words of an input sentence into a string of lexical units. First, a dictionary look-up process replaces words and phrases in the sentence with corresponding lexical entries.

Table 4-3 shows the lexical entries for the words "deorbited", "Australian", "outback", and "launched". The entire lexicon, comprising lexical entries for all three domains, is contained in Appendix B.

Table 4-3. Sample Lexical Entries

```
+----------------------------------------------------+
|                                                    |
|  :: DEORBITED    [ VB TRANS PASTP DEORBIT ]        |
|                  [ VB TRANS TENSED DEORBIT ] .;    |
|                                                    |
|  :: AUSTRALIAN   [ ADJ NATION ] .;                 |
|                                                    |
|  :: OUTBACK      [ N LOC ] .;                      |
|                                                    |
|  :: ( LAUNCH VEHICLE) [ N BOOSTER ) .;             |
+----------------------------------------------------+
```

Strings which have no entries in the dictionary are passed to the FSA Recognizer, which attempts to identify them as one of several fixed-pattern categories, (numbers, Zulu-times, geographic coordinates). In the case of input sentence (a), the strings '12' and '1979' are recognized as numbers and tagged with the features 'N' for noun, and 2DIG and 4DIG, indicating that they are two-digit and four-digit numbers respectively.

4.3.2 Parsing a Sentence. One of the major problems in constructing automated language understanding systems is that of transforming the input string of words into a canonical form which permits semantic interpretation. Part of the transformation process involves syntactic analysis. The main purpose of automated syntactic analysis is that of determining the logical structure of input sentences (or larger text units). In the course of constructing a structural description, a syntactic analyzer generally 'regularizes' sentence structure, e.g., it converts sentences and parts of sentences which have propositional structure into a canonical form. For example, in the current version of the system passive sentences are converted into their active form by the syntactic component.

Automated syntactic analysis involves the operation of parsing*. The current version of the OSI system employs an Augmented Transition Network parser (sentence acceptor),

---

* A parser is a formal algorithm which fulfills two functions. One, it takes a grammar and a lexicon and decides whether a sequence of words is a sentence with respect to that grammar and second, it builds a structural representation for that sequence of words.

and is designed to accept messages from the aircraft activities and missile and satellite domains. It produces a propositional representation which is fairly close to surface structure.

Let us now return to the input sentence under discussion. After lexical lookup, the string is input to the augmented transition network (ATN) parser, which analyzes it according to the sublanguage grammar stored in the system. Roughly speaking, the ATN processor takes the string of lexical entries derived from the sentence, combines them into phrases, and determines the logical relationships that hold among them. In this phase of processing the focus is on comparatively local and superficial aspects of sentences such as word order, and the invariant properties of words stored in the lexicon. The internal representation of the parse tree for sentence (a) is shown in Table 4-4.

Table 4-4. Parse Tree For Sentence (a)

```
PARSE OUTPUT:
LIST OF:
! NODE: 1!S
! ! LIST OF:
! ! ! NODE: 2!PP
! ! ! ! NODE: 4!DATE
! ! ! ! ! 652.. 1979
! ! ! ! ! 630.. JUL
! ! ! ! ! 608.. 12
! ! ! ! END NODE
! ! ! ! 586.. ON
! ! ! ! LIST OF:
! ! ! ! END LIST
! ! ! END NODE
! ! ! NODE: 2!PP
! ! ! ! NODE: 2!NP
! ! ! ! ! LIST OF:
! ! ! ! ! END LIST
! ! ! ! ! NODE: 5!NNOD
! ! ! ! ! ! <<NIL>>
! ! ! ! ! ! 564.. OUTBACK
! ! ! ! ! END NODE
! ! ! ! ! LIST OF:
! ! ! ! ! ! 542.. AUSTRALIAN
! ! ! ! ! END LIST
! ! ! ! ! NODE: 2!DP
! ! ! ! ! ! LIST OF:
! ! ! ! ! ! END LIST
```

```
| | | | | | 520.. THE
| | | | | | LIST OF:
| | | | | | END LIST
| | | | | END NODE
| | | | END NODE
| | | | 498.. INTO
| | | | LIST OF:
| | | | END LIST
| | | END NODE
| | END LIST
| | <<NIL>>
| | <<NIL>>
| | NODE: 2|VG
| | | 454.. DEORBITED
| | | <<NIL>>
| | | LIST OF:
| | | END LIST
| | | LIST OF:
| | | | 432.. SUCCESSFULLY
| | | END LIST
| | END NODE
| | NODE: 2|NP
| | | LIST OF:
| | | | LIST OF:
| | | | | NODE: 1|S
| | | | | | LIST OF:
| | | | | | END LIST
| | | | | | <<NIL>>
| | | | | | NODE: 2|NP
| | | | | | | LIST OF:
| | | | | | | | NODE: 2|PP
| | | | | | | | | NODE: 2|NP
| | | | | | | | | | LIST OF:
| | | | | | | | | | END LIST
| | | | | | | | | | NODE: 5|NNOD
| | | | | | | | | | | <<NIL>>
| | | | | | | | | | | 410.. LAUNCH VEHICLE
| | | | | | | | | | END NODE
| | | | | | | | | | LIST OF:
| | | | | | | | | | | 388.. SATURN-5
| | | | | | | | | | END LIST
| | | | | | | | | | NODE: 2|DP
| | | | | | | | | | | LIST OF:
| | | | | | | | | | | END LIST
| | | | | | | | | | | 366.. A
| | | | | | | | | | | LIST OF:
| | | | | | | | | | | END LIST
| | | | | | | | | | END NODE
| | | | | | | | | END NODE
| | | | | | | | | 344.. FROM
| | | | | | | | | LIST OF:
| | | | | | | | | END LIST
| | | | | | | | END NODE
```

```
| | | | | | | END LIST
| | | | | | | NODE: 5|NNOD
| | | | | | | | <<NIL>>
| | | | | | | | 322.. STAGE
| | | | | | | END NODE
| | | | | | | LIST OF:
| | | | | | | | 300.. THIRD
| | | | | | | | 278.. S-4B
| | | | | | | | 256.. CONVERTED
| | | | | | | END LIST
| | | | | | | NODE: 2|DP
| | | | | | | | LIST OF:
| | | | | | | | END LIST
| | | | | | | | 234.. A
| | | | | | | | LIST OF:
| | | | | | | | END LIST
| | | | | | | END NODE
| | | | | | END NODE
| | | | | | NODE: 2|VG
| | | | | | | <<NIL>>
| | | | | | | <<NIL>>
| | | | | | | LIST OF:
| | | | | | | END LIST
| | | | | | | LIST OF:
| | | | | | | END LIST
| | | | | | END NODE
| | | | | | <<NIL>>
| | | | | | NODE: 4|ACTV
| | | | | | | <<NIL>>
| | | | | | END NODE
| | | | | END NODE
| | | | END LIST
| | | END LIST
| | | NODE: 5|NNOD
| | | | <<NIL>>
| | | | 212.. ORBITAL WORKSHOP
| | | END NODE
| | | LIST OF:
| | | | 190.. SKYLAB
| | | END LIST
| | | NODE: 2|DP
| | | | LIST OF:
| | | | END LIST
| | | | 168.. THE
| | | | LIST OF:
| | | | END LIST
| | | END NODE
| | END NODE
| | NODE: 4|ACTV
| | | <<NIL>>
| | END NODE
| END NODE
END LIST
```

4.3.3 Interpreting the Parse Tree. A parser is a fairly complex mechanism, and it is therefore unwise to burden it with all the operations required during the syntactic analysis phrase. Some of the more complex regularizing functions are therefore offloaded onto the ERL component.

Syntactic normalizing procedures convert intermediate tree structures generated by the syntactic processor into deep structure trees for logical semantic analysis and event record synthesis.

The processes relevant here include filling in elements which are missing from the surface structure, resolving syntactic ambiguities, replacing moninalizations with their corresponding verbal constructions, and generally rearranging the elements in a sentence to regularize its structure.

In the current version of the system, all but the passive restructuring rule are incorporated into the ERL formalism, and are intermingled with the other interpretive rules.

The input sentence under discussion does not require restructuring.

As explained in a previous section, the ERL semantic interpretation rules (clauses) are used top-down, one at a time. Goals in a clause are executed from left to right. If there are alternative clauses at any point, backtracking will return to them.

The parse tree shown in Table 4-4 is input to the ERL "machine", which uses the pattern matching process ("unification mechanism") of the Event Representation Language to produce a set of one or more event records representing the information content of the input sentence.

As a first step in the interpretation process, the system activates the system generated goal 'do', which is currently the top-level procedure.

The Top-Level Procedure

```
+------------------------------------------------------------------------+
|              do([X,Y,Z]):-  build_ER(X,Y,Z,ER),  type_ER(ER).          |
|              do([Tree]):_  build_ER(Tree,ER),  type_ER(ER).            |
|              do([Tree]):_ build_ER1(Tree,ER),  type_ER(ER).            |
|                                                                        |
+------------------------------------------------------------------------+
```

The input structure unifies with the head of the third clause, giving rise to two subgoals: the build_ER1 procedure, and the type_ER procedure. The 'build_ER1 procedure is illustrated below:

The 'build_ER1' Procedure for Simple Sentences

```
+------------------------------------------------------------------------+
| build_ER1    (s(Voice,Subj1,Vbgr1,Obj,Compl,Vmods),temp(Name,ER)):-    |
|              change1(Subj1,Subj2,Vbgr1,Vbgr2),                         |
|              find_t_name(Vbgr2,Name),                                  |
|              construct(Name,s(Voice,Subj2,Vbgr2,Obj,Compl,Vmods),ER).  |
|                                                                        |
+------------------------------------------------------------------------+
```

Since the input structure under discussion does not require any restructuring, 'change1' leaves it unchanged. Next, 'find_t_name' identifies the name of the template which is to be used for interpreting the current input. The relevant information is found in the main verb of the sentence. Thus, sentence (a), whose main verb is "deorbit", will cause the DEORBIT template to be activated.

The DEORBIT template as coded in Prolog is shown below:

DEORBIT Template

```
+------------------------------------------------------------
|construct  ('DEORBIT',s(Voice,Subj,Vbgr,Obj,Compl,Vmods),
|               [Verb,  AG,OB1,Loc,Rev,DTG]):-
|          verb(Vbgr,Verb),
|          agent(Subj,Vmods,AG),
|          object(Subj,Obj,OB1),
|          location(Obj,Vmods,Loc),
|          revolution(Vmods,Rev),
|          construct('DTG',Vmods,DTG).
+------------------------------------------------------------
```

AD-A084 326 OPERATING SYSTEMS INC WOODLAND HILLS CA F/G 9/4
SATELLITE AND MISSILE DATA GENERATION FOR AIS.(U)
DEC 79 G M SILVA, C A MONTGOMERY F30602-78-C-0274
UNCLASSIFIED OSI-R79-037 RADC -TR-79-314 NL

2 OF 3
AD A
084326

All templates are encoded as Prolog "construct" clauses. The head of a "construct" clause has three arguments: a template name, the name of the syntactic constituent which serves as the context which is searched in an attempt to find fillers for the descriptor slots of the template in question, and a third argument which represents the output of the procedure, i.e., the instantiated slots.

The body of a 'construct' clause consists of several 'goals', corresponding to the 'slots' of a template. In the case of the DEORBIT template, the body of the "construct" clause consists of six "goals", each defined as a procedure which actively seeks suitable fillers for the descriptor slot it represents.

In the case of the example input sentence, each of the six "slots" actively searches the specified context in an attempt to find a component which can serve as a "filler". *Since there is no Agent specified in the input*, the Agent slot returns 'nil'. Next, the 'object' slot constructs a record for the subject nounphrase, which it decomposes into an 'Equipment' component, and a 'Relative' component.

The location clause illustrated below identifies the prepositional phrase "INTO THE AUSTRALIAN OUTBACK", as the location of the deorbit.

The 'revolution' procedure also fails to find a filler, and returns 'nil'. The DTG procedure cannot find a filler for its Time component, but identifies the prepositional phrase ON 12 JUL 1979 as the deorbit date.

The result of the interpretive process is the "instantiated" template -- or Event Record -- shown in Table 4-5.

The 'Location' Clause

```
+------------------------------------------------------+
| location(NP,List, slot('Location=',X)):-              |
|           locat1(NP,X1),                              |
|           searchlist(List,X2),                        |
|           concatenate(X1,X2,X).                       |
| locat1(NP, [NP]):-  test_nhead(NP,'LOC').             |
| locat1(_,nil).                                        |
| searchlist([M,..List], [X,..L]):-                     |
|           searchloc(M,X),  searchlist(List,L).        |
| searchlist([_,..List],L):- searchlist(List,L).        |
| searchlist(_,nil).                                    |
| searchloc(pp(L1,Prep,NP), [L1,Prep,NP]):-             |
|         member(P, ['ALONG','AT','EAST OF','IN','INTO',|
|         'NEAR','ON','SOUTHEAST OF', 'OUTSIDE OF',     |
|         'WEST OF']),                                  |
|         lexeq(Prep,P),  test_nhead(NP,'LOC').         |
|                                                       |
+------------------------------------------------------+
```

Table 4-5. Event Record for Sentence (a).

```
+------------------------------------------------------------------+
| Event:  DEORBIT                                                  |
| Action=  SUCCESSFULLY DEORBITED                                  |
| Object:  SATELLITE                                               |
| ...Equipment=  SKYLAB ORBITAL WORKSHOP                           |
| ...Number=                                                       |
| ...Relative= A CONVERTED S-4B THIRD STAGE FROM A SATURN-5 LAUNCH |
|              VEHICLE                                             |
| Location= INTO THE AUSTRALIAN OUTBACK                            |
| Date= ON 12 JUL 1979                                             |
+------------------------------------------------------------------+
```

As mentioned before, Event Records are template-derived, event-centered data structures in which the information conveyed by the input can be viewed from the perspective of time, location, type of activity, object(s) involved, etc. They provide content representations for individual sentences describing atomic events, and form the building blocks of message content representations which will eventually provide answers to Question 1 of Section 1: "What is the content of the Message?"

4.3.4 Identifying the Reported Source of an Event Report. Certain events are officially announced. Thus a Soviet Satellite launching may be announced as follows:

(b) THE SOVIET NEWS AGENCY TASS ANNOUNCED

THAT IMPACT OF COSMOS-954 TOOK PLACE

NEAR YELLOWKNIFE, CANADA.

The system as developed to date identifies the source of this report and interpret TASS as the "Infosource" of the launch event. Sentence (b) yields the event record shown in Table 4-6.

Table 4-6. Event Record for Sentence (b)

```
+-------------------------------------------------------+
|Infosource= THE SOVIET NEWS AGENCY TASS                 |
|Event: IMPACT                                           |
|Action= IMPACT                                          |
|Object:  SATELLITE                                      |
|          ...Equipment = COSMOS-954                     |
|          ...Number=                                    |
|          ...Relative=                                  |
|Location= NEAR YELLOWKNIFE  CANADA                      |
|                                                        |
+-------------------------------------------------------+
```

4.3.5 Identifying the Reported Status of an Event. Some events are reported as expected, or as having failed in some sense. The following two examples illustrate how the current version of the system processes sentences expressing these notions.

(c) THE ORBITAL WORKSHOP SKYLAB WAS

EXPECTED TO DEORBIT OVER CANADA.

Table 4-7. Event Record for Sentence (c)

```
+-------------------------------------------------------+
|Status= EXPECED                                         |
|Event: DEORBIT                                          |
|Action= DEORBIT                                         |
|Object:  SATELLITE                                      |
|          ...Equipment = ORBITAL WORKSHOP SKYLAB        |
|          ...Number=                                    |
|          ...Relative=                                  |
|Location= OVER CANADA                                   |
|                                                        |
+-------------------------------------------------------+
```

(d) THE ORBITAL WORKSHOP SKYLAB FAILED

TO DEORBIT INTO CANADA

Table 4-8. Event Record for Sentence (d)

```
+------------------------------------------------------+
|Status=FAILED                                         |
|Event: DEORBIT                                        |
|Action= DEORBIT                                       |
|Object:  SATELLITE                                    |
|         ...Equipment = ORBITAL WORSHOP SKYLAB        |
|         ...Number=                                   |
|         ...Relative=                                 |
|Location= INTO CANADA                                 |
|                                                      |
+------------------------------------------------------+
```

As pointed out in the section on the Characteristics of Messages, the key event described in a message is usually mentioned in the first sentence. This sentence introduces the TOPIC of the message, i.e., what the message is about.

In order to test and evaluate the capabilities of the system, a set of sentences were constructed modeled on the syntactic properties of first sentences of the various message types identified in the missile and satellite domain. The sentences were so designed as to test various aspects of the syntactic structure of the sublanguage. Examples of sentence types currently processed by the system together with their corresponding event records are offered in Appendix (E).

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APPENDIX A: Sample of Sanitized Message Text

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$$$ MSG 1
SPANAME CONFIRMED IN ORBIT, 2NMBR MNTH 4NMBR$$
SPANAME HAS ACHIEVED ORBIT$$
THIS SATELLITF IS A FIRST GENERATION LOW RESOLUTION PHOTGRAPHIC SATELLIT
E
(PROBABLY IN THE LSTYPE SERIES)$$
IT WAS LAUNCHED AT ZULUTIME TODAY FROM PLACENAME$$
$$$ MSG 2
PRESSNAME ANNOUNCES LAUNCHING OF SPANAME, 2NMBR MNTH$$
IN A ROUTINE STATEMENT AT ZULUTIME TODAY, THE POLITADJ NEWS AGENCY, PRES
SNAME,
ANNOUNCED THAT SPANAME WAS LAUNCHED FROM THE POLITNAME$$
ORBITAL PARAMETERS GIVEN ARE: APOGEE 3NMBR KILOMETERS; PERIGEE
3NMBR KILOMETERS; PERIOD 2NMBR MINUTES; AND INCLINATION 2NMBR DEGREES$$
(SPANAME1 IS SPANAME2, A LOW RESOLUTION PHOTOGRAPHIC
RECONNAISSANCE SATELLITE LAUNCHED FROM PLACENAME AT ZULUTIME ON 2NMBR MN
TH)$$
$$$ MSG 3
PRESSNAME ANNOUNCES LAUNCH OF SPANAME$$
AT ZULUTIME, PRESSNAME-THE POLITADJ NEWS AGENCY-ANNOUNCED THE LAUNCH OF
SPANAME, THE UNIDENTIFIED MILITARY SUPPORT SPACLASS (LSTYPE) WHICH
WAS LAUNCHED FROM THE PLACENAME MISSILE AND SPACE CENTER AT ZULUTIME
TODAY$$
ORBITAL PARAMETERS AS CONTAINED IN THE ANNOUNCEMENT ARE:
APOGEE                     3NMBR KILOMETERS
PERIGEE                    3NMBR KILOMETERS
INCLINATION                2NMBR DEGREES
PERIOD                     2NMBR MINUTES$$
$$$ MSG 4
PRESSNAME ANNOUNCES LAUNCH OF SPANAME, 2NMBR MNTH 4NMBR$$
1.  AT ZULUTIME TODAY, PRESSNAME, THE POLITADJ NEWS AGENCY, ANNOUNCED TH
E
LAUNCH OF SPANAME$$
THE ANNOUNCEMENT CONTAINED THE NAMES OF THE CREW MEMBERS WHICH ARE:
LIEUTENANT-COLONEL PERSONNAME (FLIGHT COMMANDER), AND COSMONAUT
PERSONNAME (FLIGHT ENGINEER)$$
2.  THE FLIGHT PROGRAM ENVISAGES EXPERIMENTS JOINTLY WITH THE SPASTANAME
SPACE STATION WHICH WAS PUT IN ORBIT AROUND THE EARTH ON MNTH 2NMBR THIS
 YEAR$$
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3.  SPANAME WAS LAUNCHED FROM PLACENAME AT ZULUTIME TODAY$$
PRESSNAME HAS NOT YET ANNOUNCED SPANAME'S ORBITAL PARAMETERS$$
$$$ MSG 5
POLITADJ MANNED SPACE LAUNCH, 2NMBR MNTH 4NMBR$$
AT APPROXIMATELY ZULUTIME, A MANNED POLITADJ SPATYPE FERRY CRAFT
(LSTYPE) WAS LAUNCHED FROM THE PLACENAME MISSILE TEST RANGE
(TRAC) BY THE LSTYPE SPACE BOOSTER AND INSERTED INTO AN ORBIT
INCLINED 2NMBR DEGREES TO THE EQUATOR$$
THIS SPACLASS IS EXPECTED TO RENDEZVOUS AND DOCK WITH THE ORBITING SPACE

STATION SPASTANAME$$
IF CONFIRMED IN ORBIT, SPACLASS NUMBER 4NMBR WILL BE ASSIGNED$$
SDC OBJECT NUMBER 5NMBR HAS BEEN GIVEN TO THE PAYLOAD$$
THE POLITADJ DESIGNATION WILL PROBABLY BE SPANAME$$
$$$ MSG 6
NEW POLITADJ MANNED SPACLASS ACHIEVES ORBIT, 2NMBR MNTH 4NMBR$$
SPANAME, THE MANNED SPACLASS LAUNCHED FROM PLACENAME EARLIER TODAY AT
ZULUTIME HAS BEEN CONFIRMED IN ORBIT$$
$$$ MSG 7
SPACLASS LAUNCHED FROM PLACENAME, 2NMBR MNTH 4NMBR$$
AT APPROXIMATELY ZULUTIME, A NEW SPACLASS WAS LAUNCHED FROM THE PLACENAM
E
MISSILE AND SPACE CENTER BY THE LSTYPE SPACE LAUNCH SYSTEM AND WAS INJEC
TED
INTO AN ORBIT INCLINED 2NMBR DEGREES TO THE EQUATOR$$
THIS SATELLITE'S MISSION IS UNKNOWN AT THIS TIME$$
IF CONFIRMED IN ORBIT, SPACLASS NUMBER 4NMBR WILL BE ASSIGNED$$
SDC OBJECT NUMBER 5NMBR HAS BEEN GIVEN TO THE PAYLOAD$$
$$$ MSG 8
SPANAME IDENTIFIED$$
SPANAME, THE SPACLASS LAUNCHED FROM THE PLACENAME MISSILE AND SPACE
COMPLEX BY THE LSTYPE SPACE BOOSTER AT ZULUTIME THIS DATE HAS BEEN
IDENTIFIED AS AN UNIDENTIFIED MILITARY SUPPORT SATELLITE (LSTYPE) OF
THE SPATYPE 3NMBR, 3NMBR, 3NMBR CLASS, WHICH WERE FRAGMENT
DISPENSING SATELLITES$$
$$$ MSG 9
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PRESSNAME ANNOUNCES LAUNCH OF SPANAME$$
THE POLITADJ NEWS AGENCY, PRESSNAME, ANNOUNCED THE LAUNCH OF SPANAME
(SPANAME) IN A ROUTINELY WORDED STATEMENT ON 1NMBR MNTH 4NMBR$$
THE ANNOUNCEMENT PROVIDED THE FOLLOWING ORBITAL PARAMETERS:
APOGEE 3NMBR KILOMETERS; PERIGEE 3NMBR KILOMETERS;
INCLINATION 2NMBR DEGREES; PERIOD 2NMBR MINUTES$$
SPANAME IS THE FIRST GENERATION VARIABLE RESOLUTION
PHOTO RECONNAISSANCE SATELLITE LAUNCHED FROM THE PLACENAME MISSILE SPACE
COMPLEX AT ZULUTIME ON 1NMBR MNTH$$
$$$ MSG 10
SPACLASS LAUNCHED FROM PLACENAME, 2NMBR MNTH 4NMBR FAILS TO ACHIEVE ORBI
T$$
AT APPROXIMATELY ZULUTIME, A NEW SPACLASS LAUNCH WAS ATTEMPTED FROM THE
PLACENAME MISSILE AND SPACE CENTER BY THE LSTYPE SPACE LAUNCH SYSTEM$$
THE INTENDED ORBIT WAS TO BE INCLINED 2NMBR DEGREES TO THE EQUATOR$$
THIS SATELLITE'S INTENDED MISSION IS UNKNOWN$$
PRELIMINARY INDICATIONS ARE THAT THE SECOND STAGE OF THE LAUNCH VEHICLE
FAILED TO IGNITE$$
$$$ MSG 11
POSSIBLE SECOND-GENERATION NAVSAT LAUNCHED FROM PLACENAME FAILS TO ACHIE
VE
ORBIT$$
1.  A POSSIBLE SECOND-GENERATION NAVAL SUPPORT SATELLITE (NAVSAT) WAS
LAUNCHED FROM PLACENAME AT ZULUTIME, 2NMBR MNTH$$
THE MISSION RESULTED IN FAILURE, HOWEVER, BECAUSE OF A SECOND STAGE
MALFUNCTION$$
TELEMETRY ANALYSIS INDICATED THAT THE SECOND STAGE ENGINE
FAILED TO IGNITE AS PROGRAMMED FOLLOWING FIRST STAGE SHUTDOWN$$
THUS THE SPACECRAFT FAILED TO ACHIEVE EARTH ORBIT AND REENTERED OVER THE

POLITNAME IN THE GENERAL VICINITY OF COORDINATES ABOUT NMBRNAME MINUTES
AFTER LIFT-OFF$$
THIS SPACECRAFT, LAUNCHED ON AN INCLINATION OF 2NMBR DEGREES BY THE
LSTYPE SPACE SYSTEM, WAS APPARENTLY INTENDED TO REPLACE SPANAME$$
SPANAME WAS LAUNCHED IN MNTH 4NMBR AND IS THE OLDEST SATELLITE
IN THIS NMBRNAME-SATELLITE NETWORK$$
THE NETWORK CONSISTS OF NMBRNAME SPACECRAFT, EACH OF WHICH IS SEPARATED
IN
RIGHT ASCENSION BY 2NMBR DEGREES$$
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2.  THE LAUNCH TIME FOR THE ILL-FATED SPACECRAFT RESULTED IN A RIGHT
ASCENSION OF ABOUT 3NMBR DEGREES, WHICH IS 2NMBR DEGREES FROM THE
EXISTING NETWORK AND IS ALMOST 3NMBR DEGREES OUT-OF-PHASE WITH
SPANAME$$
THE PITCH RATE PROGRAM, WHICH WAS DETERMINED BY TELEMETRY ANALYSIS,
INDICATED THAT THE SPACECRAFT, IF SUCCESSFUL, WOULD HAVE BEEN INSERTED
INTO AN ORBIT SIMILAR TO PREVIOUS NAVSATS$$
THE FOLLOWING DEPICTS THE RIGHT ASCENSION ALIGNMENT OF THE SECOND-GENERA
TION
NAVSAT NETWORK AT LIFT-OFF:
SPANAME  - - 3NMBR DEGREES
SPANAME1 - - 3NBR DEGREES
SPANAME2 - - 3NMBR DEGREES
SPANAME3 - - 3NMBR DEGREES
SPANAME4 - - 3NMBR DEGREES
SPANAME5 - - 3NMBR DEGREES
SPANAME6 - - 3NMBR DEGREES
IN-FLIGHT FAILURE - - 3NMBR DEGREES$$
$$$ MSG 12
NATNAME REACTIVATE SPANAME ON 2NMBR MNTH$$
1.  THE NATNAME REACTIVATED SPANAME ON 2NMBR MNTH AFTER NMBRNAME
DAYS OF SPACECRAFT INACTIVITY$$
SPANAME WAS LAUNCHED FROM PLACENAME ON 2NMBR MNTH, AND AFTER AN
APPARENT UNSUCCESSFUL ATTEMPT TO STABLIZE THE SATELLITE ON 1NMBR MNTH
TELEMETRY TRANSMISSION CEASED ON THE 1NMBRTH$$
SPANAME WAS EVIDENTLY TEMPORARILY ABANDONED AND WAS ALLOWED TO
CONTINUE ITS ORIGINAL WESTWARD DRIFT IN SILENCE$$
TO DATE, HOUSEKEEPING TELEMETRY TRANSMISSIONS ARE THE ONLY SIGNALS
INTERCEPTED FROM THE SATELLITE$$
THE NATNAME APPEAR TO BE PRESENTLY CONDUCTING A SYSTEMATIC CHECKOUT OF T
HE
ON-BOARD SYSTEMS$$
THE COMMUNICATIONS TRANSPONDER FREQUENCIES WILL PROBABLY BE ACTIVATED AF
TER
SPANAME IS FINALLY STABLIZED$$
THE ORBIT OF SPANAME WILL AGAIN BE FAVORABLE FOR GEOPOSITIONING
WITHIN THE NEXT SEVERAL DAYS$$
$$$ MSG 13
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DEFENSIVE MISSILE LAUNCH, 2NMBR MNTH 4NMBR$$
AT ZULUTIME, A DEFENSIVE MISSILE, POSSIBLY A MISCLASS, WAS LAUNCHED FROM THE
PLACENAME MISSILE TEST CENTER$$
NO TARGET WAS EVIDENT$$
$$$ MSG 14
NATNAME ABANDON SPANAME AFTER FAILING TO STABILIZE IT$$
1. THE ORBIT OF SPANAME, THE COMMUNICATIONS RELAY SATELLITE
LAUNCHED FROM PLACENAME ON 2NMBR MNTH, HAS NOT YET BEEN
STABLIZED AND THERE ARE INDICATIONS THAT THE NATNAME MAY HAVE--AT
LEAST TEMPORARILY--ABANDONED THE SPACECRAFT$$
ACCORDING TO RADAR DATA, THE NATNAME APPARENTLY ATTEMPTED TO GEOPOSITION
THE SATELLITE ON 1NMBR MNTH, HOWEVER, THIS INITIAL MANEUVER RESULTED
IN AN INSIGNIFICANT REDUCTION IN THE SPACECRAFT'S ORBITAL PERIOD (FROM
3NMBR MINUTES TO 3NMBR MINUTES)$$
THE PRESENT PERIOD OF SPANAME IS 2NMBR MINUTES GREATER THAN ONE-HALF
OF A SIDEREAL DAY$$
THUS THE ASCENDING NODES ARE CONTINUING TO SHIFT WESTWARD AT ABOUT NMBR
DEGREES PER DAY$$
2. PAYLOAD TELEMETRY TRANSMISSIONS FROM SPANAME HAVE NOT BEEN
INTERCEPTED SINCE 1NMBR MNTH, AND THE COMMUNICATIONS TRASPONDER
FREQUENCIES WERE NEVER ACTIVATED$$
THE FACT THAT THE HOUSEKEEPING TELEMETRY SYSTEM IS NO LONGER TRANSMITTIN
G
INDICATES THAT THE SPACECRAFT HAS BEEN ABANDONED$$
THERE IS A POSSIBILITY, HOWEVER, THAT THE SATELLITE WILL BE STABLIZED AT
A LATER DATE$$
IF SO, THE NEXT TIME THAT THE ORBIT OF SPANAME IS FAVORABLE FOR
GEOPOSITIONING IS 2NMBR MNTH$$
SPANAME WAS LAUNCHED TO REPLACE SPANAME1$$
$$$ MSG 15
STATUS OF SPANAME, A RADAR OCEAN RECONNAISSANCE SATELLITE$$
PRELIMINARY ANALYSIS OF DATA RELATED TO SPANAME, A RADAR OCEAN
RECONNAISSANCE SATELLITE LAUNCHED ON 2NMBR MNTH, SUGGESTS THAT A
MALFUNCTION MAY HAVE OCCUREED AS EARLY AS 2NMBR MNTH$$
SUBSEQUENT TO THIS DATE, NO RADAR NOR DATA TRANSMISSION SIGNALS
ASSOCIATED WITH THIS SPACECRAFT HAVE BEEN INTERCEPTED$$

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ADDITIONALLY, THE TYPE 2NMBR COMMAND TRANSPONDER SIGNAL ASSOCIATED WITH
THE
SPACECRAFT HAS NOT BEEN INTERCEPTED SINCE 1NMBR MNTH$$
IF THE APPARENT MALFUNCTION IS NOT CORRECTABLE, THE NATNAME WILL PROBABL
Y
ATTEMPT TO SEPARATE THE NUCLEAR POWER SUPPLY FROM THE MAIN PAYLOAD AND
MANEUVER THE POWER SUPPLY PORTION INTO A HIGH CIRCULAR ORBIT$$
$$$ MSG 16
SPANAME CONFIRMED IN ORBIT, 2NMBR MNTH 4NMBR$$
SPANAME, THE NEW 2NMBR DEGREE SPACLASS LAUNCHED FROM THE PLACENAME
MISSILE AND SPACE CENTER BY THE LSTYPE SPACE BOOSTER AT ZULUTIME HAS BEE
N
CONFIRMED IN ORBIT$$
THE MISSION OF THIS VEHICLE HAS NOT BEEN DETERMINED AT THIS TIME$$
$$$ MSG 17
PRESSNAME ANNOUNCES THE LAUNCH OF SPANAME$$
IN A ROUTINELY WORDED STATEMENT THE POLITADJ NEWS AGENCY NAME ANNOUNCED
THE LAUNCHING OF SPANAME$$
SPANAME (SPUT 1200) IS THE 2NMBR DEGREE FIRST GENERATION
NAVAL SUPPORT SATELLITE LAUNCHED FROM THE PLACENAME MISSILE AND SPACE CE
NTER
(TRAC) AT ZULUTIME MNTH 4NMBR$$
THE FOLLOWING PARAMETERS WERE CONTAINED IN THE STATEMENT:
APOGEE      4NMBR KMS
PERIGEE     3NMBR KMS
PERIOD      3NMBR MINS
INCLINATION 2NMBR DEGREES
$$$ MSG 18
NAVAL MISCLASS LAUNCHED FROM  SEANAME TO SEANAME1 AREA, 2NMBR MNTH$$
A PROBABLE MISNAME NAVAL MISCLASS WAS LAUNCHED FROM THE
SEANAME (NORTHERN FLEET MISSILE COMPLEX) TO THE NORTH SEANAME2
EXTENDED RANGE IMPACT AREA AT ZULUTIME, 1NMBR MNTH$$
IMPACT OCCURRED ABOUT 2NMBR MINUTES LATER AT A POINT NEAR COORDINATES,
SOME 4NMBR NAUTICAL MILES DOWNRANGE$$
IMPACT WAS ABOUT 3NMBR NAUTICAL MILES OUTSIDE OF THE NORTHWEST EDGE OF T
HE
NORTHERN SEANAME1 AREA  CIRCULAR CLOSURE$$
$$$ MSG 19
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MISNAME MISCLASS LAUNCHED FROM PLACENAME TO PLACENAME1, 2NMBR
MNTH 4NMBR$$
1. AN MISNAME MOD 1NMBR MISCLASS WAS LAUNCHED FROM PLACENAME AT
APPROXIMATELY 4NMBR ON 2NMBR MNTH$$
THE VEHICLE IMPACTED ON PLACENAME1 AFTER A FLIGHT OF ABOUT 2NMBR MINUTES
$$
PRELIMINARY ANALYSIS OF AVAILABLE DATA INDICATES THAT THIS WAS A NOMINAL
MISNAME MOD 1NMBR, WITHOUT THE FEATURES NOTED IN THE LAST
MISNAME MOD 1NMBR LAUNCH, WHICH OCCURRED ON 2NMBR MNTH$$
ON THAT DATE THE VEHICLE CARRIED A TOTALLY NEW PBV WITH A LONGER BURN
TIME$$
ADDITIONALLY, NEW RV DEPLOYMENT MECHANIZATION WAS UTILIZED AND
NEW GUIDANCE SOFTWARE WAS USED$$
2. NMBRNAME TELEMETRY LINKS, NMBRNAME BEACON SIGNALS AND NMBRNAME BOW A
ND ARROW
INTERFEROMETER DOWNLINK SIGNALS WERE INTERCEPTED DURING THE 2NMBR
MNTH LAUNCH$$
ALL THE SIGNALS INTERCEPTED WERE ON NOMINAL MISNAME TELEMETRY
AND BEACON FREQUENCIES$$
THE EXACT NUMBER OF RV'S ON THE 2NMBR MNTH EVENT IS UNKNOWN,
HOWEVER, PRELIMINARY DATA SUGGESTS THAT NMBRNAME WERE CARRIED$$
THIS WAS THE NMBRNAMETH MISNAME LAUNCH THIS YEAR, ALL MOD 1NMBR'S$$
3. EVENT HISTORY:
(READ: DATE/TIME, EVENT):
2NMBR/ZULUTIME LAUNCH
[HERE FOLLOWS A TABLE]
$$$ MSG 20
MISNAME MISCLASS LAUNCHED ON 2NMBR MNTH 4NMBR$$
AN MISNAME MISCLASS WAS LAUNCHED FROM THE SEANAME NEAR COORDINATES
AT ABOUT 4NMBR ON 2NMBR MNTH$$
REENTRY OCCURRED IN THE PLACENAME REGION AT ABOUT 4NMBR$$
THIS WAS THE 2NMBRTH MISNAME LAUNCH OF THE YEAR,
2NMBR FROM THE NORTHERN FLEET AND 1NMBR FROM THE PACIFIC FLEET$$
THE MOD TYPE FOR THE 2NMBR MNTH HAS NOT BEEN DETERMINED;
IT WILL BE CARRIED AS A MOD 1NMBR FOR RECORD KEEPING$$
THE PREVIOUS MISNAME LAUNCH IN THE NORTHERN FLEET OCCURRED ON
2NMBR MNTH$$
$$$ MSG 21

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POLITNAME LAUNCHES MISNAME MISCLASS'S FROM SRF SITES ON 2NMBR MNTH
4NMBR$$
AT ZULUTIME ON 2NMBR MNTH THE POLITNAME LAUNCHED NMBRNAME MISNAME
MISCLASS'S FROM THEIR SRF SITE AT PLACENAME$$
AT THE SAME TIME, AN MISNAME WAS LAUNCHED FROM THE SRF SITE
AT PLACENAME1$$
THE PLACENAME MISSILES IMPACTED AT/ NEAR PLACENAME2 AT ZULUTIME AND THE
PLACENAME1 MISSILE IMPACTED IN THE SAME AREA AT ZULUTIME$$
$$$ MSG 22
MISNAME LAUNCHED FROM PLACENAME 2NMBR MNTH 4NMBR$$
AT ZULUTIME, A MISNAME WAS LAUNCHED FROM PLACENAME$$
IT IMPACTED NEAR PLACENAME AT ZULUTIME$$
$$$ MSG 23
AN UNIDENTIFIED MISSILE, PERHAPS A MISCLASS, WAS FIRED FROM PLACENAME AT
ZULUTIME ON 2NMBR MNTH 4NMBR$$
$$$ MSG 24
MISNAME MISCLASS LAUNCHED FROM SRF SITE AT PLACENAME, 2NMBR
MNTH 4NMBR$$
1.  CHANGE LAST PART OF FIRST SENTENCE TO READ 2NMBR MNTH VICE
2NMBR MNTH$$
$$$ MSG 25
MISNAME MISCLASS LAUNCHED FROM SRF SITE AT PLACENAME, 2NMBR MNTH
4NMBR$$
1.  AN MISNAME MISCLASS WAS LAUNCHED FROM THE STRATEGIC ROCKET FORCES
(SRF) DEPLOYED SITE AT PLACENAME AT APPROXIMATELY 4NMBR ON 2NMBR
MNTH$$
IMPACT PROBABLY OCCURRED IN THE SEANAME JUST WEST OF THE CENTRAL PORTION
OF PLACENAME1$$
ALTHOUGH THE EXACT MOD OF THE VEHICLE CANNOT BE DETERMINED FROM AVAILABL
E
DATA, IT WILL BE CARRIED AS A MOD 1NMBR FOR RECORDKEEPING PURPOSES$$
THIS WAS THE 2NMBRTH MISNAME LAUNCH THIS YEAR, 2NMBR OF WHICH HAVE
BEEN MOD 1NMBR'S AND 1NMBR MOD 1NMBR'S$$
THIS WAS THE NMBRNAMETH MISNAME TO BE LAUNCHED FROM PLACENAME THIS
YEAR, THE LAST OCCURRING ON 2NMBR MNTH$$
$$$ MSG 26
POLITNAME LAUNCHES MISCLASS ON 2NMBR MNTH 4NMBR$$
AT ZULUTIME ON 2NMBR MNTH 4NMBR, THE POLITNAME LAUNCHED AN MISCLASS
FROM THE SEANAME$$
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THE MISSILE IMPACTED ON THE PLACENAME PENINSULA FOLLOWING A 2NMBR MINUTE
 FLIGHT$$
TENTATIVE IDENTIFICATION IS MISNAME$$
$$$ MSG 27
SUMMARY OF A DEFENSIVE MISSILE OPERATION AT THE TRAC ON 2NMBR MNTH$$
1. AN UNIDENTIFIED MISCLASS MISSILE WAS LAUNCHED AT ABOUT 4NMBR
ON 2NMBR MNTH AT THE PLACENAME MISSILE TEST CENTER (TRAC)$$
NO LIVE TARGET WAS NOTED$$
THE MISSILE WAS PROBABLY FIRED FROM LAUNCH COMPLEX "A", AND FLEW AT LEAS
T
2NMBR KM IN A WESTERLY DIRECTION$$
AFTER A FLIGHT OF AT LEAST 2NMBR SECONDS, DETONATION PROBABLY OCCURRED$$
THE POSSIBLE ASSOCIATION WITH LAUNCH COMPLEX A SUGGESTS THAT THE MISSILE
WAS AN MISNAME$$
$$$ MSG 28
UNIDENTIFIED MISCLASS LAUNCHED AT TRAC 2NMBR MNTH 4NMBR$$
1. AN UNIDENTIFIED MISCLASS, POSSIBLY AN MISNAME,
WAS LAUNCHED POSSIBLY FROM LAUNCH COMPLEX "A" AT PLACENAME AT ABOUT
4NMBR ON 2NMBR MNTH$$
NO TARGET VEHICLE DATA WERE OBSERVED$$
$$$ MSG 29
SUMMARY OF MISNAME LAUNCH ON 2NMBR MNTH 4NMBR$$
1. THE MISNAME LAUNCHED FROM THE PLACENAME MISSILE TEST RANGE
(TRAC) AT APPROXIMATELY 4NMBR ON 2NMBR MNTH FLEW TO THE
NOMINAL 4NMBR KM IMPACT AREA NEAR THE PLACENAME1 MISSILE TEST CENTER$$
TOTAL FLIGHT TIME WAS APPROXIMATELY 2NMBR MINUTES$$
THIS WAS THE NMBRNAMETH MISNAME LAUNCH DETECTED AT TRAC IN NMBRNAME
YEARS$$
THE PREVIOUS LAUNCH WAS ON 2NMBR MNTH 4NMBR, AND UNTIL THAT TIME
FIRINGS HAD BEEN CONDUCTED STEADILY SINCE THE NMBRNAMETH DETECTION IN 4N
MBR$$
THERE WERE AS MANY AS 2NMBR LAUNCHES PER YEAR IN THE 4NMBR-4NMBR PERIOD
AND AN AVERAGE OF 1NMBR PER YEAR THEREAFTER$$
ALL LAUNCHES SINCE MNTH 4NMBR HAVE BEEN TO THE 4NMBR KM IMPACT AREA$$
PRIOR LAUNCHES WERE TO LONGER RANGES$$
$$$ MSG 30
VERTIAL-6 LAUNCHED FROM PLACENAME, 2NMBR MNTH 4NMBR$$
IN NMBRNAMETH SENTENCE OF PARAGRAPH 1NMBR CHANGE MISNAME MISCLASS TO REA
D

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MISNAME MISCLASS1$$
$$$ MSG 31
MISNAME VERTICAL LAUNCH FROM TRAC, 2NMBR MNTH 4NMBR$$
AN MISNAME VERTICAL WAS LAUNCHED FROM THE PLACENAME MISSILE
TEST RANGE (TRAC) AT ZULUTIME ON 2NMBR MNTH 4NMBR$$
THE MISSILE RE-ENTERED IN THE TRAC AREA ABOUT 2NMBR MINUTES AFTER
LAUNCH AT ZULUTIME$$
$$$ MSG 32
MISNAME MISCLASS LAUNCHED FROM TRAC, 2NMBR MNTH 4NMBR$$
AT APPROXIMATELY ZULUTIME ON 2NMBR MNTH, AN MISNAME
MISCLASS (MISCLASS) WAS LAUNCHED FROM THE
PLACENAME MISSILE TEST RANGE (TRAC) AND SUCCESSFULLY FLOWN TO THE
PLACENAME1 AREA WHERE IMPACT OCCURRED AT ABOUT ZULUTIME$$
$$$ MSG 33
MISNAME MISCLASS LAUNCHED FROM TRAC, 2NMBR MNTH 4NMBR$$
AN MISNAME MISCLASS WAS LAUNCHED FROM THE PLACENAME MISSILE TEST
RANGE (TRAC) AT ZULUTIME ON 2NMBR MNTH 4NMBR$$
THE MISSILE IMPACTED ON THE PLACENAME1 PENNISULA ABOUT 2NMBR MINUTES
AFTER LAUNCH$$
$$$ MSG 34
POLITNAME LAUNCHES MISNAME MOD 1NMBR MISCLASS ON 1NMBR MNTH
4NMBR$$
AT ZULUTIME ON 1NMBR MNTH 4NMBR, THE POLITNAME LAUNCHED AN
MISNAME MOD 1NMBR MISCLASS FROM THE PLACENAME MISSILE TEST RANGE$$
THE MISSILE IMPACTED ON THE PLACENAME1 PENNINSULA FOLLOWING A 2NMBR
MINUTE FLIGHT$$
$$$ MSG 35
POLITNAME LAUNCHES MISNAME MISCLASS ON 2NMBR MNTH 4NMBR$$
AT ZULUTIME ON 2NMBR MNTH 4NMBR, THE POLITNAME LAUNCHED AN
MISNAME MISCLASS FROM THE SEANAME$$
THE MISSILE IMPACTED AT PLACENAME FOLLOWING A 2NMBR MINUTE FLIGHT$$
$$$ MSG 36
MISNAME LAUNCHED FROM TRAC, 2NMBR MNTH 4NMBR$$
AT ZULUTIME, AN MISNAME WAS LAUNCHED FROM THE PLACENAME MISSILE
TEST RANGE$$
IMPACT NEAR PLACENAME WAS AT ZULUTIME$$
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$$$ MSG 37
MISNAME (POSSIBLY DUAL) LAUNCHED FROM SEANAME, 2NMBR MNTH 4NMBR
AT APPROXIMATELY ZULUTIME, AN MISNAME (POSSIBLY DUAL) WAS LAUNCHED
FROM THE SEANAME$$
IMPACT TOOK PLACE IN THE PLACENAME 2NMBR MINUTES LATER$$
$$$ MSG 38
MISNAME RV SIMULATION LAUNCHED FROM TRAC, 2NMBR MNTH 4NMBR$$
AT ZULUTIME, AN MISNAME RV SIMULATION WAS LAUNCHED FROM THE PLACEAME
MISSILE TEST RANGE$$
IMPACT WAS AT PLACENAME1 AT APPROXIMATELY ZULUTIME$$
MCR>
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(SPACECRAFTNAME IS SPACECRAFTNAME, A LOW RESOLUTION PHOTOGRAPHIC
RECONNAISSANCE SATELLITE LAUNCHED FROM PLACENAME AT ZULUTIME ON DAYNO
MONTHNAME)$$
$$$
NAME ANNOUNCES LAUNCH OF SPACECRAFTNAME$$
AT ZULUTIME, NAME -- THE COUNTRYNAME NEWS AGENCY -- ANNOUNCED THE LAUNCH OF
SPACECRAFTNAME, THE UNIDENTIFIED MILITARY SUPPORT ESV (ALPHANMBR) WHICH
WAS LAUNCHED FROM THE PLACENAME MISSILE AND SPACE CENTER AT ZULUTIME
TODAY $$
$$$
ORBITAL PARAMETERS AS CONTAINED IN THE ANNOUNCEMENT ARE:
      APOGEE NMBR KILOMETERS
      PERIGEE NMBR KILOMETERS
      INCLINATION NMBR DEGREES
      PERIOD NMBR MINUTES $$
$$$
NAME ANNOUNCES LAUNCH OF SPACECRAFTNAME, DAYNO MONTHNAME YEARNO$$
1.  AT ZULUTIME TODAY, NAME, THE COUNTRYNAME NEWS AGENCY, ANNOUNCED THE LAUNCH
    OF SPACECRAFTNAME $$
THE ANNOUNCEMENT CONTAINED THE NAMES OF THE CREW MEMBERS WHICH ARE:
      LIEUTENANT-COLONEL PERSONNAME
      (FLIGHT COMMANDER), AND
      COSOMONAUT PERSONNAME
      (FLIGHT ENGINEER)$$
2.  THE FLIGHT PROGRAM ENVISAGES EXPERIMENTS JOINTLY WITH THE SPACECRAFTNAME
    SPACE STATION WHICH WAS PUT IN ORBIT AROUND THE EARTH ON MONTHNAME
    DAYNO THIS YEAR$$
3.  SPACECRAFTNAME WAS LAUNCHED FROM PLACENAME AT ZULUTIME TODAY $$
NAME HAS NOT YET ANNOUNCED SPACECRAFTNAME'S ORBITAL PARAMETERS $$
$$$
COUNTRYNAME MANNED SPACE LAUNCH, DAYNO MONTHNAME YEARNO $$
AT APPROXIMATELY ZULUTIME, A MANNED COUNTRYNAME SPACECRAFTCLASS FERRY CRAFT
(ALPHANMBR) WAS LAUNCHED FROM THE PLACENAME MISSILE TEST RANGE
(ACRONYM) BY THE ALPHANMBR SPACE BOOSTER AND INSERTED INTO AN ORBIT
INCLINED NMBR DEGREES TO THE EQUATOR  $$
THIS ESV IS EXPECTED TO RENDEZVOUS AND DOCK WITH THE ORBITING SPACE STATION
```

```
SPACECRAFTNAME$$
IF CONFIRMED IN ORBIT, SPACECRAFTCLASS NUMBER NMBR WILL BE ASSIGNED$$
SDC OBJECT NUMBER NMBR HAS BEEN GIVEN TO THE PAYLOAD $$
THE COUNTRYNAME DESIGNATION WILL PROBABLY BE SPACECRAFTNAME $$
$$$
A NEW COUNTRYNAME MANNED ESV ACHIEVES ORBIT, DAYNO MONTHNAME YEARNO$$
SPACECRAFTNAME, THE MANNED ESV LAUNCHED FROM PLACENAME EARLIER TODAY AT
ZULUTIME HAS BEEN CONFIRMED IN ORBIT $$
$$$
ESV LAUNCHED FROM PLACENAME, DAYNO MONTHNAME YEARNO $$
AT APPROXIMATELY ZULUTIME, A NEW ESV WAS LAUNCHED FROM THE PLACENAME MISSILE
AND SPACE CENTER BY THE ALPHANMBR SPACE LAUNCH SYSTEM AND WAS INJECTED INTO
AN ORBIT INCLINED NMBR DEGREES TO THE EQUATOR $$
THIS SATELLITE'S MISSION IS UNKNOWN AT THIS TIME$$
IF CONFIRMED IN ORBIT, SPACECRAFTCLASS NUMBER NMBR WILL BE ASSIGNED$$
SDC OBJECT NUMBER NMBR HAS BEEN GIVEN TO THE PAYLOAD $$
$$$
SPACECRAFTNAME IDENTIFIED $$
SPACECRAFTNAME, THE ESV LAUNCHED FROM THE PLACENAME MISSILE AND SPACE
COMPLEX BY THE ALPHANMBR SPACE BOOSTER AT ZULUTIME THIS DATE HAS BEEN
IDENTIFIED AS AN UNIDENTIFIED MILITARY SUPPORT SATELLITE (ALPHANMBR) OF
THE SPACECRAFTCLASS NMBR, NMBR, NMBR CLASS, WHICH WERE FRAGMENT
DISPENSING SATELLITES $$
$$$
NAME ANNOUNCES LAUNCH OF SPACECRAFTNAME$$
THE COUNTRYNAME NEWS AGENCY, NAME, ANNOUNCED THE LAUNCH OF SPACECRAFTNAME
(SPACECRAFTNAME) IN A ROUTINELY WORDED STATEMENT ON DAYNO MONTHNAME
YEARNO $$
THE ANNOUNCEMENT PROVIDED THE FOLLOWING ORBITAL PARAMETERS:
     APOGEE NMBR KILOMETERS; PERIGEE NMBR KILOMETERS;
     INCLINATION NMBR DEGREE; PERIOD NMBR MINUTES $$
SPACECRAFTNAME IS THE FIRST GENERATION VARIABLE RESOLUTION
PHOTO RECONNAISSANCE SATELLITE LAUNCHED FROM THE PLACENAME MISSILE SPACE
COMPLEX AT ZULUTIME ON DAYNO MONTHNAME $$
$$$
```

ESV LAUNCHED FROM PLACENAME, DAYNO MONTHNAME YEARNO FAILS TO ACHIEVE ORBIT $$
AT APPROXIMATELY ZULUTIME, A NEW ESV LAUNCH WAS ATTEMPTED FROM THE
PLACENAME MISSILE AND SPCE CENTER BY THE ALPHANMBR SPACE LAUNCH SYSTEM$$
THE INTENDED ORBIT WAS TO BE INCLINED NMBR DEGREES TO THE EQUATOR$$
THIS SATELLITE'S INTENDED MISSION IS UNKNOWN$$
PRELIMINARY INDICATION ARE THAT THE SECOND STAGE OF THE LAUNCH VEHICLE
FAILED TO IGNITE $$
$$$
POSSIBLE SECOND-GENERATION NAVSAT LAUNCHED FROM PLACENAME FAILS TO ACHIEVE
ORBIT $$
1. A POSSIBLE SECOND-GENERATION NAVAL SUPPORT SATELLITE (NAVSAT) WAS
LAUNCHED FROM PLACENAME AT ZULUTIME, DAYNO MONTHNAME$$
THE MISSION RESULTED IN FAILURE, HOWEVER, BECAUSE OF A SECOND STAGE
MALFUNCTION$$ TELEMETRY ANALYSIS INDICATED THAT THE SECOND STAGE ENGINE
FAILED TO IGNITE AS PROGRAMMED FOLLOWING FIRST STAGE SHUTDOWN. THUS THE
SPACECRAFT FAILED TO ACHIEVE EARTH ORBIT AND REENTERED OVER THE COUNTRYNAME
IN THE GENERAL VICINITY OF COORDINATES ABOUT NMBR MINUTES AFTER
LIFT-OFF $$
THIS SPACECRAFT, LAUNCHED ON AN INCLINATION OF NMBR DEGREES BY THE
ALPHANMBR SPACE SYSTEM, WAS APPARENTLY INTENDED TO REPLACE SPACECRAFTNAME$$
SPACECRAFTNAME WAS LAUNCHED IN MONTHNAME YEARNO AND IS THE OLDEST SATELLITE
IN THIS NUMBR-SATELLITE NETWORK$$
THE NETWORK CONSISTS OF NMBR SPACECRAFT, EACH OF WHICH IS SEPARATED IN
RIGHT ASCENSION BY NMBR DEGREES$$
2. THE LAUNCH TIME FOR THE ILL-FATED SPACECRAFT RESULTED IN A RIGHT
ASCENSION OF ABOUT NMBR DEGREES, WHICH IS NMBR DEGREES FROM THE
EXISTING NETWORK AND IS ALMOST NMBR DEGREES OUT-OF-PHASE WITH
SPACECRAFTNAME$$
THE PITCH RATE PROGRAM, WHICH WAS DETERMINED BY TELEMETRY ANALYSIS,
INDICATED THAT THE SPACECRAFT, IF SUCCESSFUL, WOULD HAVE BEEN INSERTED
INTO AN ORBIT SIMILAR TO PREVIOUS NAVSATS$$
THE FOLLOWING DEPICTS THE RIGHT ASCENSION ALIGNMENT OF THE SECOND-GENERATION
NAVSAT NETWORK AT LIFT-OFF:
SPACECRAFTNAME1 -- NMBR DEGREES
SPACECRAFTNAME2 -- NMBR DEGREES
SPACECRAFTNAME3 -- NMBR DEGREES

SPACECRAFTNAME4 -- NMBR DEGREES
SPACECRAFTNAME5 -- NMBR DEGREES
SPACECRAFTNAME6 -- NMBR DEGREES
SPACECRAFTNAME7 -- NMBR DEGREES
IN-FLIGHT FAILURE -- NMBR DEGREES$$

$$$

COUNTRYNAME REACTIVATE SATELLITENAME ON DAYNO MONTHNAME$$

1. THE COUNTRYNAME REACHIVATED SATELLITENAME ON DAYNO MONTHNAME AFTER NMBR DAYS OF SPACECRAFT INACTIVITY$$

SATELLITENAME WAS LAUNCHED FROM PLACENAME ON DAYNO MONTHNAME, AND AFTER AN APPARENT UNSUCCESSFUL ATTEMPT TO STABLIZE THE SATELLITE ON NMBR MONTHNAME TELEMETRY TRANSMISSION CEASED ON THE NMBRD $$

SATELLITENAME WAS EVIDENTLY TEMPORARILY ABANDONED AND WAS ALLOWED TO CONTINUE ITS ORIGINAL WESTWARD DRIFT IN SILENCE$$

TO DATE, HOUSEKEEPING TELEMETRY TRANSMISSION ARE THE ONLY SIGNALS INTERCEPTED FROM THE SATELLITE$$

THE COUNTRYNAME APPEAR TO BE PRESENTLY CONDUCTING A SYSTEMATIC CHECKOUT OF THE ON-BOARD SYSTEMS$$

THE COMMUNICATIONS TRANSPONDER FREQUENCIES WILL PROBABLY BE ACTIVATED AFTER SATELLITENAME IS FINALLY STABLIZED$$

THE ORBIT OF SATELLITENAME WILL AGAIN BE FAVORABLE FOR GEOPOSITIONING WITHIN THE NEXT SEVERAL DAYS$$

$$$

DEFENSIVE MISSILE LAUNCH, DAYNO MONTHNAME YEARNO$$

AT ZULUTIME, A DEFENSIVE MISSILE, POSSIBLY A SAM, WAS LAUNCHED FROM THE PLACENAME MISSILE TEST CENTER $$

NO TARGET WAS EVIDENT $$

$$$

COUNTRYNAME ABANDON SATELLITENAME AFTER FAILING TO STABLIZE IT $$

1. THE ORBIT OF SATELLITENAME, THE COMMUNICATIONS RELAY SATELLITE LAUNCHED FROM PLACENAME ON DAYNO MONTHNAME, HAS NOT YET BEEN STABLIZED AND THERE ARE INDICATIONS THAT THE COUNTRYNAME MAY HAVE - AT LEAST TEMPORARILY ABANDONED THE SPACECRAFT $$

ACCORDING TO RADAR DATA, THE COUNTRYNAME APPARENTLY ATTEMPTED TO GEOPOSITION THE SATELLITE ON DAYNO MONTHNAME, HOWEVER, THIS INITIAL MANEUVER RESULTED IN AN INSIGNIFICANT REDUCTION IN THE SPACECRAFT'S ORBITAL PERIOD (FROM

NMBR MINUTES TO NMBR MINUTES) $$
THE PRESENT PERIOD OF SATELLITENAME IS NMBRMINUTES GREATER THAN ONE-HALF
OF A SIDEREAL DAY $$
THUS THE ASCENDING NODES ARE CONTINUING TO SIFT WESTWARD AT ABOUT NMBR
DEGREES PER DAY $$
2. PAYLOAD TELEMETRY TRANSMISSION FROM SATELLITENAME HAVE NOT BEEN
INTERCEPTED SINCE DAYNO MONTHNAME, AND THE COMMUNICATIONS TRASPONDER
FREQUENCIES WERE NEVER ACTIVATED $$
THE FACT THAT THE HOUSEKEEPING TELEMETRY SYSTEM IS NO LONGER TRANSMITTING
INDICATES THAT THE SPACECRAFT HAS BEEN ABANDONED $$
THERE IS A POSSIBILITY, HOWEVER, THAT THE SATELLITE WILL BE STABLIZED AT
A LATER DATE $$
IF SO, THE NEXT TIME THAT THE ORBIT OF SATELLITENAME IS FAVORABLE FOR
GEOPOSITIONING IS DAYNO MONTHNAME $$
SATELLITENAME WAS LAUNCHED TO REPLACE SATELLITENAME $$
$$$
STATUS OF SPACECRAFTNAME, RADAR OCEAN RECONNAISSANCE SATELLITE $$
PRELIMINARY ANALYSIS OF DATA RELATED TO SPACECRAFTNAME, RADAR OCEAN
RECONNAISSANCE SATELLITE LAUNCHED ON DAYNO MONTHNAME, SUGGESTS THAT A
MALFUNCTION MAY HAVE OCCUREED AS EARLY AS DAYNO MONTHNAME $$
SUBSEQUENT TO THIS DATE, NO RADAR NOR DATA TRANSMISSION SIGNALS
ASSOCIATED WITH THIS SPACECRAFT HAVE BEEN INTERCEPTED $$
ADDITIONALLY, THE TYPE NMBR COMMAND TRANSPONDER SIGNAL ASSOCIATED WITH THE
SPACECRAFT HAS NOT BEEN INTERCEPTED SNCE DAYNO MONTHNAME $$
IF THE APPARENT MALFUNCTION IS NOT CORRECTABLE, THE COUNTRYNAME WILL PROBABLY
ATTEMPT TO SEPARATE THE NUCLEAR POWER SUPPLY FROM THE MAIN PAYLOAD AND
MANEUVER THE POWER SUPPLY PORTION INTO A HIGH CIRCULAR ORBIT $$
$$$
SPACECRAFTNAME CONFIRMED IN ORBIT, DAYNO MONTHNAME YEARNO $$
SPACECRAFTNAME, THE NEW NMBR DEGREE ESV LAUNCHED FROM PLACENAME MISSILE
AND SPACE CENTER BY THE ALPHANMBR SPACE BOOSTER AT ZULUTIME HAS BEEN
CONFIRMED IN ORBIT $$
THE MISSION OF THIS VEHICLE HAS NOT BEEN DETERMINED AT THIS TIME $$
$$$

NAME ANNOUNCES THE LAUNCH OF SPACECRAFTNAME $$
IN A ROUTINELY WORDED STATEMENT THE COUNTRYNAME NEWS AGENCY NAME ANNOUNCED THE LAUNCHING OF SPACECRAFTNAME $$
SPACECRAFTNAME (SPACECRAFTNAME) IS THE NMBR DEGREE FIRST GENERATION NAVAL SUPPORT SATELLITE LAUNCHED FROM PLACENAME MISSILE AND SPACE CENTER (ACRONYM) AT ZULUTIME MONTHNAME YEARNO $$
THE FOLLOWING PARAMETERS WERE CONTAINED IN THE STATEMENT:

APOGEE NMBR KMS
PERIGREE NMBR KMS
PERIOD NMBR MINS
INCLINATION NMBR DEGREES

$$$
... ICMB LAUNCHED FROM OCEANNAME TO BROAD OCEAN AREA, DAYNO MONTHNAME $$
A PROBABLE MISSILECATEGORY NAVAL ICBM WAS LAUNCHED FROM THE OCEANNAME (NORTHERN FLEET MISSILE COMPLEX) TO THE OCEANNAME EXTENDED RANGE IMPACT AREA AT ZULUTIME, DAYNO MONTHNAME $$
IMPACT OCCURRED ABOUT NMBR MINUTES LATER AT A POINT NEAR COORDINATES, SOME NMBR NAUTICAL MILES DOWNRANGE $$
IMPACT WAS ABOUT NMBR NAUTICAL MILES OUTSIDE OF THE NORTHWEST EDGE OF THE NORTHERN BROAD OCEAN AREA (BOA) CIRCULAR CLOSURE $$
$$$
MISSILECATEGORY ICBM LAUNCHED FROM PLACENAME TO PLACENAME, DAYNO MONTHNAME YEARNO $$

1. AN MISSILECATEGORY MOD NMBR ICBM WAS LAUNCHED FROM PLACENAME AT APPROXIMATELY ZULUTIME (Z MISSING) ON DAYNO MONTHNAME $$

THE VEHICLE IMPACTED O PLACENAME AFTER A FLIGHT OF ABOUT NMBR MINUTES $$
PRELIMINARY ANALYSIS OF AVAILABLE DATA INDICATES THAT THIS WAS A NOMINAL MISSILECATEGORY MOD NMBR, WITHOUT THE FEATURES NOTED IN THE LAST MISSILECATEGORY MOD NMBR LAUNCH, WHICH OCCURRED ON DAYNO MONTHNAME $$
ON THAT DATE THE VEHICLE CARRIED A TOTALLY NEW PBV WITH A LONGER BURN TIME $$ ADDITIONALLY, NEW RV DEPLOYMENT MECHANIZATION WAS UTILIZED AND NEW GUIDANCE SOFTWARE WAS USED $$

2. NMBR TELEMETRY LINKS, NMBR BEACON SIGNALS AND NMBR BOW AND ARROW INTERFEROMETER DOWNLINK SIGNALS WERE INTERCEPTED DURING THE DAYNO MONTHNAME LAUNCH $$

ALL THE SIGNALS INTERCEPTED WERE ON NOMINAL MISSILECATEGORY TELEMETRY
AND BEACON FREQUENCIES $$
THE EXACT NUMBER OF BV'S ON THE DAYNO MONTHNAME EVENT IS UNKNOWN $$
HOWEVER, PRELIMINARY DATA SUGGESTS THAT NMBR WERE CARRIED $$
THIS WAS THE NMBRTH MISSILECATEGORY LAUNCH THIS YEAR, ALL MOD NMBR'S $$
NOTE: THIS IS FOLLOWED BY AN EVENT HISTORY IN TABULAR FORMAT $$
$$$
MISSILECATEGORY SLBM LAUNCHED ON DAYNO MONTHNAME YEARNO $$
AN MISSILECATEGORY SLBM WAS LAUNCHED FROM THE OCEANNAME NEAR COORDINATES
AT ABOUT ZULUTIME (NOTE 'Z' MISSING) ON DAYNO MONTHNAME $$
REENTRY OCCURRED IN THE PLACENAME REGION AT ABOUT ZULUTIME (NOTE 'Z' MISSING)
$$
THIS WAS THE NMBRST MISSILECATEGORY LAUNCH OF THE YEAR $$
NMBR FROM THE NORTHERN FLEET AND NMBR FROM THE PACIFIC FLEET $$
THE MOD TYPE FOR THE DAYNO MONTHNAME HAS NOT BEEN DETERMINED $$
IT WILL BE CARRIED AS A MOD NMBR FOR RECORD KEEPING $$
THE PREVIOUS MISSILECATEGORY LAUNCH IN THE NORTHERN FLEET OCCURRED ON
DAYNO MONTHNAME $$
$$$
COUNTRYNAME LAUNCHES MISSILECATEGORY ICBM'S FROM SRF SITES ON DAYNO MONTHNAME
YEARNO $$
AT ZULUTIME ON DAYNO MONTHNAME THE COUNTRYNAME LAUNCHES TWO MISSILECATEGORY
ICBM'S FROM THEIR SRF SITE AT PLACENAME $$
AT THE SAME TIME, AN MISSILECATEGORY WAS LAUNCHED FROM THE SRF SITE
AT PLACENAME $$
THE PLACENAME MISSILES IMPACTED AT/ NEAR PLACENAME AT ZULUTIME AND THE
PLACENAME MISSILE IMPACTED IN THE SAME AREA AT ZULUTIME $$
$$$
MISSILECATEGORY LAUNCHED FROM PLACENAME DAYNO MONTHNAME YEARNO $$ AT
ZULUTIME, A MISSILECATEGORY WAS LAUNCHED FROM PLACENAME $$ IT
IMPACTED NEAR PLACENAME AT ZULUTIME $$
AN UNIDENTIFIED MISSILE, PERHAPS A DRONE, WAS FIRED FROM PLACENAME AT
ZULUTIME ON DAYNO MONTHNAME YEARNO $$
$$$
MISSILECATEGORY ICBM LAUNCHED FROM SRF SITE AT PLACENAME, DAYNO
MONTHNAME YEARNO $$
1. CHANGE LAST PART OF FIRST SENTENCE TO READ DAYNO MONTHNAME VICE
DAYNO MONTHNAME $$

```
$$$
MISSILECATEGORY ICBM LAUNCHED FROM SRF SITE AT PLACENAME, DAYNO MONTHNAME
YEARNO$$
1.  AN MISSILECATEGORY ICBM WAS LAUNCHED FROM THE STRATEGIC ROCKET FORCES
    (SRF) DEPLOYED SITE AT PLACENAME AT APPROXIMATELY ZULUTIME ON DAYNO
    MONTHNAME$$
IMPACT PROBABLY OCCURRED IN THE OCEANNAME JUST WEST OF THE CENTRAL PORTION
OF PLACENAME$$
ALTHOUGH THE EXACT MOD OF THE VEHICLE CANNOT BE DETERMINED FROM AVAILABLE
DATA, IT WILL BE CARRIED AS ) MOD NMBR FOR RECORDKEEPING PURPOSES$$
THIS WAS THE NMBRTH MISSILECATEGORY LAUNCH THIS YEAR, NMBR OF WHICH HAVE
BEEN NOD NMBR'S AND NMBR MOD NMBR'S$$
THIS WAS THE THIRD MISSILECATEGORY TO BE LAUNCHED FROM PLACENAME THIS
YEAR, THE LAST OCCURRING ON DAYNO MONTHNAME$$
$$$
COUNTRYNAME LAUNCHES SLBM ON DAYNO MONTHNAME YEARNO$$
AT ZULUTIME ON DAYNO MONTHNAME YEARNO, THE COUNTRYNAME LAUNCHED ON SLBM
FROM THE OCEANNAME$$
THE MISSILE IMPACTED ON PLACENAME PENINSULA FOLLOWING A NMBR MINUTE FLIGHT$$
TENTATIVE IDENTIFICATION IS MISSILECATEGORY$$
$$$
SUMMARY OF A DEFENSIVE MISSILE OPERATION AT THE ACRONYM ON DAYNO MONTHNAME$$
1.  AN UNIDENTIFIED SURFACE-TO-AIR MISSILE WAS LAUNCHED AT ABOUT ZULUTIME
    ON DAYNO MONTHNAME AT THE PLACENAME MISSILE TEST CENTER (ACRONYM)$$
NO LIVE TARGET WAS NOTED$$
THE MISSILE WAS PROBABLY FIRED FROM LAUNCH COMPLEX "A", AND FLEW AT LEAST
NMBR KM IN A WESTERLY DIRECTION$$
AFTER A FLIGHT OF AT LEAST NMBR SECONDS, DETONATION PROBABLY OCCURRED$$
THE POSSIBLE ASSOCIATION WITH LAUNCH COMPLEX A SUGGESTS THAT THE MISSILE
WAS AN MISSILECATEGORY$$
$$$
UNIDENTIFIED SAM LAUNCHED AT ACRONYM DAYNO MONTHNAME YEARNO$$
1.  AN UNIDENTIFIED SURFACE-TO-AIR MISSILE, POSSIBLY AN MISSILECATEGORY,
    WAS LAUNCHED POSSIBLY FROM LAUNCH COMPLEX "A" AT PLACENAME AT ABOUT
    ZULUTIME ON DAYNO MONTHNAME$$
NO TARGET VEHICLE DATA WERE OBSERVED$$
$$$
```

SUMMARY OF MISSILECATEGORY LAUNCH ON DAYNO MONTHNAME YEARNO$$

1. THE MISSILECATEGORY LAUNCHED FROM THE PLACENAME MISSILE TEST RANGE (ACRONYM) AT APPROXIMATELY ZULUTIME ON DAYNO MONTHNAME FLEW TO THE NOMINAL NMBR KM IMPACT AREA NEAR THE PLACENAME MISSILE TEST CENTER$$

TOTAL FLIGHT TIME WAS APPROXIMATELY NMBR MINUTES$$

THIS WAS THE FIRST MISSILECATEGORY LAUNCH DETECTED AT ACRONYM IN [illegible] YEARS$$

THE PREVIOUS LAUNCH WAS ON DAYNO MONTHNAME YEARNO, AND UNTIL THAT TIME FIRINGS HAD BEEN CONDUCTED STEADILY SINCE THE FIRST DETECTION IN YEARNO$$

THERE WERE AS MANY AS NMBR LAUNCHES PER YEAR IN THE YEARNO-YEARNO PERIOD AND AN AVERAGE OF NMBR PER YEAR THEREAFTER$$

ALL LAUNCHES SINCE MONTHNAME YEARNO HAVE BEEN TO THE NMBR KM IMPACT [illegible]$$

PRIOR LAUNCHES WERE TO LONGER RANGES$$

$$$

MISSILECATEGORY LAUNCHED FROM PLACENAME, DAYNO MONTHNAME YEARNO$$

IN SECOND SENTENCE OF PARAGRAPH 1 CHANGE MISSILECATEGORY IRBM TO READ MISSILECATEGORY IRBM$$

$$$

MISSILECATEGORY VERTICAL LAUNCH FROM ACRONYM, DAYNO MONTHNAME YEARNO$$

AN MISSILECATEGORY VERTICAL WAS LAUNCHED FROM THE PLACENAME MISSILE TEST RANGE (ACRONYM) AT ZULUTIME ON DAYNO MONTHNAME YEARNO$$

THE MISSILE RE-ENTERED IN THE ACRONYM AREA ABOUT NMBR MINUTES AFTER LAUNCH AT ZULUTIME$$

$$$

MISSILECATEGORY IRBM LAUNCHED FROM ACRONYM, DAYNO MONTHNAME YEARNO$$

AT APPROXIMATELY ZULUTIME ON DAYNO MONTHNAME, AN MISSILECATEGORY INTERMEDIATE RANGE BALLISTIC MISSILE (IRBM) WAS LAUNCHED FROM THE PLACENAME MISSILE TEST RANGE (ACRONYM) AND SUCCESSFULLY FLOWN TO THE PLACENAME AREA WHERE IMPACT OCCURRED AT ABOUT ZULUTIME $$

$$$

MISSILECATEGORY ICBM LAUNCHED FROM ACRONYM, DAYNO MONTHNAME YEARNO $$

AN MISSILECATEGORY ICBM WAS LAUNCHED FROM THE PLACENAME MISSILE TEST RANGE (ACRONYM) AT ZULUTIME ON DAYNO MONTHNAME YEARNO$$

THE MISSILE IMPACTED ON THE PLACENAME PENNISULA ABOUT NMBR MINUTES AFTER LAUNCH$$

$$$

COUNTRYNAME LAUNCHES MISSILECATEGORY MOD NMBR ICBM ON DAYNO MONTHNAME
YEARNO$$
AT ZULUTIME ON DAYNO MONTHNAME YEARNO, THE COUNTRYNAME LAUNCHED AN
MISSILECATEGORY MOD NMBR ICBM FROM THE PLACENAME MISSILE TEST RANGE$$
THE MISSILE IMPACTED ON THE PLACENAME PENNINSULA FOLLOWING A NMBR
MINUTE FLIGHT$$
$$$
COUNTRYNAME LAUNCHES MISSILECATEGORY IRBM ON DAYNO MONTHNAME YEARNO$$
AT ZULUTIME ON DAYNO MONTHNAME YEARNO, THE COUNTRYNAME LAUNCHED AN
MISSILECATEGORY IRBM FROM THE OCEANNAME$$
THE MISSILE IMPACTED AT PLACENAME FOLLOWING A NMBR MINUTE FLIGHT$$
$$$
MISSILECATEGORY LAUNCHED FROM ACRONYM, DAYNO MONTHNAME YEARNO$$
AT ZULUTIME, AN MISSILECATEGORY WAS LAUNCHED FROM PLACENAME MISSILE TEST
RANGE$$
IMPACT NEAR PLACENAME WAS AT ZULUTIME$$
$$$
MISSILECATEGORY (POSSIBLY DUAL) WAS LAUNCHED FROM OCEANNAME, DAYNO
MONTHNAME YEARNO$$
AT APPROXIMATELY ZULUTIME, AN MISSILECATEGORY (POSSIBLY DUAL) WAS LAUNCHED
FROM THE OCEANNAME$$
IMPACT TOOK PLACE IN THE PLACENAME NMBR MINUTES LATER$$
$$$
MISSILECATEGORY SIMULATION LAUNCHED FROM ACRONYM, DAYNO MONTHNAME YEARNO$$
AT ZULUTIME, AN MISSILECATEGORY SIMULATION WAS LAUNCHED FROM THE PLACEAME
MISSILE TEST RANGE$$
IMPACT WAS AT PLACENAME AT APPROXIMATELY ZULUTIME$$

APPENDIX B: Lexicon

LEXICON
FEATURE 1DIG
FEATURE 2DIG
FEATURE 3DIG
FEATURE 4DIG
FEATURE 5DIG
FEATURE 6DIG
FEATURE ACRAFT
FEATURE ADVB
FEATURE ADJ
FEATURE ACTVTY
FEATURE ALT
FEATURE ARRIVE
FEATURE BE
FEATURE BEFORE
FEATURE BOOSTER
FEATURE COMM
FEATURE CONFIRM
FEATURE CONTINUE
FEATURE CONJ
FEATURE COPULA
FEATURE DAYTE
FEATURE DEMONS
FEATURE DEORBIT
FEATURE DEPART
FEATURE DEPLOY
FEATURE DIR
FEATURE ART
FEATURE EVAL
FEATURE EMOD
FEATURE ENROUTE
FEATURE FLIGHT
FEATURE GO
FEATURE HEAD
FEATURE HAVE
FEATURE IMPACT
FEATURE INCL
FEATURE INTRANS
FEATURE LOC
FEATURE LOCATE
FEATURE LAND
FEATURE LAUNCH
FEATURE MISSILE
FEATURE MO
FEATURE MODAL
FEATURE EVENTIVE
FEATURE NUM
FEATURE NUMMOD
FEATURE NATION
FEATURE NATO

```
FEATURE N
FEATURE OBSERVE
FEATURE ORD
FEATURE PASTP
FEATURE PMOD
FEATURE POSPRO
FEATURE PREDET
FEATURE PRESP
FEATURE PRO
FEATURE PRTCL
FEATURE PREP
FEATURE PENETRATE
FEATURE QUANT
FEATURE REENTRY
FEATURE REF
FEATURE RETURN
FEATURE RELPRO
FEATURE REV
FEATURE ROBJ
FEATURE RSUBJ
FEATURE SATELLITE
FEATURE SCONJ
FEATURE SERVICE
FEATURE SUBNUM
FEATURE SUPER
FEATURE STAGE
FEATURE THATCOMP
FEATURE TJPE
FEATURE TOCOMP
FEATURE TYME
FEATURE TENSED
FEATURE TRANS
FEATURE UNIT
FEATURE VB
FEATURE VMOD
FEATURE VPASSIVE
:: ( AIR FORCE) [ N ] .;
:: ( AIR REGIMENT) [ N ] .;
:: ( AIR SPACE) [ N LOC ] .;
:: ( AL JAGHBUB) [ N LOC ] .;
:: ( A MINIMUM OF) [ NUMMOD ] .;
:: ( ARABIAN SEA) [ N LOC ] .;
:: ( AS FAR) [ PREP EMOD ] .;
:: ( AS MANY AS) [ NUMMOD ] .;
:: ( AT LEAST) [ NUMMOD ] .;
:: ( AT MOST) [ NUMMOD ] .;
:: ( BARENTS SEA) [ N LOC ] .;
:: ( BOMBER CORPS) [ N ] .;
:: ( BUFF A) [ N NATO ACRAFT ] .;
:: ( BUFF B) [ N NATO ACRAFT ] .;
:: ( BUFF C) [ N NATO ACRAFT ] .;
:: ( BUFF D) [ N NATO ACRAFT ] .;
:: ( BUFF O) [ N NATO ACRAFT ] .;
:: ( CAPE VERDE ISLANDS) [ N LOC ] .;
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:: ( COMMAND AND CONTROL) [ ADJ ] .;
:: ( COMMAND AND SERVICE) [ ADJ ] .;
:: ( CONTROL AND REPORTING) [ ADJ ] .;
:: ( DEORBITED AND RECOVERED) [ VB TRANS TENSED DEORBIT ]
                              [ VB TRANS PASTP DEORBIT ] .;
:: ( EARTH'S ATMOSPHERE) [ N LOC ] .;
:: ( EAST OF) [ PREP ] .;
:: ( GULF OF ADEN) [ N LOC ] .;
:: ( GULF OF AQABA) [ N LOC ] .;
:: ( HEAVY BOMBERS) [ N ACRAFT ] .;
:: ( HEAVY BOMBER) [ N ACRAFT ] .;
:: ( IN CONJUNCTION WITH) [ PREP ] .;
:: ( IN CONNECTION WITH) [ PREP ] .;
:: ( IN REACTION TO) [ PREP ] .;
:: ( INDIAN OCEAN) [ N LOC ] .;
:: ( LACCADIVE ISLANDS) [ N LOC ] .;
:: ( LAUNCH SYSTEM) [ N BOOSTER ] .;
:: ( LAUNCH VEHICLE) [ N BOOSTER ] .;
:: ( MALDIVE ISLANDS) [ N LOC ] .;
:: ( MEDIUM BOMBER) [ N ACRAFT ] .;
:: ( MEDIUM BOMBERS) [ N ACRAFT ] .;
:: ( MIRAGE III) [ N TJPE ACRAFT ] .;
:: ( NATIONAL GUARDS) [ N ] .;
:: ( NATIONAL GUARD) [ N ] .;
:: ( NORTH OF) [ PREP ] .;
:: ( NORTHEAST OF) [ PREP ] .;
:: ( ORBITAL WORKSHOP) [ N SATELLITE ] .;
:: ( OUTSIDE OF) [ PREP ] .;
:: ( NORTHWEST OF) [ PREP ] .;
:: ( RED SEA) [ N LOC ] .;
:: ( SAUDI ARABIAN) [ ADJ NATION ] .;
:: ( SEA OF CRISES) [ N LOC ] .;
:: ( SEYCHELLE ISLANDS) [ N LOC ] .;
:: ( SEYCHELLE ISLAND CHAIN) [ N LOC ] .;
:: ( SMALL SCALE) [ ADJ ] .;
:: ( SOUTH AFRICAN) [ ADJ NATION ] .;
:: ( SOUTH OF) [ PREP ] .;
:: ( SOUTHEAST OF) [ PREP ] .;
:: ( SOUTHWEST OF) [ PREP ] .;
:: ( SOVIET UNION) [ N LOC NATION ] .;
:: ( ST HELENA) [ N LOC ] .;
:: ( SPACE CENTER) [ N LOC ] .;
:: ( TEST CENTER) [ N LOC ] .;
:: ( TEST RANGE) [ N LOC ] .;
:: ( TOOK PLACE) [ VB TENSED INTRANS ] .;
:: ( TAKE PLACE) [ VB TENSED INTRANS ] .;
:: ( WEST OF) [ PREP ] .;
:: ( WHITE SEA) [ N LOC ] .;
:: A [ ART ] .;
:: A313 [ N SUBNUM ] .;
:: AA [ ADJ ] .;
:: ABOUT [ ADVB EVAL PREDET ] [ PREP EMOD ] .;
:: ACFT [ N ACRAFT ] .;
```

```
:: ACHIEVE [ VB TRANS ] .;
:: ACTIVE [ ADJ ] [ VB ACTVTY ] .;
:: ACTIVITY [ N EVENTIVE ] .;
:: ACTY [ N EVENTIVE ] .;
:: ADDITIONAL [ ADJ REF ] .;
:: ADX [ N EVENTIVE ] .;
:: ADZ [ N LOC ] .;
:: AFRICAN [ ADJ ] .;
:: AFTER [ PREP TYME SCONJ ] .;
:: AGAINST [ PREP EMOD ] .;
:: AGENCY [ N ] .;
:: AIR-TO-SURFACE [ ADJ ] .;
:: AIR [ N ] .;
:: AIRBORNE [ ADJ ] [ VB FLIGHT ] .;
:: AIRCRAFT [ N ACRAFT ] .;
:: ALEXANDRIA [ N LOC ] .;
:: ALL [ QUANT ] .;
:: ALONG [ PREP EMOD ] .;
:: ALTITUDE [ N ALT ] .;
:: ALTITUDES [ N ALT ] .;
:: AN [ ART ] .;
:: AND [ CONJ ] .;
:: ANNOUNCED [ VB TRANS TENSED THATCOMP COMM ]
     [ VB TRANS PASTP THATCOMP COMM ] .;
:: APOLLO [ N SATELLITE ] .;
:: APPROXIMATELY [ ADVB EVAL PREDET ] .;
:: APR [ N TYME MO ] .;
:: APRIL [ N TYME MO ] .;
:: ARE [ BE ] [ COPULA ] [ VB TRANS ] .;
:: AREA [ N LOC ] .;
:: AREAS [ N LOC ] .;
:: ARRIVED [ VB PASTP ARRIVE ] [ VB TENSED ARRIVE ] .;
:: AS [ PRTCL ] .;
:: ASSOCIATED [ ADJ ] .;
:: ASM [ ADJ ] .;
:: ASTRONAUT [ N ] .;
:: ASW [ ADJ ] .;
:: AT [ PREP EMOD TYME ] .;
:: ATLANTIC [ N LOC ] .;
:: ATMOSPHERE [ N LOC ] .;
:: AUG [ N TYME MO ] .;
:: AUGUST [ N TYME MO ] .;
:: AUSTRALIA [ N LOC NATION ] .;
:: AUSTRALIAN [ ADJ ] .;
:: AUXILIARY [ ADJ ] .;
:: AVIATION [ N EVENTIVE ] .;
:: A-4 [ N TJPE ACRAFT ] .;
:: B-75 [ N TJPE ACRAFT ] .;
:: B-75S [ N TJPE ACRAFT ] .;
:: B-60 [ N TJPE ACRAFT ] .;
:: B-60'S [ N TJPE ACRAFT ] .;
:: B-61 [ N TJPE ACRAFT ] .;
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:: B-63 [ N TJPE ACRAFT ] .;
:: B-63'S [ N TJPE ACRAFT ] .;
:: B-63S [ N TJPE ACRAFT ] .;
:: B-67S [ N TJPE ACRAFT  ] .;
:: B-80 [ N TJPE ACRAFT ] .;
:: B-TYPE [ N TJPE ACRAFT ] .;
:: B-TYPES [ N TJPE ACRAFT ] .;
:: BACTERIOLOGICAL [ ADJ ] .;
:: BAIKONUR [ N LOC ] .;
:: BARFLY [ N NATO ACRAFT ] .;
:: BASE [ N LOC ] .;
:: BASED [ PASTP ] .;
:: BC254 [ N SUBNUM ] .;
:: BE [ BE ] [ COPULA ] [ VB TRANS ] .;
:: BEACON [ N NATO ACRAFT ] .;
:: BEAGLE [ N NATO ACRAFT ] .;
:: BED [ N ] .;
:: BEEN [ BE PASTP ] [ COPULA PASTP ] [ VB TRANS PASTP ] .;
:: BEETLES [ N ] .;
:: BEFORE [ PREP TYME SCONJ ] .;
:: BEING [ BE PRESP ] [ COPULA PRESP ] [ VB TRANS PRESP ] .;
:: BETWEEN [ PREP EMOD TYME ] .;
:: BOMBER [ N ACRAFT ] .;
:: BOMBERS [ N ACRAFT ] .;
:: BOOSTER [ N BOOSTER ] .;
:: BORDER [ N LOC ] .;
:: BOUNDED [ ADJ ] .;
:: BUFF [ N NATO ACRAFT ] .;
:: BUJUMBURA [ N LOC ] .;
:: BUTTER [ N NATO ACRAFT ] .;
:: BY [ PREP EMOD TYME ] .;
:: CANADA [ N LOC ] .;
:: CAPETOWN-BASED [ ADJ ] .;
:: CAPETOWN [ N LOC ] .;
:: CAPSULE [ N ] .;
:: CARRYING [ VB TRANS PRESP ] .;
:: CENTER [ N LOC ] .;
:: CENTRAL [ ADJ ] .;
:: COAST [ N LOC ] .;
:: COLLECTION [ N EVENTIVE ] .;
:: COMBAT [ N EVENTIVE ] .;
:: COMBATANT [ N ] .;
:: COMBATANTS [ N ] .;
:: COMMUNICATION [ N ] .;
:: COMPLEX [ N LOC ] .;
:: CONDUCTING [ VB TRANS PRESP ] .;
:: CONDUCTED [ VB TRANS PASTP ] [ VB TRANS TENSED ] .;
:: CONFIRMED [ VB TRANS PASTP CONFIRM ]
          [ VB TRANS TENSED CONFIRM ] .;
:: CONGO [ N LOC ] .;
:: CONTAINING [ VB TRANS PRESP ] .;
:: CONTINUED [ VB TRANS PASTP ] [ VB TRANS TENSED ] .;
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:: CONTINUING [ VB TRANS PRESP DIR CONTINUE ] .;
:: CONTINENTAL [ ADJ ] .;
:: CONTROLLER [ N ] .;
:: CONVERTED [ ADJ ] .;
:: CORNER [ N ] .;
:: COSMODROME [ N LOC ] .;
:: COSMONAUT [ N ] .;
:: COSMONAUTS [ N ] .;
:: COSMOS [ N SATELLITE ] .;
:: COSMOS-605 [ N SATELLITE ] .;
:: COSMOS-629 [ N SATELLITE ] .;
:: COSMOS-706 [ N SATELLITE ] .;
:: COSMOS-722 [ N SATELLITE ] .;
:: CRAFT [ N SATELLITE ] .;
:: CSM [ N SATELLITE ] .;
:: CURRENTLY [ ADVB REF TYME ] .;
:: DAMASCUS [ N LOC ] .;
:: DATE [ N DAYTE ] .;
:: DAY [ N DAYTE ] .;
:: DEC [ N TYME MO ] .;
:: DECEMBER [ N TYME MO ] .;
:: DEFENSIVE [ ADJ ] .;
:: DEGREE [ N ] .;
:: DEGREES [ N ] .;
:: DELTA-CLASS [ ADJ ] .;
:: DEORBIT [ N EVENTIVE DEORBIT ] [ VB DEORBIT ] .;
:: DEORBITED [ VB TRANS PASTP DEORBIT ]
             [ VB TRANS TENSED DEORBIT ] .;
:: DEPARTED [ VB TRANS PASTP DEPART ]
            [ VB TRANS TENSED DEPART ] .;
:: DEPLOYED [ VB TRANS PASTP DEPLOY ]
             [ VB TRANS TENSED DEPLOY ] .;
:: DEPLOYMENTS [ N EVENTIVE ] .;
:: DESTINATION [ N ] .;
:: DIVISION [ N ] .;
:: DJIBOUTI [ N LOC ] .;
:: DOWNED [ VB TRANS PASTP ] [ VB TRANS TENSED ] .;
:: DOWNRANGE [ N LOC ] .;
:: DURING [ PREP EMOD TYME ] .;
:: E1651D [ N SUBNUM ] .;
:: EABC [ N NATION ] .;
:: EAFAF [ N NATION SERVICE ] .;
:: EARLIER [ ADVB TYME REF VMOD ] .;
:: EARLY [ ADVB PMOD ] [ ADJ TYME ] [ ADVB TYME ] .;
:: EARTH [ N ] .;
:: EAST [  ADVB DIR ] [ ADJ ] .;
:: EASTERN [ ADJ ] .;
:: EGYPTIAN [ ADJ NATION ] .;
:: EIGHT [ N NUM ] .;
:: EQUATOR [ N LOC ] .;
:: ENROUTE [ VB TOCOMP ENROUTE ] .;
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:: ENTEBBE [ N LOC ] .;
:: EQUIPMENT [ N ] .;
:: ETBF [ N LOC ] .;
:: ETHIOPIAN [ ADJ ] .;
:: EXERCISE [ N EVENTIVE ] .;
:: EXPECTED [ VB TRANS TENSED TOCOMP EVAL ROBJ ]
            [ VB TRANS PASTP TOCOMP EVAL ROBJ ] .;
:: F-4 [ N TJPE ACRAFT ] .;
:: F-4E [ N TJPE ACRAFT ] .;
:: F-5E [ N TJPE ACRAFT ] .;
:: FAILED [ VB INTRANS TENSED TOCOMP EVAL RSUBJ ]
          [ VB INTRANS PASTP TOCOMP EVAL RSUBJ ] .;
:: FEB [ N TYME MO ] .;
:: FEBRUARY [ N TYME MO ] .;
:: FERRY [ N ] .;
:: FIGHTER-BOMBERS [ N ACRAFT ] .;
:: FIGHTER [ N ACRAFT ] .;
:: FIGHTERS [ N ACRAFT ] .;
:: FIRED [ VB TRANS PASTP LAUNCH ] [ VB TRANS TENSED LAUNCH ] .;
:: FLEET [ N ] .;
:: FLEW [ VB TRANS TENSED DIR FLIGHT ] .;
:: FLIGHT [ N EVENTIVE FLIGHT ] .;
:: FLIGHTS [ N EVENTIVE FLIGHT ] .;
:: FLOGGER [ N NATO ACRAFT ] .;
:: FODDER [ N NATO ACRAFT ] .;
:: FOLLOWING [ SCONJ ] .;
:: FOR [ PREP ] .;
:: FOUR [ N NUM ] .;
:: FRESCO [ N NATO ACRAFT ] .;
:: FROM [ PREP EMOD TYME ] .;
:: GENERAL [ ADJ ] .;
:: GROUP [ N ] .;
:: GUAM [ N LOC ] .;
:: GULU-BASED [ ADJ ] .;
:: GULU [ N LOC ] .;
:: HAD [ HAVE ] [ VB TRANS PASTP ] [ VB TRANS TENSED ] .;
:: HAIFA [ N LOC ] .;
:: HAS [ HAVE ] [ VB TRANS TENSED ] .;
:: HAVE [ HAVE ] [ VB TRANS ] .;
:: HAVING [ VB TRANS PRESP ] .;
:: HEADING [ VB PRESP DIR HEAD ] .;
:: HERMETICALLY [ ADVB ] .;
:: HOMEBASE [ N LOC ] .;
:: HOUR [ N TYME UNIT ] .;
:: HOURS [ N TYME UNIT ] .;
:: HR [ N TYME UNIT ] .;
:: IL-28 [ N TJPE ACRAFT ] .;
:: IMPACT [ N EVENTIVE IMPACT ] [ VB INTRANS IMPACT ] .;
:: IMPACTED [ VB INTRANS TENSED IMPACT ] .;
:: IN [ PREP EMOD ] .;
:: INCLINATION [ N INCL ] .;
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:: INDEPENDENT [ ADJ ] .;
:: INDICATES [ VB TRANS THATCOMP ] .;
:: INFORMED [ VB TRANS PASTP THATCOMP COMM ]
            [ VB TRANS TENSED THATCOMP COMM ] .;
:: INITIAL [ ADJ ] .;
:: INTELLIGENCE [ N  ] .;
:: INTO [ PREP EMOD ] .;
:: INVOLVING [ VB TRANS PRESP ] .;
:: IRANIAN [ ADJ NATION ] .;
:: IS [ BE ] [ COPULA ] [ VB TRANS ] .;
:: ISRAEL [ N LOC NATION ] .;
:: ISRAELI [ ADJ NATION ] .;
:: JAN. [ N TYME MO ] .;
:: JANUARY [ N TYME MO ] .;
:: JUBA [ N LOC ] .;
:: JUN [ N TYME MO ] .;
:: JUNE [ N TYME MO ] .;
:: JUL [ N TYME MO ] .;
:: JULY [ N TYME MO ] .;
:: JUST [ ADVB PMOD ] .;
:: KALGOORLIE [ N LOC ] .;
:: KATHMANDU [ N LOC ] .;
:: KB252 [ N SUBNUM ] .;
:: KE843 [ N SUBNUM ] .;
:: KENNEDY [ N ] .;
:: KENYA [ N LOC NATION ] .;
:: KENYAN [ ADJ NATION ] .;
:: KFIR [ N TJPE ACRAFT ] .;
:: KILOMETERS [ N LOC UNIT ] .;
:: KINSHASA [ N LOC ] .;
:: KM [ N LOC UNIT ] .;
:: KMS [ N LOC UNIT ] .;
:: LACCADIVES [ N LOC ] .;
:: LANDED [ VB PASTP LAND ] [ VB TENSED LAND ] .;
:: LANDMASS [ N LOC ] .;
:: LAST [ ADJ ] .;
:: LATE [ ADJ TYME ] .;
:: LATER [ ADJ TYME ] .;
:: LAUNCH [ N EVENTIVE LAUNCH ] .;
:: LAUNCHED [ VB TRANS PASTP LAUNCH ]
            [ VB TRANS TENSED LAUNCH ] .;
:: LAUNCHER [ N BOOSTER ] .;
:: LEBANON [ N LOC NATION ] .;
:: LIBYAN [ ADJ NATION ] .;
:: LIVING [ ADJ ] .;
:: LOCATED [ ADJ VB TRANS PASTP LOCATE ]
            [ VB TRANS TENSED LOCATE ] .;
:: LUNA-23 [ N SATELLITE ] .;
:: LUNAR [ ADJ ] .;
:: MALAGASY [ N LOC ] .;
:: MANEUVERABLE [ ADJ ] .;
:: MANNED [ ADJ ] .;
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:: MANY [ QUANT ] .;
:: MAR [ N TYME MO ] .;
:: MARCH [ N TYME MO ] .;
:: MARITIME [ ADJ ] .;
:: MASSAWA [ N LOC ] .;
:: MAURITIUS [ N LOC ] .;
:: MAY [ MODAL ] [ N TYME MO ] .;
:: METERS [ N LOC UNIT ] .;
:: MID [ ADJ ] .;
:: MIG-17 [ N TJPE ACRAFT ] .;
:: MIG-21 [ N TJPE ACRAFT ] .;
:: MIG-23 [ N TJPE ACRAFT ] .;
:: MILES [ N LOC  UNIT ] .;
:: MILITARY [ ADJ ] .;
:: MINUTE [ N TYME UNIT ] .;
:: MINUTES [ N TYME UNIT ] .;
:: MISSILE [ N MISSILE ] .;
:: MISSILES [ N MISSILE ] .;
:: MISSION [ N EVENTIVE ] .;
:: ML-28 [ N  TJPE ACRAFT ] .;
:: MODIFIED [ ADJ ] .;
:: MODULE [ N SATELLITE ] .;
:: MOGADISHU [ N LOC ] .;
:: MOMBASA-BASED [ ADJ ] .;
:: MOMBASA [ N LOC ] .;
:: MONTH [ N TYME ] .;
:: MOON [ N LOC ] .;
:: MORNING [ N TYME ] .;
:: MOST [ QUANT ] .;
:: MUSHROOM [ N ] .;
:: NAIROBI-BASED [ ADJ ] .;
:: NAIROBI [ N LOC ] .;
:: NASA [ N NATION ] .;
:: NATIONAL [ ADJ ] .;
:: NATURE [ N ] .;
:: NAUTICAL [ ADJ ] .;
:: NAVIGATIONAL [ ADJ ] .;
:: NEAR [ PREP EMOD ] .;
:: NEPAL [ N LOC NATION ] .;
:: NEWS [ N ] .;
:: NIGERIAN [ ADJ NATION ] .;
:: NINE [ N NUM ] .;
:: NM [ N LOC UNIT ] .;
:: NMS [ N LOC UNIT ] .;
:: NO [ QUANT ] .;
:: NORMAL [ ADJ ] .;
:: NORTH [ ADVB DIR ] [ ADJ ] .;
:: NORTHEAST [ ADVB DIR ] [ ADJ ] .;
:: NORTHERN [ ADJ ] .;
:: NORTHWEST [ ADVB DIR ] [ ADJ ] .;
:: NORTHWESTERN [ ADJ ] .;
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:: NOTED [ VB TRANS PASTP OBSERVE ] [ VB TRANS TENSED OBSERVE ] .;
:: NOV [ N TYME MO ] .;
:: NOVEMBER [ N TYME MO ] .;
:: NYANJA [ N LOC ] .;
:: OCCUR [ VB INTRANS ] .;
:: OCCURRED [ VB TENSED INTRANS ] .;
:: OCEAN [ N LOC ] .;
:: OCT [ N TYME MO ] .;
:: OCTOBER [ N TYME MO ] .;
:: OF [ PREP ] .;
:: ON [ PREP EMOD DAYTE ] .;
:: ONE [ N NUM ] .;
:: OPEN [ ADJ ] .;
:: OPERATED [ VB PASTP ACTVTY ] [ VB TENSED ACTVTY ] .;
:: OPERATING [ VB PRESP ACTVTY ] .;
:: OPERATIONS [ N EVENTIVE ] .;
:: ORBIT [ N LOC ] .;
:: ORBITAL [ ADJ ] .;
:: OUTBACK [ N LOC ] .;
:: OVER [ PREP EMOD ] .;
:: PACIFIC [ N LOC ] .;
:: PENETRATED [ VB TRANS PASTP PENETRATE ]
                [ VB TRANS TENSED PENETRATE ] .;
:: PENETRATION [ N EVENTIVE ] .;
:: PERFORMING [ VB TRANS PRESP ACTVTY ] .;
:: PERIOD [ N TYME ] .;
:: PERTH [ N LOC ] .;
:: PHANTOM [ N NATO ACRAFT ] .;
:: PILOTS [ N ] .;
:: PLESETSK [ N LOC ] .;
:: POINT [ N LOC ] .;
:: PORTION [ N ] .;
:: POSSIBLE [ ADJ EVAL ] .;
:: POSSIBLY [ ADVB EVAL ] .;
:: PRECEDED [ VB TRANS PASTP BEFORE ] [ VB TRANS TENSED
                    BEFORE ] .;
:: PRECEDES [ VB TRANS TENSED BEFORE ] .;
:: PRESENTLY [ ADVB REF TYME ] .;
:: PRETORIA-BASED [ ADJ ] .;
:: PRETORIA [ N LOC ] .;
:: PREVIOUS [ ADJ REF TYME ] .;
:: PREVIOUSLY [ ADVB REF TYME ] .;
:: PRIMARILY [ ADVB EVAL ] .;
:: PROBABLE [ ADJ EVAL ] .;
:: PROBABLY [ ADVB EVAL PMOD ] .;
:: PROCEEDING [ VB PRESP DIR ] .;
:: RATS [ N ] .;
:: RECONNAISSANCE [ N EVENTIVE ] .;
:: RECOVERABLE [ ADJ ] .;
:: RECOVERY [ N ] .;
:: REENTER [ VB TRANS REENTRY ] .;
:: RE-ENTERED [ VB TRANS TENSED REENTRY ] .;
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:: REENTERED [ VB TRANS TENSED REENTRY ] .;
:: REENTRY [ N EVENTIVE REENTRY ] .;
:: REGT [ N ] .;
:: REGIMENT [ N ] .;
:: REGIMENTS [ N ] .;
:: REGION [ N LOC ] .;
:: REMAIN [ COPULA TENSED ] .;
:: REMAINED [ COPULA TENSED ] .;
:: REPORT [ N ] .;
:: REPORTING [ VB TRANS PRESP ] .;
:: REPRESENTING [ VB TRANS PRESP ] .;
:: RETURNED [ VB PASTP RETURN ] [ VB TENSED RETURN ] .;
:: RETURNING [ VB PRESP RETURN ] .;
:: REVOLUTION [ N REV ] .;
:: RGT [ N ] .;
:: RIYADH [ N LOC ] .;
:: ROUTINE [ ADJ ] .;
:: ROUTINELY  [ ADVB ] .;
:: S1234B [ N SUBNUM ] .;
:: SA554 [ N SUBNUM ] .;
:: SA622 [ N SUBNUM ] .;
:: SAFAF [ N NATION SERVICE ] .;
:: SAFLT [ N NATION SERVICE ] .;
:: SATELLITE [ N SATELLITE ] .;
:: SATELLITES [ N SATELLITE ] .;
:: SATURN-1B [ N BOOSTER ] .;
:: SATURN-5 [ N BOOSTER ] .;
:: SAM-3 [ N MISSILE ] .;
:: SAME [ ADJ ] .;
:: SC462 [ N SUBNUM ] .;
:: SCRAMBLED [ ADJ ] .;
:: SEALED [ ADJ ] .;
:: SEP [ N TYME MO ] .;
:: SEPTEMBER [ N TYME MO ] .;
:: SEYCHELLES [ N LOC ] .;
:: SIBERIA [ N LOC ] .;
:: SIMULATED [ ADJ ] .;
:: SINCE [ PREP EMOD TYME ] .;
:: SIWAH [ N LOC ] .;
:: SIX [ N NUM ] .;
:: SKYHAWK [ N NATO ACRAFT ] .;
:: SKYLAB [ N SATELLITE ] .;
:: SOFTLANDED [ VB TRANS PASTP LAND ] [ VB TRANS TENSED LAND ] .;
:: SOMALIA [ N LOC NATION ] .;
:: SOME [ QUANT ] .;
:: SOUTH [ ADVB DIR ] [ ADJ ] .;
:: SOUTHERN [ ADJ ] .;
:: SOUTHEAST [ ADVB DIR ] [ ADJ ] .;
:: SOUTHWEST [ ADVB DIR ] [ ADJ ] .;
:: SOUTHWESTERN [ ADJ ] .;
:: SOVIET [ ADJ NATION ] .;
:: SOYUZ [ N SATELLITE ] .;
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:: SOYUZ-22 [N SATELLITE] .;
:: SOYUZ-28 [N SATELLITE] .;
:: SOYUZ-TYPE [ADJ SATELLITE] .;
:: SP265 [N SUBNUM] .;
:: SPACE [N LOC] .;
:: SPACECRAFT [N SATELLITE] .;
:: SPACEFLIGHT [N FLIGHT] .;
:: SPORES [N] .;
:: SR-71 [N TJPE ACRAFT] .;
:: SS-11 [N MISSILE] .;
:: S-4B [N] .;
:: STAGE [N] .;
:: STAGING [VB PRESP STAGE] .;
:: STATEMENT [N] .;
:: STATION [N LOC] .;
:: STRATEGIC [ADJ] .;
:: STRIKE [N EVENTIVE] .;
:: STRIKES [N EVENTIVE] .;
:: SUAM [N LOC] .;
:: SUBMARINE [N] .;
:: SUBORDINATE [ADJ] .;
:: SUCCESSFULLY [ADVB EVAL] .;
:: SUDAN [N LOC] .;
:: SUDANESE [ADJ] .;
:: SUGGESTS [VB TRANS THATCOMP] .;
:: SUPPORT [N EVENTIVE] .;
:: SURFACE-TO-AIR [ADJ] .;
:: SURFACE [N LOC] .;
:: SURGUT [N LOC] .;
:: SURVEILLANCE [N EVENTIVE] .;
:: SYRIAN [ADJ NATION] .;
:: TAIPEI [N LOC] .;
:: TAIWAN [N LOC NATION] .;
:: TASK [N EVENTIVE] .;
:: TASS [N] .;
:: TEN [N NUM] .;
:: TESTING [VB TRANS PRESP] .;
:: THAT [CONJ] [RELPRO] [ART REF] .;
:: THE [ART] .;
:: THESE [ART REF] .;
:: THEY [PRO] .;
:: THEIR [ART POSPRO] .;
:: THIRD [ORD ADJ] .;
:: THIS [ART REF DEMONS] .;
:: THOSE [ART REF] .;
:: THREE [N NUM] .;
:: TIME [N TYME] .;
:: TO [PREP EMOD] .;
:: TOBRUK [N LOC] .;
:: TODAY [ADVB REF TYME VMOD DAYTE] .;
:: TORORO [N LOC] .;
:: TORTOISES [N] .;

```
:: TRACKING [ ADJ ] .;
:: TRAINING [ N ] .;
:: TURNED [ VB PASTP DIR ] [ VB TENSED DIR ] .;
:: TURNING [ VB PRESP DIR ] .;
:: TU-95 [ N TJPE ACRAFT ] .;
:: TWO [ N NUM ] .;
:: TYPE [ N ] .;
:: TYRE [ N LOC ] .;
:: TYURATAM [ N LOC ] .;
:: U-43 [ N TJPE ACRAFT ] .;
:: U1009B [ N SUBNUM ] .;
:: U1211B [ N SUBNUM ] .;
:: U1232 [ N SUBNUM ] .;
:: U1324B [ N SUBNUM ] .;
:: UABC [ N ] .;
:: UAF [ N ] .;
:: UBBC [ N ] .;
:: UG254 [ N SUBNUM ] .;
:: UG836C [ N SUBNUM ] .;
:: UGANDA [ N LOC NATION ] .;
:: UGANDAN [ ADJ NATION ] .;
:: UNDERWAY [ VB FLIGHT ] .;
:: UNDETERMINED [ ADJ ] .;
:: UNIDENTIFIED [ ADJ ] .;
:: UNITS [ N ] .;
:: VARIOUS [ ADJ ] .;
:: VEHICLE [ N SATELLITE MISSILE ] .;
:: VICINITY [ N ] .;
:: VIOLATED [ VB TRANS PASTP PENETRATE ]
           [ VB TRANS TENSED PENETRATE ] .;
:: WAS [ BE ] [ COPULA ] [ VB TRANS ] .;
:: WEATHER [ N ] .;
:: WERE [ BE ] [ COPULA ] [ VB TRANS ] .;
:: WEST [ ADVB DIR ] [ ADJ ] .;
:: WESTERN [ ADJ ] .;
:: WESTWARD [ ADVB DIR ] .;
:: WHICH [ RELPRO PRO ] .;
:: WOULD [ MODAL ] .;
:: X [ N LOC ] .;
:: XB442 [ N SUBNUM ] .;
:: XB262 [ N SUBNUM ] .;
:: YEAR [ N DAYTE ] .;
:: ZEILA [ N LOC ] .;
ENDLEX
MCR>BYE$
```

APPENDIX C: Templates and Auxiliary

Procedures.

```
***** MASTER  Template and auxiliaries as of Aug 10, 1979. *****
!       File TEMPLATE.ERL

! The top-level procedure

do([X,Y,Z]):-  build_ER(X,Y,Z,ER), type_ER(ER).
do([Tree]):-  build_ER(Tree,ER),  type_ER(ER).
do([Tree]):- build_ER1(Tree,ER), type_ER(ER).

! the 'build_ER' procedure for sentences with  embedded complements
build_ER(s(Voice,Subj,Vbgr,Obj,s(A1,A2,A3,A4,A5,A6),Vmods),
          [Is,Status, DTG,temp(Name,ER)]):-
          change2(Subj,Vbgr,Obj,A2,X),
          build_ER1(s(A1,X,A3,A4,A5,A6),temp(Name,ER)),
          status(Vbgr,Status),
          infosource(Subj,Vbgr,Is),
          construct('DTG',Vmods,DTG).

! the 'build_ER' procedure for sentences with AFTER clauses
build_ER(S,W,NP,[ER1,ER2]):-
     build_ER1(S,ER1),
     build_ER1(NP,ER2),
     feat(W,'SCONJ').
! The 'build_ER1' procedure for simple sentences

build_ER1 (s(Voice,Subj1,Vbgr1,Obj,Compl,Vmods1),temp(Name,ER)):-
          change1(Subj1,Subj2,Vbgr1,Vbgr2,Vmods1,Vmods2),
          find_t_name(Vbgr2,Name),
          construct(Name,s(Voice,Subj2,Vbgr2,Obj,Compl,Vmods2),ER).


! The 'construct' procedure for events

  construct('CONFIRM',s(Voice,Subj,Vbgr,Obj,Compl,Vmods),
                    [Verb,OB1,Rev,DTG]):-
            verb(Vbgr,Verb),
            object(Subj,Obj,OB1),
```

```
        construct('DTG',Vmods,DTG),
        revolution(Vmods,Rev).


  construct('DEORBIT',s(Voice,Subj,Vbgr,Obj,Compl,Vmods),
                [Verb,AG,OB1,Loc,Rev,DTG]):-
        verb(Vbgr,Verb),
        agent(Subj,Vmods,AG),
        object(Subj,Obj,OB1),
        location(Obj,Vmods,Loc),
        revolution(Vmods,Rev),
        construct('DTG',Vmods,DTG).

construct('LAUNCH',s(Voice,np(Det,L1,Head,L2),Vbgr,Obj,Compl,Vmods),
                    [Verb,AG,Instr,OB1,LS,Incl,Dest,DTG]):-
      verb(Vbgr,Verb),
      agent(np(Det,L1,Head,L2),Vmods,AG),
      object(np(Det,L1,Head,L2),Obj, OB1),
      launchsys(Vmods,Det,L1,Head,Instr),
      launchsite (Vmods,LS),
      inclination(Vmods,Incl),
      destination2 (Vmods,Dest),
      construct('DTG',Vmods,DTG).

!    For sentences of the form 'Thing impacted on Loc at Time'
construct('IMPACT',s(Voice,Subj,Vbgr,Obj,Compl,Vmods),
                    [Verb,OB1,Loc,DTG]):-
      verb(Vbgr,Verb),
      object(Subj,Obj, OB1),
      location(Obj,Vmods,Loc),
      construct('DTG',Vmods,DTG).


! for sentences of the form 'Thing reentered Loc at Time'
  construct('REENTRY',s(Voice,Subj,Vbgr,Obj,Compl,Vmods),
```

```
          [Verb,OB1,Loc,DTG]):-
          verb(Vbsr,Verb),
          object(Subj,Obj,OB1),
          location(Obj,Vmods,Loc),
          construct('DTG',Vmods,DTG).

! construct procedure for nominalized flight sentences
construct('FLIGHT',NP,Dur):-
     duration(NP,Dur).

! The 'construct' procedure for objects

construct('MISSILE',np(Det,L1,Head,L2),[EQ,SET,REL]):-
        equipment('MISSILE',L1,Head,EQ),
        setspec(Det,SET),
        relative(L2,REL).

construct('SATELLITE',np(Det,L1,Head,L2),[EQ,SET,REL]):-
        equipment('SATELLITE',L1,Head,EQ),
        setspec(Det,SET),
        relative(L2,REL).
! The 'construct' procedure for DTG
construct('DTG',List,[TI,DT]):- time(List, TI), date(List,DT).

! 'CHANGE' Procedures
change1(np(_,_,nnode(W,nil),L2),nil,
         vs(X1,X2,X3,X4), vs(X1,X2,X3,W),V1,V2):- feat(W,'EVENTIVE'),
                                     concatenate(L2,V1,V2).
change1(np(_,_,nnode(W,pp(_,_,NP)),L2),NP,
         vs(X1,X2,X3,X4), vs(X1,X2,X3,W),V1,V2):- feat(W,'EVENTIVE'),
                                      concatenate(L2,V1,V2).
change1(Subj1,Subj1,Vbsr1,Vbsr1,Vmods1,Vmods1).
change2(_,vs(_,_,_,W),Obj,A2,Obj):-  feat(W,'ROBJ').
change2(Subj,vs(_,_,_,W),_,A2,Subj):- feat(W,'RSUBJ').
change2(_,_,_,A2,A2).
! Procedures for filling in template slots
```

```
agent(np(Det,L1,nnode(W,X),_),_,slot('Agent=',[Det,L1,nnode(W,X)])):-
        feat(W,'NATION').
agent(_,List,slot('Agent=', Slot)):-
         fill_slot(List,['BY'],'NATION',Slot).
agent(_,_,nil).
inclination(List,slot('Inclination=',Slot)):-
      fill_slot(List,['ON'],'INCL',Slot).
inclination(_,nil).
infosource(Subj,vg(_,_,_,W),slot('Infosource=',Subj)):-
         feat(W,'COMM').
infosource(_,_,nil).
launchsys(List,Det,L1,nnode(W,X),slot('Launchsys=',[Det,L1,nnode(W,X)])):-
         feat(W,'BOOSTER').
launchsys(List,_,_,_,slot('Launchsys=',Slot)):- fill_slot(List,['BY'],
                 'BOOSTER',Slot).
launchsys(_,_,_,_,nil).
date(List,slot('Date=',[L,W,Day,Month,Year])):-
       member(pp(L,W,date(Day,Month,Year)),List).
date(List,slot('Date=',Slot)):-
      fill_slot(List,'DAYTE',Slot).
date(_, nil).

destination1(List,slot('Destination=',Slot)):- fill_slot(List,['TO','INTO'],
                                                            'LOC',Slot).
destination2 (X,Y):-  destination1(X,Y).
destination2 (_,nil).

duration(np(Det,L1,nnode(W,PP),L2), slot('...Duration=',
         [Det,L1,nnode(W,PP),L2])).
equipment(Feature,List, nnode(W,_), slot('...Equipment=',[List,W])):-
        feat(W,Feature).

status(vg(_,_,_,W),slot('Status=',W)):-
         feat(W,'EVAL').
status(_,nil).
```

```
location(NP,List,slot('Location=',X)):-
          locat1(NP,X1),
          searchlist(List,X2),
          concatenate(X1,X2,X).
locat1(NP,[NP]):-  test_nhead(NP,'LOC').
locat1(_,nil).
searchlist([M,..List],[X,..L]):-
          search(M,X), searchlist(List,L).
searchlist([_,..List],L):- searchlist(List,L).
searchlist(_,nil).
search(pp(L1,Prep,NP),[L1,Prep,NP]):-
        member(P,['ALONG','AT','EAST OF','FROM','IN','INTO','NEAR',
                    'NORTHEAST OF',
        'ON', 'OVER','SOUTHEAST OF',  'OUTSIDE OF',  'WEST OF']),
        lexeq(Prep,P), test_nhead(NP,'LOC').

search([s(Vo,S,V,O,I,Vm)],[S,V,O,I,Vm]).
relative(List,slot('...Relative=',X)):-
                    searchlist(List,X).
relative(_,nil).

setspec(dp(_,_,Num),slot('...Number=',Num)).
setspec(_, nil).

launchsite(List,slot('Launchsite=',Slot)):-  searchlist(List,Slot).
launchsite(_,nil).

object(Subj,_, slot('Object:',[Name,Slot])):-
               fill_object(Subj,Name,Slot).
object(_,Obj,slot('Object:',[Name,Slot])):-
              fill_object(Obj,Name,Slot).
object (_,_,nil).
```

```
  revolution(List,slot('Revolution=',Slot)):-
          revolute(List,['ON','DURING'],'REV',Slot).
  revolution(_,nil).
  revolute(List,Preplist,Feature,Slot):-
           revol(List,Preplist,Feature,Slot).
  revolute(List,Preplist,Feature,Slot):-
            fill_slot(List,Preplist,Feature,Slot).
  revol(List,Preplist,Feature,[L1,Prep,NP]):-
            member(pp(L1,Prep,NP),List),
            member(Prepa,Preplist),
            lexeq(Prep,Prepa),
            test_np(NP,Feature).
test_np(np(_,L1,nnode(W,_),_),Feature):-
          member(X,L1), feat(X,Feature).
test_np(np(_,_,nnode(W,pp(_,_,NP)),_),Feature):-
          test_np(NP,Feature).
time(List,slot('Time=',Slot)):-
      fill_slot(List,'TYME',Slot).
time(List,slot('Time=',Slot)):-
      fill_slot(List,'4DIG',Slot).
time(List,slot('Time=',Slot)):-
      fill_slot(List,'6DIG',Slot).
time(_,nil).

verb(Vbgr,slot('Action=',Vbgr)).
! Other Procedures

fill_object(NP,Name,Slot):- find_o_name(NP,Name),
                           construct(Name,NP,Slot).
concatenate([X,..L1],L2,[X,..L3]):-
         concatenate(L1,L2,L3).
concatenate([],L,L).
```

```
fill_slot(List, Preplist, Feature, [L1,Prep,NP]):-
          member (pp(L1,Prep,NP),List),
          member(Prepa, Preplist), lexeq(Prep, Prepa),
          test_nhead(NP,Feature).

fill_slot(List, Feature,[L1,Prep,NP]):-
         member (pp(L1,Prep,NP),List),
         test_nhead(NP, Feature).
fill_slot(List, Feature,W):-
         member(W, List),
         feat(W,'ADVB'),
         feat(W, Feature).
fill_slot(NP, Feature,NP):-  test_nhead(NP,'LOC').

find_feat(W,L,Y):-  member(Y,L), feat(W,Y).

find_t_name(vg(_,_,_,W),Name):-
         find_feat(W,['CONFIRM','DEORBIT','DEPLOY','FLIGHT','IMPACT',
                      'LAUNCH','LOCATE','PENETRATE','PRECEDE','RECOVER',
                      'REENTRY'],Name).
find_o_name(np(_,_,nnode(W,_),_),Name):- find_feat(W,['ACRAFT','MISSILE',
                         'SATELLITE'],Name).


member(X,[X,.._]).
member(X,[_,..L]):-  member(X,L).

test_nhead(np(_,_,nnode(W,_),_),Feature):- feat(W,Feature).
test_nhead(np(_,_,nnode(_,pp(_,_,NP)),_),Feature):-
          test_nhead(NP,Feature).
| Procedure to type event records (type leaves of structure)
```

```
type_ER(temp(N,L)):-  typcr(0), typatom('Event:'), typatom(N), type_ER(L).
type_ER(slot(S,L)):-  typcr(0), typatom(S), type_ER(L).
type_ER([X,..L]):-  type_ER(X), type_ER(L).
type_ER(nil).
type_ER(X):-  typlex(X).
type_ER(X):-  typatom(X).
type_ER(s(V,A,B,C,D,E)):-  type_ER(A),type_ER(B),type_ER(C),type_ER(D),type_ER(E).
type_ER(np(A,B,C,D)):-  type_ER(A), type_ER(B), type_ER(C), type_ER(D).
type_ER(qp(A,B)):-  type_ER(A), type_ER(B).
type_ER(dp(A,B,C)):- type_ER(A), type_ER(B), type_ER(C).
type_ER(nnode(A,B)):-  type_ER(A), type_ER(B).
type_ER(v(A,B)):-  type_ER(A), type_ER(B).
type_ER(pp(A,B,C)):-  type_ER(A), type_ER(B), type_ER(C).
type_ER(p(A)):-  type_ER(A).
type_ER(vg(A,B,C,D)):-  type_ER(A), type_ER(B), type_ER(C), type_ER(D).
type_ER(date(A,B,C)):-  type_ER(A), type_ER(B), type_ER(C).
type_ER(X):- typatom('**UNKNOWN STRUCTURE**').
```

APPENDIX: D   FSA Listing

```
PATTERN N0
:S N0
  :A 0123456789 => N1 ,,
;;

:S N1
  :A 0123456789 => N2 ,,
  :A S => ORDS ,,
  :A N => ORDN ,,
  :A R => ORDR ,,
  :A T => ORDT ,,
  :F *BLANK* [ N NUM 1DIG ] ,,
  :F -,/: [ N NUM 1DIG ] ,,
;;

:S N2
  :A 0123456789 => N3 ,,
  :A S => N2S ,,
  :A N => N2N ,,
  :A R => ORDR ,,
  :A T => ORDT ,,
  :F *BLANK* [ N NUM 2DIG ] ,,
  :F -,/: [ N NUM 2DIG ] ,,
;;

:S N3
  :A 0123456789 => N4 ,,
  :A S => ORDS ,,
  :A N => ORDN ,,
  :A R => ORDR ,,
  :A T => ORDT ,,
  :F *BLANK* [ N NUM 3DIG ] ,,
  :F -,/: [ N NUM 3DIG ] ,,
;;

:S N4
  :A 0123456789 => N5 ,,
  :A Z => TMF ,,
  :A S => N4S ,,
  :A N => N4N ,,
  :A R => ORDR ,,
  :A T => ORDT ,,
  :F *BLANK* [ N NUM 4DIG ] ,,
  :F -,/: [ N NUM 4DIG ] ,,
;;
```

```
:S N5
  :A Ø123456789 => N6 ,,
  :A S => ORDS ,,
  :A N => ORDN ,,
  :A R => ORDR ,,
  :A T => ORDT ,,
  :F *BLANK* [ N NUM 5DIG ] ,,
  :F -,/: [ N NUM 5DIG ] ,,
;;

:S N6
  :A Ø123456789 => NF ,,
  :A Z => TMF ,,
  :A S => N6S ,,
  :A N => N6N ,,
  :A R => ORDR ,,
  :A T => ORDT ,,
  :F *BLANK* [ N NUM 6DIG ] ,,
  :F -,/: [ N NUM 6DIG ] ,,
;;

:S NF
  :A Ø123456789 => NF ,,
  :A S => ORDS ,,
  :A N => ORDN ,,
  :A R => ORDR ,,
  :A T => ORDT ,,
  :F *BLANK* [ N NUM ] ,,
  :F -,/: [ N NUM ] ,,
;;

:S TMF
  :F *BLANK* [ N TYME ] ,,
  :F -,/: [ N TYME ] ,,
;;

:S ORDS
  :A T => ORDF ,,
;;

:S ORDN
  :A D => ORDF ,,
;;
```

```
:S ORDR
  :A D => ORDF ,,
;;

:S ORDT
  :A H => ORDF ,,
;;

:S ORDF
  :F *BLANK* [ NUM ORD ] ,,
  :F -,/: [ NUM ORD ] ,,
;;

:S N2S
  :A T => ORDF ,,
  :A 0123456789 => 2LN1 ,,
;;

:S N2N
  :A D => ORDF ,,
  :A 0123456789 => 2LN1 ,,
;;

:S 2LN1
  :A 0123456789 => 2LN2 ,,
;;

:S 2LN2
  :A EW => 2LF ,,
;;

:S 2LF
  :F *BLANK* [ N LOC ] ,,
  :F -,/: [ N LOC ] ,,
;;

:S N4S
  :A T => ORDF ,,
  :A 0123456789 => 4LN1 ,,
;;
```

```
:S N4N
  :A D => ORDF ,,
  :A 0123456789 => 4LN1 ,,
;;

:S 4LN1
  :A 0123456789 => 4LN2 ,,
;;

:S 4LN2
  :A 0123456789 => 4LN3 ,,
;;

:S 4LN3
  :A 0123456789 => 4LN4 ,,
;;

:S 4LN4
  :A EW => 4LF ,,
;;

:S 4LF
  :F *BLANK* [ N LOC ] ,,
  :F -,/: [ N LOC ] ,,
;;

:S N6S
  :A T => ORDF ,,
  :A 0123456789 => 6LN1 ,,
;;

:S N6N
  :A D => ORDF ,,
  :A 0123456789 => 6LN1 ,,
;;

:S 6LN1
  :A 0123456789 => 6LN2 ,,
;;
```

```
:S 6LN2
  :A 0123456789 => 6LN3 ,,
;;

:S 6LN3
  :A 0123456789 => 6LN4 ,,
;;

:S 6LN4
  :A 0123456789 => 6LN5 ,,
;;

:S 6LN5
  :A 0123456789 => 6LN6 ,,
;;

:S 6LN6
  :A EV => 6LF ,,
;;

:S 6LF
  :F *BLANK* [ N LOC ] ,,
  :F -,/: [ N LOC ] ,,
;;

ENDPATTERN
```

APPENDIX E: Examples of System

Input/Output

```
    PIP TI:=LAUNCH.
>> THE SKYLAB ORBITAL WORKSHOP, A CONVERTED S-4B THIRD STAGE
FROM A SATURN-5 LAUNCH VEHICLE, WAS LAUNCHED FROM THE
KENNEDY SPACE CENTER AT 1330 HOURS ON 14 MAY 1973.
>> THE SKYLAB ORBITAL WORKSHOP, A CONVERTED S-4B
THIRD STAGE FROM A SATURN-5 LAUNCH VEHICLE,
WAS FIRED FROM THE KENNEDY SPACE CENTER AT 1330 HOURS ON 14 MAY 1973.
>> AT APPROXIMATELY 1330 HOURS ON 14 MAY 1973,
THE SKYLAB ORBITAL WORKSHOP WAS FIRED FROM THE KENNEDY
SPACE CENTER BY A SATURN-5 TYPE LAUNCHER.
>> THE SKYLAB ORBITAL WORKSHOP WAS LAUNCHED
FROM THE KENNEDY SPACE CENTER AT APPROXIMATELY
1330 HOURS ON 14 MAY 1973 BY A SATURN-5 TYPE
LAUNCHER.
>> AT APPROXIMATELY 1330 HOURS, THE SATELLITE
 WAS LAUNCHED FROM THE KENNEDY SPACE CENTER
ON AN INCLINATION OF 70 DEGREES.
>> THE SATELLITE WAS LAUNCHED ON A 67 DEGREE ORBITAL
INCLINATION.
>> THE LAUNCH OF SKYLAB TOOK PLACE ON 14 MAY 1973.

*@LAUNCH.
Event: LAUNCH
Action= LAUNCHED
Object: SATELLITE
...Equipment= SKYLAB ORBITAL WORKSHOP
...Number=
...Relative= A CONVERTED S-4B THIRD STAGE FROM A SATURN-5 LAUNCH VEHICLE
Launchsite= FROM THE KENNEDY SPACE CENTER
Time= AT 1330 HOURS
Date= ON 14 MAY 1973
SUCCESS!  STACK USE:  -3134 3482 490
```

```
Event: LAUNCH
Action= FIRED
Object: SATELLITE
...Equipment= SKYLAB ORBITAL WORKSHOP
...Number=
...Relative= A CONVERTED S-4B THIRD STAGE FROM A SATURN-5 LAUNCH VEHICLE
Launchsite= FROM THE KENNEDY SPACE CENTER
Time= AT 1330 HOURS
Date= ON 14 MAY 1973
SUCCESS!  STACK USE:  -3134 3478 490
Event: LAUNCH
Action= FIRED
Launchsys= BY A SATURN-5 TYPE LAUNCHER
Object: SATELLITE
...Equipment= SKYLAB ORBITAL WORKSHOP
...Number=
...Relative=
Launchsite= FROM THE KENNEDY SPACE CENTER
Time= AT APPROXIMATELY 1330 HOURS
Date= ON 14 MAY 1973
SUCCESS!  STACK USE:  -2826 3058 444
Event: LAUNCH
Action= LAUNCHED
Launchsys= BY A SATURN-5 TYPE LAUNCHER
Object: SATELLITE
...Equipment= SKYLAB ORBITAL WORKSHOP
...Number=
...Relative=
Launchsite= FROM THE KENNEDY SPACE CENTER
Time= AT APPROXIMATELY 1330 HOURS
Date= ON 14 MAY 1973
SUCCESS!  STACK USE:  -2876 3094 448
```

```
Event: LAUNCH
Action= LAUNCHED
Object: SATELLITE
...Equipment= SATELLITE
...Number=
...Relative=
Launchsite= FROM THE KENNEDY SPACE CENTER
Inclination= ON AN INCLINATION OF 70 DEGREES
Time= AT APPROXIMATELY 1330 HOURS
SUCCESS!  STACK USE:  -2668 2842 418
Event: LAUNCH
Action= LAUNCHED
Object: SATELLITE
...Equipment= SATELLITE
...Number=
...Relative=
Launchsite=
Inclination= ON A 67 DEGREE ORBITAL INCLINATION
SUCCESS!  STACK USE:  -1632 1776 278


Event: LAUNCH
Action= LAUNCH
Object: SATELLITE
...Equipment= SKYLAB
...Relative=
Launchsite=
Date= ON 14 MAY 1973
SUCCESS!  STACK USE:  -1418 1510 258
*
```

```
    PIP TI:=IMPACT.
>> NASA ANNOUNCED THAT THE IMPACT OF SKYLAB TOOK PLACE
IN AN AREA ABOUT 500 MILES FROM PERTH IN WESTERN
AUSTRALIA.
>> THE SKYLAB ORBITAL WORKSHOP,
A CONVERTED S-4B THIRD STAGE FROM A SATURN-5
LAUNCH VEHICLE, IMPACTED IN WESTERN AUSTRALIA
JUST NORTHEAST OF KALGOORLIE ON 12 JULY 1979.
>> THE VEHICLE IMPACTED NEAR KALGOORLIE
IN THE AUSTRALIAN OUTBACK.
>> IMPACT OF SKYLAB OCCURRED IN WESTERN
AUSTRALIA JUST NORTHEAST OF KALGOORLIE
ON 12 JULY 1979.
>> IMPACT OCCURRED INTO THE NORMAL RECOVERY AREA.
>> IMPACT OCCURRED AT 1900Z ON 12 JULY 1979.
>> IMPACT IN WESTERN AUSTRALIA
WAS NEAR KALGOORLIE.
>> THE IMPACT OF SKYLAB TOOK PLACE IN THE
AUSTRALIAN OUTBACK.
>> IMPACT OF SKYLAB WAS ABOUT 500 MILES
NORTHEAST OF PERTH IN WESTERN AUSTRALIA.
>> IMPACT WAS ABOUT 10 NM OUTSIDE OF THE
NORMAL RECOVERY AREA.
>> THE MISSILE IMPACTED NEAR THE NORMAL RECOVERY
AREA AT 1900Z ON 13 APR 1999.
>> IMPACT PROBABLY OCCURRED IN THE AUSTRALIAN OUTBACK
JUST NORTHEAST OF THE CENTRAL PORTION OF THE
RECOVERY AREA.
>> IMPACT OF SKYLAB IN WESTERN AUSTRALIA
WAS ON THE 12TH JULY 1979.
>> IMPACT IN AN AREA JUST NORTHEAST OF
KALGOORLIE IN WESTERN AUSTRALIA WAS
ON THE 12TH JULY 1979.
>> IMPACT WAS PROBABLY IN AN AREA ABOUT
500 KMS FROM PERTH IN WESTERN
AUSTRALIA ON 12TH JULY 1979.
```

```
>> IMPACT PROBABLY OCCURRED IN AN AREA ABOUT 100 KMS FROM
KALGOORLIE.
>> IMPACT OF SKYLAB WAS PROBABLY IN AN AREA
ABOUT 500 KMS NORTHEAST OF PERTH.
MCR>
*@IMPACT.
Infosource= NASA
Event: IMPACT
Action= IMPACT
Object: SATELLITE
...Equipment= SKYLAB
...Relative=
Location= IN AN AREA ABOUT 500 MILES FROM PERTH IN WESTERN AUSTRALIA
SUCCESS!  STACK USE:  -2672 3094 462
Event: IMPACT
Action= IMPACTED
Object: SATELLITE
...Equipment= SKYLAB ORBITAL WORKSHOP
...Number=
...Relative= A CONVERTED S-4B THIRD STAGE FROM A SATURN-5 LAUNCH VEHICLE
Location= IN WESTERN AUSTRALIA JUST NORTHEAST OF KALGOORLIE
Date= ON 12 JULY 1979
SUCCESS!  STACK USE:  -3016 3256 472
Event: IMPACT
Action= IMPACTED
Object: MISSILE
...Equipment= VEHICLE
...Number=
...Relative=
Location= NEAR KALGOORLIE IN THE AUSTRALIAN OUTBACK
SUCCESS!  STACK USE:  -1856 1896 312
Event: IMPACT
Action= IMPACT
Object: SATELLITE
...Equipment= SKYLAB
...Relative=
Location= IN WESTERN AUSTRALIA JUST NORTHEAST OF KALGOORLIE
Date= ON 12 JULY 1979
SUCCESS!  STACK USE:  -2200 2290 362
```

```
Event: IMPACT
Action= IMPACT
Location= INTO THE NORMAL RECOVERY AREA
SUCCESS!  STACK USE:  -1064 1250 194
Event: IMPACT
Action= IMPACT
Location=
Time= AT 1900Z
Date= ON 12 JULY 1979
SUCCESS!  STACK USE:  -1150 1318 204
Event: IMPACT
Action= IMPACT
Location= IN WESTERN AUSTRALIA NEAR KALGOORLIE
SUCCESS!  STACK USE:  -1384 1528 248
Event: IMPACT
Action= IMPACT
Object: SATELLITE
...Equipment= SKYLAB
...Relative=
Location= IN THE AUSTRALIAN OUTBACK
SUCCESS!  STACK USE:  -1474 1630 260
Event: IMPACT
Action= IMPACT

Object: SATELLITE
...Equipment= SKYLAB
...Relative=
Location= ABOUT 500 MILES NORTHEAST OF PERTH IN WESTERN AUSTRALIA
SUCCESS!  STACK USE:  -2144 2284 358
Event: IMPACT
Action= IMPACT
Location= ABOUT 10 NM OUTSIDE OF THE NORMAL RECOVERY AREA
SUCCESS!  STACK USE:  -1470 1686 248
```

```
Event: IMPACT
Action= IMPACTED
Object: MISSILE
...Equipment= MISSILE
...Number=
...Relative=
Location= NEAR THE NORMAL RECOVERY AREA
Time= AT 1900Z
Date= ON 13 APR 1999
SUCCESS!  STACK USE:  -2162 2230 346
Event: IMPACT
Action= PROBABLY IMPACT
Location= IN THE AUSTRALIAN OUTBACK JUST NORTHEAST OF THE CENTRAL PORTION OF
ECOVERY AREA
SUCCESS!  STACK USE:  -1836 2140 298
Event: IMPACT
Action= IMPACT
Object: SATELLITE
...Equipment= SKYLAB
...Relative=
Location= IN WESTERN AUSTRALIA
Date= JULY 1979
SUCCESS!  STACK USE:  -1776 1942 304
Event: IMPACT
Action= IMPACT
Location= IN AN AREA JUST NORTHEAST OF KALGOORLIE IN WESTERN AUSTRALIA
Date= JULY 1979
SUCCESS!  STACK USE:  -2288 2424 376
Event: IMPACT
Action= IMPACT
Location= PROBABLY IN AN AREA ABOUT 500 KMS FROM PERTH IN WESTERN AUSTRALIA
Date= JULY 1979
SUCCESS!  STACK USE:  -2296 2542 366
```

```
Event: IMPACT
Action= PROBABLY IMPACT
Location= IN AN AREA ABOUT 100 KMS FROM KALGOORLIE
SUCCESS!  STACK USE:  -1496 1720 258
Event: IMPACT
Action= IMPACT
Object: SATELLITE
...Equipment= SKYLAB
...Relative=
Location= PROBABLY IN AN AREA ABOUT 500 KMS NORTHEAST OF PERTH
SUCCESS!  STACK USE:  -2030 2204 338
*
    PIP TI:=REENTRY.
>> SKYLAB REENTERED THE EARTH'S ATMOSPHERE OVER CANADA
ON 12 JUL 1979.
>> REENTRY OCCURRED IN THE KALGOORLIE REGION
AT ABOUT 1900 HOURS ON 12 JUL 1979.
>> REENTRY OF SKYLAB TOOK PLACE OVER CANADA ON 21 JUL 1979.
>> THE SPACECRAFT REENTERED  THE EARTH'S ATMOSPHERE
AT 0000Z IN THE VICINITY OF 9999N9999E.
MCR>

 @REENTRY.
Event: REENTRY
Action= REENTERED
Object: SATELLITE
...Equipment= SKYLAB
...Relative=
Location= THE EARTH'S ATMOSPHERE OVER CANADA
Date= ON 12 JUL 1979
SUCCESS!  STACK USE:  -2072 2034 334
Event: REENTRY
Action= REENTRY
Location= IN THE KALGOORLIE REGION
Time= AT ABOUT 1900 HOURS
Date= ON 12 JUL 1979
SUCCESS!  STACK USE:  -1876 2018 300
```

```
Event: REENTRY
Action= REENTRY
Object: SATELLITE
...Equipment= SKYLAB
...Relative=
Location= OVER CANADA
Date= ON 21 JUL 1979
SUCCESS!  STACK USE:  -1876 1852 312
Event: REENTRY
Action= REENTERED
Object: SATELLITE
...Equipment= SPACECRAFT
...Number=
...Relative=
Location= THE EARTH'S ATMOSPHERE IN THE VICINITY OF 9999N9999E
Time= AT 0000Z
SUCCESS!  STACK USE:  -2264 2306 358
*
```

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MCR>PIP TI:=DEORBIT.
>> THE SOVIET NEWS AGENCY TASS ANNOUNCED THAT
SKYLAB DEORBITED INTO THE INDIAN OCEAN
ON THE 34981ST REVOLUTION.
>> THE SOVIET NEWS AGENCY TASS ANNOUNCED THAT
THE DEORBIT OF SKYLAB PROBABLY OCCURRED OVER
CANADA EARLY ON REVOLUTION 34981.
>> THE DEORBIT OF SKYLAB WAS OVER CANADA ON 12
JULY 1979.
>> DEORBIT TOOK PLACE INTO THE AUSTRALIAN OUTBACK.
>> DEORBIT TOOK PLACE AT 1900Z ON 12TH JULY 1979.
>> THE DEORBIT OF SKYLAB OVER CANADA
TOOK PLACE ON THE 12 JULY 1979.
>> THE DEORBIT OF SKYLAB WAS DURING THE INITIAL
PORTION OF REVOLUTION 34981.
>> THE DEORBIT OF SKYLAB OCCURRED DURING THE EARLY
PORTION OF REVOLUTION 34981.
>> THE DEORBIT OF SKYLAB WAS PROBABLY OVER CANADA
ON 12 JULY 1979.
>> THE SKYLAB ORBITAL WORKSHOP,
A CONVERTED S-4B THIRD STAGE FROM A SATURN-5
LAUNCH VEHICLE, WAS DEORBITED INTO THE INDIAN OCEAN
ON 12 JUL 1979.
>> THE SKYLAB ORBITAL WORKSHOP,
A CONVERTED S-4B THIRD STAGE FROM A SATURN-5
LAUNCH VEHICLE, SUCCESSFULLY DEORBITED INTO THE AUSTRALIAN
OUTBACK ON 12 JUL 1979.
>> THE SATELLITE WAS DEORBITED EARLY ON REVOLUTION 125.
>> THE SATELLITE WAS DEORBITED INTO THE INDIAN OCEAN.
>> NASA DEORBITED THE SATELLITE INTO THE INDIAN OCEAN
ON THE EARLY PORTION OF REVOLUTION 145.
>> THE SATELLITE WAS DEORBITED INTO INDIAN OCEAN
EARLY ON REVOLUTION ONE.
>> DEORBIT OF SKYLAB OCCURRED OVER CANADA EARLY ON
REVOLUTION 34981.
>> DEORBIT TOOK PLACE EARLY ON REVOLUTION 34981.
>> NASA DEORBITED THE SATELLITE INTO THE
INDIAN OCEAN ON REVOLUTION 123.
```

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>> THE SATELLITE WAS DEORBITED BY NASA INTO
THE INDIAN OCEAN ON REVOLUTION 123.
>>  THE SATELLITE WAS EXPECTED TO DEORBIT INTO THE
INDIAN OCEAN.
>> DEORBIT WAS EXPECTED TO OCCUR IN THE INDIAN
OCEAN.
>> DEORBIT OF THE SATELLITE WAS EXPECTED TO OCCUR
IN THE INDIAN OCEAN.
>> DEORBIT OF THE SATELLITE FAILED TO OCCUR
IN THE INDIAN OCEAN.
>> THE SATELLITE FAILED TO DEORBIT INTO THE INDIAN OCEAN.
MCR>
 @DEORBIT.
Infosource= THE SOVIET NEWS AGENCY TASS
Event: DEORBIT
Action= DEORBITED
Object: SATELLITE
...Equipment= SKYLAB
...Relative=
Location= INTO THE INDIAN OCEAN
Revolution= ON THE 34981ST REVOLUTION
SUCCESS!  STACK USE:  -2282 2568 384
Infosource= THE SOVIET NEWS AGENCY TASS
Event: DEORBIT
Action= PROBABLY DEORBIT
Object: SATELLITE
...Equipment= SKYLAB
...Relative=
Location= OVER CANADA
Revolution= EARLY ON REVOLUTION 34981
SUCCESS!  STACK USE:  -2376 2706 404
Event: DEORBIT
Action= DEORBIT
Object: SATELLITE
...Equipment= SKYLAB
...Relative=
Location= OVER CANADA
Time= ON 12TH JULY 1979
SUCCESS!  STACK USE:  -1946 1996 324
```

```
Event: DEORBIT
Action= DEORBIT
Location= INTO THE AUSTRALIAN OUTBACK
SUCCESS!  STACK USE:  -1040 1188 196

Event: DEORBIT
Action= DEORBIT
Location=
Time= AT 1900Z
SUCCESS!  STACK USE:  -910 1108 172
Event: DEORBIT
Action= DEORBIT
Object: SATELLITE
...Equipment= SKYLAB
...Relative=
Location= OVER CANADA
Time= ON THE 12TH JULY 1979
SUCCESS!  STACK USE:  -1966 1992 330
Event: DEORBIT
Action= DEORBIT
Object: SATELLITE
...Equipment= SKYLAB
...Relative=
Location=
Revolution= DURING THE INITIAL PORTION OF REVOLUTION 34981
SUCCESS!  STACK USE:  -1698 1894 286
Event: DEORBIT
Action= DEORBIT
Object: SATELLITE
...Equipment= SKYLAB
...Relative=
Location=
Revolution= DURING THE EARLY PORTION OF REVOLUTION 34981
SUCCESS!  STACK USE:  -1698 1898 286
```

```
Event: DEORBIT
Action= DEORBIT
Object: SATELLITE
...Equipment= SKYLAB
...Relative=
Location= PROBABLY OVER CANADA
Time= ON 12TH JULY 1979
SUCCESS!  STACK USE:  -1980 2050 328
Event: DEORBIT
Action= DEORBITED
Object: SATELLITE
...Equipment= SKYLAB ORBITAL WORKSHOP
...Number=
...Relative= A CONVERTED S-4B THIRD STAGE FROM A SATURN-5 LAUNCH VEHICLE
Location= INTO THE INDIAN OCEAN
Date= ON 12 JUL 1979
SUCCESS!  STACK USE:  -2572 2898 414
Event: DEORBIT
Action= SUCCESSFULLY DEORBITED
Object: SATELLITE
...Equipment= SKYLAB ORBITAL WORKSHOP
...Number=
...Relative= A CONVERTED S-4B THIRD STAGE FROM A SATURN-5 LAUNCH VEHICLE
Location= INTO THE AUSTRALIAN OUTBACK
Date= ON 12 JUL 1979
SUCCESS!  STACK USE:  -2640 2948 422

Event: DEORBIT
Action= DEORBITED
Object: SATELLITE
...Equipment= SATELLITE
...Number=
...Relative=
Location=
Revolution= EARLY ON REVOLUTION 125
SUCCESS!  STACK USE:  -1460 1532 252
```

```
Event: DEORBIT
Action= DEORBITED
Object: SATELLITE
...Equipment= SATELLITE
...Number=
...Relative=
Location= INTO THE INDIAN OCEAN
SUCCESS!  STACK USE:  -1464 1566 258
Event: DEORBIT
Action= DEORBITED
Agent= NASA
Object: SATELLITE
...Equipment= SATELLITE
...Number=
...Relative=
Location= INTO THE INDIAN OCEAN
Revolution= ON THE EARLY PORTION OF REVOLUTION 145
SUCCESS!  STACK USE:  -2292 2432 372
Event: DEORBIT
Action= DEORBITED
Object: SATELLITE
...Equipment= SATELLITE
...Number=
...Relative=
Location= INTO INDIAN OCEAN
Revolution= EARLY ON REVOLUTION ONE
SUCCESS!  STACK USE:  -1864 1956 312
```

```
Event: DEORBIT
Action= DEORBIT
Object: SATELLITE
...Equipment= SKYLAB
...Relative=
Location= OVER CANADA
Revolution= EARLY ON REVOLUTION 34981
SUCCESS!  STACK USE:  -1940 1954 326
Event: DEORBIT
Action= DEORBIT
Location=
Revolution= EARLY ON REVOLUTION 34981
SUCCESS!  STACK USE:  -1002 1166 186

Event: DEORBIT
Action= DEORBITED
Agent= NASA
Object: SATELLITE
...Equipment= SATELLITE
...Number=
...Relative=
Location= INTO THE INDIAN OCEAN
Revolution= ON REVOLUTION 123
SUCCESS!  STACK USE:  -2042 2046 342
Event: DEORBIT
Action= DEORBITED
Agent= NASA
Object: SATELLITE
...Equipment= SATELLITE
...Number=
...Relative=
Location=
SUCCESS!  STACK USE:  -1166 1518 220
```

AD-A084 326 OPERATING SYSTEMS INC WOODLAND HILLS CA F/G 9/4
SATELLITE AND MISSILE DATA GENERATION FOR AIS.(U)
DEC 79 G M SILVA, C A MONTGOMERY F30602-78-C-0274
UNCLASSIFIED OSI-R79-037 RADC -TR-79-314 NL

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*>> DEORBIT OF THE SATELLITE WAS EXPECTED TO OCCUR
*OVER CANADA.
Status= EXPECTED
Event: DEORBIT
Action= DEORBIT
Object: SATELLITE
...Equipment= SATELLITE
...Number=
...Relative=
Location= OVER CANADA
SUCCESS!  STACK USE:  -1790 1982 336

 >> DEORBIT OF THE SATELLITE FAILED TO
*OCCUR IN THE INDIAN OCEAN.
Status= FAILED
Event: DEORBIT
Action= DEORBIT
Object: SATELLITE
...Equipment= SATELLITE
...Number=
...Relative=
Location= IN THE INDIAN OCEAN
SUCCESS!  STACK USE:  -1750 1948 332

 >> THE SATELLITE FAILED TO DEORBIT INTO THE INDIAN OCEAN.
Status= FAILED
Event: DEORBIT
Action= DEORBIT
Object: SATELLITE
...Equipment= SATELLITE
...Number=
...Relative=
Location= INTO THE INDIAN OCEAN
SUCCESS!  STACK USE:  -1732 1882 322
```

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