To avoid a stilted style, write in a way that comes easily, using words and phrases that come naturally to you. Do not try to impress readers with your vocabulary, but be certain that the words you use convey your exact meaning. Your readers will be interested in what you have to say and not in how eloquently you say it. Avoid long, complicated terms if shorter and more familiar ones are available. But be careful not to use jargon because it may be misinterpreted.

Guiding the Reader

To achieve clarity and continuity in a report, you must carefully direct your readers' attention throughout the report. Many successful writers do this by using the three classic principles of presentation:

1. Tell readers what you plan to tell them (Introduction).
2. Then tell them (main text).
3. Finally tell them what you told them (Summary of Results or Conclusions).

State your purpose or objective clearly and follow it with a concise description of the method you will use in presenting the subsequent discussion. Then proceed with your presentation, making certain that it is consistent in every respect with your plan. Finally summarize your conclusions and recommendations.

Getting to the Point

Technical reports are not mystery novels; get to the point as directly as possible. Do not lead your readers in and out of blind alleys before taking them to the final destination. Omit information that does not directly relate to the conclusions. Remember, readers are interested primarily in conclusions and supporting evidence.

If you must include some information or discussion that may be of interest but is not directly pertinent to your conclusions, put it in an appendix. Using an appendix allows you to bring up points that may be of interest to some of your readers without distracting the reader who is interested solely in your conclusions.

Emphasizing Major Ideas

Because the purpose of technical reports is to transmit ideas, emphasize your major ideas so that they cannot be missed. To do this, clearly subordinate any supporting information to the major ideas. The report outline is particularly useful here because it establishes the major and supporting points for each section of the report.

Your major ideas can also be emphasized by briefly stating them at the beginning of each section and then summarizing them at the end of the section. Emphasis can also be aided by careful use of headings.

Separating Fact From Opinion

Reports should clearly differentiate between facts and opinions. Many authors are remiss in doing this, overlapping discussions of their experimental results and the conclusions they have drawn. Carefully alert your readers when fact ends and opinion begins.

The statement of your opinions is an instance where the use of the first person is desirable. For example, if you follow the presentation of some specific results with "It is believed that . . .," your readers cannot be sure if this is your opinion or a generally accepted belief. To avoid this confusion, use the first-person

APPLYING THE 21st CENTURY TECHNOLOGY TO THE 20th CENTURY MISSION CONTROL

Rozenfeld P., Orlando V., Ferreira M.G.V.
INPE, Brazil

ABSTRACT

Bringing the space operations into the 21st century, sometimes, means to bring a long lasting 20th century mission into the 21st century. Some of the missions conceived in the mid 80's have endured up to the present days. Certainly, the corresponding ground control system have been based on the technology available at that time. However, the technology has changed a great deal in the past decade and the ground system maintenance cost has became a major issue. At the present time INPE's Satellite Tracking and Control center (CRC) is facing this problem. It is operating in orbit three satellites and readying itself to operate a fourth one, to be launched this year, technologically similar to the ones already in orbit. It is out of question to wait for the brief termination of all these missions. CRC is, therefore, facing a complete reformulation of its ground system architecture caused by the departure from ALPHA(DEC) platform to embrace the PC platform. The architecture reformulation is not a simple software migration from one computer platform to a new one. It means to use new Ground Station equipment based on PCs, new communication protocol between the Satellite Control Center computers and the Ground Station equipment and an intensive use of the new operating system services which come with it. Besides, it means also, of course, the development of a practically new version of the entire real-time application software of the INPE's Satellite Control Center, under more user-friendly graphical interfaces. The flight dynamical application software, which operates off-line, was basically adopted to run on PC's through development of graphical user-friendly interfaces. This paper describe the way it is being implemented at CRC during this process without jeopardizing the satellite in-orbit control.

Revising the Rough Draft

The last stage of report preparation, rough-draft revision, is just as important as the previous stages, but it is the one most scorned by inexperienced writers. Revising a draft is comparable to painting a house: the appearance is improved without influencing the structure. But a report's "appearance" (readability) may determine whether or not it is read.

Before you can revise your rough draft, you must recognize that it is not perfect. Approach it with a critical attitude. This can best be done by setting the draft aside for a few days, or at least overnight. This time lag should give you a fresh viewpoint and allow you to change to the role of a reader. This change in roles is most important because you must try to see what is actually written rather than what you think you wrote.

Successful technical writers use a wide variety of methods to review and revise. One of the best involves three *separate* reviews of the report:

1. The first review is of the material in the report. In this check ask yourself these questions: Are the conclusions valid? Is sufficient information given to support the conclusions? Is enough background information given to explain the results? Have all irrelevant ideas been deleted? Are the illustrations pertinent and necessary?

2. The second review is of the mechanics and organization. Are the subject and purpose clearly stated? Does the report flow smoothly from topic to topic? Are the relations between topics clear? Is each illustration clear and properly labeled? Are all required parts of the report included?

3. The third review is of spelling and grammar (see refs. 1 to 6), particularly punctuation (see ref. 10) and sentence structure. Is each sentence written effectively? Are the sentences varied in length and complexity to avoid monotony? Are the words specific rather than vague? Have all unnecessary words been deleted?

Make sure you can truly answer yes to all of these questions before you consider your draft finished. Do not try to make one review do the work of three. Trying to cover too many categories in one review usually results in oversights and errors. Some common faults observed in rough drafts are (1) faulty grammar; (2) clusters of nouns and adjectives modifying a noun and conversely strings of prepositional phrases after a noun; (3) use of abstract nouns instead of action verbs; (4) nonparallel construction of words, phrases, and sentences in enumerations; and (5) more complicated phrasings than required. Carefully review your draft to make sure you have avoided these common faults.

Foreword

Chapter 2

- Contents

APPLYING THE 21st CENTURY TECHNOLOGY TO THE 20th CENTURY MISSION CONTROL

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INTRODUCTION

The long lasting extended life space missions are a blessing and a curse. A blessing for the users for getting more mission data. A curse for the operational team for representing daily struggle to keep the system up and to keep the maintenance costs down. This is more so when the mission extended life spans over a period of time when rapid technological changes take place. Precisely this is what happened with INPE's Satellite Tracking and Control Center (CRC) since the launch of its first satellite SCD1 in 1993. A small experimental satellite, planned for one year in orbit life, has turned out to stay in orbit for almost 10 years and continuing and sprouting demand from satisfied user community.

The very rapid change in the computer technology during the last decade has had its impact on CRC's architecture. An overview is done of its step-by-step evolution during this time period always incorporating new missions without leaving out the older ones.

GROUND SEGMENT CONFIGURATION FOR THE FIRST SATELLITE LAUNCH

The specification and development of INPE's ground control system, presently called Satellite Tracking and Control Center (CRC), have started in mid 80's [1], [2], [3], [4].

CRC is composed by a Satellite Control Center (CCS) located in São José dos Campos (23°17'S; 45°51'W) and two Ground Stations. One in Cuiabá (15°33'S; 56°04'W), about 2000km from São José dos Campos and another one in Alcântara (02°20'S; 44°24'W), about 3000km from São José dos Campos. To connect the three sites a private data communication network have been set up. The ESA standards available at that time were adopted throughout the system. The system development was material that must be treated under that item. Other authors follow a similar method but use full sheets of paper for each subject and give a much fuller description of the material under the subject headings. The latter method puts you in a good position to complete the report in a short time: Each subject has been so fully expanded that the problem remaining is one of combining and rewriting the information contained on the separate sheets of paper. Others choose to do their outlining on a computer. Any of these methods permit you to note thoughts that occur during the course of writing one report section but that should be treated in other sections. Cultivate the habit of going to the original outline to record thoughts for later consideration.

Another useful purpose of the outline is to indicate the relative importance of headings. This relation can be shown by using a numbering system. (The numbers appear in the final report only when there is extensive cross-referencing.) Headings of equal weight, or importance, must be written in the same form. The order and form of the various headings used in NASA rough drafts are

1. MAIN HEADING
2. Subheading
3. *Run-in heading.*-- (This heading is indented on the same line as the first line of the paragraph.)
4. Below run-in heading: (This heading is indented on the same line as the first line of the paragraph.)

Three levels of headings should be sufficient; more may disrupt your readers' concentration. The typeface and placement of headings will vary with the type of publication.

Thorough outlining will make both writing and reading the report easier. Study your outline carefully to be certain that each item blends into a logical plan and ordered presentation.

Writing the Rough Draft

With a logically organized outline and the necessary illustrations already prepared, writing the rough draft should be much easier than you thought. But do not expect to write the final version in the first attempt. The rough draft should be the last of several versions, each an improvement of the preceding one. This final version is considered a "rough" draft because it still must go through a series of technical and editorial reviews. But it should be as polished as you can make it. From your point of view it should be ready for printing and distribution to a critical audience.

Try to start writing the first version of the draft immediately after completing the outline while the ideas developed there are still fresh in your mind. Write this first version as rapidly as possible. Concentrate on *what* you want to say rather than how to say it. Keep writing down the thoughts as they flow into your mind, following your outline. Avoid going back over what you have written until you are through writing. Then review this version--but only for its technical content. Are all of the ideas you wanted to express included? Have you included irrelevant ideas? Does the report organization still seem logical? Sometimes writing the first version will reveal some unexpected problems that require a change in the outline.

In the second version of the rough draft, writing style becomes important. With the technical content in a well-organized form from the first version, this is the time to concentrate on how you say it. Keep your readers in mind. Remember, your purpose in writing the report is to transmit the information needed to support your conclusions. To make sure your readers understand your conclusions, you must transmit your information clearly, logically, concisely, honestly, and tactfully.

oriented to incorporate the technologies prevailing then. The Ground Segment was implemented to be able to control in orbit the first satellite to be built and launched by INPE. This satellite, called SCD1, is dedicated to environmental data collecting by using a set of automatic terminals called Data Collecting Platforms (DCP) which collect the data and transmit them to the satellite in UHF band. The on-board Data Collecting Transponder translates the data to S-band and transmits them to the Ground Stations. From the Ground Stations the collected data are transferred to the Data Processing Facility which process them and distribute to the users. 25 DCPs have been scattered throughout the Brazilian territory at the SCD1 launch.

The satellite itself is a low earth orbit (25° inclination) spinner with attitude control only. Its nominal life is one year. CRC configuration, as readied for SCD1 launch in February 1993, is described below.

The Satellite Control Center (CCS) was based on two VAX8350 computers (16 Mbytes RAM, 3 Gbytes disk and 4 MIPS) in cluster configuration. The operational system VMS in its 4.7 version have been frozen for SCD1 launch.

The CCS application software (real time and flight dynamics) was developed in house using FORTRAN language.

The communication between CCS application software and Ground Station equipment have been done according the ESA SDID protocol. At the Ground Station a DEC microVAXII computer (8 Mbytes RAM, 100 Mbytes disk, 3 MIPS) is used for managing the Ground Station equipment as well as being a back up for the CCS control functions. Therefore, it has the same real time software as CCS augmented by a specific module dedicated to antenna management. The antenna system manufactured by an American supplier, including antenna, RF and receivers and featuring a 2000w klystron High Power Amplifier, have been installed at the Ground Stations. A German built telecommand encoder Mark II, using X.25 protocol to communicate to CCS or to the station computer, is a part of telecommand chain.

The Telemetry chain was based on a mixture of American and in house built equipment using X.25 communication protocol.

Still other equipment like ranging and Data Collecting Processor have been developed in house, always implementing X.25 protocol.

The Data Communication nodes, developed by a Brazilian manufacturer, have used X.25 protocol for communication. The communication network was managed by a Brazilian built minicomputer.

The whole Ground Segment performed very well since SCD1 launch in 1993. However, the maintenance contracts with DEC for the computers, the communication nodes manufacturer and the network management computer manufacturer represented the biggest share of the CRC running costs.

Also, the communication nodes required an operational team by themselves, putting the Ground Segment operational man-power up.

GROUND SEGMENT CONFIGURATION FOR THE SECOND SATELLITE LAUNCH

During the preparation for the SCD2 launch, which happened in 1998, several measures have been taken in order to ease up on the budget by incorporating some technological advancement. [5]

The first one was to substitute the X.25 nodes mounted on 19 inch racks and the network management minicomputer by small routers based on PCs which performed as the nodes and the network management computer all in one. Besides saving on space and electrical power, the operational team size have also been decreased. The nodes and network management computer maintenance contracts have been nullified.

part of the report. This expanded outline should show the complete scope of the report, the relation of the various parts of the work discussed, the amount of space to be given each part, the order of treatment, the places for inclusion of illustrations, and the conclusions. Remember, the more detailed the outline is, the more useful it will be to you. Each heading, subheading, subsubheading, etc., should have as much detail as you will need to trigger your thoughts when you later write the corresponding sentences and paragraphs.

NASA reports typically contain a number of commonly used headings:

- Summary
- Introduction
- Symbols
- Theory
- Analysis
- Apparatus
- Test Specimens
- Test Procedure
- Sample Calculation
- Results and Discussion
- Summary of Results
- Conclusions
- Concluding Remarks
- Appendix
- References

All these headings need not be used in any single report. And headings may be combined. For example, Apparatus, Test Specimens, and Test Procedure can be combined into Experimental Methods.

These commonly used headings may be replaced with more descriptive headings, particularly in program summary reports, where details may be subordinated to broad objectives and generalizations. In these reports the more descriptive headings provide a means of ready reference and aid clarity. Descriptive headings usually make a report more interesting to read. But you must exercise originality to make them brief but clear.

The final outline should show the exact form, wording, and value of the headings to be used in the report. The headings, although brief, must serve as a reliable guide to the included material. They should be consistent in grammatical structure and should not contain verbs. Headings are not an integral part of the text but are provided to assist the reader in finding information. Therefore the paragraph below a heading should begin with a topic sentence that does not depend on the heading for clarity.

The whole text of the report should be accounted for under the headings shown in your outline, except for short introductory or transition paragraphs included to make the presentation flow smoothly. Because a subject cannot be subdivided into less than two parts, an outline should have at least two subheadings under a main heading--or none. Exceptions to this rule include an occasional short remark or a single example put in to illustrate a method. In addition to headings the outline may also contain descriptive words and key phrases to serve as reminders.

Several methods can be used to arrange the subject matter that will be represented in an outline. One of the best ways to start is to write down all the points that you want to include without regard to their order. You can then more easily arrange them in a logical order. Some authors use an index card system in which each separate item of the proposed report is tabulated together with a paragraph describing the

The second step was to substitute the DEC VAXes and microVAXes by DEC's newer model computers, the ALPHAs with OpenVMS operating system. This have required real time and flight dynamics software migration to the new computers which have been successfully performed [4].

After operating in parallel for some time the old and the new computer systems and confirming good performance of the new system, the old one have been deactivated. It should be mentioned that, basically, there have been no modification to the satellite control software.

The Figure 1 presents the Ground Segment computer architecture for the second launch.

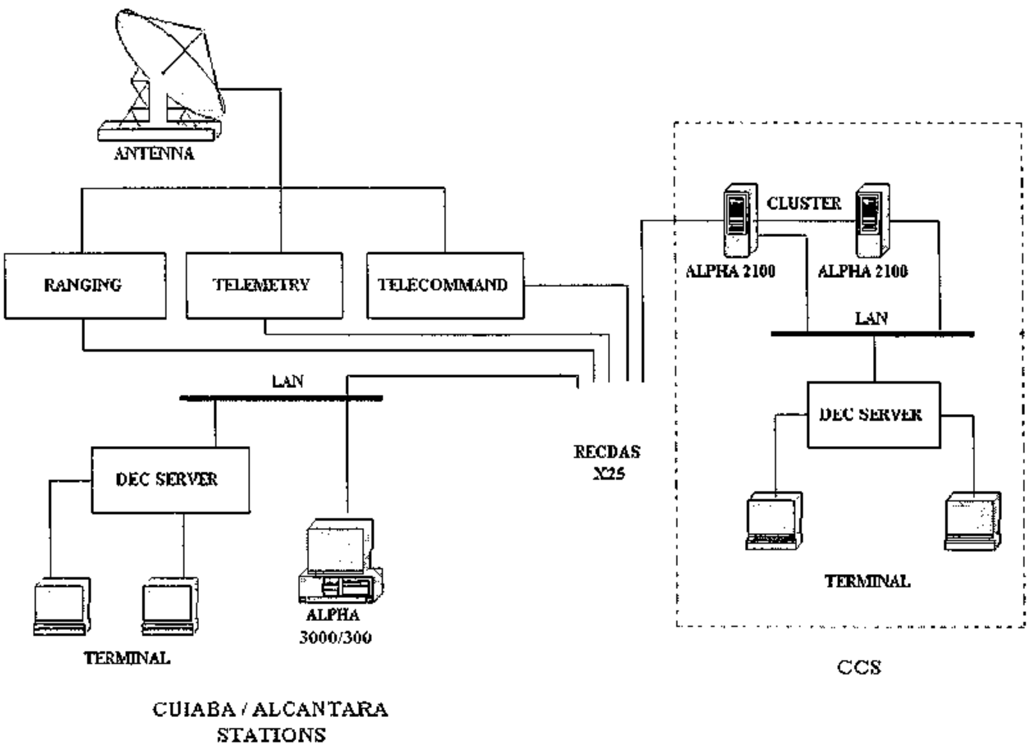

Fig. 1 – CRC computer architecture for SCD2 launch.

At the Control Center (CCS), there are two ALPHA 2100 computers (128 Mbytes RAM, 12 Gbytes disk, 190 MIPS) in a cluster arrangement with DEC-Servers allowing connection between the computers and the user terminals. At each Ground Station there is one ALPHA 3000/310 workstation (64 Mbytes RAM, 1 Gbytes disk, 30 MIPS) which is a backup, in degraded mode, to the CCS computers. The connection between the user terminals in done by means of DEC-Servers. The data communication network implements X.25 protocol.

Some small improvements in terms of hardware at the Ground Stations have also been done. Because SCD2, differently from SCD1, has 2 downlink polarizations, depending on SCD2 attitude, a new tracking chain have been installed in the antenna systems. From that point on, the Ground Stations could perform tracking of the satellites having 2 different polarizations.

A new 50w solid state power amplifier have been installed at the Ground Station as prime remaining the klystron HPA as a redundant equipment.

The number of DCP's started to grow reaching the total of 270 thanks to the excellent performance of the data collecting system using the SCD1 and SCD2 satellites [8].

destination. You will not know where you are going, and you will never know when you get far enough to stop. Therefore choose your report destination early by drawing and clearly defining the program conclusions before you begin to organize and write the report. This is best done by first writing down all significant results in no particular order and then sorting them so that the results pertaining to a common factor are grouped together. Once the conclusions are drawn, list them in descending order of importance.

Selection of the data to be used in the report is another important part of this step. Choose only the data necessary to help your readers reach the conclusions you are drawing. Excessive data or data only loosely related to the conclusions will obscure them and confuse your readers. Of course, do not hide contradictory results. When definite contradictions exist, clearly alert your readers to this fact.

The next step in data analysis involves organizing the selected data into illustrations for the report. Sometimes the figures and tables prepared during the program can be used with only minor modifications. But usually these data-book illustrations contain extraneous information. And they seldom are arranged to emphasize the significance of the data and the corresponding results. For example, although data tabulated during a program are commonly arranged chronologically, that is not necessarily the best way to present the data to the reader.

New figures and tables usually must be prepared. Their organization should be carefully considered because illustrations are one of the best means of emphasizing and supporting conclusions.

After the illustrations have been prepared, write the significant points about each on an attached sheet of paper. What is the figure (table) supposed to show? How were the data obtained? Are there any qualifications to the figure (table)? This information will be useful when you begin writing the report.

Before beginning to outline your report you may find one additional step useful--writing a limiting sentence. This is a single sentence that states the subject, scope, and purpose of the report. It is an additional tool to help define the report's direction and limit its scope. As an example, the following limiting sentence could be written for this guide:

```
SUBJECT     The Glenn Research Center guide "Technical Report Writing"
SCOPE       covering the fundamentals of organizing, writing, and
            reviewing NASA technical reports,
PURPOSE     was written to improve the writing skills of Glenn technical
            authors and the overall quality of their reports.
```

Preparing a limiting sentence is not simple. It takes additional time and effort. But it is a worthwhile exercise because it forces you to focus your attention on exactly what you expect the report to do.

Outlining the Report

Outlining is a necessary preliminary step to report writing. It involves the planning needed to prepare a clear report that is logically organized, concise, and easy to read. Without an outline most inexperienced authors write reports that are confusing and difficult to follow. The outlining stage is a natural progression from the analysis and sorting stage. In the sorting stage concentration is on what results should be presented in a report. In the outlining stage attention is directed to *how* these results should be presented.

Often the preliminary outline prepared at the beginning of the program can be used as a starting point for the report outline. But it should be revised and expanded to emphasize the conclusions drawn in the analysis and sorting stage. The revised outline should contain descriptive headings of each significant

GROUND SEGMENT CONFIGURATION FOR THE THIRD SATELLITE LAUNCH

In mid 90's INPE was preparing itself for the launch of the CBERS1 satellite. This is a cooperative satellite dedicated to the earth remote sensing mission developed by Brazil and China. It is 3-axis stabilized and much more complex than SCD series. [6], [7] It has on-board a Data Collecting Transponder also.

CBERS1 launch have occurred in 1999. Based on INPE's past experience in satellite operation and a clear computer technology evolution, it was decided to develop, for this satellite, a new real time software on PC using Windows 2000.

The flight dynamics software remained on the ALPHA's. Because the telemetry chain at the Ground Stations was not able to cope with the CBERS1 telemetry, it was decided to develop in-house a new piece of hardware dedicated to CBERS1 telemetry and telecommand functions. This piece of hardware was based on a PC in such a way that it communicate itself with the real time software using TCP/IP protocol. With this purpose new routers, which implemented TCP/IP protocol, have been included in the communication network. The ALPHA's based system dedicated to SCD1 and SCD2 control still used X.25 protocol.

A small hardware improvement have been done at the Ground Stations. Because the ground control system has to control now 3 satellites with different on-board TTC transponders with different uplink frequency sweeping times and short time intervals between different satellite passes it was decided to substitute HP8662. Synthesized Signal Generator by a frequency synthesizer controlled by a PC. The uplink frequency sweeping curve for each transponder have been stored in the PC allowing very quick reconfiguration from one satellite to the next one. At the same time effort has been done to develop a range rate (Doppler) equipment as an alternative to the old, ranging equipment. This Doppler equipment is based on PC also and uses TCP/IP protocol for communications.

PRESENT TIME CONFIGURATION

The excellent performance of the data collecting system as witnessed by about 600 DCP all over Brazil by now and still healthy status of SCD1 and SCD2 satellites, implying that their mission could be extended for some time to come, led to consider moving off all together from ALPHA's and X.25 protocol to PC's and TCP/IP protocol.

In order for this to happen, it is necessary to migrate the real time and flight dynamics software from ALPHA to PCs. In terms of real time software it was decided to configure the CBERS real time software for SCD1 and SCD2 needs. This was done successfully making use of some of the Windows 2000 features.

One of the biggest problems with the migration is to preserve the SCD1 and SCD2 history files stored on DEC tapes which represent about 10GB of data.

This was done in two steps. Initially, the history files on the tapes are transferred to ALPHA hard disk. From it the history files are transferred to PC hard disk where they are stored in the data base developed for CBERS. The Access 2000 data base is used.

The flight dynamics software for SCD1 and SCD2 have been developed using FORTRAN77 and the corresponding user interfaces using the DEC Screen Manager library procedures. This software, excluding the user interface, was transferred to PC, which runs FORTRAN90. For this purpose the flight dynamics software was converted to Dynamic Link Library (DLL). A new user-friendly graphical interface was developed using Visual Basic.

NASA TM-105419

Chapter 1--Stages of Report Preparation

Research information has limited value unless it is collected and published in a usable form and presented to those who may apply it. For these reasons never assume that your job is finished when the experimental or analytical phase has been completed. It is also your responsibility as an engineer or scientist to show promptly that your results are worthwhile and that you have reason to believe the field will be advanced by your efforts. The only way to convey these thoughts is by writing a good report.

The five major stages of report preparation are

1. Gathering the data (or developing the theory)
2. Analyzing and sorting the results
3. Outlining the report
4. Writing the rough draft
5. Revising the rough draft

Gathering the Data

Report preparation begins with planning the research program. An orderly investigation is a requisite for an orderly report. Report planning and program planning should be considered one and the same. To become a successful technical writer, you should develop the ability to foresee the general content of the report before the program begins. In most cases you should be able to prepare a preliminary report outline at the beginning of the program. Outlining should benefit both the report and the program, for obviously a well-prepared outline requires a carefully planned program.

During the course of the program keep the future report in mind. Maintain orderly records as the data are gathered. The little extra time required to record the results carefully can be of great value later. Report writing is difficult enough without having to recollect misplaced or unrecorded data. Write out your opinions as soon as the data are obtained. Comparing these opinions with those based on hindsight will often help you to interpret the data properly.

During the data-gathering stage consider how the data should be presented in the report and record the results in this manner. Any need for additional data will thus be revealed before the program is completed.

Analyzing and Sorting the Results

The second stage of report preparation, data analysis and sorting, is probably the most difficult because it requires considerable mental effort to decide what you want to tell your readers. The beginning of this stage overlaps the data-gathering stage, for data analysis should begin as the data are collected. But the bulk of data analysis must be done near completion of the program. At this time reexamine the pertinent data and review your earlier opinions with respect to subsequent results.

During this data review the program conclusions should be drawn. This is the most important step in report preparation because the conclusions are the reason for the report and the basis for report preparation: They dictate what to include in a report and how to organize it. Trying to organize and write a report without knowing the conclusions is like starting an automobile trip without knowing the

While all this process was going on, at the Ground Stations, the Antenna Control Unit (ACU) started to present obsolescence problem. The original manufacturer has phased out some of the ACU analog board, generating a problem of ACU maintenance. It was decided to substitute the old ACU by a new digital controller of the same manufacturer. The new controller is more flexible in terms of its remote control by a PC. Profiting from this feature a new Antenna Management software for PC have been developed using DELPHI 6.0.

The present time Ground Segment computer architecture is shown in Figure 2.

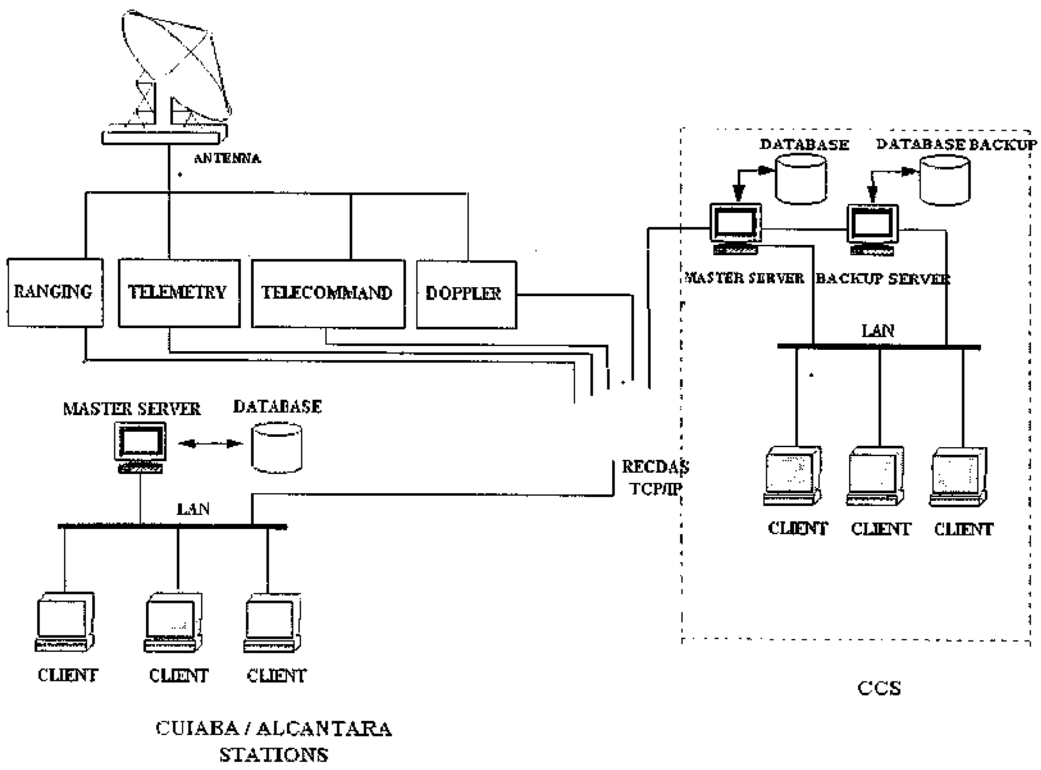

Fig.2 - Present time CRC computer architecture

Even though the new architecture is based on PCs, the care with the system fault tolerance and the system availability is still present in this system. The cluster technology used previously is substituted by a back up server. The ALPHAs centralized technology have been replaced by a server-client architecture.

In terms of the communication network, now wholly using TCP/IP protocol, given the possibility of hackers intrusion, a physically isolated private communication network have been configured.

Summing up, presently INPE's ground control system has completely evolved to a PC based architecture. This new architecture will be controlling four satellites: SCD1, SCD2, CBERS1 and CBERS2 to be launched during the second half of this year.

The future cooperative French-Brazilian scientific minisatellite (FBM), to be launched in 2004, will be controlled by CRC only. The Ground Segment, being prepared now for its control, is based on PCs, making profit of the operational experience gained from previous missions. The FBM ground control

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CONCLUSIONS

By a step-by-step approach, INPE was able to transform a 20th century satellite control technology to 21st century technology. This was done by incorporating new computer technology, new communication technology and new information technology.

This was done by a small team of dedicated people with very good knowledge of the past architecture and very good knowledge of new technologies. Staying in tune with the advances of the Software Engineering, CRC have started a research work on development of a prototype satellite control system, based on the distributed objects and agent technology. The system which started controlling only 1 satellite now is able to control 4 satellites satisfying the demand of ever growing user community. This transition from older technology to the newer one is bringing with it lower system operational costs. The high autonomy level of the ground control system has been incremented, reducing, in this way, the probability of human operational errors. The CRC trend, from now on, is to proceed in this direction, promoting a continuous increase of the ground system operational autonomy.

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Chapter 6--Concluding and Supporting Sections

This final chapter on the mechanics of report writing is a catchall in that it encompasses all parts of a report not previously discussed: concluding section, Summary, Abstract, title, appendixes, and references.

The concluding section is where you tell your readers what you have told them. It is also the section usually examined first by the prospective reader with limited available time. The Summary and Abstract are concise recapitulations of the report content. The title is the "punch line" and is most effective when short and informative. Each of these parts is important because of its potential to reach a different group of readers. Each should be written clearly and concisely.

Concluding Section

It is common practice in NASA reports to end the main text with a concluding section. In spite of skillful writing the reader may become confused or overwhelmed by the large number of details in a complicated report. Clearly the writer needs to bring out the most important facts and discuss their significance. Many busy people read the concluding section of a report first. On the strength of this reading they may become interested in the details, or they may discard the entire report. Therefore the concluding section must be self-contained and independent of the main body of the report. Preferably it should be so worded that a person not completely familiar with that particular branch of science can understand what was learned from the investigation.

"Summary of Results," "Conclusions," and sometimes "Concluding Remarks" are the common headings for this section. These headings connote somewhat different contents distinguished by the degree of generality and certainty of the material included in them. Since statements made in this section are often quoted by other investigators, each statement should be critically evaluated for accuracy and clarity. A useful stage-setting approach to the concluding section is to briefly state the purpose and scope of your work.

A few ground rules should be observed in writing the concluding section:

1. Do not use undefined symbols.
2. Do not cite equations, tables, figures, references, and appendixes.
3. Do not introduce new material.

Summary of Results

The Summary of Results is the most straightforward concluding section. It simply restates the major findings of the investigation. All of the material presented must have appeared in the main body of the report. A frequently used method is to itemize the main factual results, usually in single sentences. The facts given are supplied from experimentation or theory--but not from any reasoning (i.e., they are not deduced).

Conclusions

A Conclusions section allows the inclusion of "deductions." The usual form of reasoning in reports is to