MANAGEMENT OF SMALL SATELLITE PROJECT IN DEVELOPING COUNTRIES

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ABSTRACT
A number of developing countries are undertaking projects pertaining to design and development of small satellites either using their own resources or in collaboration with foreign countries on regional or international basis. Suparco is involved in both types of endeavors.

Pakistan's first experimental satellite, Badr-1 was totally an indigenous effort. The second satellite, Badr-2, is an improved version of Badr-1. This satellite has been designed and fabricated by Suparco. Some of its sub-systems/payloads have been jointly designed by Suparco and foreign companies/organisations on the basis of agreed specifications. Such collaborations will facilitate mutually beneficial long-term relationship between countries/organisations involved in similar efforts.

Pakistan is also actively involved in development of Small Multi-Mission Satellite (SMMS) project of the Asia Pacific Multilateral Cooperation in Space Technology & Applications (AP-MCSTA). In this project, Suparco is collaborating with counterpart space agencies in China, Thailand, Rep. of Korea and some other regional countries.

The main aims of these efforts are to give a filip to the country's R&D efforts in space technology and develop human resources in this field through hands-on experience in building and operation of satellites, and acquisition of new skills in project definition, funding and implementation.

Suparco has thus acquired much useful experience in management of small satellite projects. This paper highlights the problems faced and how they were resolved inspite of technical and financial resource constraints. It also provides an outline for efficient management of such projects in developing countries.

INTRODUCTION
Most of the developing countries have neither the infrastructure nor experience/expertise in development of satellites, but would like to have their own satellites in orbit. This can not be achieved unless they have their own infrastructure.

Therefore it is necessary to develop a complete methodology which lays emphasis on strategic planning, design and implementation to meet performance, time and cost goals of the project. This is because satellite development from its very nature requires multi-disciplinary approach. A feasibility study is also required to be prepared to define in detail project objectives and satellite capabilities in terms of specific payload elements to be developed. This would also help in reducing number of problems at the start of the project.

Prior to or at the time of undertaking satellite projects, steps have to be initiated to setup laboratories and workshops. These laboratories and workshops have to cater for the specialised needs such as clean rooms for payload fabrication, thermal and vacuum test chambers, vibration test facilities, hardware and software simulation facilities etc. Satellite project life cycle is possibly as under:

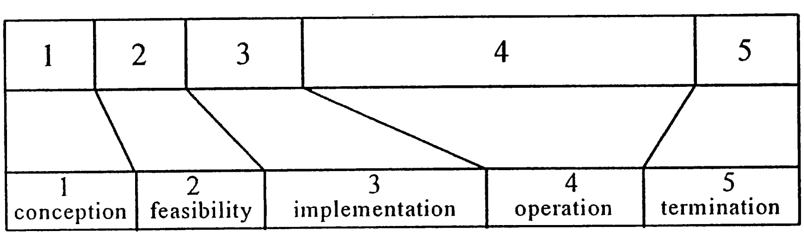

Figure 1. Project Life Cycle - BS 6079

Proceedings of the Euro-Asia Space Week on Cooperation in Space – 'Where East & West Finally Meet', 23-27 November 1998, Singapore (ESA SP-430, February1999).

PROJECT PLAN

Comprehensive planning is essential to successfully implement a satellites project. Coordination with and approval of the relevant authorities is also needed. During the process of planning a number of issues and potential difficulties which may have to be faced would be brought-out. These must be addressed and resolved. At the end of this exercise the role and responsibilities of various players such as Project Manager, Project Team. Functional Managers, contractors would be spelled out. Approval of this plan would signify a commitment of resources by the organization. This plan is essential for both technical and management reasons, as it identifies specific elements of the project, delineates responsibilities and schedule. It is also valuable as a tool for monitoring progress and pin-pointing problems areas.

MAJOR ACTIVITIES IN PROJECT IMPLEMENTATION

The major activities needed to implement a Project of this nature would consist of the following:

- Appointment of Project Manager. Consultant (if needed) and selections of project team
- Definition in clear terms of the goal and objectives
- Development of schedules and estimation of resources (manpower & financial-separation of capital cost and recurring expenditure)
- Definition of Quality and Product Assurance Policy
- Radiation Effect and Hardness Assurance Plan
- Assembly, Integration and Test Plan
- Contingency plan to deal with unfavorable circumstances such as technical failures, contractor defaults, sudden resource crunch etc.
- Design, development (or procurement) of various ground and space segment elements
- Continuous monitoring and evaluation of the project progress through periodic monthly and quarterly reviews etc.
- Integration and launch of the satellite

The above activities have to be described in detail and would form the basis of Project Plan.

MAJOR ELEMENTS IN PROJECT IMPLEMENTATION

The major elements would include the following:

- Project Management
- System Engineering
- Space and Ground Segment
- Launch Arrangements
- Post Launch Operations
- Financial Management

Project Management

This would include technical and administrative management of the project. Its main task would be to ensure that various activities are accomplished within budget and on schedule. In view of the nature of this project, it is essential that a small well-knit and highly motivated team work in close proximity of the project. The team also needs to be technically competent and has easy access to technical information and advice. Interaction, communications and personal relations among the team members enhance chances of better implementation of the project.

System Engineering

It plays a crucial role in aspects such as system design, performance, reliability, quality, maintainability etc. It also deals with integrating technical disciplines to achieve project objectives. So, in nutshell it could be stated that it involves developing an overall system concept and coordinating the various elements, so that they all chime harmoniously together.

Space and Ground Segment

The satellite system basically consists of the following two prime components:

- Space Segment
- Ground Segment

The space segment consists of satellite(s). The ground segment is where user and control facilities are located. There has to be a liaison and interface between these two segments. This is the reason that the communication systems form an integral part of the satellite system. Figure 2 gives the basic architectures of the inter-segment link.

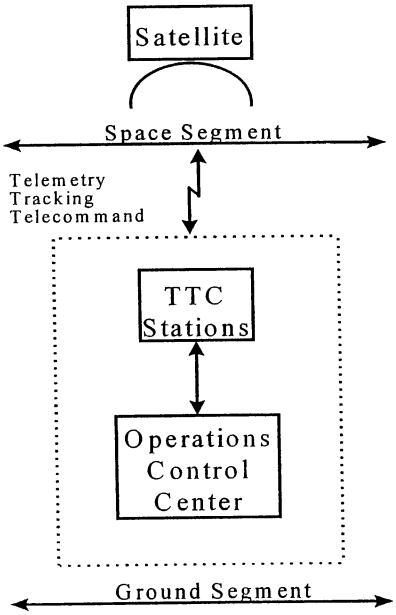

Figure 2. Inter-Segment Link

Space Segment

The specific payload elements or experimental packages which makeup the satellite are identified and developed under this activity. The satellite may consist of the following elements:

- Remote sensing package
- Scientific package
- Communication package
- Data collection package
- Support subsystem package (power, altitude control, RF, propulsion etc.)
- Satellite structure

In addition
- Satellite integration and testing

For each of the above elements it is important to describe the objectives, configuration, in-orbit operational requirement (orbit height, orientation with respect to earth etc.), overall specifications of interest for total payload (weight, volume, power requirements, special mountings etc.) and any other pertinent parameter. Some or all of these elements can either be designed, developed, and tested in-house or through contractors. Contractors have to be evaluated thoroughly before assigning them stated task(s). In this regard ISO-9000 certified companies should be preferred over non-certified companies. After individual testing of the payload elements, they have to be integrated in the total satellite and tested once again. Thus payload integration and testing is a major activity by itself. Sufficient time should be scheduled for this activity. A typical assembly, integration and testing sequence is given as Figure 3.

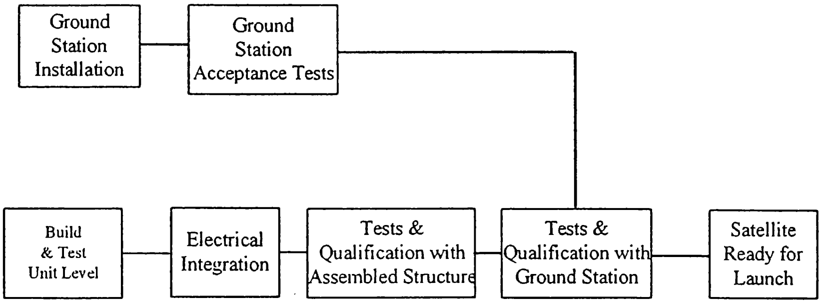

Figure 3. Satellite Assembly Integration and Test Sequence

Ground Segment

The satellite needs to be supported for both pre and post launch operations. There would be commonalties and even an amount of exact duplication of requirements for pre and post launch ground segment. These commonalties are centered around the control aspect of the satellite operations. The satellite support facilities are provided by the ground segment and are termed as TT&C station. The TT&C station is operated under centralized control of the Operational Control Centre (OCC). Proper definition of objectives, configuration, operational requirements and top level specifications for all constituent elements of the ground segment such as type of RF links, uplink and downlink data rates, type of modulation, data format etc. are required before the development work is initiated on ground station. Reusability of the ground station for future mission is also to be catered for.

It is essential that a decision should be taken at a very early stage of the project life regarding development of the ground station either in house or through contractors.

Launch Arrangements

These usually require high-level management decisions and agreements with foreign entities that can provide launch and tracking services. The process of discussions with the prospective launch service providers should be initiated at the initial stages of the project so that a confirmed launch date is available at least a year prior to the schedule completion of the satellite. This would definitely help in better project scheduling and planning.

Launch Operations

Planning for the in-orbit operations of the satellite is an important part of the project. Usually these operations include configuring and monitoring conditions of the satellite. The tasks that are part of on-station mission control activities would consists of the following.

- Satellite Health Control - Satellite health is determined by analysis of digital status parameters and analogue values which are transmitted by satellite as telemetry signal. Control is achieved by telecommand to the satellite which can change its status and instigate an action

- Flight Dynamics - The orbital determination, control and verification activities are part of flight dynamics. Post launch flight dynamics activities include orbital determination tasks. It would also includes activation of attitude and orbit control system (AOCS) to make necessary correction to the orbit if needed. These activities would continue for full in-flight operational life of the satellite

- Trend Analysis - These are done to establish trends in satellite performance and usually done off-line

FINANCIAL MANAGEMENT & CONTRACT

These are critical support functions. The plan should clearly delineate responsibilities in order to take appropriate action to expedite acquisition of major and minor items of equipment, that contracts are awarded in time to the contractors who can perform the task and assure their timely completion etc.

PROJECT ORGANISATION

Most of the developing countries do not have at present sufficient number of trained manpower in the field of satellite technology. In order to optimize the use of available resource it would be much better to adopt Matrix Organizational structure for the project. As the basis for this approach is an attempt to create synergism through shared responsibilities between Project and Functional management. This structure also provides adequate authority to both project and Functional Managers. Fig-4 gives an outline of this structure.

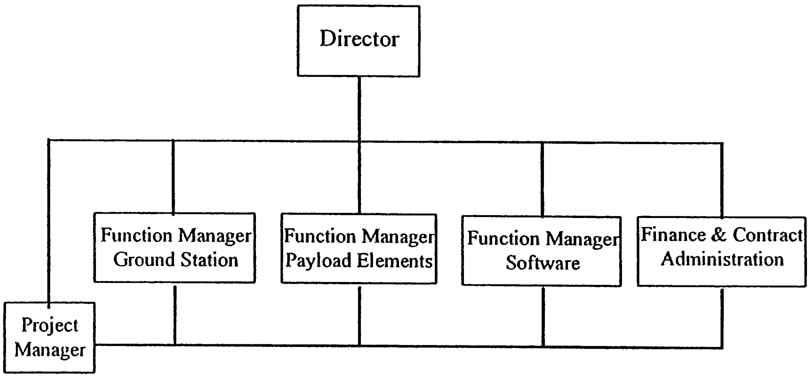

Figure 4. Matrix Organisational Structure

MAJOR MILESTONES

The following two types of milestones should be used for the project.

Level-1 Milestones: Dates for these milestones are set by the top management and cannot be changed by Project Management team. However, such milestones are few in number and could be as follows:

- Initiation of project and designation of Project Manager
- Approval/Authorisation of Resources
- Payload element integration completion
- Ground segment setup
- Ground segment readiness for operation
- Launch agreement finalization
- Delivery of complete and tested satellite to the Launcher
- Satellite launch

Level-2 Milestones: The dates for these milestones would be set by the Project Manager subject to the constraints of Level-1 milestones. The Project Manager may modify these dates in consultation with Functional Managers. Typical Level-2 milestones could be as follows:

- Complete initial draft of project plan
- Submission of the final draft of project plan
- Completion of payload elements definition
- Completion of payload element interface requirements
- Payload element design reviews: PDR, CDR etc.
- Satellite fabrication and assembly
- Satellite final testing

Lower level milestones (Level-3,4,5) could be determined by Functional manager for timely completion of the tasks delegated to them.

PROJECT IMPLEMENTATION

It is of paramount importance to establish an effective, and responsive management system from the start of the project. Project management team should also have complete control over all aspects of the project. In this regard Project Manager would have the overall responsibility to ensure completion of the project on time and within budget. The Project personnel and funds would be directly controlled by him. Activities such as definition of various satellite elements, integration, setting up of ground station etc. may be carried-out under the supervision of the Project Manager.

Each Functional/Payload Manager would be responsible for preparation of detailed specifications and design for the satellite element given to him for development. He would also prepare development schedule. Furthermore, he would take steps for purchase of components/subsystem which are required for completion of the sub-system allocated to him. However, funding for these activities would be provided from the project budget. Project Manager has to ensure that funds are provided to the Functional/Payload Manager in time so that no delay occurs in procurement of needed parts.

Any change/modification in the element specifications must be approved by the Project Manager in consultation with Functional Managers. The information concerning the modification should be disseminated to all the concerned officials. Project manager has to ensure that this dissemination takes place within very short time.

Review of the progress with various Functional Managers is required to take place frequently Formal reviews should take place at least once a month. Any problems which could not be resolved should be promptly brought to the attention of senior management for appropriate action.

CONCLUSIONS

Nowadays small satellites can easily be designed, developed and launched within two to three time frame at an affordable cost. The pre-requisite is that a small trained and motivated team is assembled and delegated with the task with clear objectives.

Conflict situation should be avoided. Project Management should not become a constant fire fighting team. Instead, it should look ahead, identifying issues that pose a potential threat to the project and focus efforts on avoiding, reducing and controlling these issues.

A matrix organisational structure would provide a good structure for a short-lived project of this nature. In order to reduce the project cost it would be advisable to use already qualified components/ sub-system to military specifications, commercial components could also be used if they have been properly qualified. Quality control should be given paramount importance in this regard ISO-9000 guidelines may be followed. Also to keep the cost at minimum two structures and two models of units policy need to be adopted. Product assurance plan should be clearly stated and should address areas such as reliability, build standards and documentation.

REFERENCES

1. Meredith J.R & Sameul J.M., *Project Management: A Managerial Approach.*
2. Dimitris N, *Handbook of Management.*
3. Dooley A, Death of Project Management: *IEE Review*, Vol. 44 No 1.
4. British Standard Institution: BS 6079: 1996.