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THE PLAN FOR THE ECONOMIC EVALUATION
OF THE PUBLIC SERVICE COMMUNICATION
SATELLITE SYSTEM



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THE PLAN FOR THE ECONOMIC EVALUATION
OF THE PUBLIC SERVICE COMMUNICATION
SATELLITE SYSTEM

Prepared for

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INTRODUCTION

In 1976 NASA began studies of a Public Service Communications Satellite (PSCS). The purpose of the PSCS program is to develop and demonstrate the operation of a new communication satellite system that will introduce and encourage the use of improved communications in sectors of the economy such as education, health, law enforcement, medicine, public safety, and many facets of public radio and television. The objective of PSCS is to deliver existing services in a more cost-effective manner and to provide a means to reach a large part of the population of the United States with new services that cannot be delivered using existing communications systems.

The NASA PSCS is a preoperational or demonstration system. If the PSCS is successful in demonstrating the utility of improved communications services, it is anticipated that operational requirements for these services will be developed by the users. When the demand and market uncertainties have been sufficiently reduced, it is anticipated that the operational systems to deliver these services will be provided in the public or private sectors of the economy. It is therefore a major concern of the NASA efforts to formulate and conduct an R&D and experimental program which will efficiently lead to the continuing delivery of beneficial communication services.

This document describes the plan for the economic evaluation of the PSCS program. In order to estimate the economic and social benefits of the PSCS program, it is necessary to look beyond the planned NASA program and into the era when the successful PSCS services are delivered by operational systems. The benefits that result from the NASA research and development come from the operational systems that provide a continuity of services to users for many years. The economic and social benefits of the PSCS derive from increased productivity achieved through the use of improved communications in the sectors served by the PSCS, from ability to provide new services not possible with existing technology and from the delivery of these services to segments of the population not reached by existing services. The costs to achieve these benefits are the costs of the NASA PSCS and the costs of the operational systems, including users costs. Thus, the economic evaluation of the PSCS program requires not only an understanding of users requirements and operations, but also the facility to cause the costs and benefits to interact through the technology used in the PSCS and follow-on operational systems.

At the time of preparation of this plan, a significant body of experience exists in the economic analysis of new space applications ventures. During the past four years, the tools of economic analysis have been used in support of the LANDSAT, SEASAT and the weather and climate programs in the NASA Office of Applications. While there are many similarities between the PSCS and these other programs there are also important differences, particularly in the areas of users, institutions and public regulatory policies. In the formulation of this plan, we have drawn upon those tools and techniques that have proven successful, and have adopted, extended and applied them to the unique requirements of the PSCS program.

The plan presented in this document is a total plan for the economic evaluation of the PSCS within domestic markets. It extends from the present through the planning, performance and evaluation of economic experiments following the launch of the PSCS in 1982, and includes the consideration of how the results of these experiments impact the transfer from demonstration to operations. The implementation of this plan will provide NASA with information needed to understand and manage the economic and social impacts of the PSCS program.

OBJECTIVES OF ECONOMIC EVALUATION

Should the federal government invest in an R&D program aimed at developing the technology and creating the environment which will lead to commercial systems capable of providing public communications services on a continuing basis?

Government is often required to help develop and to provide goods and services when, because of undue perceived risk and magnitude of investment, the private sector deems it undesirable to provide goods and services which would, if offered, confer benefits to members of society. Government participation is also often required when the production or consumption of goods or services provides to individuals benefits other than those normally provided to the parties of a market transaction. The benefits thus provided to members of a society in total are larger than the benefits received by the individual parties to the market transaction.

A necessary condition for public sector funding of an R&D program is that the benefits which are the direct result of the R&D program exceed the cost of the R&D program. Thus the initial objective of the economic analysis is to determine if the benefits which may result from the achievement and utilization of an operational PSCS system will exceed the present value of the cost of initiating and maintaining the operational system plus the present value of the cost of the R&D program which is required in order to make the operational system a reality.

Given that the benefits exceed the costs, then a sufficient condition for public sector funding of an R&D program is the anticipated lack of adequate private sector participation required to achieve the indicated benefits. Thus, a second objective is to establish the likelihood and level of private sector participation in the absence of public sector participation and the desired form and level of public and private sector participation from the R&D stage through operations.

The economic analysis should also have as an objective the determination of those R&D and experimental program initiatives which will be most useful in promoting the anticipated benefits. To achieve this it is necessary to understand the obstacles and constraints which deter private sector investment (in particular the impact of perceived uncertainty and resulting risk in combination with large investments and long payback period) so that a program can be formulated specifically aimed at "buying" information which will lead to the reduction or elimination of the obstacles and constraints to operational system implementation.

Finally, the economic analysis should establish benefits and costs in terms of system capability so that technical and economic tradeoffs associated with satellite configuration and capability are possible for PSCS and follow-on systems.

OBJECTIVES OF ECONOMIC EVALUATION

- Do the benefits exceed the costs?

Determine if there will be net economic and other benefits from the achievement of an operational PSCS system.

- What are the public and private sector roles?

Establish the level of participation of the public and private sectors from the R&D stage through operations.

- Which applications are economically important?

Select, implement and evaluate economic and technical verification experiments to determine those remaining actions required for achieving operational system implementation.

- What technical and economic tradeoffs should be made?

Determine the technical and economic tradeoffs associated with satellite configuration and capability for PSCS and follow-on systems.

LEVELS OF ECONOMIC EVALUATION

Three levels of economic evaluation will be used to estimate the economic and social benefits of the PSCS and to facilitate the transfer of the services provided by the PSCS from demonstrations to operations. The levels of economic analysis to be used are program specific analysis, macro or sector analysis, and the analysis of societal issues.

Program specific analysis consists of the evaluation of the benefits and the costs of specific services that could be provided by the PSCS. The economics of the specific services will be evaluated by the performance of user case studies. The user case studies will involve the examination of the costs and benefits of specific services such as the delivery of secondary education programming materials to students with and without the PSCS capability. A necessary part of the case study is the examination of the operations of a specific set of users with and without the PSCS capability, and the generalization of the results obtained in the study of a specific set of users to the larger community of users. In many previous economic evaluations case studies have been performed using empirical estimates of performance changes obtained from interaction with users. In PSCS case studies, the opportunity exists to supplement empirical information with experiments that could be performed using the ATS-6, CTS, or the commercial satellites, or non-space systems. With the launch of PSCS in 1982 it will be possible to perform economic verification experiments using the PSCS. The purposes of these economic verification experiments are to assist in the evaluation of those services delivered by the PSCS that are of economic or social importance to users, to help validate earlier estimates of benefits and costs, and to begin the process of the transfer of the delivery of services from the PSCS demonstrations to operational systems. The economic verification experiments are an important factor in reducing the uncertainty and economic risk of future operational systems.

Whereas program specific analysis deals with user case studies and economic experiments, macro and sector analysis deals with the broader issues of efficiency and productivity within the communications sector, and the economic relationships of improved communications to other sectors of the economy. In the macro and sector level of analysis, econometric and input/output models will be used to evaluate the contribution of R&D in the communications sector of the economy, especially the contribution of government-sponsored R&D, and to examine how improved communications technology may effect the behavior of communications and other sectors of the economy. The program specific and macro levels of analysis are interrelated in that the measures of improvement determined in case studies will be used in estimating the effects of improved communications on productivity in other sectors of the economy.

The PSCS and operational systems that may follow the PSCS will directly interact with and deliver services to a large part of the population. The scope of the PSCS and follow-on operational systems raises societal, legal, and institutional issues that must be considered as boundary conditions and constraints to the economic evaluation. Various options and alternatives for ownership, access, programming content, and regulation of the operational systems can have significant impacts upon the benefits and costs. Although the eventual outcome of many of these issues will largely be determined within the political process, the economic and social effects of options and alternatives must be considered. Within the design of the PSCS program, specific consideration must be given in both the formulation of the program and in the selection of the scope and nature of the experiments to be performed using the PSCS.

LEVELS OF ECONOMIC EVALUATION PROGRAM

- Program Specific Analysis
 - Benefit/cost analysis
 - Economic verification experiments

- Macro and Sector Level Analysis
 - Econometric analysis
 - Input/output analysis

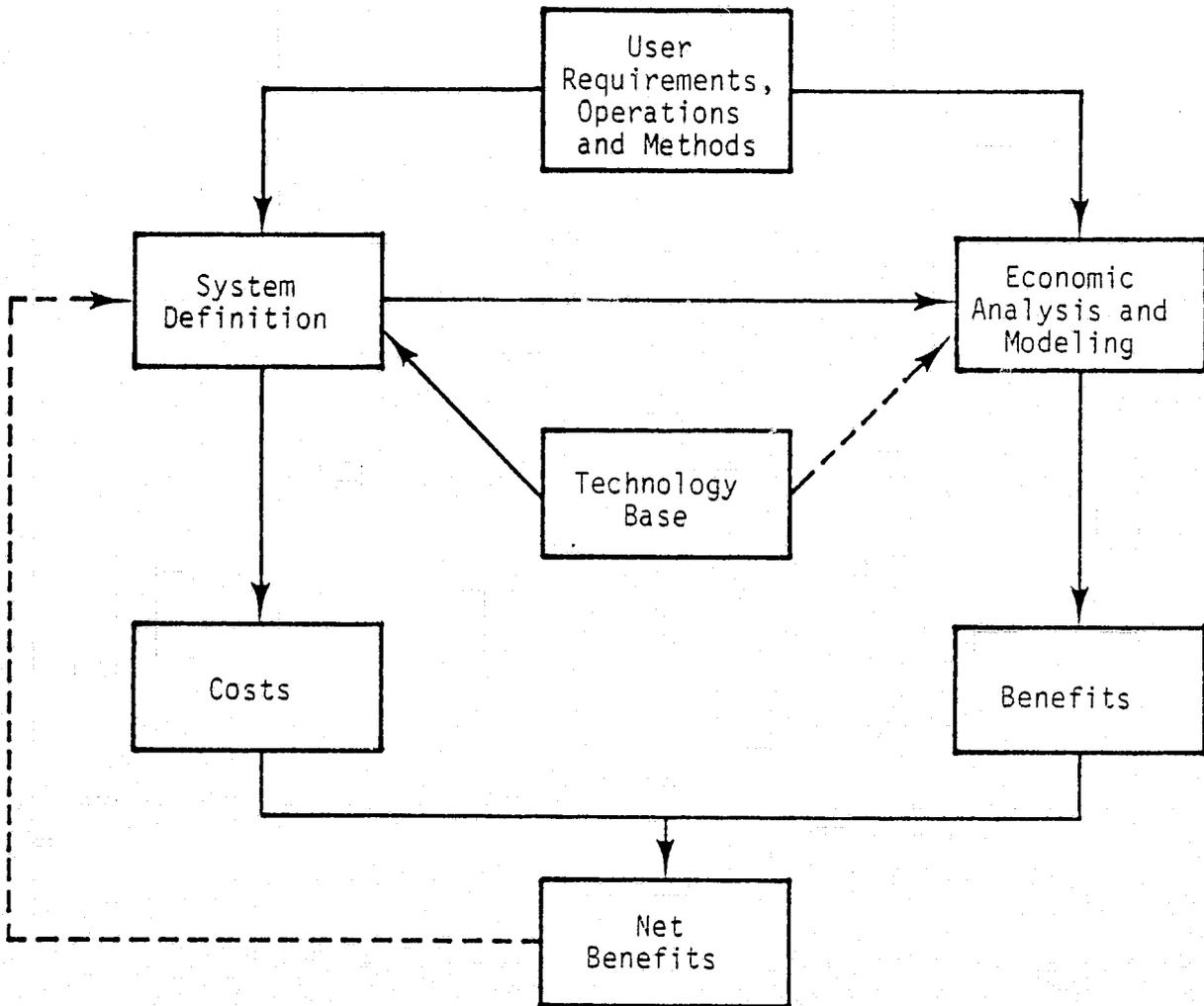
- Societal Issues
 - User participation
 - Scope and nature of experiments

INFORMATION CONTEXT OF ECONOMIC EVALUATION

The economic evaluation of the PSCS requires extensive interaction between the user community, the system designers, and the economic analysis team. User requirements are the forcing function for both the definition of the PSCS and follow-on operation systems, as well as the economic analysis and modeling. The PSCS is intended to be a demonstration system that will lead to subsequent operational capability. The development of the benefit and cost streams requires the formulation of a hypothetical operational system, and the analysis of the benefits and costs of this operational system over a period of time. User requirements determine the level of capability needed in the system, as well as the important areas of use that are the candidates for case studies and experiments. The nature of the operations performed by the users and their potential use of the services provided by PSCS are important factors in the selection and design of case studies and experiments. These factors also enter into the consideration of the interaction of improved communications with other sectors of the economy. The existing technology base and the expected advancement of state-of-the-art as a result of R&D performed in the PSCS program serve as constraints on system performance. Along with system design, the technology base represents an area of trade off in the consideration of cost and benefits. System capabilities become the primary driver of costs, while system capabilities and their impacts upon user operations are the primary factor in the development of benefits.

It is important to recognize the interactive potential of the economic evaluation, in that it is possible to effect both costs and benefits by changing the system capabilities. Thus, by the use of economic analysis and modeling it is possible to achieve a system configuration that will maximize the economic benefits for a particular set of users, or across all users.

INFORMATION CONTEXT OF ECONOMIC EVALUATION



ECONOMIC EVALUATION--BENEFIT/COST ANALYSIS

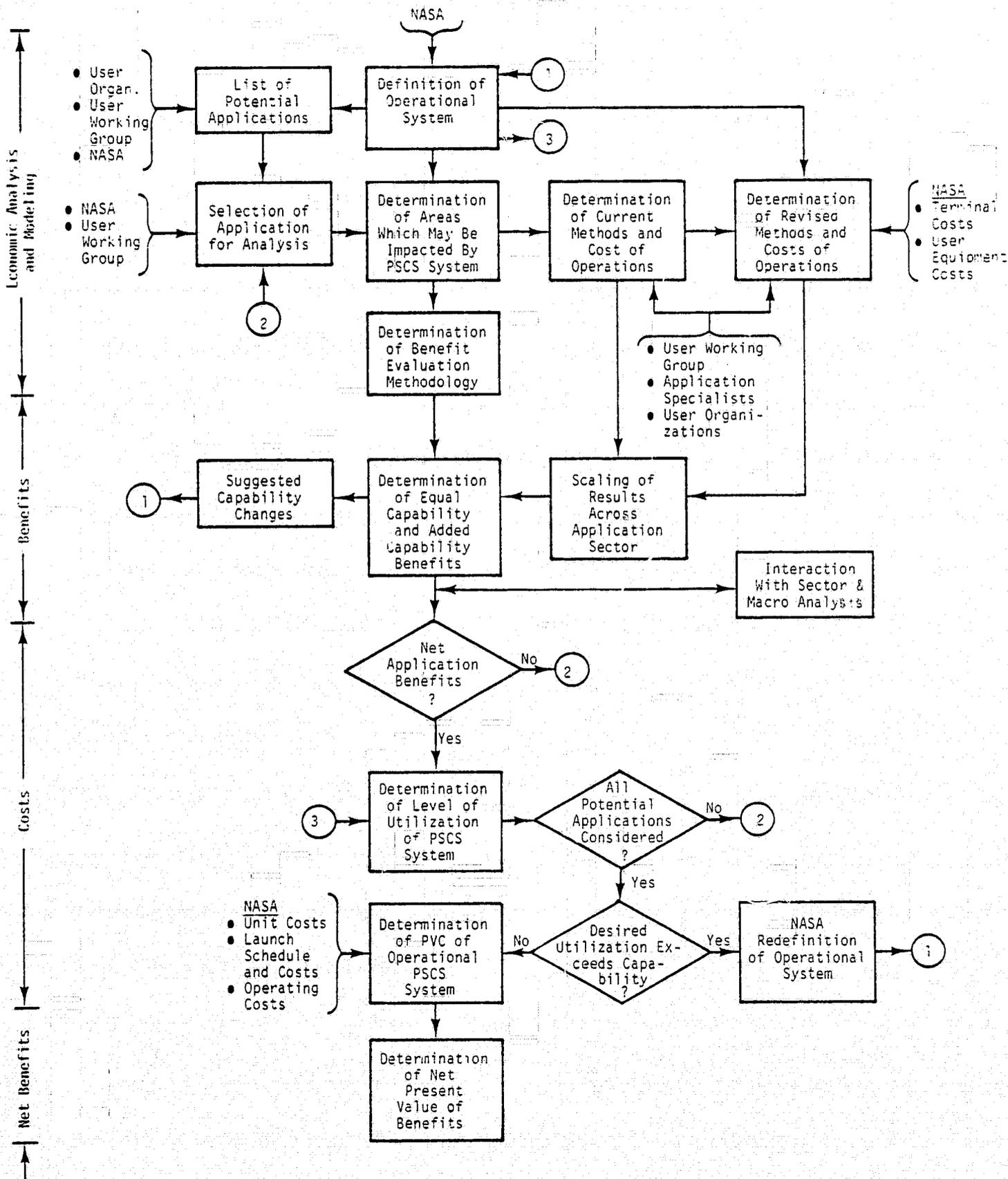
Benefit-cost analysis is concerned with evaluating the benefits and the costs which may result from the public sector investment in an R&D program aimed at providing new and/or improved communications services on a continuing basis. The benefits and costs are those that would be realized by society and include the benefits received and costs incurred by members of society who are direct parties to resulting market transactions (the provider and user of a communications service) as well as to those who are not direct parties to the market transaction but are indirectly effected. A standard method of analysis in benefit-cost studies involves a principle that may be called "with and without" analysis. This approach,* outlined on the facing page, compares the existing methods and costs of operations with revised (based upon utilization of new and/or improved communication services) methods and costs of operations and the resulting benefits.

The general approach illustrates the various tasks which comprise the benefit-cost analysis, the feedback paths and the data sources. In order to start the analysis it is necessary to have a definition of the capability of an operational system and a list of potential applications which may be impacted by the new and/or improved services. It is necessary to consider an operational system since the benefits of an R&D program are the result of its effect (timing and level of capability) on achieving an operational system. Through the combined efforts of NASA, User Working Groups and user organizations specific application areas need to be selected which may be impacted by the PSCS system. The "with and without" analysis can then be performed for each application area and results scaled across each application sector. Since diverse applications are to be considered it is anticipated that different benefit evaluation methods will be established and used to determine equal capability and added capability benefits. Equal capability implies cost savings whereas added capability benefits may be achieved only if increased budgets are possible. Since multiple agencies and organizations are involved it is important to identify those benefits which may be achieved only if budgets are increased. Based upon insights gained from the benefit-cost studies, desirable capability changes may become apparent.

Since the operational system may not be appropriately matched to application needs (for example, desired utilization may exceed capability), system redefinition may be necessary. Once the system definition is deemed adequate the present value of life cycle costs can be determined, compared with the present value of benefits and the net present value of benefits (i.e., benefits less costs) determined.

* To be used at different levels of detail for the preliminary economic analysis, case study and benefit-cost analysis tasks described in the following pages.

ECONOMIC EVALUATION - BENEFIT/COST ANALYSIS



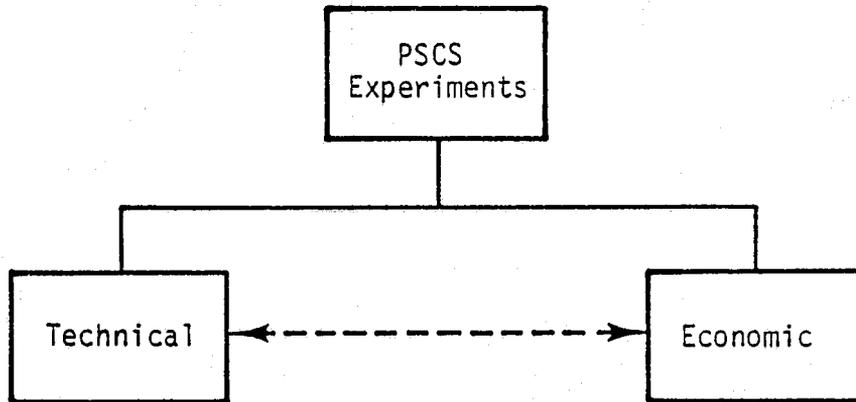
ECONOMIC VERIFICATION EXPERIMENTS

The purpose of the PSCS is to demonstrate the technical capability for the improved delivery of existing services and new services that cannot be provided by existing systems, and the economic and social impacts of these improved and new services. The demonstration of the technical capability and its economic and social impact will be accomplished by the performance of experiments with the PSCS after it is launched in 1982. Since there is a history of prior experimentation with the ATS series, CTS, and commercial satellites, some of the possible uses of the PSCS will be relatively mature while others will be in a very early stage of development. For this reason, the experiments to be performed using the PSCS will range from demonstrations of technical performance in areas of new or high technology to the use of the PSCS in a pre-operational mode to demonstrate the economic integration of users into a viable market.

Since an objective of the PSCS is to identify and develop services that can be transferred to operational systems, it is important that the experiments to be performed with the PSCS be designed to yield data on the operational and economic impacts of PSCS capabilities on users' operations. Thus, while some experiments will be designed to reduce the cost and technical risk of using PSCS technology in follow-on operational systems, the economic verification experiments will be designed to demonstrate the economic potential of operational systems and to reduce the market uncertainty. Moreover, some experiments may combine features of technical and economic demonstration.

The economic verification experiments are ground-based experiments using the PSCS, fixed and mobile earth terminals and the user infrastructure for the delivery services and information. A specific objective of the economic verification experiments is to provide quantitative data on the economic and social impacts of improved communications on users and their operations.

ECONOMIC VERIFICATION EXPERIMENTS



- Demonstrate High Technology
- Prove Technical Performance
- Reduce Cost and Technical Risk and Uncertainty

- Obtain Information on System Characteristics of Economic Importance to Users
- Demonstrate Economic Impacts
- Identify Operational Possibilities
- Provide Data Useful in Design of Follow-on Systems
- Reduce Market Uncertainty

Launch of PSCS in 1982 will provide opportunity to obtain experimental evidence on effects of improved communications on economic performance of public services

PRE-PSCS EXPERIMENT POSSIBILITIES

The economic evaluations that have been performed on other space applications programs have had to rely to a great extent upon empirical estimates of the impacts of proposed new systems on users operations. The use of empirical data has been necessary in most cases as the capability to obtain experimental data does not exist until the new space applications system is launched. While specific experiments involving improved communications or large-scale preoperational demonstrations cannot be performed until the PSCS is launched, considerable capability exists with which meaningful experiments can be performed as an integral part of the economic evaluation prior to the launch of the PSCS in 1982. These experiments can make use of capabilities of the ATS-6, commercial communications satellites, and possibly non-space systems, to perform experiments as a part of the user case studies. Using this approach it will be possible to obtain more direct participation of users in the formulation of the PSCS program, to obtain experimental evidence to support estimates of the benefits and costs of operational systems, and to obtain information useful in setting criteria for selection of the PSCS economic verification experiments.

PRE-PSCS EXPERIMENT POSSIBILITIES

- Opportunity to obtain data on impact of communication on public services before launch of PSCS
- Use ATS-6, CTS, commercial communications satellites and non-space systems in experiments to support economic evaluation case studies

ECONOMIC EVALUATION - ECONOMETRIC MODELING & SIMULATION

The major objectives of econometric analyses are to examine the contribution of R&D in the communication sector, especially the contribution made by federal R&D; and to examine how improved communications technology may affect the behavior of the communication and other sectors of the economy. These issues are important in evaluating whether investment in communication R&D can be expected to yield a reasonable rate of return from public and private points of view. They are also important in determining an appropriate role for the Federal Government.

Recent studies on the contribution of R&D have provided some evidence on the returns to R&D in agriculture and manufacturing sectors. Although there are a number of economic studies on the communication industry, most of them have failed to adequately examine the issues related to R&D and technological progress. In particular, most studies have failed to examine the effects of communication R&D on technological progress and its impacts on the various sectors of the economy.

A recent study of the U.S. telecommunications industry conducted by ECON, Inc. attempted to evaluate the contribution of communication R&D through the use of an econometric model which incorporates major supply and demand relationships in a coherent framework. To examine the important issues related to communication R&D, further development and modification of this telecommunication model into a more inclusive and more detailed communication model is necessary.

Unlike most existing studies of R&D which attempt to evaluate R&D at either the national or company level, it is necessary to examine R&D at the industry or sector model and then link this communication model to a macro econometric model or an input-output analysis. This will result in the development of an expanded communication econometric model useful for simulation of the behavior of the communication sector. In addition, the impacts of the communication sector on the other sectors of the economy can be examined by linking the communication econometric model with a macro econometric model or an input-output analysis.

ECONOMIC EVALUATION - ECONOMETRIC MODELING & SIMULATION

Issues to be addressed by econometric modeling and simulation:

- What is the contribution of R&D to technological progress or productive efficiency in the communication sector?
- What is the role of Federal Government R&D in promoting advancement of communication technology?
- How is the behavior of the communication sector (in terms of price and services) affected by R&D?
- How is the communication sector interrelated with the other sectors of the economy?

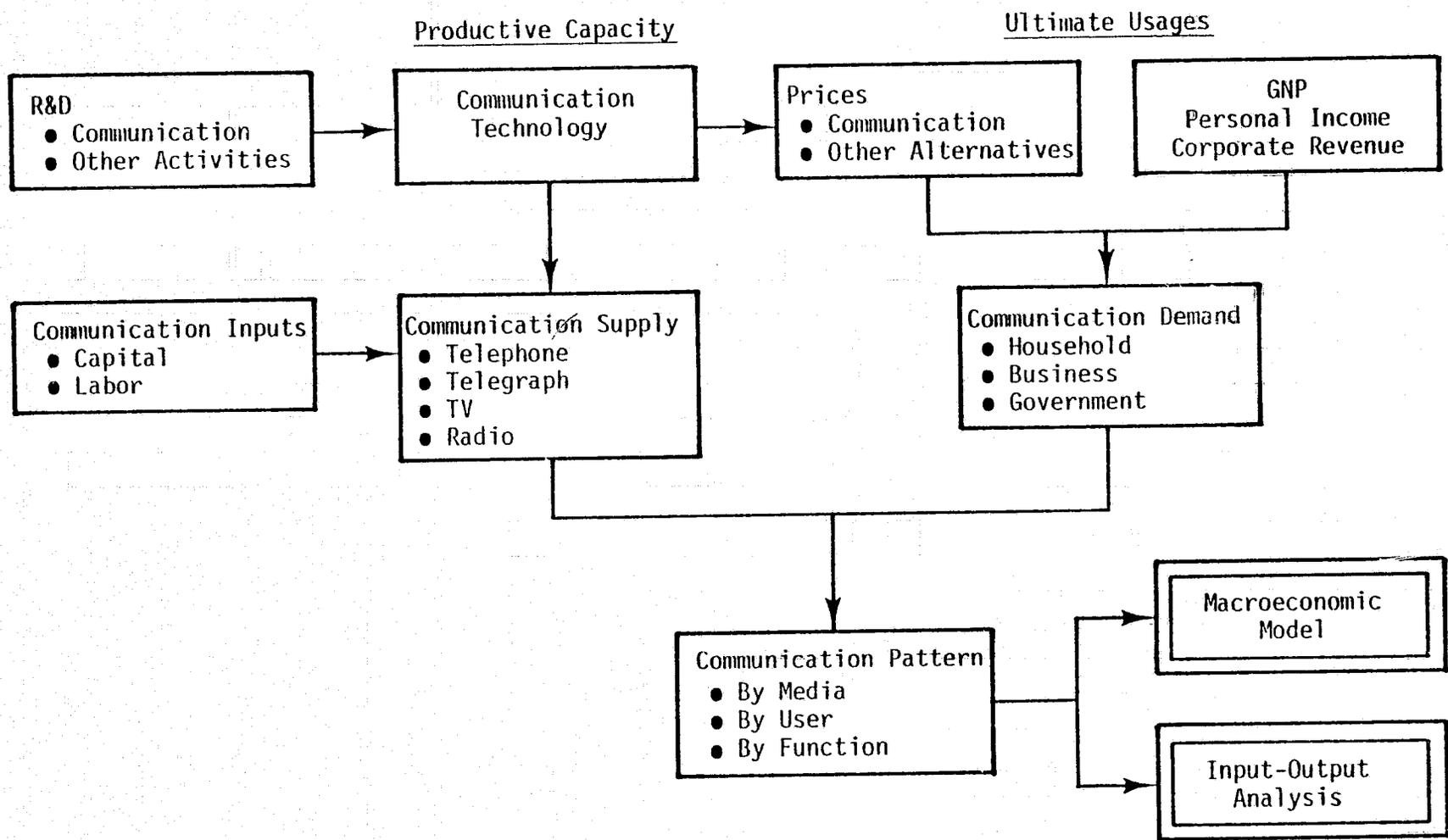
ANALYTICAL FRAMEWORK FOR COMMUNICATION SECTOR ECONOMETRIC MODEL

As the analytical framework indicates, R&D in communication and other activities determines the level of communication technology, which in turn determines the volume and the price of communication services. The supply of communication services, including telephone, telegraph, TV and radio, is the result of an application of communication inputs and communication technology. With an advance in communication technology, the same level of inputs is expected to produce more or better communication services.

On the demand side, the pattern of communication demand is largely affected by the prices of communication services and other alternatives as well as the level of economic activities in general as reflected by personal income or corporate revenue. The communication services are required by household, business and government agencies. Therefore, their behavior must be studied to determine how the price and other factors affect their communication usages.

Finally, both the supply and the demand conditions determine the communication patterns, which can be studied by media, by user or by function. Of immediate concern, are public service communication services which may result from federal government investment in R&D. However, to evaluate this particular type of communication service appropriately, a broader picture must be examined which includes not only the communication sector but also the entire economy. Thus, the communication econometric model must be linked to either a macroeconometric model or an input-output analysis in order to examine the full extent of the impact of communication R&D.

ANALYTICAL FRAMEWORK FOR COMMUNICATION SECTOR ECONOMETRIC MODEL



ROLE OF PARTICIPANTS IN ECONOMIC EVALUATION

The two PSCS workshops (Easton, Maryland, October 1976 and Alexandria, Virginia, March 1977) have served to demonstrate the large number of potential participants in the PSCS program and the wide range of their interests. In economic terms, the end users of the system essentially represent the demand for services. The end user needs are an important factor in establishing the design requirements of the PSCS, the design of experiments using the PSCS and other systems, as well as the economic viability of an operational system. The end users jointly determine the demand for the communications services, or the quantity of communications services that they are willing to purchase in a specified period, at a specified price and under a given set of conditions. Federal and state agencies play a multiplicity of roles. In addition to being users, some federal and state agencies also perform the important function of coordinating and focusing the requirements of the constituency that they serve. Other government agencies establish regulatory policies that can accelerate or inhibit the successful transfer of PSCS capabilities or operational systems. Just as the end users and user agencies determine the demand function for the communications services by their willingness to purchase, the systems suppliers and designers, and the carriers and communications industry determine the supply or production function by their willingness to supply the services in a specified time, at a specified price, and under a given set of conditions. Technology, costs, market and financial considerations, and policy, legal and institutional factors all enter into the determination of the supply function. All of the foregoing factors must be considered in evaluating the economic and social impact of the capabilities and services provided by the PSCS and derivative operational systems.

ROLE OF PARTICIPANTS IN ECONOMIC EVALUATION

Type	Examples	Role
End Users	<ul style="list-style-type: none"> ● Regional Education Services ● National Federation of Community Broadcasters ● Hershey Medical Center ● Public Service Consortium <li style="text-align: center;">. <li style="text-align: center;">. <li style="text-align: center;">. 	<ul style="list-style-type: none"> ● User Needs ● Demand for Service ● Experiment Requirements ● Experiment Formulation
Federal Agencies	<ul style="list-style-type: none"> ● GSA ● DEA ● NWS ● LEAA ● FCC <li style="text-align: center;">. <li style="text-align: center;">. <li style="text-align: center;">. 	<ul style="list-style-type: none"> ● Agency Needs ● Coordinate Special User Requirements ● Experiment Requirements ● Regulatory Constraints
Systems Designers and Suppliers	<ul style="list-style-type: none"> ● NASA ● Spacecraft and Ground Station Suppliers 	<ul style="list-style-type: none"> ● Technical Capabilities ● Performance Determination ● Costs
Carriers and Communications Industry	<ul style="list-style-type: none"> ● Carriers ● Financial Community ● OTP ● NASA ● FCC 	<ul style="list-style-type: none"> ● Market Development Concepts ● Financial and Business Considerations ● Policy, Institutional and Legal Issues

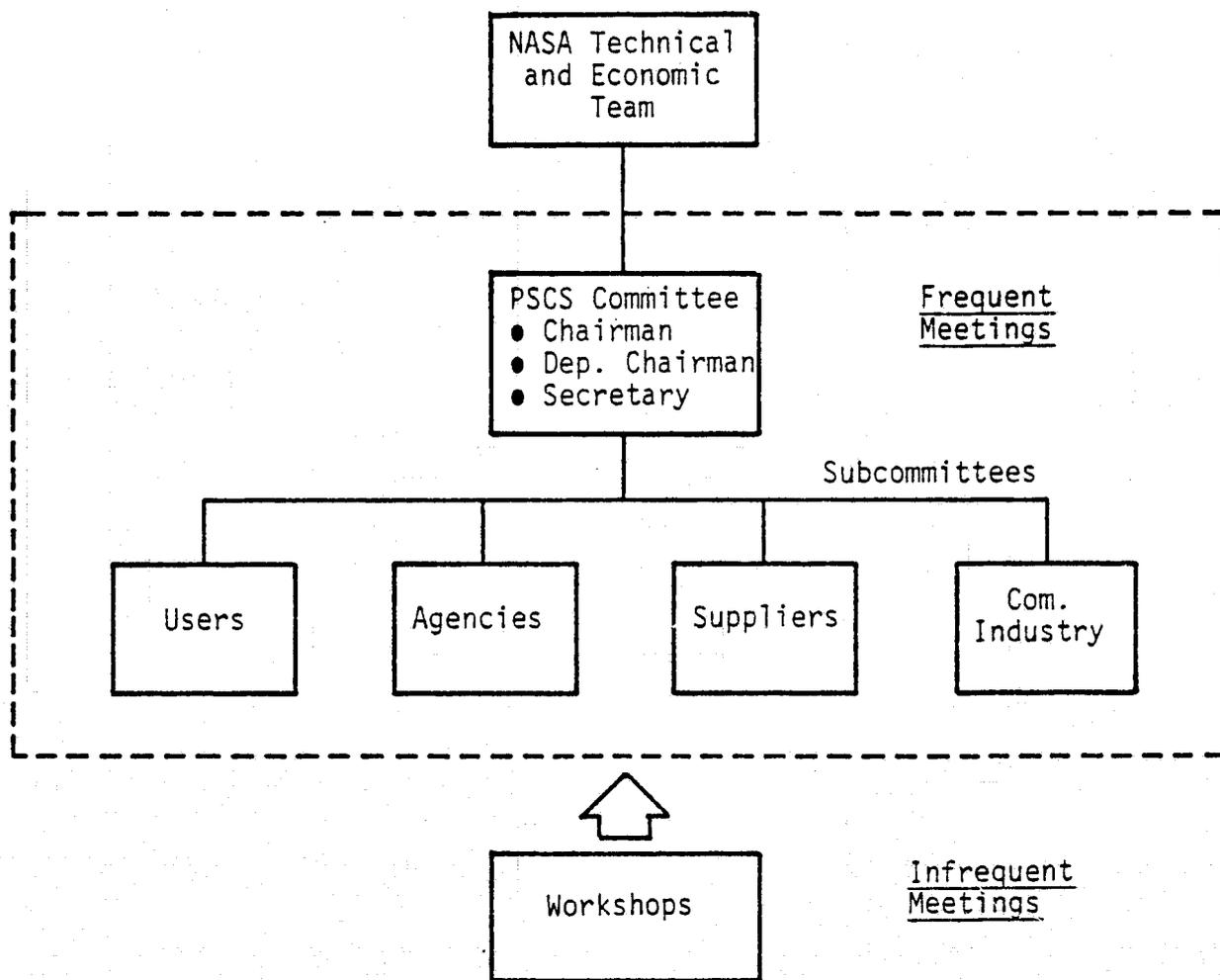
ORGANIZATION OF THE USERS AND PARTICIPANTS

The goal of the PSCS is to provide to a large sector of the public existing services in a more cost effective manner, and new services that cannot be provided by existing technology and systems. With this goal in mind, it is important that the broad range of participants in the PSCS be provided with a mechanism to interact with NASA in the establishment of the requirements for the PSCS and its applications. In recognition of the need, NASA has held two users workshops and has established an Interagency Coordinating Committee. The users workshops, involving several hundred participants, provide an excellent forum for the broad range of program participants to make their needs known to NASA and to review NASA plans. For these reasons, NASA will continue to sponsor these workshops periodically during the program. However, because of its size, the workshop does not represent an effective body for frequent interaction with the NASA program team. On the other hand, the Interagency Coordinating Committee represents only the interested federal agencies, and does not represent the other categories of program participants such as end users, carriers and the communications industry. In order to provide an effective body that is more representative of the participating community for NASA to interact with on a frequent basis, NASA will establish a PSCS advisory committee.

During the formative period of the PSCS program, the PSCS committee will be maintained as an informal working group under the cognizance of a NASA contractor. Upon receipt of program approval, the working group will be constituted as a formal advisory committee to the PSCS program.

It is anticipated that the PSCS working group, and at a later date the PSCS advisory committee, will play an important role in the review of technical and economic studies, in the establishment of systems requirements, and the selection of the experiments to be performed with the PSCS.

ORGANIZATION OF USERS AND PARTICIPANTS



PHASES OF ECONOMIC EVALUATION

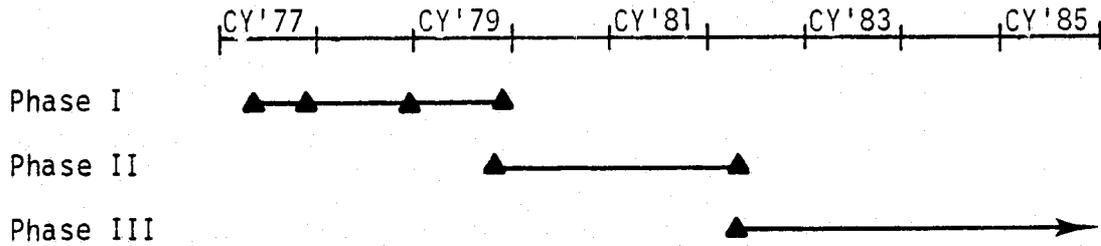
The overall economic evaluation may be considered as consisting of the three (3) indicated phases. These phases are the result of the general time schedule of events (for example, 1982 launch date for the PSCS and budgetary cycles and constraints) and the concomitant emphasis of required results. Thus, the first phase of the economic evaluation is concerned with a series of economic assessments and analyses aimed specifically at supporting NASA's new start information requirements. It is anticipated that economic evaluation results, at increasing levels of detail and thoroughness, will be required in the October-November time frame of calendar years 1977, 1978 and 1979.

Since major funding commitments will have been made and the PSCS will not have been launched, the second phase of the economic evaluation is concerned with experiment planning, selection and scheduling. Emphasis is placed on the development of criteria and techniques for experiment proposal evaluation and on the analysis, evaluation and selection of experiments to be performed with the PSCS. These experiments will be conducted after the launch of the PSCS. Other experiments may be conducted as part of the Phase I activities in support of the NASA's new start information requirements.

Experimental results will be forthcoming after successful PSCS launch. Therefore, the third phase of the economic evaluation is concerned with the evaluation of experiment results and future program planning in light of results received to date. The third phase efforts are also concerned with coordination with, and technology transfer to, the private sector.

PHASES OF ECONOMIC EVALUATION

- Phase I Economic Assessment to Support New Start
- Phase II Experiment Planning, Selection and Scheduling
- Phase III Evaluation of Experiment Results and Future Program Planning



MAJOR MILESTONE COMPLETION SCHEDULE--PHASE I

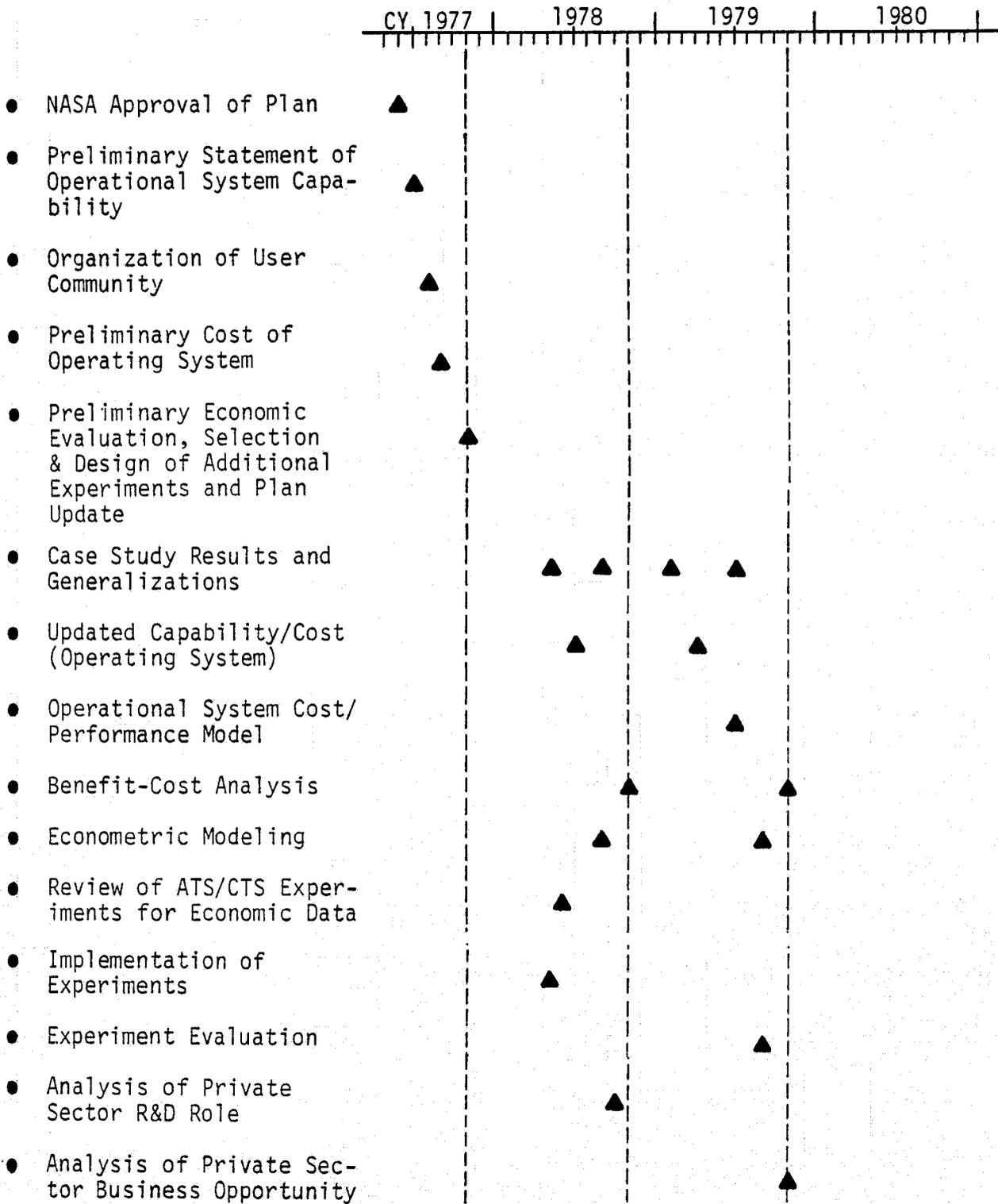
The facing milestone completion schedule indicates the sequence of events associated with the Phase I economic assessment to support the new start. The sequence of events is constrained primarily by the starting date (assumed NASA approval of the economic evaluation plan) and the need to provide successively more comprehensive results in the October-November time frame of 1977, 1978 and 1979. The specific schedules for performing the identified economic tasks are indicated in the following pages. Brief task descriptions are provided for each of the economic tasks in the Task Description section.

The principal FY'77 efforts are to be devoted toward performing and completing a preliminary evaluation of the benefits which may result from the implementation of an operational PSCS system which is the outgrowth of the PSCS R&D and experimental program. In order to accomplish this it is necessary that (a) the user community be organized as previously discussed to provide an efficient flow of information to the economic analysis, (b) a preliminary operational PSCS system be described in terms of its performance capabilities as might effect user methods, operations and costs, and (c) a preliminary cost estimate be developed for the operational PSCS system. The FY'77 efforts will also be devoted to determining case studies (including economic oriented experiments which can utilize existing satellite or other communication systems) which can be performed during FY'78 and FY'79 and can lead to improved understanding of the economic benefits and increasingly supportive benefit estimates. As a result of FY'77 efforts the economics evaluation plan will be reviewed and updated.

During FY'78 it is necessary to initiate and complete a number of case studies, generalize the results across the application sectors and perform benefit-cost analyses based upon the results obtained and economic data which may be obtained from ATS/CTS experiments currently underway or previously completed. The benefit-cost analysis requires that updated capability and cost estimates be available for an operational PSCS system. Econometric and other models will be developed and preliminary estimates made of the benefits which may result from communications R&D expenditures. Benefits will be evaluated at the macro level as well as by an aggregation of benefit evaluations at the micro level. Also during FY'78 an analysis will be completed of the likelihood of private sector participation in the absence of public sector investment and it is necessary to complete the implementation of experiments to be performed in conjunction with case studies.

The FY'79 efforts are concerned with completing the benefit-cost analyses and requires the completion of additional case studies, generalization of results, evaluation of experiment results, the use of econometric and sector models, and updated system capability and cost estimates. During FY'79 operational system cost/performance models will be developed and used to establish system costs in terms of required capability (as determined from the case studies and benefit analysis). The private sector business opportunities will be analyzed to establish a detailed understanding of the obstacles and constraints to commercialization.

PHASE I - SUPPORT OF NEW START: MAJOR MILESTONE COMPLETION SCHEDULE

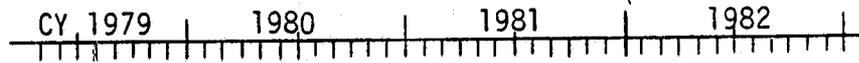


MAJOR MILESTONE COMPLETION SCHEDULE--PHASE II

The facing milestone completion schedule indicates the sequence of events associated with the Phase II experiment planning, selection and scheduling efforts. The specific tasks encompassed by this phase included an analysis of the transfer of technology to the private sector (i.e., determining the ways and means of eliminating the obstacles and constraints to private sector commercialization of PSCS demonstrated services), the development of criteria, procedures and techniques which will lead to the selection of those R&D and experimental program initiatives which will be most useful in promoting (i.e., eliminating obstacles and constraints) the benefits which are likely to develop as a result of operational implementation of PSCS demonstrated services, and finally the analysis, evaluation and selection of experiments to be conducted using the PSCS.

In order to insure the timely flow of experimental results after the PSCS launch in early 1982 it is desirable to complete a preliminary study of possible economic experiments by mid-1980, coordinate and establish an interagency strategy for joint experiments by mid-1980, call for experiment proposals by third-quarter of 1980 so that experiment proposals will be received during the latter part of 1980, analyze, evaluate and select experiments for implementation early in 1981 and shortly thereafter give the go-ahead on experimentation. This sequence of events will lead to experiments in-place and checked-out at the time of PSCS launch.

PHASE II - EXPERIMENT PLANNING, SELECTION AND SCHEDULING: MAJOR MILESTONE COMPLETION SCHEDULE

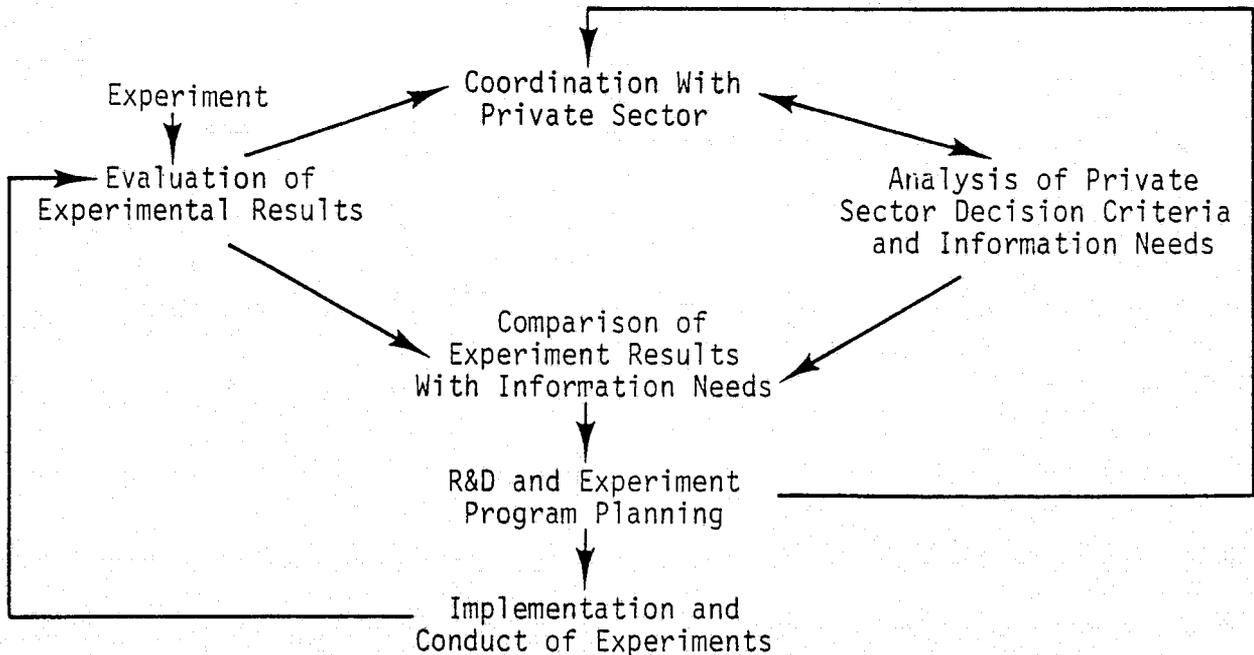


- Analysis of Transfer to Private Sector
- Preliminary Study of Possible Economic Experiments
- Criteria for Experiment Proposal Evaluation and Selection
- Interagency Strategy for Joint Experiments
- Call for Experiment Proposals
- Submission of Experiment Proposals
- Analysis, Evaluation and Selection of Experiments
- Go-Ahead on Experiments
- Experiments In-Place and Checked-Out
- Launch of PSCS

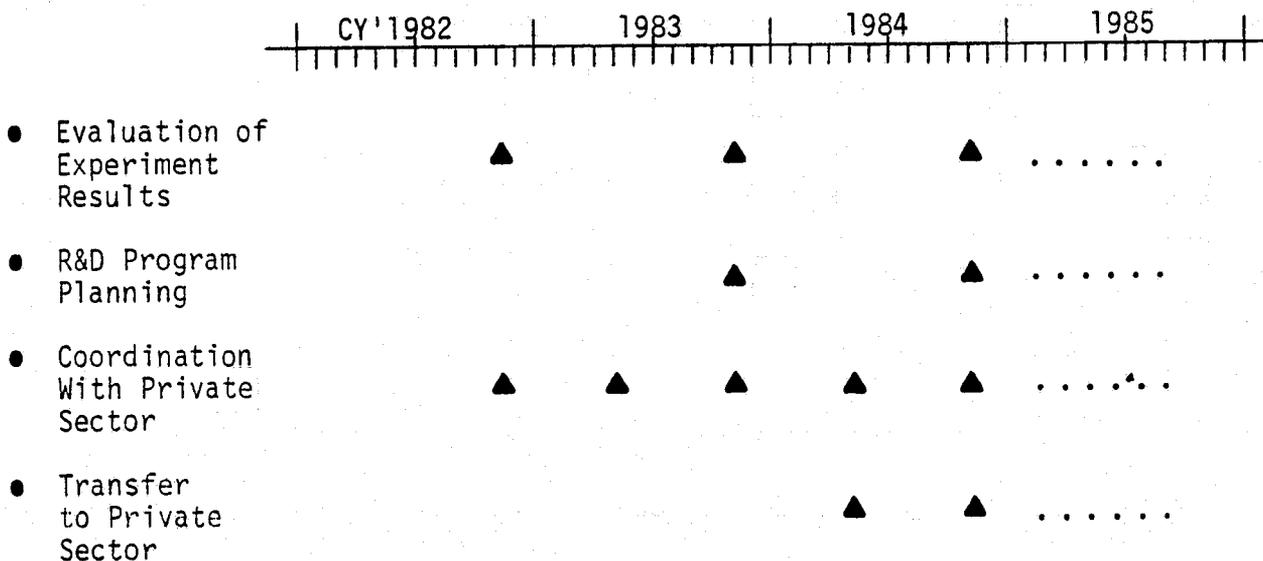
MAJOR MILESTONE COMPLETION SCHEDULE--PHASE III

The milestone completion schedule on the facing page indicates the sequence of events associated with the Phase III evaluation of experiment results and future program planning efforts. This phase is concerned with the continuing evaluation of experiment results and the planning of future efforts in light of the experimental results and continuing analysis of obstacles and constraints to private sector commercialization of demonstrated services. Since the activities and results are inherently continuous in nature, the indicated milestones represent annual reporting of obtained results, findings and decisions.

The basic flow of the Phase III efforts is illustrated below and indicates the comparison of experimental results with information needed by the private sector in order to bring about commercial services which have been found to be beneficial to society. Also indicated is the need of continued coordination with the private sector in order to appraise it of results obtained and future experiment and R&D plans and to keep informed as to the private sector obstacles and constraints to implementation of services and plans for initiating new and/or improved services.



PHASE III - EVALUATION OF EXPERIMENT RESULTS AND FUTURE PROGRAM PLANNING:
 MAJOR MILESTONE COMPLETION SCHEDULE

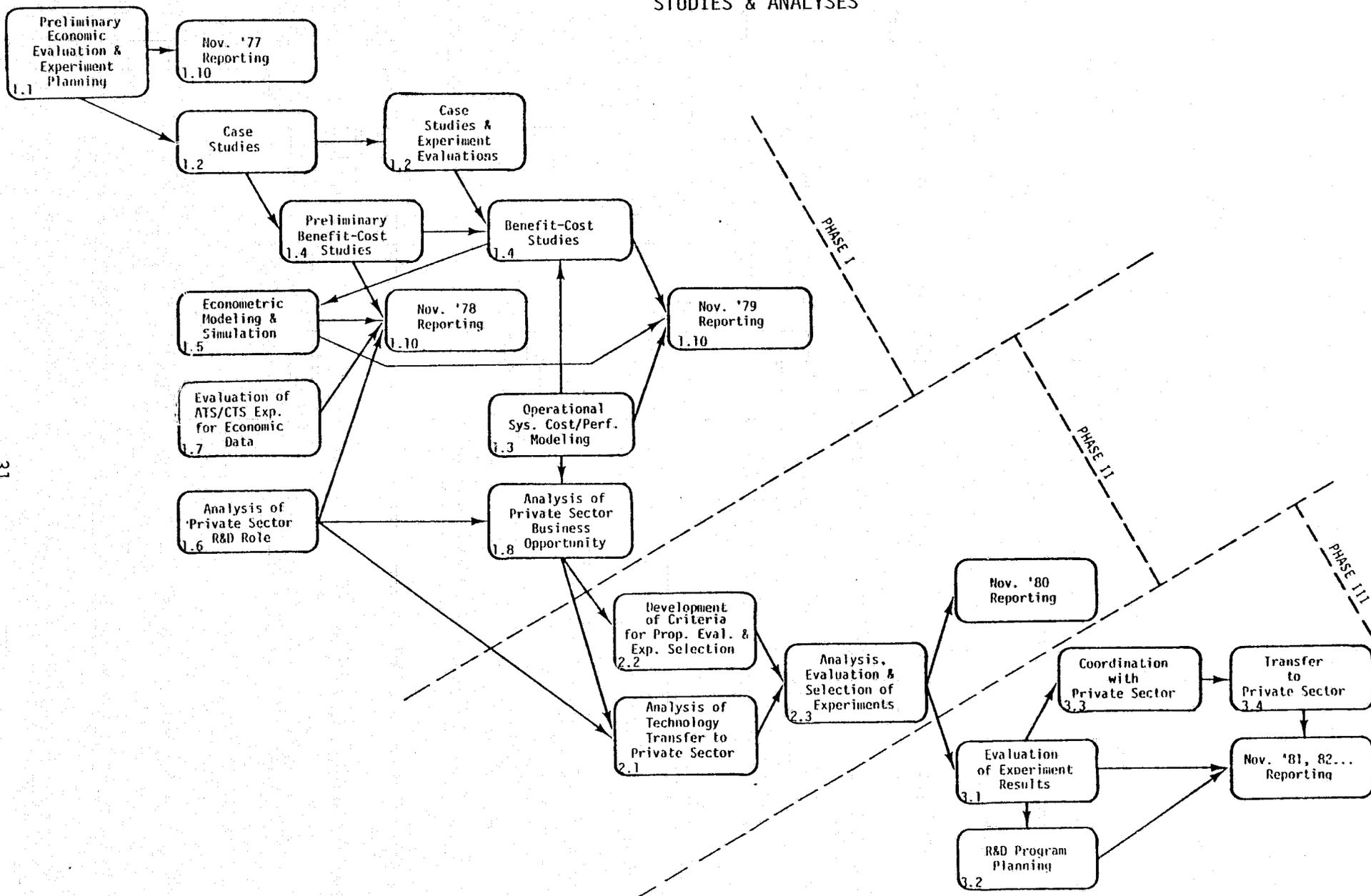


FLOW OF ECONOMIC EVALUATION STUDIES AND ANALYSES

The flow of the economic evaluation studies and analyses is indicated with specific tasks being identified by number. The specific task statements are presented in the section entitled, "Task Descriptions" and for Phase I and II tasks indicate the purpose of the task and the general approach to be taken to achieve the desired results.

As can be seen most tasks will draw heavily on the results of previous tasks. For example, it is envisioned that Task 2.2, Development of Criteria for Proposal Evaluation and Experiment Selection, will bring together and augment the simulation models developed in Tasks 1.3 and 1.8, Operational System Cost/Performance Modeling, and Analysis of Private Sector Business Opportunity, respectively.

FLOW OF ECONOMIC EVALUATION STUDIES & ANALYSES



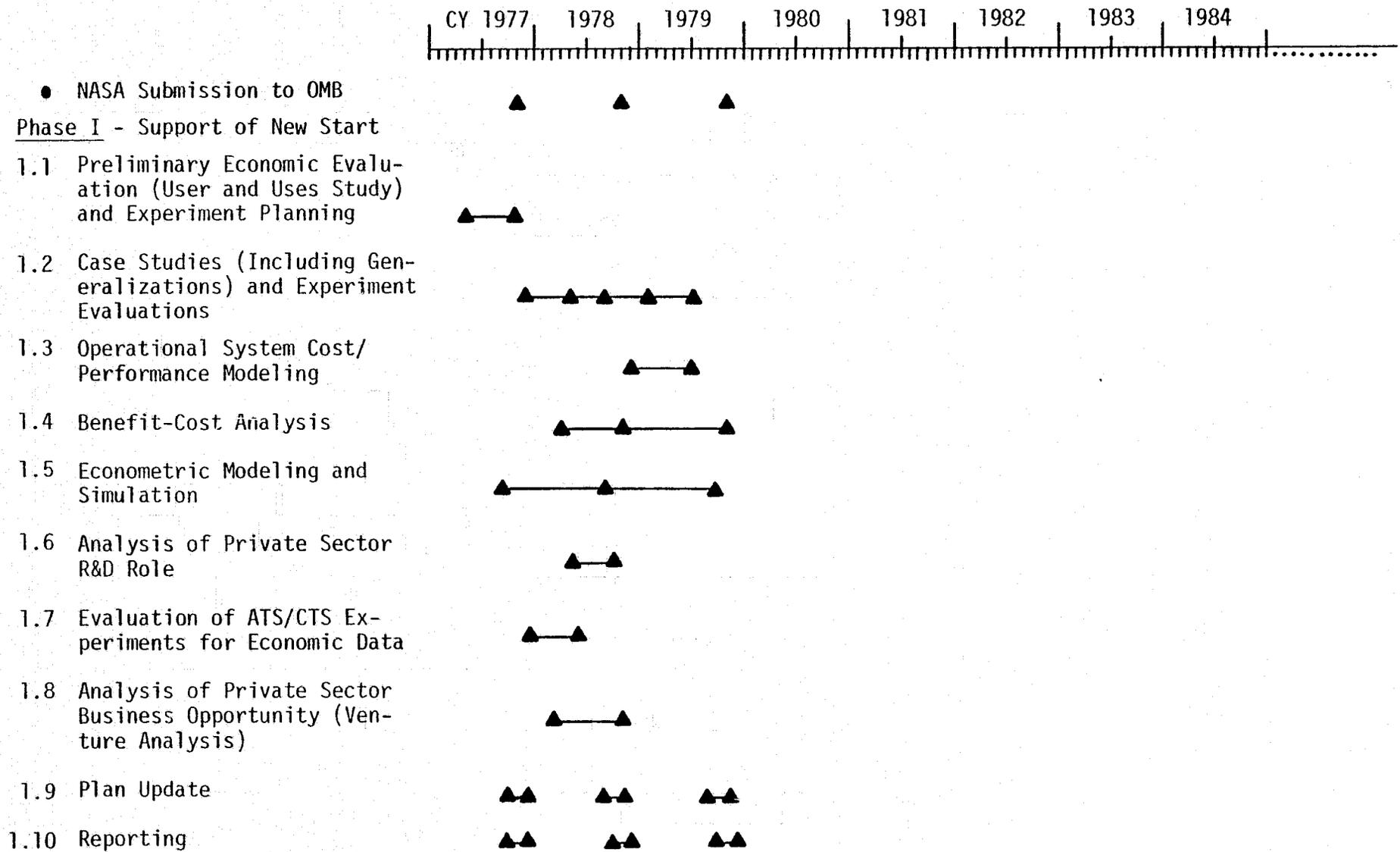
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ECONOMIC EVALUATION TASK SCHEDULE

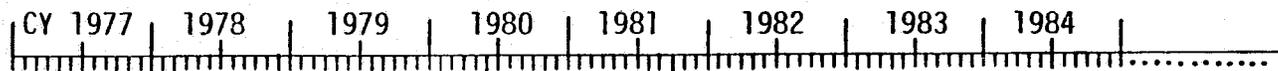
The accompanying Task Schedule indicates the specific sequencing of the economic evaluation tasks associated with the three phases of the economic evaluation. The specific timing of the Phase I tasks is influenced significantly by the desire to have results available in the October-November time frame in 1977, 1978 and 1979. It should be noted that several of the tasks (for example, Task 1.2) have indicated intermediate milestones and are the result of natural division of efforts (for example, Task 1.2 consists of a series of case studies) or need for reporting results (for example, Tasks 1.5 and 3.1).

ECONOMIC EVALUATION TASK SCHEDULE



ECONOMIC EVALUATION
TASK SCHEDULE (continued)

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Phase II - Experiment Planning,
Selection and Scheduling

2.1 Analysis of Technology
Transfer to Private Sector



2.2 Development of Criteria for
Proposal Evaluation and
Selection



2.3 Analysis, Evaluation and
Selection of Experiments



Phase III - Evaluation of Exper-
iment Results and Future
Program Planning

3.1 Evaluation of Experiment
Results



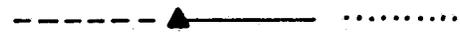
3.2 R&D Program Planning



3.3 Coordination With Private
Sector



3.4 Transfer to Private Sector



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BUDGETARY ESTIMATES

Budgetary estimates are presented in the accompanying table in terms of manpower (professional man-months) and thousands of dollars (K\$). These estimates are presented by task, phase and total economic evaluation program by year from FY'77 through FY'82. The budgetary estimates for FY'83 through FY'85 are given for this total period (not year by year).

Several points should be noted. All dollars are current dollars and take into account an estimated 7 percent per year average increase in labor and related costs. The case study budgetary estimates are based upon the performance of eight (8) case studies at an average of six (6) man-months per study.

The economic evaluation plan which has been developed requires an expenditure of approximately \$120K during FY'77 (beginning May 2, 1977). The rate of expenditure increases to approximately \$425K in FY'78 and \$500K in FY'79. From FY'80 through FY'85 it appears that annual expenditures will be on the order of \$200K.

BUDGETARY ESTIMATES

	FY '77		FY '78		FY '79		FY '80		FY '81		FY '82		FY '83 Through FY '85		Total	
	MM	K\$	MM	K\$*	MM	K\$*	MM	K\$*								
Phase I - Support of New Start																
1.1 Preliminary Economic Evaluation (User and Uses Study) and Experiment Planning	16	95	--	--	--	--	--	--	--	--	--	--	--	--	16	95
1.2 Case Studies (Including Generalizations)* and Experiment Evaluations	--	--	30	187	15	100	--	--	--	--	--	--	--	--	45	287
1.3 Operational System Cost/Performance Modeling	--	--	--	--	6	46	--	--	--	--	--	--	--	--	6	46
1.4 Benefit-Cost Analysis	--	--	8	50	12	80	--	--	--	--	--	--	--	--	20	130
1.5 Econometric Modeling	3	15	21	125	36	220	--	--	--	--	--	--	--	--	60	360
1.6 Analysis of Private Sector R&D Role	--	--	4	25	--	--	--	--	--	--	--	--	--	--	4	25
1.7 Review ATIS/CTS Experiment for Economic Data	--	--	6	37	--	--	--	--	--	--	--	--	--	--	6	37
1.8 Analysis of Private Sector Business Opportunity	--	--	--	--	8	55	--	--	--	--	--	--	--	--	8	55
1.9 Plan Update	1	6	1	6	1	7	--	--	--	--	--	--	--	--	3	19
Subtotal	20	116	70	430	78	508	--	--	--	--	--	--	--	--	168	1054
Phase II - Experiment Planning, Selection and Scheduling																
2.1 Analysis of Technology Transfer to Private Sector	--	--	--	--	--	--	12	100	--	--	--	--	--	--	12	100
2.2 Development of Criteria for Proposal Evaluation and Selection	--	--	--	--	--	--	8	58	--	--	--	--	--	--	8	58
2.3 Analysis, Evaluation and Selection of Experiments	--	--	--	--	--	--	2	15	12	85	12	90	12	100	36	290
Subtotal	--	--	--	--	--	--	22	173	12	85	12	90	12	100	56	448
Phase III - Evaluation of Experiment Results and Future Program Planning																
3.1 Evaluation of Experiment Results	--	--	--	--	--	--	--	--	--	--	6	45	18	150	24	195
3.2 R&D Program Planning	--	--	--	--	--	--	--	--	--	--	--	--	18	150	18	150
3.3 Coordination With Private Sector	--	--	--	--	--	--	--	--	--	--	6	45	18	150	24	195
3.4 Transfer to Private Sector	--	--	--	--	--	--	--	--	--	--	3	23	18	150	21	173
Subtotal	--	--	--	--	--	--	--	--	--	--	15	113	72	600	87	713
Annual Total	20	116	70	430	78	508	22	173	12	85	27	203	84	700	313	2215
Cumulative Total	20	116	90	546	168	1054	190	1227	202	1312	229	1515	313	2215		

* Assuming eight (8) case studies @ 6 mm/study.

† Based upon 7 percent/year average increase in labor cost.

FUNDING OF ECONOMIC STUDIES--COMPARISON WITH OTHER MAJOR
APPLICATIONS PROGRAMS

In order to place the plan for the economic evaluation of the PSCS in perspective, a comparison has been made with two other major space applications programs. Two factors are compared, the starting date of the economic evaluation with respect to the launch date of the system that the economic evaluation is intended to support, and the sum of the actual and estimated expenditures through launch. While each element of the PSCS plan must be justified on its own merit, the comparison does suggest that both the timing and the level of effort of the PSCS economic evaluation is not disparate with previous experience.

FUNDING OF ECONOMIC STUDIES - COMPARISON WITH OTHER MAJOR APPLICATIONS PROGRAMS

		1	2	3	4	5	6	7	8	Spent to Date (K\$)	Total (K\$) Through Launch
SEASAT	Begin Economic Evaluation	△ (1973)				Launch	□ SEASAT-A (1978)			725*	975**
LANDSAT		△ (1974)						LANDSAT-D (1981)	□	NASA-Other Agencies- 1600 <u>1500</u> 3100	> 3100
PSCS		△ (1977)					□ PSCS			125	1700

* Battelle, ECON, JPL through fiscal year 1978 (Economic Studies).

** Assumes approval of three to five Economic Verification Experiments.

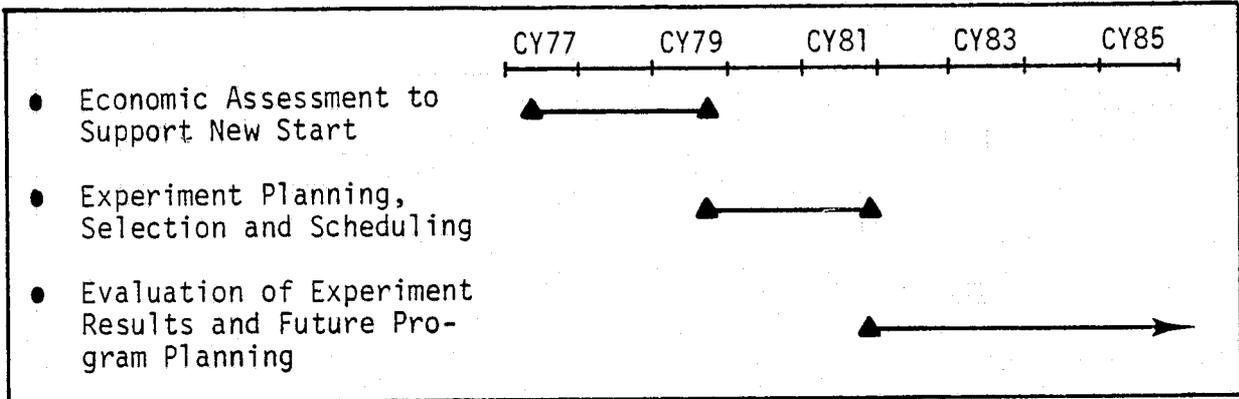
SUMMARY

This document presents a total plan for the economic evaluation of the PSCS. The plan begins during FY 1977 with a preliminary economic evaluation that is intended to support internal NASA planning for a new start, and continues for the duration of the PSCS program through the evaluation of the economic aspects of experiments performed with the PSCS after it is launched in 1982.

The formulation of this plan has drawn upon more than four years of experience in the economic evaluation of other successful space applications programs. While there are many similarities between this plan and the use of economic evaluations in other space applications programs such as LANDSAT and SEASAT, the plan also recognizes the fact that there are significant institutional, legal, political, regulatory and users differences between PSCS and other space applications programs. The SEASAT program has shown the desirability of the early and continued participation of the users in the formulation and the implementation of the program. Both LANDSAT and SEASAT have shown the usefulness of rigorous economic analysis to NASA management, users and the other organizations involved in the program approval cycle. In addition, both of these programs have shown the desirability of a structured users community to interact with the NASA program team, as well as the desirability of interaction between the economics and technical study teams and the users in the formulation of system requirements and applications. This experience has been incorporated in the preparation of the PSCS plan.

The plan describes three major phases of the PSCS economic evaluation. The first phase, consisting of the economic assessment to support the new start has begun and will continue through 1979. The first phase consists of an analysis of the uses and users of the PSCS, and an economic assessment involving user case studies and econometric modeling. A significant feature of the first phase is the possibility of using experiments that could be performed before the launch of the PSCS as a central part of the user case studies. Beginning in 1979 and continuing through 1981, the second phase of the economic evaluation involves the planning, selection and pre-launch implementation of economic verification experiments to be performed using the PSCS. The third phase of the economic evaluation begins with launch in 1982 and consists of the evaluation of the economic experiments, and the interaction with users and systems operators to facilitate transfer of PSCS services to an operational status.

SUMMARY



- Comprehensive Plan covers program from inception through evaluation of experiments and transfer to private sector.
- Economic assessment requires inputs from broad range of activities for evaluating costs and benefits.
- Need to formally structure participants to interact with study team.

TASK DESCRIPTIONS

The following pages contain a compilation of brief task statements for each of the tasks contained in the economic evaluation program plan. For the Phase I and II tasks, the task statements include a statement of the purpose of the task and an outline of the approach to be taken. For Phase III tasks, only a statement of the purpose of the task is given. Each task is identified by a task number so that the task statements can be easily cross-referenced to the tasks discussed in the previous pages.

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PHASE I
TASK STATEMENTS

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TASK STATEMENT

1.1 PRELIMINARY ECONOMIC EVALUATION (USER AND USES STUDY) AND EXPERIMENT PLANNING

Purpose: Establish a preliminary estimate of economic benefits which may result from an operation PSCS system.

Approach: * For a selected group of applications, determine in a preliminary fashion:

- Areas which may be impacted by PSCS operating systems
- Current methods and costs of operations
- Revised (based upon PSCS services) methods and costs of operations
- Scaling across application sector
- Benefit evaluation methodology
- Benefits per application sector
- Net benefits across all sectors
- Analyze and participate in planning of experiments which may be conducted to assist with new start justification

* Basic approach is as illustrated in chart entitled "Economic Analysis - Benefit/Cost Approach".

TASK STATEMENT

1.2 CASE STUDIES (INCLUDING GENERALIZATIONS) AND EXPERIMENT EVALUATIONS

Purpose: Establish a detailed understanding of user requirements, current methods and costs of operations, and revised (based upon use of PSCS services) methods and costs of operations, using this detailed knowledge generalize requirements and costs across application sector.

Approach: * For a selected group of applications, work with a selected group of potential users to determine in depth:

- Areas which may be impacted by PSCS operating systems
- Current methods and costs of operations
- Revised (based upon PSCS services) methods and costs of operations
- Scaling across users within each application sector
- Benefit evaluation methodology
- Benefits per application sector
- Participate in the evaluation of results of experiments conducted to assist with new start justification

* Basic approach is as illustrated in chart entitled "Economic Analysis - Benefit Cost Approach".

TASK STATEMENT

1.3 OPERATIONAL SYSTEM COST/PERFORMANCE MODELING

Purpose: To establish the operational PSCS system annual costs, and present value of costs, in terms of performance as determined by user requirements.

Approach: Develop an operational system simulation model which considers:

- Space and ground segment costs
- Nominal S/C configuration, capability and cost
- Sensitivity coefficients (scaling factors)
- Cost uncertainties
- Subsystem reliability
- User demand characteristics

and develops, using unit cost and other data provided by NASA and demand data from generalized case studies:

- Launch schedules
- Probability distribution of annual cost
- Probability distribution of present value of cost.

TASK STATEMENT

1.4 BENEFIT-COST ANALYSIS

Purpose: Establish the net benefits which may result from an operational PSCS system.

Approach: For applications considered in case studies and using operational system cost/performance model:

- Develop benefit models^{*} in terms of level and price of service
- Evaluate equal and added capability benefits
- Determine level of utilization (per application) of PSCS operational system
- Determine operational system cost in terms of capability
- Iteratively determine price and level of service
- Determine net benefits (benefits less costs).

* Taking into account all user costs.

TASK STATEMENT

1.5 ECONOMETRIC MODELING AND SIMULATION

Purpose: To develop an econometric model of the communication sector and to establish its links with a macroeconomic model and/or an input-output analysis so that the full extent of the contribution of communication R&D can be evaluated.

Approach: Construct an econometric model of the communication sector, incorporating both supply and demand relationships. The econometric model will consider:

- Telephone, telegraph, TV and radio
- Demand for communication services by various users
- Supply of communication services and its relation to technological progress and R&D
- Revenue and cost relationships
- Investment and employment requirements.

The contribution of R&D to the communication sector will be examined by the econometric model of the communication sector, and its effects on other sectors of the economy will be evaluated by linking the communication model to an existing macroeconomic model, e.g., the OBE model used by the Department of Commerce and/or an input-output analysis.

TASK STATEMENT

1.6 ANALYSIS OF PRIVATE SECTOR R&D ROLE

Purpose: To assess the likelihood and degree of private sector participation in the absence of public sector investment.

Approach: Using NASA preliminary cost estimates and data obtained from corporate business planners and investment analysts.

- Establish preliminary proforma business plans (income, cash flow, and other projections) based upon an operational PSCS system.
- Review private sector investment criteria and recent large scale business opportunities.
- Review other factors which affect private sector investment decisions.
- Compare preliminary proforma plans with investment criteria, other factors and recent opportunity/decision experiences.
- Assess likelihood and degree of private sector participation in absence of public sector investment.

TASK STATEMENT

1.7 EVALUATION OF ATS/CTS EXPERIMENTS FOR ECONOMIC DATA

Purpose: Review ATS/CTS experiments to establish and evaluate economic data base which may be useful by providing a systematically organized source of data to support claims that might be made in the new start justification process.

Approach: Review pertinent ATS/CTS experiments and establish the following by reviewing experiment documentation and interviewing experimenters.

- Experiment goals
- Experiment technical results
- Experiment demonstrated (measured and/or inferred) economic results
- Evaluate what has been learned to-date about user economics as impacted by improved and/or new communication services.

TASK STATEMENT

1.8 ANALYSIS OF PRIVATE SECTOR BUSINESS OPPORTUNITY

Purpose: To establish a detailed understanding of the possible private sector PSCS system business opportunities and to establish the obstacles and constraints to commercialization.

Approach: Using NASA refined cost estimates and data obtained from corporate business planners and investment analysts

- Develop possible business scenarios
- Develop simulation models for private sector business ventures
- Consider impact of uncertain demand and costs and impact of unreliability
- For possible business scenarios develop probability distributions of net profit, cash flow, cumulative cash flow, payback, etc., based upon cost data provided by NASA, common carriers, etc., and demand estimates resulting from case studies and other sources.
- Assess the attractiveness of the private sector business opportunities (explicit consideration of risk, exposure and payback)
- Assess the implications of input data uncertainty reduction on the attractiveness of the private sector business opportunity.

TASK STATEMENT

1.9 PLAN UPDATE

Purpose: Periodically update the plan for the economic evaluation of the PSCS system in order to reassess necessary tasks, schedules and costs in terms of what has been learned to-date.

Approach: Using most recent plan as starting point

- Review results of studies and analysis since formulation of plan
- Review ultimate goals and objectives
- Reformulate plan so as to achieve goals and objectives.

PHASE II
TASK STATEMENTS

TASK STATEMENT

2.1 ANALYSIS OF TECHNOLOGY TRANSFER TO PRIVATE SECTOR

Purpose: Determination of the ways and means of eliminating the obstacles and constraints to private sector commercialization of PSCS demonstrated services.

Approach: Using business simulation models and guidance from corporate business planners and investment analysts

- Determine financial, institutional and other obstacles and constraints to private sector commercialization of PSCS demonstrated services
- Investigate ways of reducing uncertainty, risk and exposure
- Analyze alternative private sector participation scenarios such as buying or leasing PSCS
- Analyze impact on other carriers
- Analyze role of regulatory policies
- Analyze pricing policy and impact on rate of commercialization

TASK STATEMENT

2.2 DEVELOPMENT OF CRITERIA FOR PROJECT EVALUATION & SELECTION

Purpose: Develop models, procedures, and criteria which will lead to the selection of those R&D and experimental program initiatives which will be most useful in promoting the net economic benefits which are likely to develop as a result of operational implementation of PSCS demonstrated services

Approach: Formulate models, procedures and criteria aimed at "buying" information through R&D and experimental programs which will lead to the reduction or elimination of the obstacles and constraints to operational system implementation. This will require

- Development of simulation models* which will allow service price to be estimated in terms of level of service and regulatory constraints
- Development of procedures for assessing impact of an R&D project or experiment on uncertainty
- Development of procedures (using simulation models) for assessing impact of reduction of uncertainty on risk and/or exposure reduction and effect on implementation decisions
- Development of models leading to the evaluation of consumer surplus and producer surplus benefits in terms of price of communication service.
- Development of data requirements and procedures for data collection
- Development of pricing policies for experiments

* It is anticipated that models developed in previous tasks will be utilized and modified.

TASK STATEMENT

2.3 ANALYSIS, EVALUATION & SELECTION OF EXPERIMENTS

Purpose: Analyze, evaluate and assist in the selection of proposed experiments

Approach: Utilizing models, procedures, and criteria previously developed (Task 2.2), combinations of different proposed experiments will be analyzed and evaluated to determine that combination which will be most useful in promoting the achievable net economic benefits. Close coordination will be maintained with proposed experimenters so as to insure the availability of data for the analyses and evaluations.

PHASE III
TASK STATEMENTS

TASK STATEMENT

3.1 EVALUATION OF EXPERIMENT RESULTS

Purpose: On a continuing basis, review the experiment results to ensure that desired economic data is forthcoming and thence when data is available, re-evaluate the application economic benefits (and costs) as indicated by experiment results, reassess user requirements and impact on system capability in light of experiment results.

TASK STATEMENT

3.2 R&D PROGRAM PLANNING

Purpose: On a continuing basis, analyze, evaluate and assist in the selection of proposed experiments and the continuation of experiments already underway. The evaluation of experiments already underway will consider the information obtained to date and the economic value of continuing the experiment to obtain additional information.

TASK STATEMENT

3.3 COORDINATION WITH PRIVATE SECTOR

Purpose: Maintain continuing contact and liaison with the private sector (carriers, business planners and financial analysts) in order to keep current with their decision criteria regarding commercialization of services and inform them of experiment results obtained to date and future plans.

TASK STATEMENT

3.4 TRANSFER TO PRIVATE SECTOR

Purpose: Continually review the private sector decision criteria, and perceived obstacles and constraints, and reasses, in light of experiment results and regulatory and other changes, the scenarios for transferring the communication technology to the private sector.