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Commercial Non-Aerospace Technology Transfer Program for the 2000s: Strategic Analysis and Implementation

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List of Acronyms

ABP	Associated Business Publications
CAES	Commercial Applications Engineering System
CASI	Center for Aerospace Information
CoC	Council on Competitiveness
COSMIC	Computer Software Management and Information Center
CTI	Civil Technology Initiative
CUFT	Center for the Utilization of Federal Technology
DOC	Department of Commerce
DoD	Department of Defense
DOE	Department of Energy
FISTTS	Federal Inter-Sector Technology Transfer System
FLC	Federal Laboratory Consortium
FY	Fiscal Year
IAC	Industrial Application Center
ICT	International Computer Technologies
MSOS	Multi-Sector Outreach System
NASA	National Aeronautics and Space Administration
NESTTS	NASA Extra-Sector Technology Transfer System
NTI	National Technology Initiative
NTTC	National Technology Transfer Center
OCP	Office of Commercial Programs
ORTA	Office of Research and Technology Applications
OSTP	Office of Science and Technology Policy
RBSE	Repository-Based Software Engineering
RSIDS	Remote Sensing Information Distribution System
RTI	Research Triangle Institute
RTTC	Regional Technology Transfer Center
SEDS	Software Engineering and Distribution System
SIC	Standard Industrial Code
SRI	Stanford Research Institute
TAC	Technology Applications Center
TAT	Technology Application Team
TTCS	Technology Transfer Center System
TTD	Technology Transfer Division
TTO	Technology Transfer Office

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NASA Headquarters
Office of Commercial Programs
Technology Transfer Division

Gary A. P. Horsham

1.0 Introduction

By the first decade of the twenty-first century, the United States will probably be forced to have an "official" industrial/ technology policy, in order to be a successful player in the newly emerging global economic arena. Given today's changing international economic conditions, it is clear that techno-economic governmental agencies (such as NASA) will most likely have to initiate and lead a process to harmonize federal/state/local agency to agency and public to private working interfaces.

As the year 2000 approaches, many fundamental politico-techno-economic paradigms and rules of twentieth century engagement will probably be discarded. The coming era will almost certainly alter some traditional relationship between the U.S. public and private sectors. Any economic efficiency/effectiveness oriented program/strategy (such as technology transfer) must be flexible enough to respond to the rapid changes of a highly uncertain environment. Given these considerations (and in concordance with the new NASA Administrator's "better, faster, cheaper," philosophy), NASA's twenty-first century technology transfer organization should be shaped by the principles of harmonization and responsiveness - that is, to help harmonize or coordinate public sector technology transfer instruments, as a whole, to make them more responsive to private sector technology transfer needs in the future.

This report presents a strategic analysis and implementation plan for NASA's Office of Commercial Programs (OCP), Technology Transfer Division's (TTD), Technology Transfer Program. The main objectives of this study are to (1) analyze and characterize the NASA TTD's environment and past organizational structure, (2) clearly identify current and prospective programmatic efforts, (3) determine an evolutionary view of an organizational structure which could lead to the accomplishment of NASA's future technology transfer aims, and (4) formulate a strategy and plan to improve NASA's (and other federal agencies') ability to transfer technology to the non-aerospace sectors of the U.S. economy. The planning horizon for this study extends through the remainder of the 1990s to the year 2000.

Five sections follow this introduction. The first two present supplementary, chronological external and internal environmental assessments in which pertinent legislative, national policy, and other background factors are introduced. After this, an overview/examination of each of the current TTD organizational components are presented and explained from a systems perspective. Near-term factors which tend to govern future programmatic trends are discussed. Then, in relation to these factors, the present organization's near-term direction and aims are discussed, followed by an outline of future programmatic objectives. In the first of two remaining sections, the key strengths and weaknesses of the current organization are identified based on all the information discussed previously. The last section presents a strategy and implementation methodology.

2.0 External Environmental Assessment

2.1 Legislative Background

NASA (with its nine field Installations) was the first federal agency to formally establish a technology transfer function in 1962. In 1971, eleven Department of Defense (DoD) laboratories established the Federal Laboratory Consortium (FLC) (which has expanded to include over six-hundred DoD and non-DoD laboratories). Both the FLC's and NASA's technology transfer functions operated independently throughout the 1970s without any strong supporting legislation. During the late 1970s, Congress addressed the need for additional legislation to encourage more effective extra-governmental (inter-sectoral) technology transfer. This resulted in the passage of the Stevenson-Wydler Technology Innovation Act (Public Law 96-480) of 1980. The Act mandated that "federal laboratories transfer federally originated technology to state and local governments and to the private sector."

In 1984, in response to the Stevenson-Wydler Act, most federal laboratories established what are still referred to as Offices of Research and Technology Applications (ORTAs). In addition, the Federal Laboratory Consortium (FLC) (the "ad hoc" association of ORTAs) was formally recognized by the Joint Economic Committee of the Congress as the main organ for generating intra- and extra-governmental technology transfer. To complement these activities, the Department of Commerce established the Center for the Utilization of Federal Technology (CUFT). CUFT would provide a service as a "clearinghouse for the dissemination of information on federal technologies with potential application to state and local governments and to private industry."

The Stevenson-Wydler Act approached maximum effectiveness by 1984. By then it became evident that further legislative action would be necessary to "incentivize" federal laboratories. To address this need, the Federal Technology Transfer Act (Public Law 99-502) of 1986 was enacted to provide a statutory basis for the role of the Federal Laboratory Consortium (FLC). Each of these pieces of federal legislation forms the pillars of the external framework of inducements by which all federal technology transfer functions are encouraged and supported.

2.2 National Policy Considerations

The industrial and federal technology transfer communities were recently stimulated by a series of policy related activities. In 1990, the Office of Science and Technology Policy (OSTP) compiled a list of "critical technologies" which must be mastered in order to ensure U.S. economic (international) competitiveness in the early twenty-first century. This list resulted from the merging of three individual preceding lists compiled by the Department of Defense (DoD), the Department of Commerce (DOC), and the Department of Energy (DOE), respectively. As a result, a series of public policy debates and congressional hearings have occurred on the subject of establishing an official United States "technology/industrial policy."

Certain influential elements of the Council on Competitiveness (CoC) have articulated support for establishing an "official" United States technology policy, predicated upon the critical technologies lists. This would be tantamount to an acknowledgement and strategical response by the United States to the rules of the new tri-polar international economic game - with Japan (including the Association of South East Asian Nations (ASEAN)) and the European Community. In any case, strong philosophical opposition has been voiced by organizations such as the American Enterprise Institute (which believes, along with many other right wing organizations, that the government should not get into the business of picking winners).

The present (Bush) Administration has been officially opposed to the notion of any policy proposals which violate its free market economic doctrine. Nonetheless, the pressing need for Presidential leadership in the face of blistering economic competition (from Japan and other Asian nations and the European Community), and the pressures of domestic, election-year politics, prompted some philosophically contrary action. In late 1991 and early 1992, the Administration launched the Civilian Technology Initiative (CTI) and its companion, the National Technology Initiative (NTI). These initiatives, particularly the NTI, have inspired a burst of high level interest in technology transfer in many mission-dependent, technology development oriented agencies (Department of Defense, Department of Energy, NASA, etcetera).

Recent actions by the military mission-dependent federal agencies to emphasize technology transfer are largely in response to the threatening effects of some permanent institutional restructuring in the domestic and geo-political arenas, which are perceived threats to their existence. The most significant concerns stem from the end of the cold-war, and the worsening U.S. domestic social and fiscal climate (largely caused by the seemingly endemic budget deficit, and the increasing interest due on the national debt). These austere conditions are almost certain to have severe policy and budgetary ramifications for most mission-dependent federal organizations in the 1990s (and, perhaps, into the first decade of the twenty-first century).

3.0 Internal Environmental Assessment

3.1 Background

After being created and given a legal framework and authority in 1958 to "explore space," NASA committed virtually all its resources to the "Moon Mission" proclamation of 1960. The Agency was essentially an instrument of the mid-cold-war period. During the early 1960s, Congress provided the Agency with relatively easy access to funding needed to execute its prime mission. The Agency was a beneficiary of abundant discretionary reserves which had accrued from about two decades of uncontested international economic growth in all sectors. NASA first instituted an "extra-sectoral" technology transfer function back in 1962 to demonstrate the "benefits to all mankind," as stipulated in the National Aeronautics and Space Act of 1958. However, technology transfer never received sufficient internal (NASA) support to become maximally effective, due to the Agency's intensely focused advanced (space) missions oriented culture.

Throughout the 1960s, NASA was a young and unique new agency - the special creation of a resource rich, super-powerful, economically unchallenged United States at the crest of its competitive form, militarily, in all important areas. The Agency was not held accountable for economic performance, and so its leadership had no incentive to interpret changes in the economic environment. Almost complete emphasis was placed on responding to (space/aeronautical related) technological challenges/threats in the geo-political environment. As a competitive instrument of the cold-war, the young agency learned to value international recognition and leadership, technological superiority, mission success, and scientific inquiry. The value for technology transfer as a means of multiplying the tangible benefits from space expenditures (i.e., making space expenditures a more widespread economic investment/stimulant) was never properly instilled.

As NASA matured, it continued to thrive on the competitive tensions of the cold war throughout the 1970s and most of the 1980s. The Agency was still incapable of seeing the necessity of formulating an all encompassing strategic view of itself in the face of very obvious changing social, political, and economic indicators. The demise of a military pretext, and the increasing relative importance of economic competition in the 1990s (fiscal/financial accountability and non-aerospace economic return/payback), have now come together to force greater institutional acceptance of, and real support for a "return on investment" function like technology transfer .

There still exist some remnants of the cold-war era mind-set/culture throughout NASA's organizational structure(s), at headquarters, and also at the nine field Installations. This mind-set tends to lack a practical appreciation for the larger socio-economic context in which the Agency must exist (and on which its continued existence increasingly depends). Such a mind-set yearns for a semblance of a 1960s-like (Apollo) period when a strict science and technology focused *raison d'etre* was the only one necessary. This dominant culture views non-aerospace (extra-sectoral) technology transfer as a second class function, unsuited to the image of an agency on the vanguard of space exploration. To this culture, active technology transfer (for non-aerospace applications) is ordinary and perfunctory, and should not be part of NASA's (noble) responsibility or "Mission."

3.2 Policy Considerations

In the past, the governing attitude in NASA believed that the Agency should continue to be well funded solely on the basis of its contribution to national pride and "manifest destiny." In other words, technological achievement, and the acquisition of space scientific knowledge, should be the Agency's only products, and, therefore, its only measures of success. By projecting such an imbalanced idealism, this attitude has acted to negate the internal effectiveness of its Technology Transfer Division (TTD) and the supporting Technology Transfer Offices at each field Installation. In principle, the solution to this problem is education. This can be achieved through the creation of better, more internally active organizational linkages between the TTD's structure and the overall NASA organization.

There are two aspects to the internal environment for which more effective and cooperative linkages must be established: (1) the immediate internal environment (e.g., at headquarters, the TTD's mother/foster organization, Code C, Office of Commercial Programs (OCP) and its other related functions.); and, (2) the non-immediate internal environment (e.g., at headquarters, OCP's mother/foster organization, NASA Headquarters, and its other Codes or related functions.). Similarly, at each field Installation, there is both an immediate and a non-immediate internal environment surrounding the TTO. From a policy standpoint, each entity in the immediate and non-immediate internal environments of the TTD/TTO is a stakeholder which needs to be better educated and informed.

In other areas, the actions of the TTD (and TTO) are controlled by formal and informal policies/guidelines within its NASA internal environment. The TTD/TTO must conduct and modify its activities relative to the Agency's internal policies and guidelines in the following areas: human resource management and consumption, contractual support and management, financial management and budgetary preparation, inter- and intra-organization (and vertical and horizontal protocol) communication, congressional interaction, public promotion (external relations), performance measurements, etcetera. The TTD/TTO tends to encounter non-policy related obstacles, due to the unsupportive, informal value system that drives the Agency. This has acted to further suboptimize the TTD's/TTO's internal (and external, to some extent) effectiveness.

It is interesting to note, that the new NASA Administrator (in the latter half of fiscal year (FY) 1992) has instituted a process of change to increase the Agency's internal awareness of its national economic responsibilities, among other things. This process is designed to increase the internal (and external) visibility of technology transfer, thereby making it a major component of NASA's total responsibility. However, it remains to be seen at what rate the traditional NASA establishment will yield to this and other inevitable modern era forces or indicators of change.

4.0 Present Evolutionary Characteristics

Between FY 1991 and 1992, NASA's Technology Transfer Division (TTD) launched the development of an improved (NASA sponsored) "National Technology Transfer Network." In order to facilitate the systems analysis approach applied in this study, the author has chosen to describe the "Network" (unofficially) as a "Federal Inter-Sectoral Technology Transfer System (FISTTS)" (where "inter-sectoral" implies transfer from public sector to public sector, or, public sector to private sector). The following sections discuss the present evolutionary characteristics of each component of the FISTTS and introduce systemic/systematic relationships, nomenclature and acronyms, accordingly.

4.1 Federal Inter-Sector Technology Transfer System

The FISTTS is geographically distributed throughout the United States. Its primary function is to enable/facilitate more efficient and effective technology transfer from any federal laboratory (with a primary emphasis on NASA laboratories) to private and other public sectors through a well coordinated network of federal and contracted technology transfer specialists. In the paragraphs below, each component of the present baseline structure of the FISTTS is examined.

It is expected that the FISTTS will evolve from today's NASA-centered baseline into an equitable, coordinated system which facilitates and possibly increases the transfer of federal technology to private and public economic concerns. The transitional structure of the NASA headquarters' TTD organization responsible for establishing the FISTTS is shown in figure 2. Figures 2A, 2B and 2C illustrate the phased evolution of NASA's TTD into a component of the FISTTS, based on certain philosophical considerations to be introduced in later sections. The FISTTS incorporates NASA's technology transfer system which was developed over the course of the last twenty-seven years. A major component of the old NASA capability, Industrial Application Centers (IACs), was replaced by a Technology Transfer Center System (TTCS). The new TTCS is designed to provide more pro-active and interactive (value-added) technology transfer services to American industry and federal laboratories.

While the NASA headquarters' TTD is responsible for establishing the FISTTS, it must simultaneously transform itself from an independently operating entity, into a co-operating component of a federal system in which all technology producing federal agencies are aligned toward achieving the common goal of technology transfer to enhance U.S. international competitiveness. Therefore, in addition to the emerging Technology Transfer Center(s) System (TTCS), the FISTTS consists of two additional functional components: (1) the relatively mature NASA TTD or NASA Extra-Sector Technology Transfer System (NESTTS) (where "extra-sector" implies transfer from NASA and its aerospace industry sector to other industrial sectors, such as mining, agriculture, etc.); and, (2) a soon to be established working interface for other governmental agencies. Figure 2A shows the organizational relationship between these three top level components of the FISTTS.

4.2 Technology Transfer Center System

The TTCS consists of a National Technology Transfer Center (NTTC) and six Regional Technology Transfer Centers (RTTCs) (The NTTC and RTTCs began operating under contract to NASA headquarters in FY 1991 and FY 1992, respectively). This new system is in a "start-up" mode and is combining the twenty-seven year experience base from the former IACs with a new, pro-active approach. The NTTC and RTTCs must actively develop and establish channels of communication between U.S. industry and all federal laboratories. This activity is designed to increase the level of awareness of federal technology availability throughout, and encourage or induce more technology research and development cooperation and application. Both the NTTC and the RTTCs are operated by non-profit organizations contracted to NASA for five years. Each RTTC organization must attempt (either intra- or extra-regionally) to augment its basic funding in areas directly related to the objectives specified in the statement of work.

As discussed in the previous section, the TTCS is a relatively independent arm of the FISTTS. According to the NASA contract, the TTCS must primarily serve NASA. However, the TTCS must also expand its capacity to assist other governmental agencies and laboratories, through the established Federal Laboratory Consortium (FLC) for technology transfer. The NASA Headquarters' TTD monitors the performance of the overall TTCS and provides the necessary funding and direction. The NTTC is supposed to provide top level guidance and support to the six RTTC working level components. Figure 3A shows the emerging 1992 baseline structure of the TTCS.

Each of the six RTTCs in the TTCS operate as a marketing field agent for any federal laboratory. In general, the RTTCs perform regional market analyses, and planning and implementation functions for a designated region comprised of five or more states. In so doing, each RTTC penetrates and analyzes regional industrial structures down to the company level. In addition, the RTTCs analyze and penetrate regional state governmental structures down to the local level. These activities develop, establish and maintain working relationships which facilitate more efficient transfer of technology by concentrating on specific private (and/or public) needs or problems that may be addressed by federally generated technologies.

4.3 NASA Extra-Sector Technology Transfer System

The present NESTTS (or NASA TTD) has four main functional components/arms: (1) Applications Engineering; (2) Outreach; (3) Software Engineering and Distribution; and (4) Remote Sensing and Geographic Information Distribution. Also, a communications network upgrade function, which has no direct technology transfer function, is not included. Each arm, and the instruments through which it operates, is identified and described below:

- Applications Engineering: NASA field Installations/Technology Transfer Offices (TTOs); A Technology Application Teams (TAT) provided by Research Triangle Institute (RTI).

- Outreach: NASA field Installations/TTOs; Center for Aerospace Information (CASI); Stanford Research Institute (SRI); International Computer and Telecommunications (ICT); Associated Business Publications (ABP).

- Software Engineering and Distribution: NASA field Installations/TTOs; Computer Software Management and Information Center (COSMIC); Repository-Based Software Engineering (RBSE).

- Remote Sensing and Geographic Information Distribution: NASA Field Installations/TTOs; Technology Application Center (TAC).

(CASI, COSMIC, RBSE, TAC are all institutions established by the Technology Transfer Program and operated by different concerns under contract to NASA headquarters' TTD. SRI, ICT, and RTI are contractors which provide different support services to the program. ABP is a contractor provides a zero cost service to the program.)

Within the NESTTS software and hardware technology transfers are accomplished in different ways. Essentially, the field Installations provide COSMIC with software specific technology which might have commercial potential. COSMIC then determines the commercial potential, and then processes and markets, thereby transferring the software to the commercial sector. Hardware technology, on the other hand, is processed and transferred by the technology application team. Both the hardware and software transfer processes are independent arms of the NESTTS (and FISTTS), each having distinct technology transfer functions. Both of these areas benefit indirectly from the activities of the outreach function.

Collectively, the NASA field Installations, and their TTOs are the most critical component of the NESTTS. The nine field Installations produce/generate hardware and software related technical information which is processed and transferred by the TTOs. Figure 2A shows the NESTTS structure within the emerging FISTTS and includes the communications network upgrade function (the upgrade task is discussed in an upcoming subsection). The present transitional and baseline operating structure of each functional component of the NASA TTD (see figure 2) is described in the sections that follow.

4.3.1 Applications Engineering System

Applications engineering is defined as the process by which adaptive engineering projects are identified, selected and managed, with the committed participation of (user organization) industrial partners, in order to transfer NASA technology from the aerospace sector to the non-aerospace industrial sectors. Applications Engineering is concerned with the active identification of secondary uses for hardware (and software to some extent) technologies.

NASA headquarters' Technology Transfer Division (TTD), monitors the performance of the system and provides the necessary funding and some direction. At the working level, each field Installation generates technology and, through its TTO, attempts to cultivate technology transfer projects with companies from any State in the United States. They also try to forge relationships with state and local governments in their respective region. (These two activities will soon be performed completely by the RTTCs). A Technology Application Team (TAT - provided by Research Triangle Institute (RTI)) provides technical and market analytical support to the NASA field Installation TTOs and headquarters. The TAT essentially plays an important middleman or "brokering" role by assisting in matching technology demand with supply. Figure 4A shows the FY 1992 baseline structure of the applications engineering system.

4.3.2 Outreach System

Outreach is defined as the process by which transferrable technology and commercial end-items are advertised and promoted to aerospace and non-aerospace industry concerns. Outreach is concerned with the conveyance of information pertaining to actual, potentially "commercializable" technology "end-products" from the Agency's technology development programs. This system essentially performs the NESTTS (technology product and/or technology transfer service) marketing activities by creating broad awareness among potential user groups.

NASA headquarters' TTD monitors the performance of the system and provides the necessary funding and direction to its two primary, production oriented, support organizations, CASI and ABP. CASI responds to general program inquiries, serves as an information clearinghouse and referral center, and publishes "Spinoff" magazine. ABP publishes "Tech Briefs" magazine. At a lower working level, the nine NASA field Installations generate technology (products) and passes raw and/or partially processed, new technology information to the system through their TTOs. Two additional support organizations supplied by headquarters are ICT and SRI. These two support organizations operate in monthly and/or annual project-like support modes as intermediate, information refining/processing components between the field Installations, CASI, and ABP. Figure 5A shows the FY 1992 baseline structure of the outreach system.

The primary activities performed by this system can be divided into two categories: (1) pre-adoption (of a technology product), and (2) post-adoption. The pre-adoption activity involves advertising or information dissemination/distribution. Specific pre-adoption activities include: the publication of NASA Tech Briefs magazine (which ABP operates strictly through paid advertising); the Technology 200X series; workshops and seminars for industry; trade show exhibits; Spinoff magazine; and, popular media (electronic and print). The post-adoption activity involves what might be considered as market share analysis to track, identify and document the specific results of related and unrelated pre-adoption activities (the post-adoption function has not received much attention in the past).

4.3.3 Software Engineering and Distribution System

Software engineering and distribution is defined as the re-engineering and subsequent marketing of aerospace software product technology for use in non-aerospace applications. Software re-engineering is concerned with increasing software reusability through upgrading and modularization.

NASA headquarters' TTD, monitors the performance of this system and provides the necessary funding and direction. Two organizations, COSMIC and RBSE, are contracted to support NASA headquarters as field agents. COSMIC assesses NASA's general software product outputs for commercial potential. If evident, COSMIC modifies (if appropriate), advertises and distributes the software to the private sector. Although supported financially by NASA headquarters, to some extent, COSMIC operates in a non-profit mode, only charging its customers enough to cover any remaining costs. also attempts to operate as a profit center). RBSE performs a similar function to COSMIC, but specializes in the reuse and documentation of Ada-language software applications (AdaNET) (RBSE has been in operation for about three years). At a lower working level, the nine field Installations generate the software technology (product) which is transmitted to COSMIC and RBSE as raw material for additional processing and packaging. Figure 6A shows the FY 1992 baseline structure for the software engineering system.

4.3.4 Remote Sensing and Information Distribution System

Remote sensing and (geographic) information distribution is defined as the marketing of remote sensing data and technology for non-aerospace related terrestrial applications.

NASA headquarters' TTD, monitors the performance of this system and provides the necessary funding and direction. One organization, TAC, is a contracted to support NASA headquarters as field agent . TAC collects image processing technology and remote sensing data received from NASA and provides technology and expertise to industry. At a lower working level, the nine field Installations generate the information processing technology (product) and remote sensing data which are transmitted to TAC as raw material for marketing. Figure 7A shows the FY 1992 baseline structure for the remote sensing and information distribution system.

4.3.5 Communications Network Upgrade System

Communications network upgrade is a planned contractual effort which does not contribute directly to the technology transfer objective of the NASA TTD. It will be concerned with the expansion and improvement of a computerized network of new technology information. This new network will replace an old version which never achieved its planned level of performance and usability. The end-result should be an increase in the communicative efficiency of the NESTTS (and eventually, the FISTTS). NASA headquarters' TTD will monitor the upgrade of the computerized network and provide the necessary funding and direction. The field Installations will be the primary source of network information and communications traffic.

The upgraded network software architecture will be designed to consist of a "central repository" with several geographically separate input/output access locations. The data/information contained in the repository will be supplied and maintained by NASA field Installations. The new network is supposed to facilitate more rapid collection and dissemination of new technology information by NASA's TTOs (field Installations) and technology transfer agents in the TTCS. Essentially, the network will be a support tool with an integrative, information storage and transmission function. Figure 8 indicates how this task might be executed organizationally.

4.4 Near-Term Direction and Aims

NASA Headquarters' Technology Transfer Division presently has two main responsibilities relative to the emerging FISTTS: (1) the continued management of the day to day operations of the current NASA TTD; and, (2) the overall design, development and implementation of the emerging FISTTS. Table 1 shows the present real total funding and performance period plans for each contractual component of the current NASA TTD.

Approximately one-third of the TTD's FY 1993 financial resources (a Congressionally imposed apportionment) is intended to be directed towards the development of the national and regional technology transfer center system. This level of expenditure (which might decrease slightly in FY 1994) is aimed at bringing the TTCS to an early operational level by FY 1995.

Of the remaining two-thirds, about fifty percent will probably go toward supporting the applications engineering system. This amount (which might increase slightly in FY 1994) is aimed at increasing the effectiveness of this relatively mature operational system. Another twenty percent will most likely go toward the software engineering system. This amount is aimed at operating the mature COSMIC component of this operational system and further augmenting the relatively new RBSE/AdaNET addition (which also receives a Congressionally imposed apportionment). The remaining thirty percent will probably go toward the outreach system, the communications network upgrade, and other areas. This amount is aimed at maintaining the outreach system (CASI, ABP, etc.) and upgrading the TTD/TTO communications network.

4.5 <u>Future Program Objectives</u>

In relation to the overall developmental goals of the FISTTS, NASA headquarters Technology Transfer Division has outlined the following objectives:

- Develop and operate a Federal Inter-Sector Technology Transfer System in cooperation with leading federal Research and Development agencies. With respect to this objective, the TTD states that NASA will:

    -- Establish agency-to-agency agreements to support the system.

    -- Facilitate the transfer of all federal technology to the U.S. private sector.

    -- Actively employ federal technology transfer and the system/network as a means of strengthening U.S. industrial competitiveness.

- Continually improve the NASA extra-sector technology transfer process to accelerate the secondary use of NASA technologies throughout the U.S. private and public sectors.

- Promote innovative approaches to shorten the time between NASA technology development and commercial applications.

- Increase volume and effectiveness of NASA/industry partnerships via Space Act agreements and technology applications projects.

- Focus NASA technology applications projects to maximize economic benefits.

5.0 Strengths and Weaknesses

5.1 Current Strengths

The technology transfer effort within NASA has developed into a fairly well known and respected effort from an external (to NASA) perspective. Today, in a time of increasing emphasis on clear demonstrations of economic relevance, the TTD's program offers NASA the opportunity to enhance its socio-economic responsiveness. At this point, the TTD's key strengths are identified as:

- A well established network of technology transfer contacts/expertise;

- Well developed information distribution channels based on the nationally recognized technology transfer publications, "Tech Briefs" and "Spinoffs, which have become synonymous with the Agency's technology transfer effort;"

- Strong Congressional favor and support for the intrinsic national value of federal technology.

5.2 Current Weaknesses

It became quite clear in the "Internal Environmental Assessment" section, that the TTD has been largely neglected and ignored by the Agency's "mainstream" internal establishment for many years. Due to the difficulty accompanying these circumstances throughout the years, the TTD was unable to properly achieve institutional support and alignment. Consequently, and also due to some lack of aggressiveness on its own behalf, the TTD has operated under vaguely defined organizational structures with goals and objectives largely apart from the NASA mainstream establishment. Four key weaknesses have developed over time:

- "Bottle-necking" of information output from the critical field Installation Technology Transfer Office components due to insufficient resources (the weakness of these components reduce the efficiency of the entire system);

    -- Insufficient resources available (at headquarters and the field Installations) to enable more understanding and identification of potential technology transfer opportunities which might be available at each stage of a technology's development.

- A lack of inter-organizational/communications linkages between headquarters' program offices;

- A lack of systemic tracking and performance measurement mechanisms.

6.0 Strategy and Implementation

As was stated in the introduction, the main objectives of this study are to (1) analyze and characterize the NASA TTD's environment and past organizational structure, (2) clearly identify current and prospective programmatic efforts, (3) determine an evolutionary view of an organizational structure which could lead to the accomplishment of the NASA TTD's future goals and objectives, and (4) formulate a strategy and implementation plan to continue and improve NASA's (and other federal agencies') ability to transfer technology to the non-aerospace sectors of the U.S. economy. The first, second and third objectives were addressed in previous sections. This section introduces a strategy and implementation approaches which will potentially satisfy the aims of the fourth objective.

6.1 Harmonization and Responsiveness Strategy

In the broadest sense, the harmonization and responsiveness strategy aims to harmonize or coordinate all public sector technology transfer arms/instruments to make them more responsive, as a whole, to the private sector's technology transfer needs. This implies that each federal agency must clearly define and increase the sensitivity of its respective technology transfer instruments. For the NASA TTD, the assessment of its internal and external environment, the description of its present evolutionary characteristics, and identification of current strengths and weaknesses, all point to a strategy based on a continuation of the general evolutionary patterns, but with a sharper definition of the various organizational sub-structures - through which public (and private) interfaces (or connections) may be made "better," "faster," and "cheaper."

The top-level strategy to carry NASA headquarters' TTD from its FY 1992 operating baseline to a fully integrated FISTTS, by FY 1998, is displayed in figure 1 (The development of individual, detailed strategies for accomplishing each top-level milestone was beyond the scope of this study.). The strategy assumes that a funding level twice that of the FY 1992 total program level (about $32M in FY 1992) is possible during the FY 1993 through 1994 time-frame; doubling again for the FY 1995 through 1996 time-frame; and leveling off at five times the FY 1992 level beyond FY 1996. These funding assumptions are based on current (internal and external) political (and economic) trends, and critical strategical effectiveness needs. In addition, this assumption does not violate the new NASA Administrator's "better, faster, cheaper" theme. Instead, it is a recognition of the fact that the Agency's mainstream has consistently neglected its commercial non-aerospace responsibilities (refer to section 3.0); and, a realization that, in the economic environment of the future, the Agency must seriously attend to ensuring the most reasonable "return on investment" to the "commercial" society which finances its existence.

In this section the name “Commercial Applications Engineering System (CAES)” replaces “Applications Engineering System” (refer to section 4.3.1); the name “Multi-Sector Outreach System (MSOS)” replaces “Outreach System” (refer to section 4.3.2); the name “Software Engineering and Distribution System (SEDS)” replaces “Software Engineering and Distribution System” (refer to section 4.3.3); and the name “Remote Sensing and Information Distribution System (RSIDS)” replaces “Remote Sensing and Information Distribution System” (refer to section 4.3.4). The strategy presented in figure 1 is interpreted as follows:

- Toward the middle of FY 1993, six-month studies should be performed to tabulate and measure the preliminary economic effect of the TTCS, CAES, MSOS, SEDS and RSIDS. This will permit responsiveness to the downward budgetary pressures (movement) and political sensitivities expected in FY 1994. By the end of the first quarter of FY 1994 the TTCS component of the FISTTS will be through its start-up phase. In addition, the NTTC and RTTCs should have smooth, working interfaces, as well as the NASA TTOs and the RTTCs. Both the NTTC and the NASA TTOs must initiate coordination with the RTTCs and possess the organizational flexibility necessary to secure proper interfaces.

- In FY 1995 the NESTTS organization will be restructured to reflect the increased demands being placed on the organization. The MSOS will complete organizational changes to create a system better equipped to more effectively interface with standard industry code (SIC) sectors as required.

- Between FY 1994 and 1997, most of the five-year support contractual arrangements used by the NESTTS should be up for renewal. This period should therefore be used to strategically alter some relationships, remove redundancies, and streamline the system as necessary. The achievement of operating cost reductions without compromising key (NESTTS) system capabilities should be the guiding objective of this activity. Toward the middle of FY 1995, six-month studies should be performed to tabulate and measure the preliminary economic effect of the TTCS, CAES, MSOS, SEDS and RSIDS. This will permit greater responsiveness to the potential downward budgetary pressures (movement) and political sensitivities expected in FY 1996 and 1997. In FY 1996, all RTTCs should be fully integrated having operational satellite or affiliate systems in their respective regions. In addition, a re-organization of the CAES will be accomplished to form new critical interfaces for the harmonization/coordination of technological emphases with business and industry, and other governmental agencies, etcetera.

- By the end of FY 1998, each bilateral memorandum of understanding (MOU) between NASA and other technology producing government agencies should be well established and functioning. Interfaces between the RTTCs, regional businesses, and state and local governments should be fully operational.

6.2 Implementation Plan

The organizational methodology which will be used to implement the strategy described above is graphically portrayed in figures 2A, 2B, and 2C; 3A, 3B, and 3C; 4A, 4B, 4C, and 4D; 5A, 5B, 5C, and 5D; 6A, 6B, 6C; and 7. In order to maximize the chances for success, the evolutionary organizational structures shown are formulated based on balance, alignment, relevance, centrality, and change. More pronounced or visible product and function areas, technology and industry sectors, as shown in figures 4C and 4D and 5C and 5D, respectively, would promote/facilitate more efficient internal and external interactions. At the same time, the ability of crucial external constituencies (the Administration, Congress, and Industry) to understand and communicate the Agency's technology transfer aims should be enhanced. Clearly, the vagueness (identified as a factor contributing to current weaknesses - see section 5.2) which has restricted NASA TTD's external and internal interfacing capabilities is eliminated by this organizational approach. Toward FY 2000, this evolving (FISTTS) organization offers greater product and function coordination which should lead to better categorization of outputs, and sharper, more communicable and identifiable organizational performance measurements from the overall system and each of its components, and an overall increase in the Agency's technology transfer efficiency and effectiveness.

6.2.1 Weakness Correction

Considering the strategy and implementation approach outlined above, each of the weaknesses identified in the previous section is addressed in the following manner:

- The TTO bottle-necking identified in the previous section compromises the efficiency and effectiveness of the entire FISTTS. This is the system's most critical component. Figures 3B, 4A, 5A, and 6A clearly illustrate the critical reliance the technology transfer function has on the field Installations, through the TTOs. The only way to correct this problem is to increase the resources assigned to the TTOs. Strong and consistent internal (upper management) support (encouraging science and engineering personnel to embrace technology transfer as one of their critical duties and quickly transfer their technology/knowledge), especially at the field Installation, is probably the only way the weakness of this critical component can be corrected. In other words, an increase in resources should reduce (or eliminate) the primary and secondary effects of the bottleneck in this systemically important area. It should also enable TTO and headquarters personnel to penetrate and capture transfer opportunities occurring at deeper levels in the technology development process.

- Next, the lack of clearly identifiable inter-organizational/communications linkages is another weakness which has evolved over time. The same factors that produced the field Installation bottleneck have contributed to the creation of this weakness as well. Organizational/functional ambiguity (from both an external and internal perspective) has resulted in too much high level involvement/decision-making for lower level functions. This ambiguity has occurred due to the lack of a clearly defined organizational structure, with clearly distributed, fully accountable points of contact. Better organizational definition leading to greater authority, accountability and responsibility at the lower levels would correct this weakness.

- Concerning tracking and measurement deficiencies, responsibility for this activity should be placed in each of the critical functional areas which has direct external interfaces. In the NESTTS, for example, the CAES and MSOS have such interfaces with their NASA employed and contracted components. With reference to the present baseline organizational structures, the TTOs, CASI and ICT, for example, are the components at which some important system performance measurements can be made. When the NTTC and RTTCs are included, the entire FISTTS performance can be measured and tracked by centrally integrating and analyzing all the data from these sources within the NASA headquarters' TTD.

7.0 Conclusion

NASA's long experience (twenty-seven years) in technology transfer makes the Agency a reasonable choice to plan and initiate a coordinated federal technology transfer system for the 2000s. If the harmonization and responsiveness strategy is applied it should produce a well coordinated public sector system with technology transfer capabilities far superior to anything presently available. This new public sector working relationship (structure) will provide a highly transparent technology transfer service. The transparency of the structure would enable any U.S. company to access federal resources most rapidly, with unprecedented ease. Both private and public companies (knowledgeable or not knowledgeable about the inner workings of the system) will be able to acquire federally developed technological know-how, solutions and expertise from any Agency through any single initial (random) contact point in the FISTTS. As a consequence, therefore, the (international) competitive postures of a sizable fraction of commercial non-aerospace businesses and industries might be significantly enhanced.

Total Funding Commitments and Performance Period Plans for Present Contracts *

Contractor (Description)	Amount ($)	Period of Performance
1. SRI International (New Technology Evaluation)	1,164,672	01/23/88 to 01/24/93
2. Research Triangle Institute (Technology Applications Team)	6,478,545	07/01/86 to 09/30/93
3. TECH PUBS-ICT, Inc. (Publication Preparation)	5,000,000	02/01/89 to 01/31/94
4. CASI-RMS Associates, Inc. (Operation of the Center for Aerospace Information (CASI))	5,000,000	03/01/91 to 02/28/96
5. COSMIC-University of Georgia (Computer Software Management & Information Center)	2,683,000	12/01/91 to 11/30/96
6. RTTC-Center for Tech Commercial. (Northeast Region)**	5,000,000	01/01/92 to 12/31/96
7. RTTC-University of Florida (Southeast Region)**	5,000,000	01/01/92 to 12/31/96
8. RTTC-University of Pittsburgh (Mid-Atlantic Region)**	5,000,000	01/01/92 to 12/31/96
9. RTTC-Battelle Memorial Institute (Mid-West Region)**	5,000,000	01/01/92 to 12/31/96
10. RTTC-Texas A&M University (Mid-Continent Region) **	5,000,000	01/01/92 to 12/31/96
11. RTTC-University of Southern California (Far West Region) **	5,000,000	01/01/92 to 12/31/96
12. University of New Mexico (Operation of the Technology Applications Center)	1,644,000	05/01/92 to 12/31/96
13. Rural Enterprises, Inc. (REI) (Manage and Operate a Rural Applications Team (RTAT))	299,475	05/08/92 to 12/07/92
14. NTTC-Wheeling Jesuit College (NASA/Wheeling Jesuit College Cooperative Agreement)**	22,300,000	04/24/91 to 04/23/96

* From the OCP Contracts/Grants Accounting Record of August 1992. (NASA Field Installations' Technology Transfer Offices not shown)

** Strategic thrust areas where expenditures greater than the presently (1992) planned five-year total expenditures shown may be required to achieve the expected effectiveness.

Table 1

Commercial Non-Aerospace Technology Transfer Program Plan

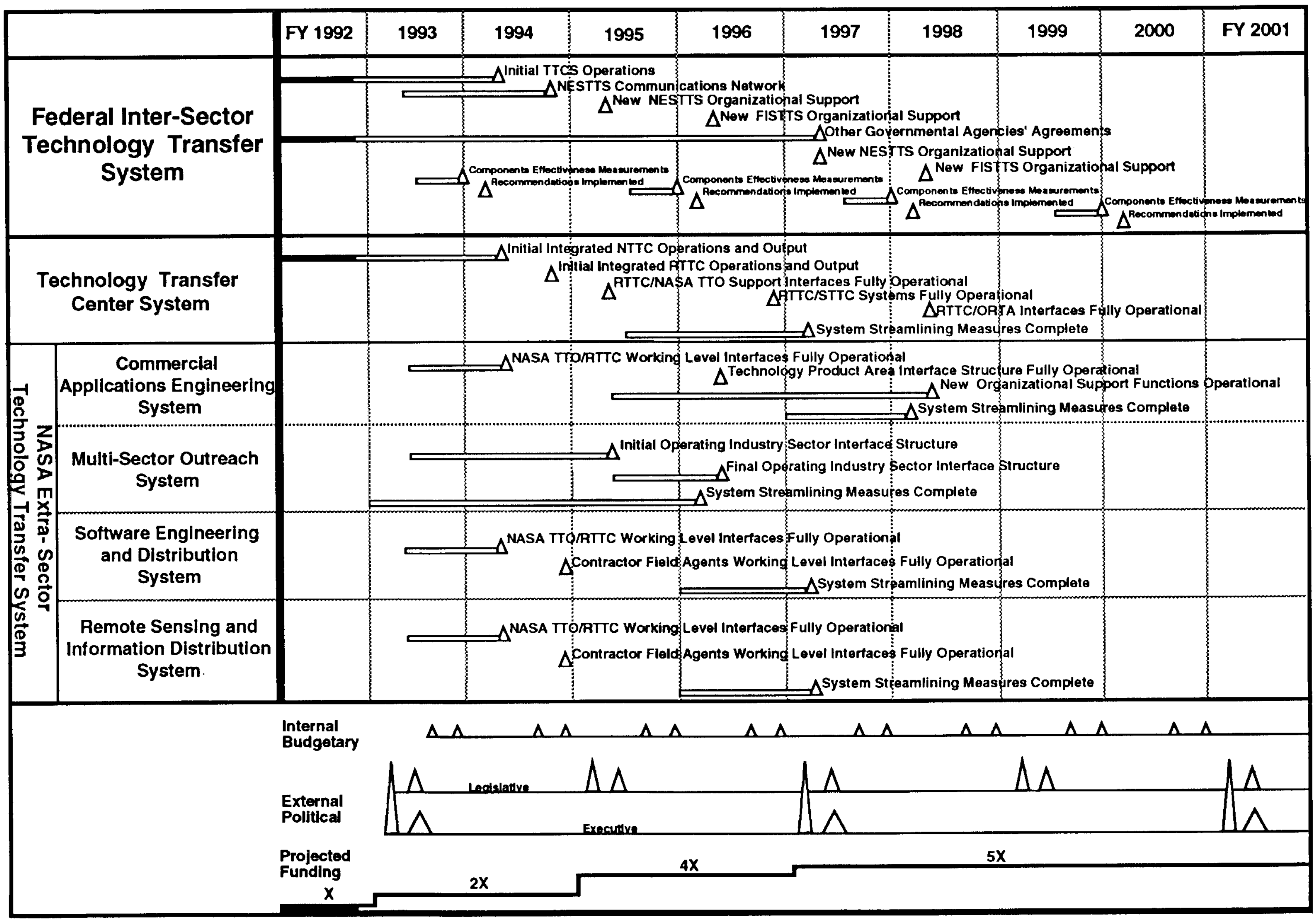


Figure 1

Horsham/Code C Organization/Office Organization-C 08/92

Transitional
FY 1992

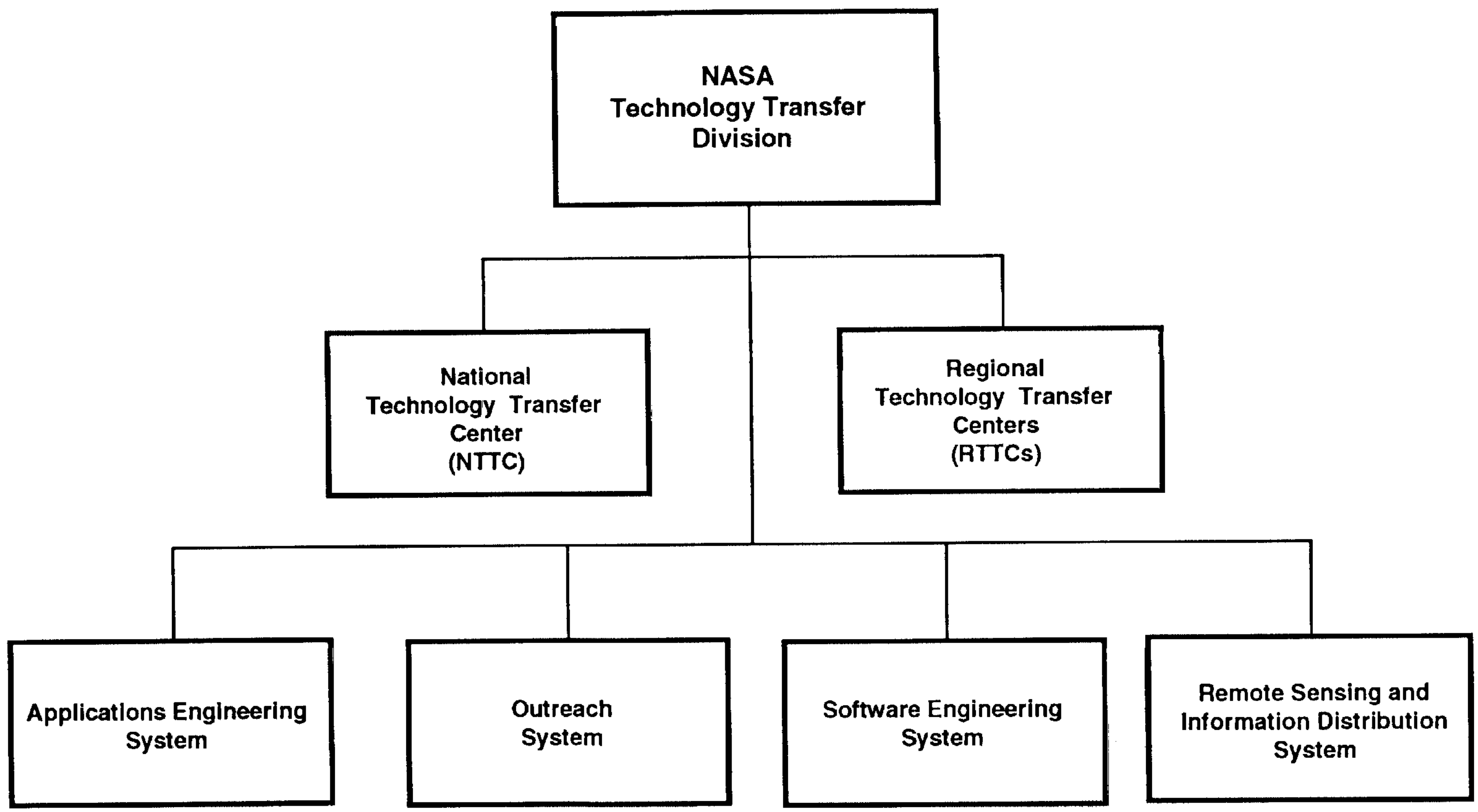


Figure 2

Horsham/Code C Organization/Office Organization-U 08/92

Baseline
FY 1992 - 1993

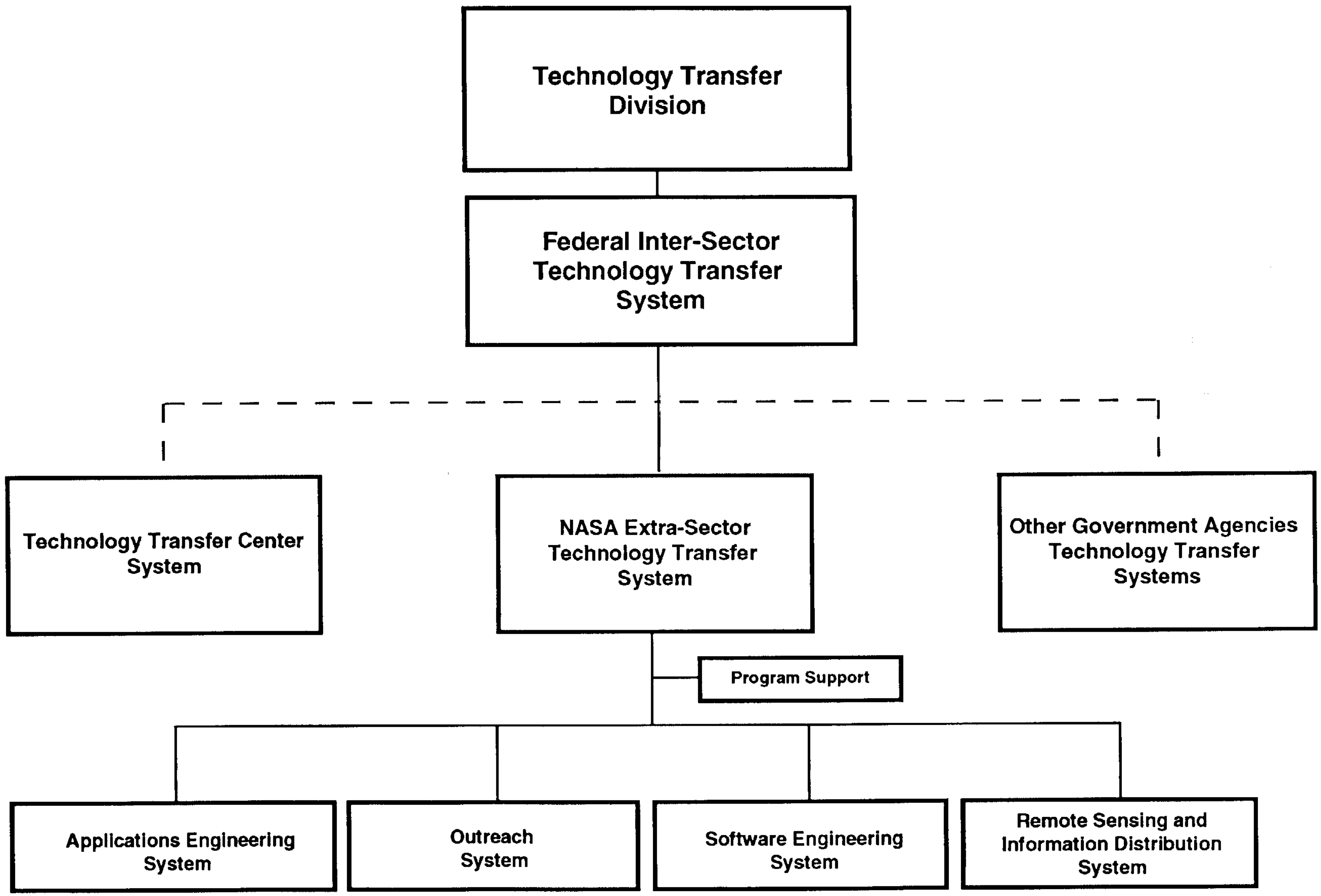


Figure 2A

Horsham/Code C Organization/Office Organization-U 08/92

Implementation Strategy
FY 1994 - 1995

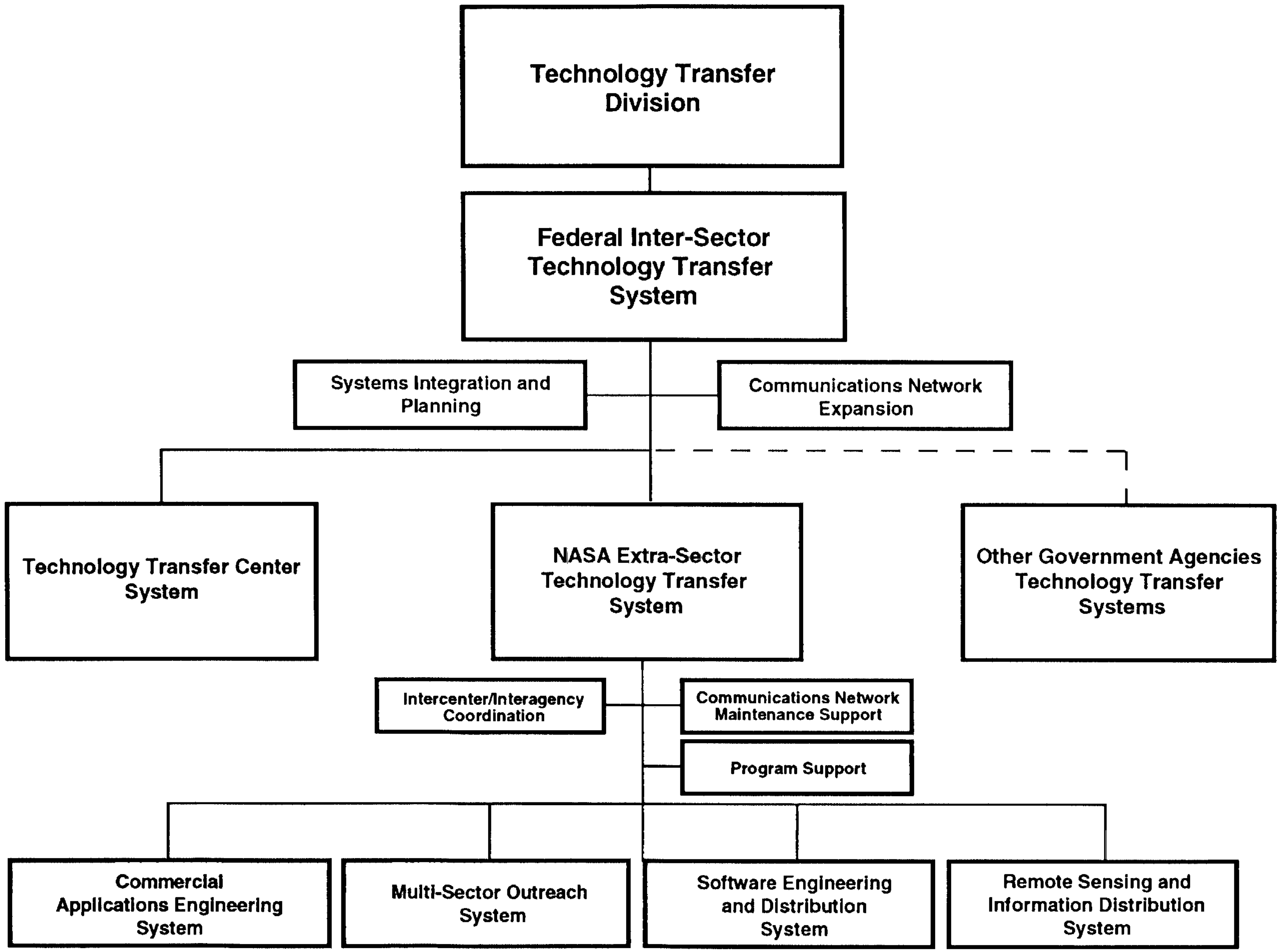


Figure 2B

Horsham/Code C Organization/Office Organization-U 08/92

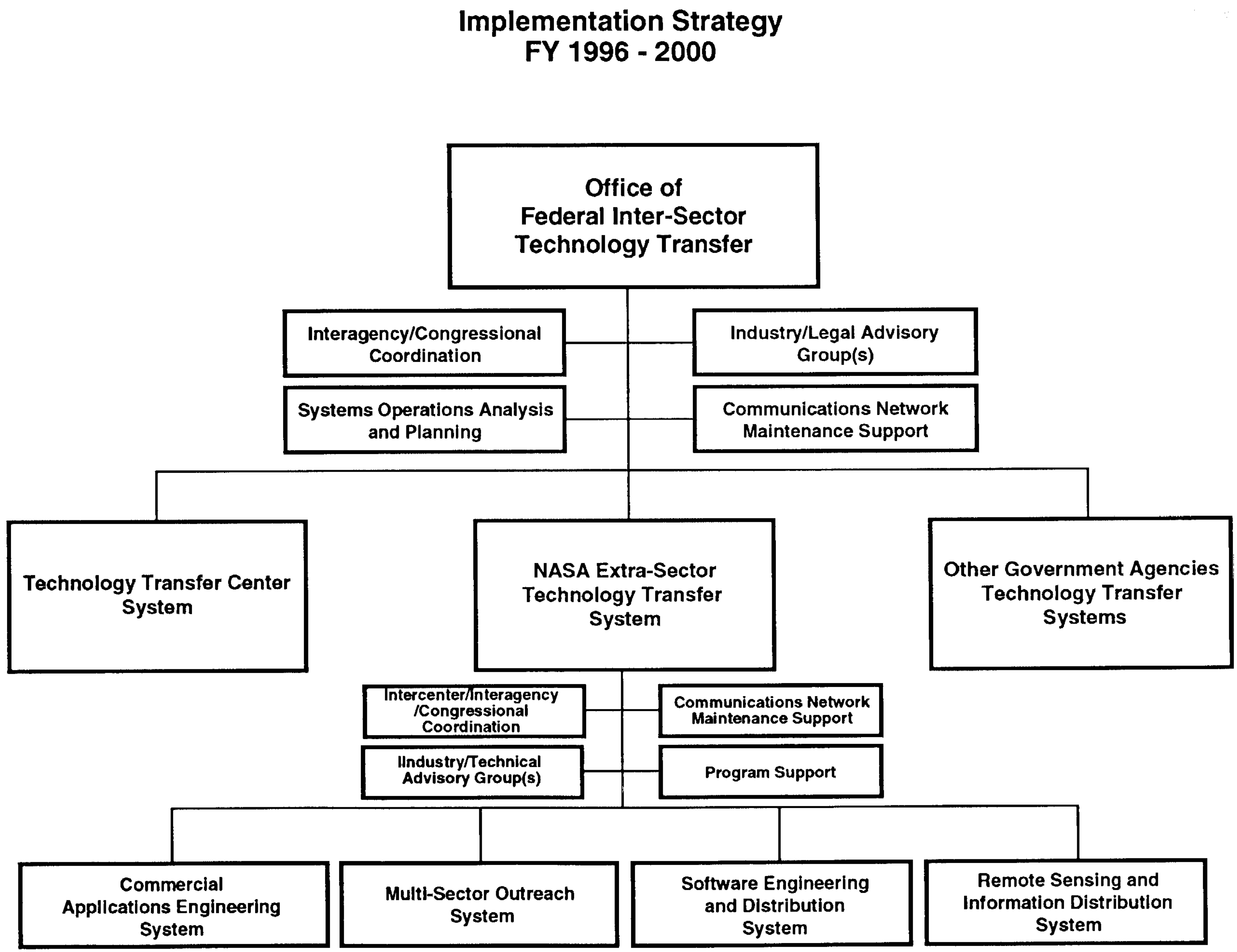


Figure 2C

Horsham/Code C Organization/Office Organization-U 08/92

Baseline
FY 1992

RTTC - Regional Technology Transfer Center

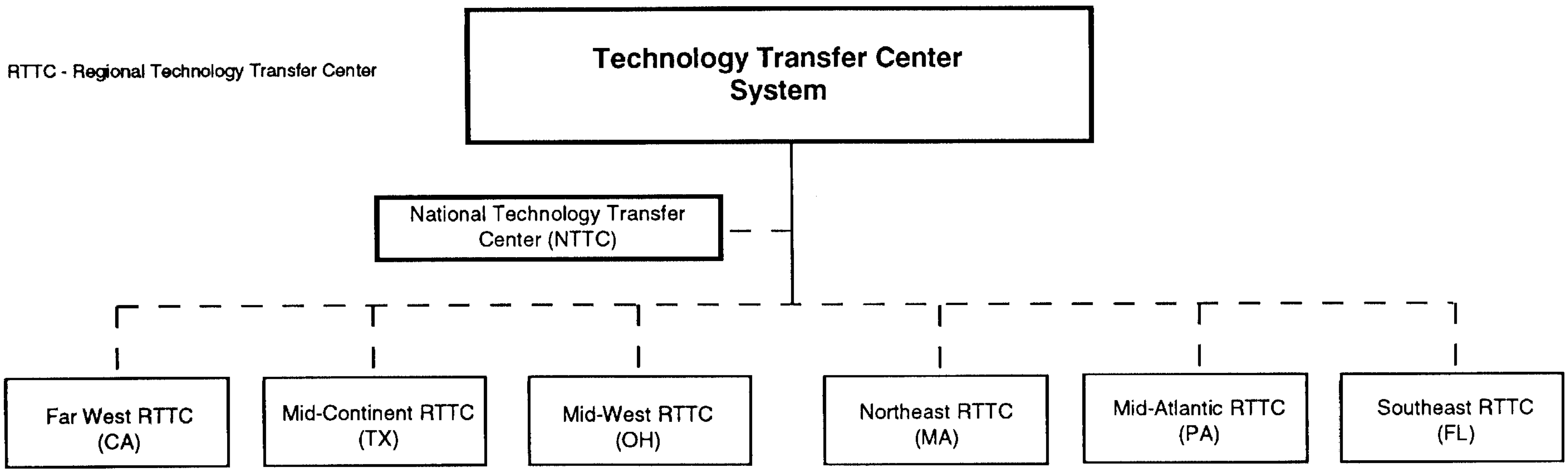


Figure 3A

Horsham/Code C Organization/Office Organization-U 08/92

Implementation Strategy
FY 1993 - 1995

TTO - Technology Transfer Office
NTTC - National Technology Transfer Center
RTTC - Regional Technology Transfer Center
STTC - Satellite Technology Transfer Center

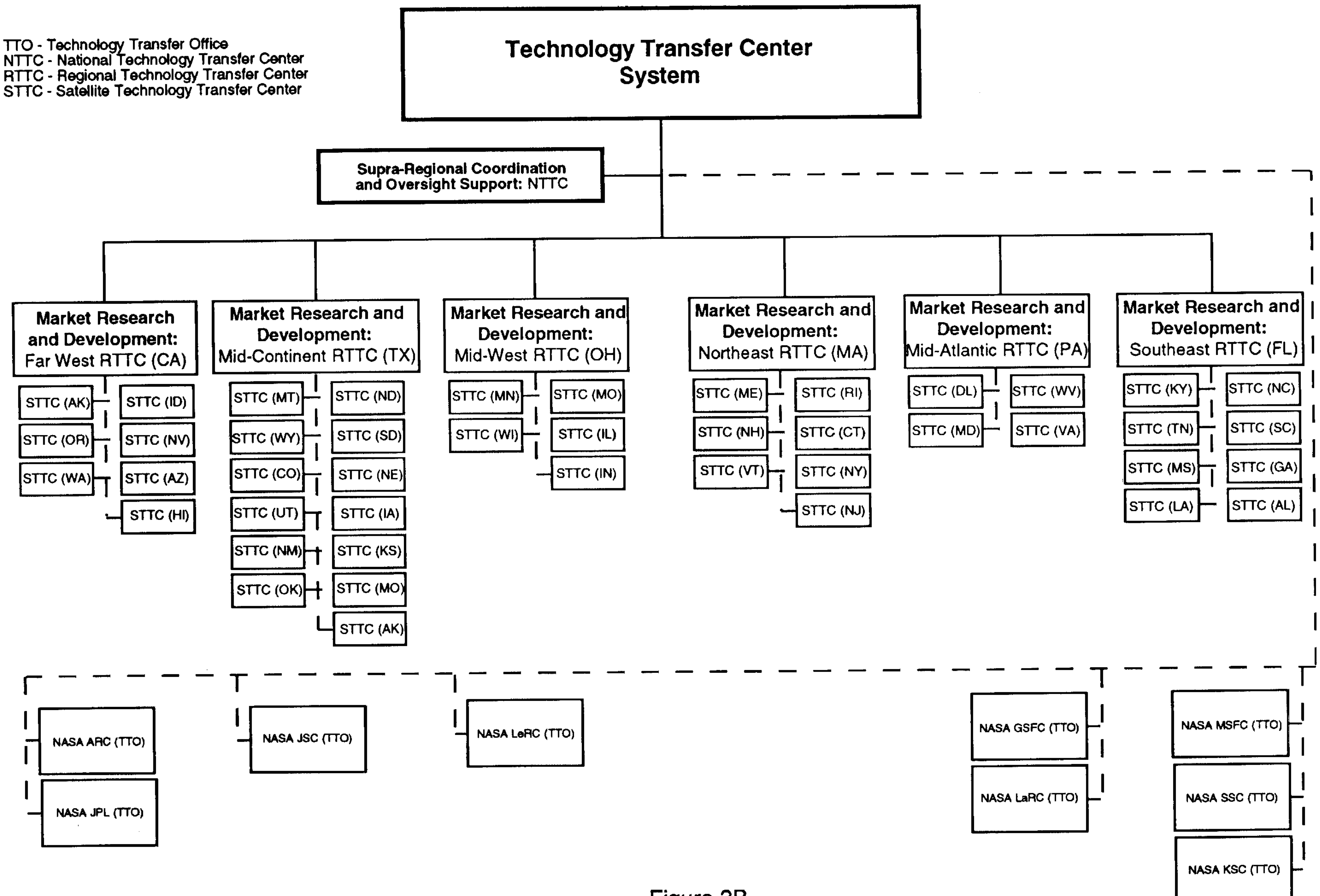


Figure 3B

Horsham/Code C Organization/Office Organization-U 08/92

Implementation Strategy
FY 1996 - 2000

TTO - Technology Transfer Office
NTTC - National Technology Transfer Center
RTTC - Regional Technology Transfer Center
STTC - Satellite Technology Transfer Center
ORTA - Office of Research and Technology Applications

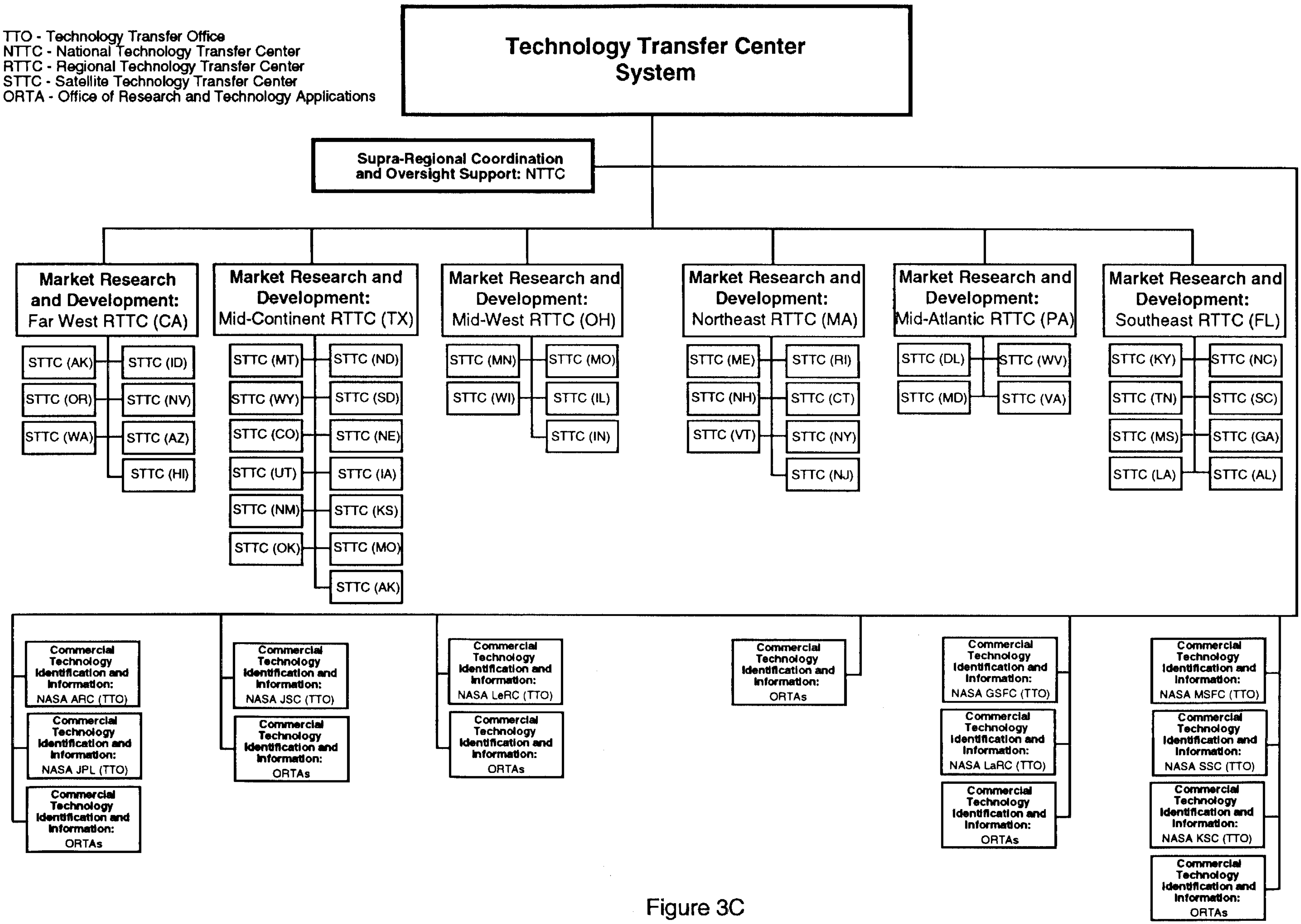


Figure 3C

Horsham/Code C Organization/Office Organization-U 08/92

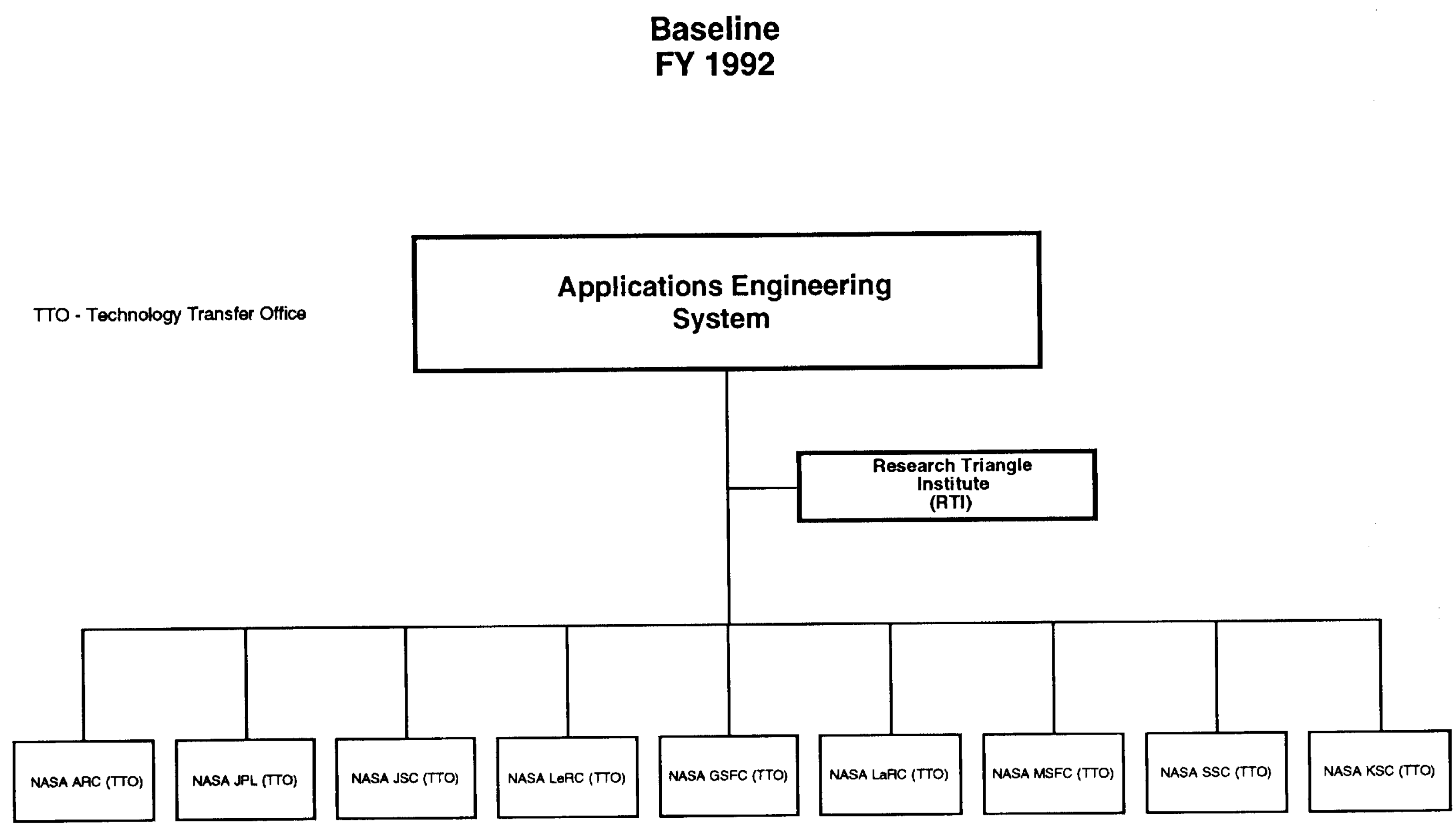
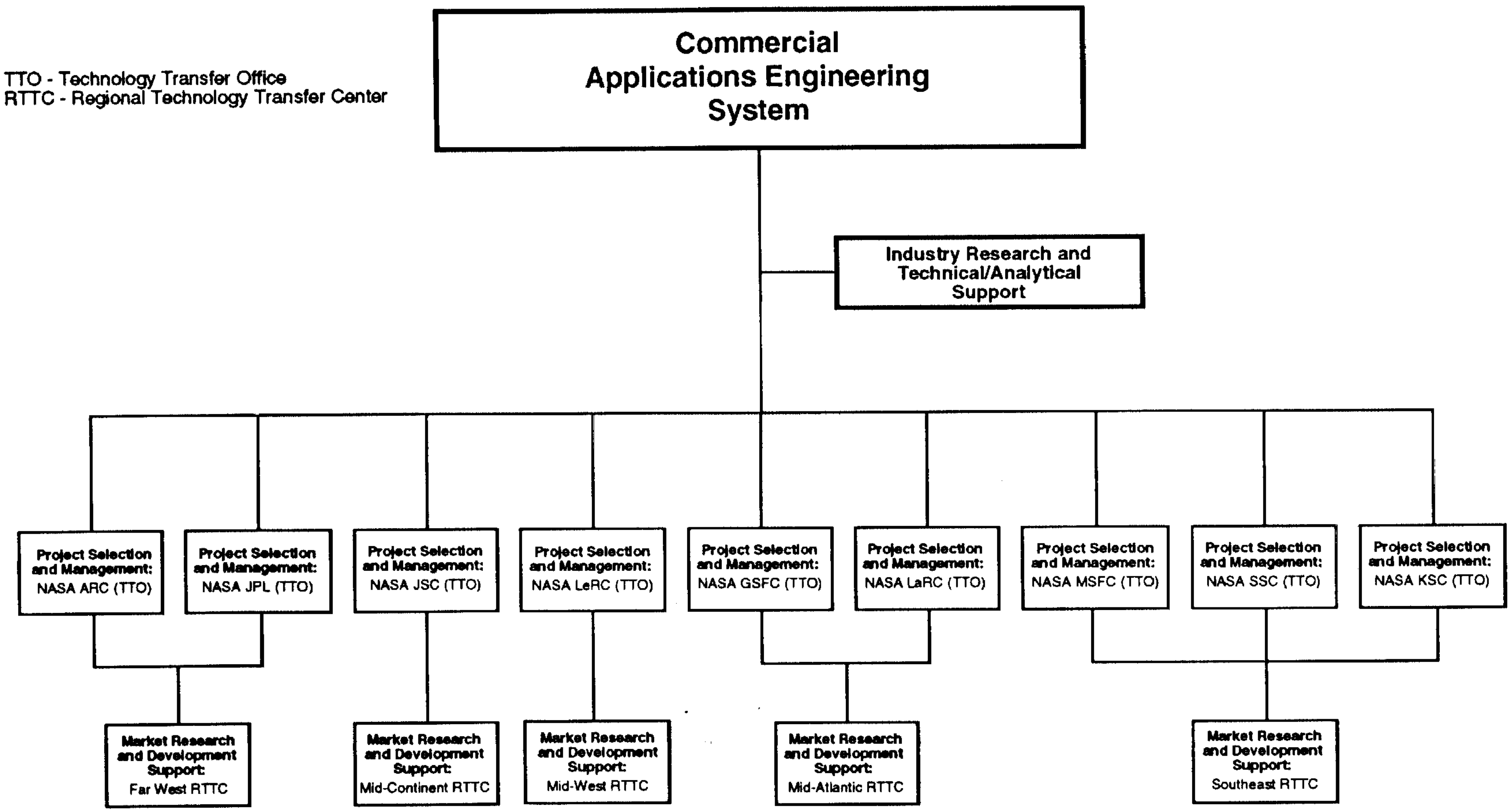


Figure 4A

Horsham/Code C Organization/Office Organization-U 08/92

Implementation Strategy
FY 1993 - 1995

TTO - Technology Transfer Office
RTTC - Regional Technology Transfer Center



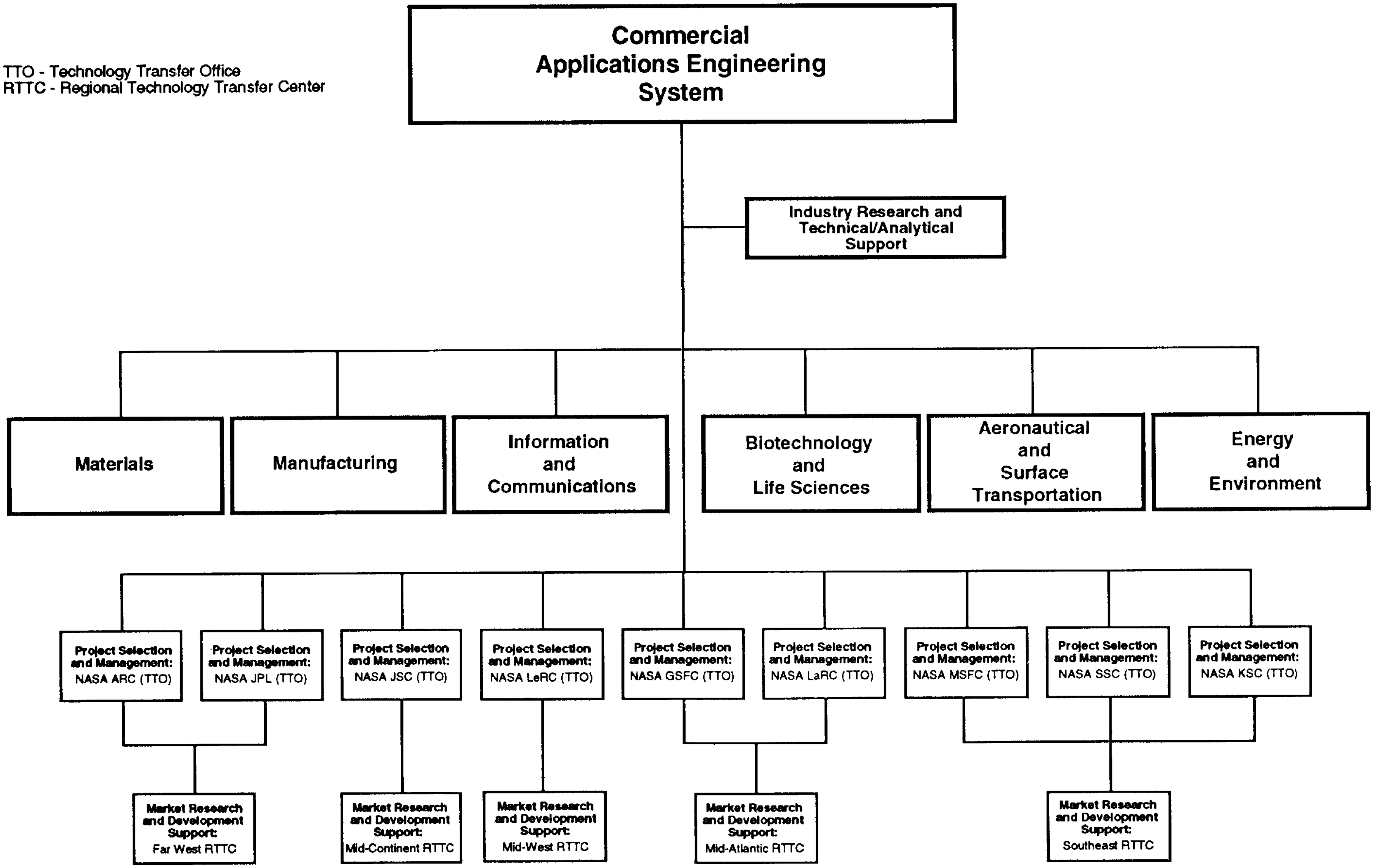
Note: Structure shows initial system interfaces. Northeast RTTC has no NASA Field Installations in its region (refer to Figure 3C).

Figure 4B

Horsham/Code C Organization/Office Organization-U 08/92

Implementation Strategy
FY 1996 - 1997

TTO - Technology Transfer Office
RTTC - Regional Technology Transfer Center



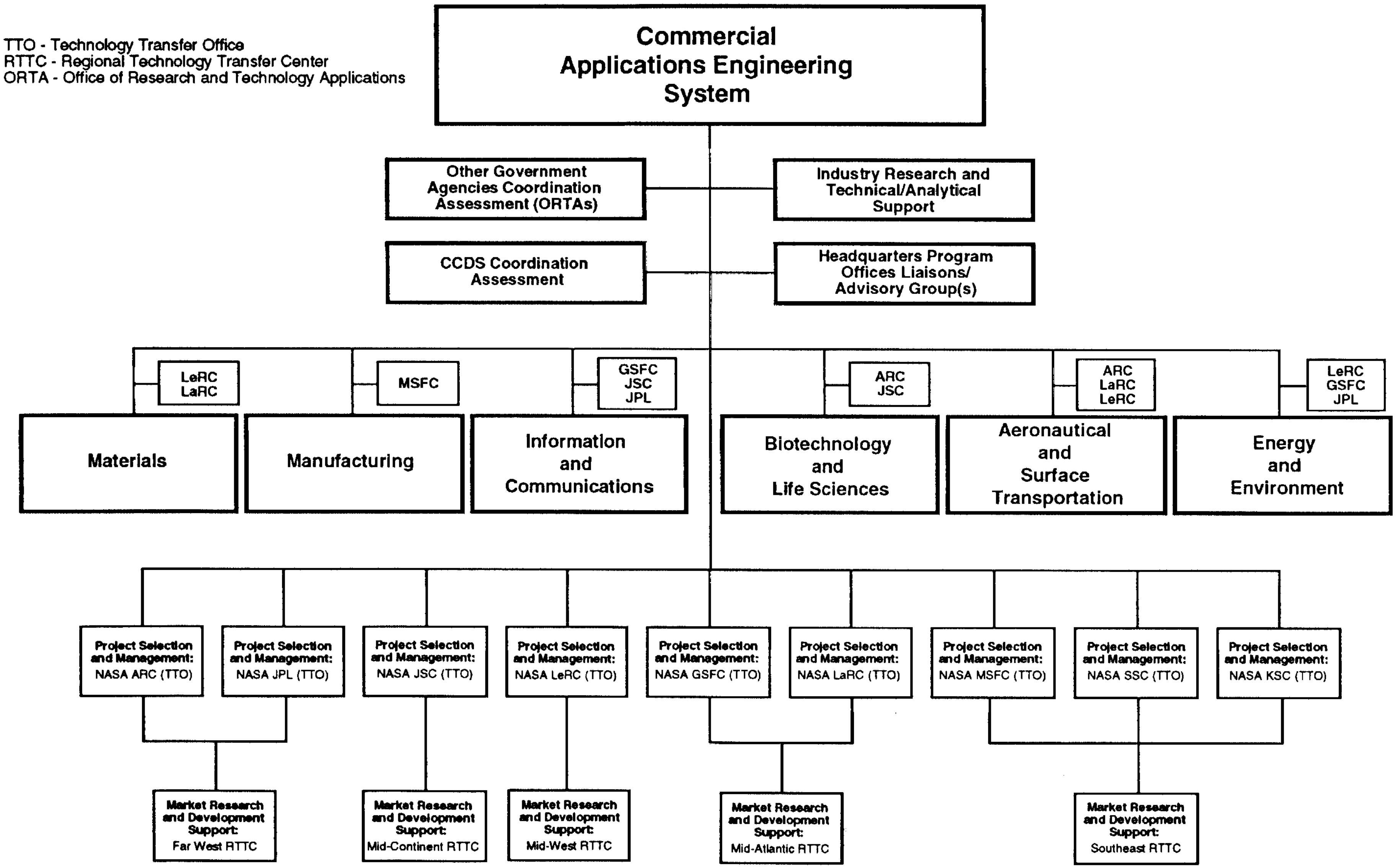
Note: Structure shows initial system interfaces. Northeast RTTC has no NASA Field Installations in its region (refer to Figure 3C).

Figure 4C

Horsham/Code C Organization/Office Organization-U 08/92

Implementation Strategy
FY 1998 - 2000

TTO - Technology Transfer Office
RTTC - Regional Technology Transfer Center
ORTA - Office of Research and Technology Applications



Note: Structure shows initial system interfaces. Northeast RTTC has no NASA Field Installations in its region (refer to Figure 3C).

Figure 4D

Horsham/Code C Organization/Office Organization-U 08/92

Baseline
FY 1992

TTO - Technology Transfer Office
CASI - Center for Aerospace Information
ABP - Associated Business Publications
SRI - Stanford Research Institute
ICT - International Computer and Telecommunications

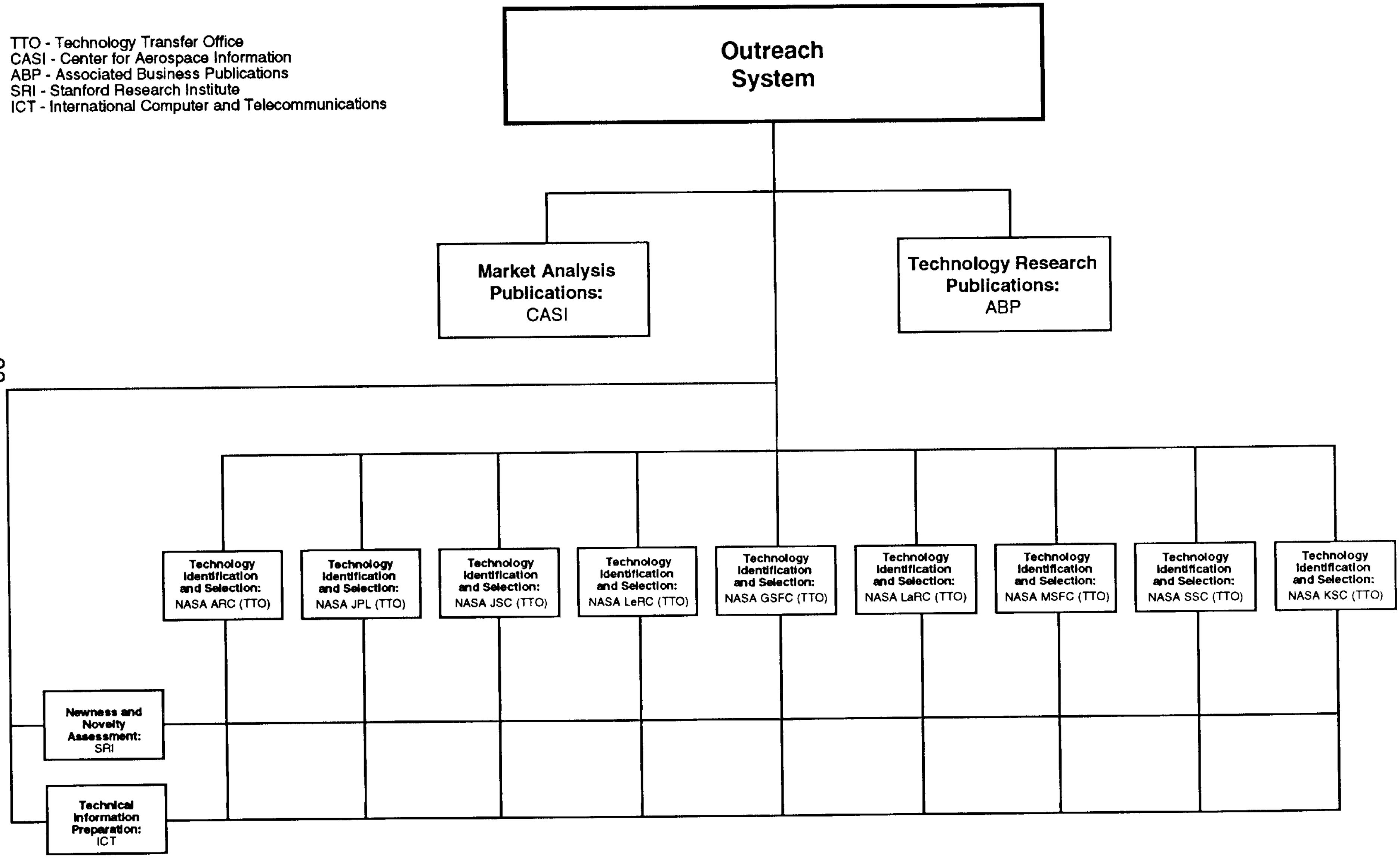


Figure 5A

Horsham/Code C Organization/Office Organization-U 08/92

Implementation Strategy
FY 1993

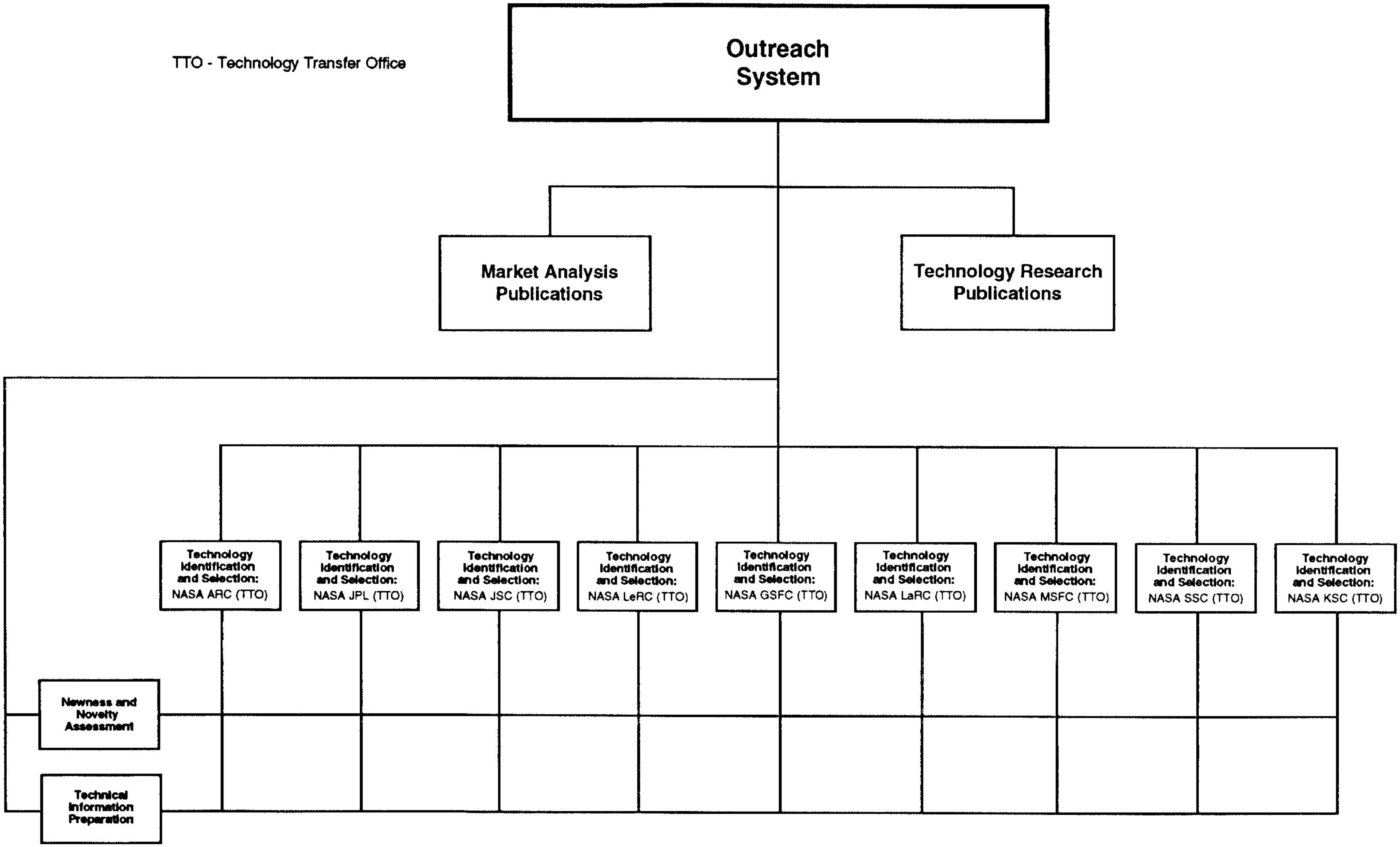


Figure 5B

Horsham/Code C Organization/Office Organization-U 08/92

Implementation Strategy
FY 1994 - 1995

TTO - Technology Transfer Office

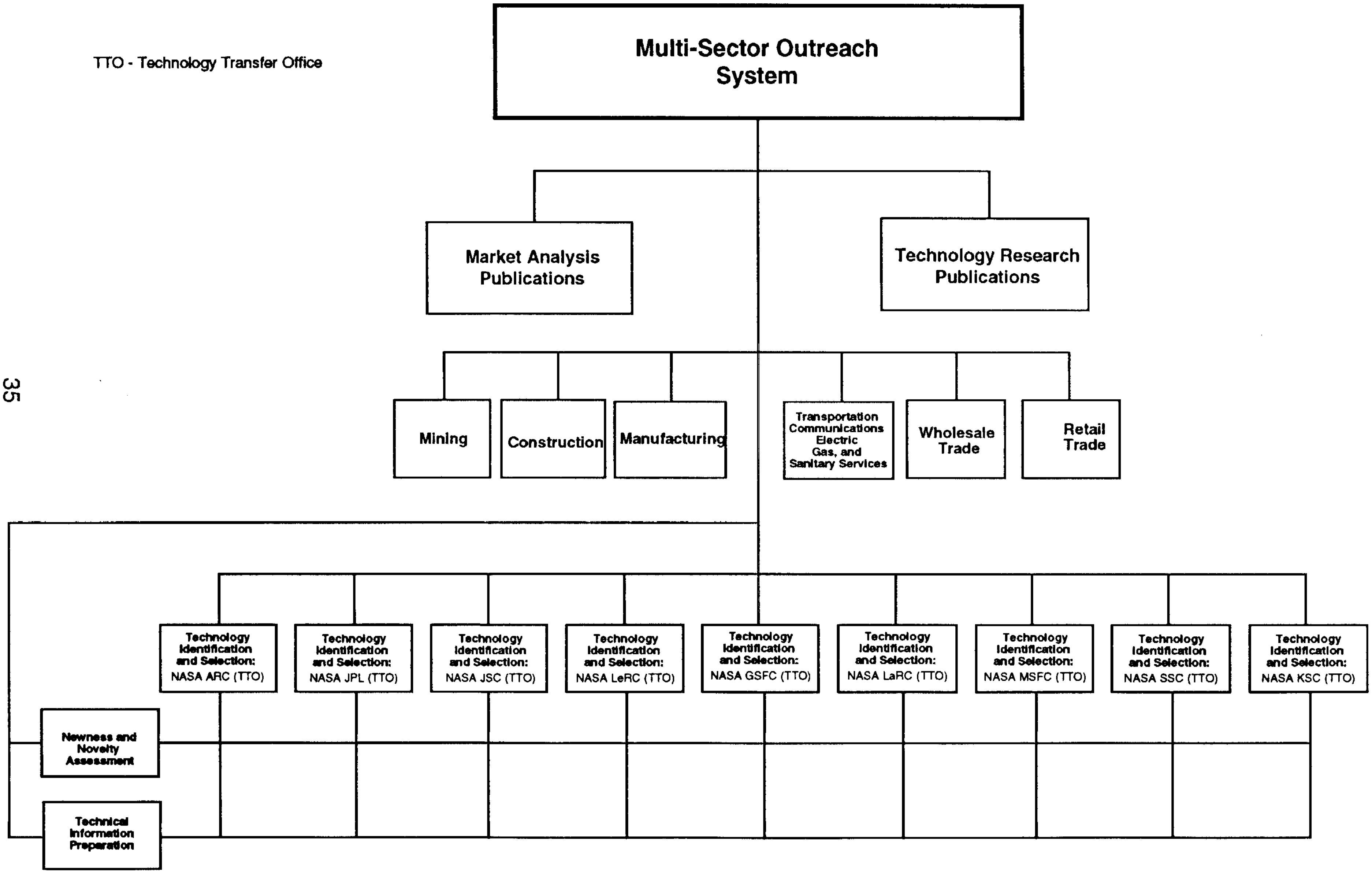


Figure 5C

Horsham/Code C Organization/Office Organization-U 08/92

TTO - Technology Transfer Office

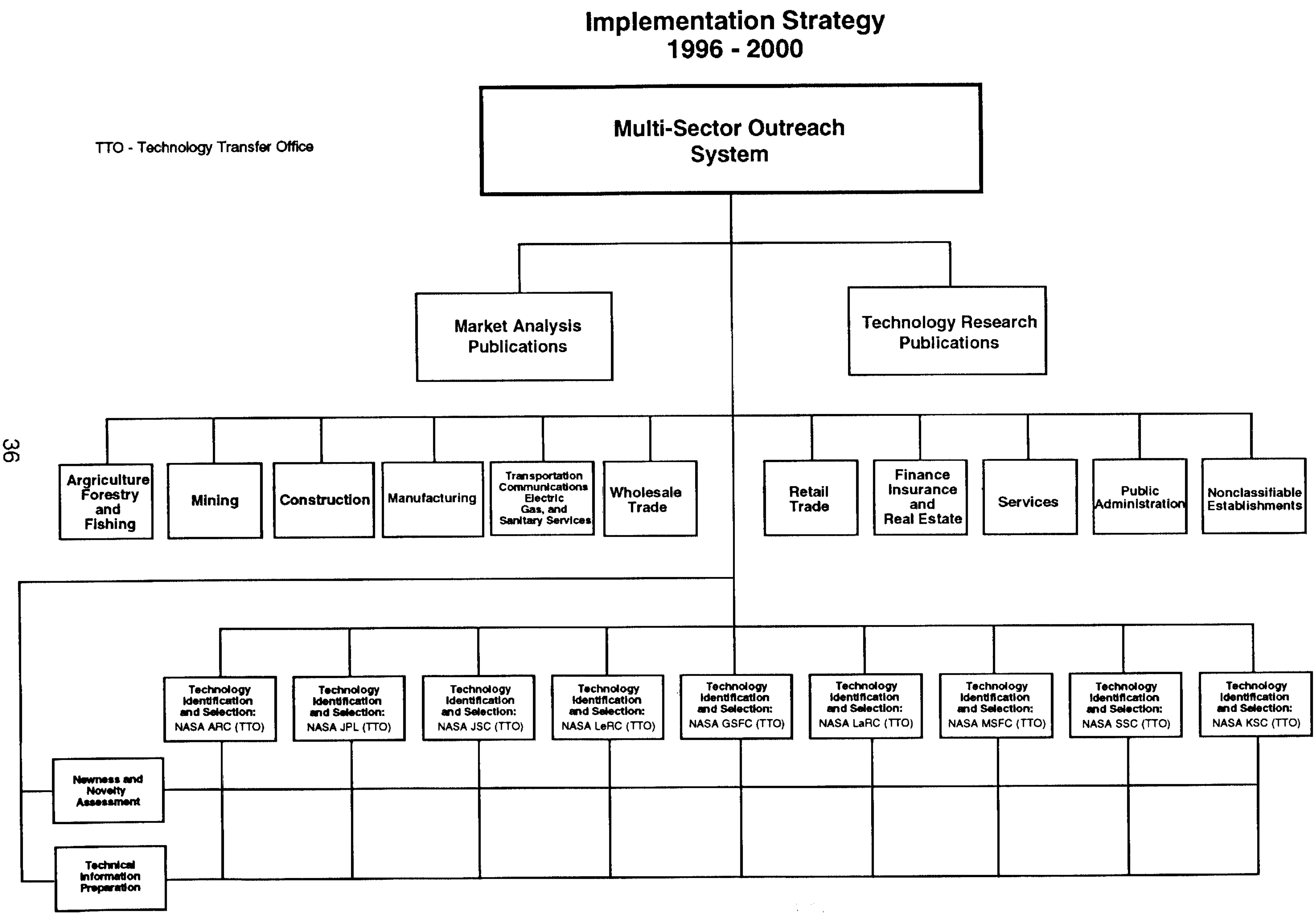


Figure 5D

Horsham/Code C Organization/Office Organization-U 08/92

Baseline
FY 1992

TTO - Technology Transfer Office
COSMIC - Computer Software Management and Information Center
RBSE - Repository-Based Software Engineering

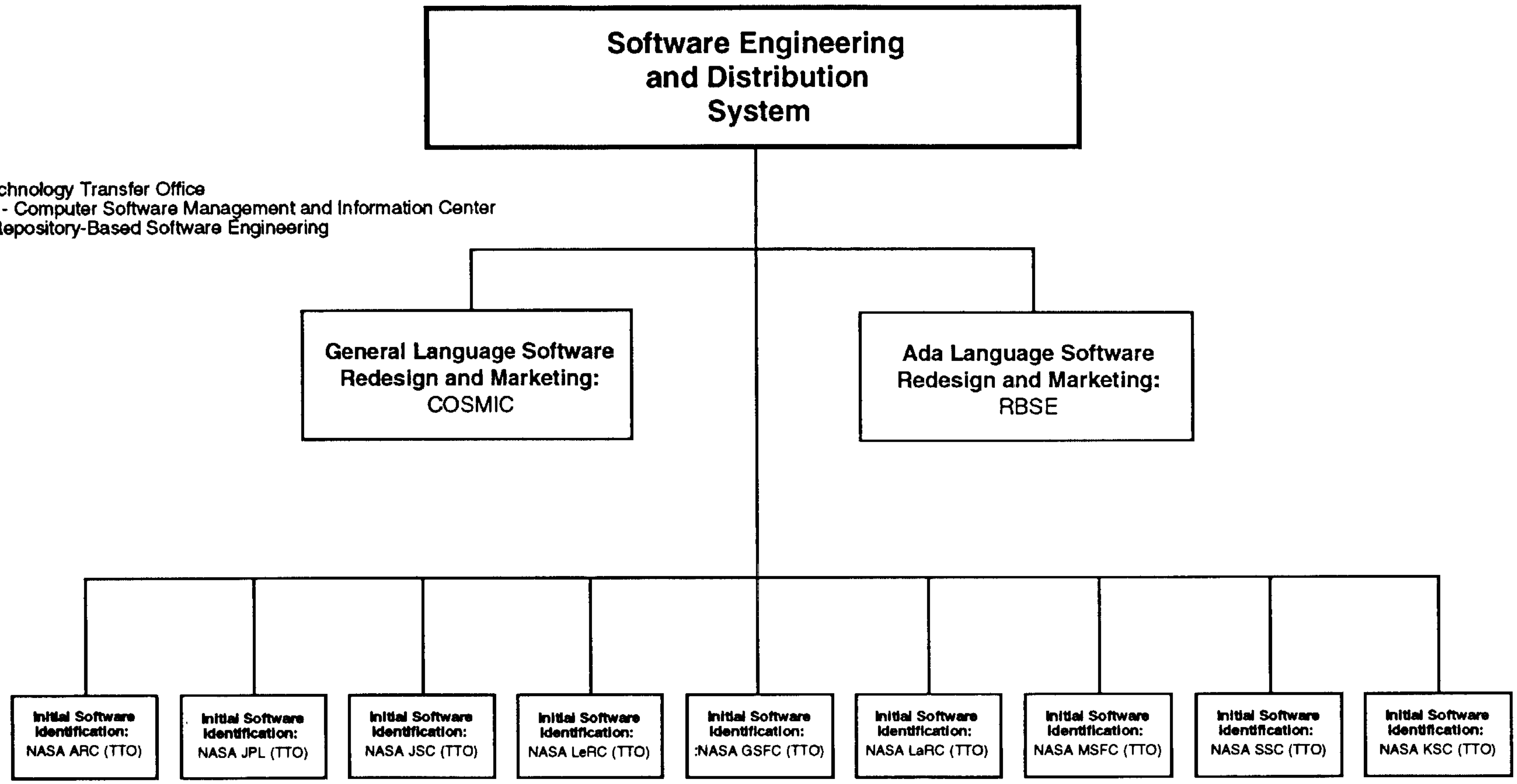
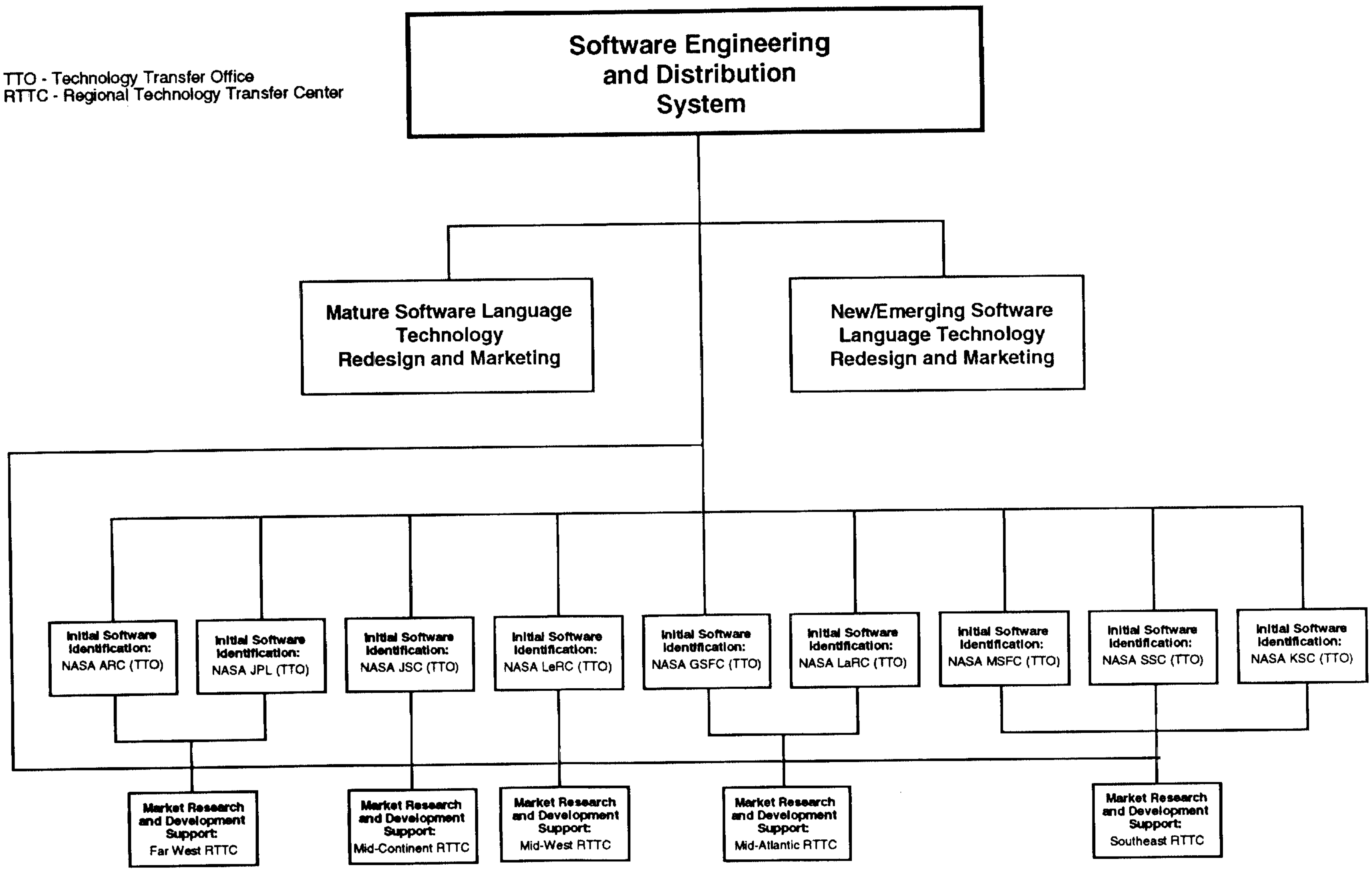


Figure 6A

Horsham/Code C Organization/Office Organization-U 08/92

Implementation Strategy
FY 1993 to 2000

TTO - Technology Transfer Office
RTTC - Regional Technology Transfer Center



Note: Structure shows initial system interfaces. Northeast RTTC has no NASA Field Installations in its region (refer to Figure 3C).

Figure 6B

Horsham/Code C Organization/Office Organization-U 08/92

Baseline
FY 1992

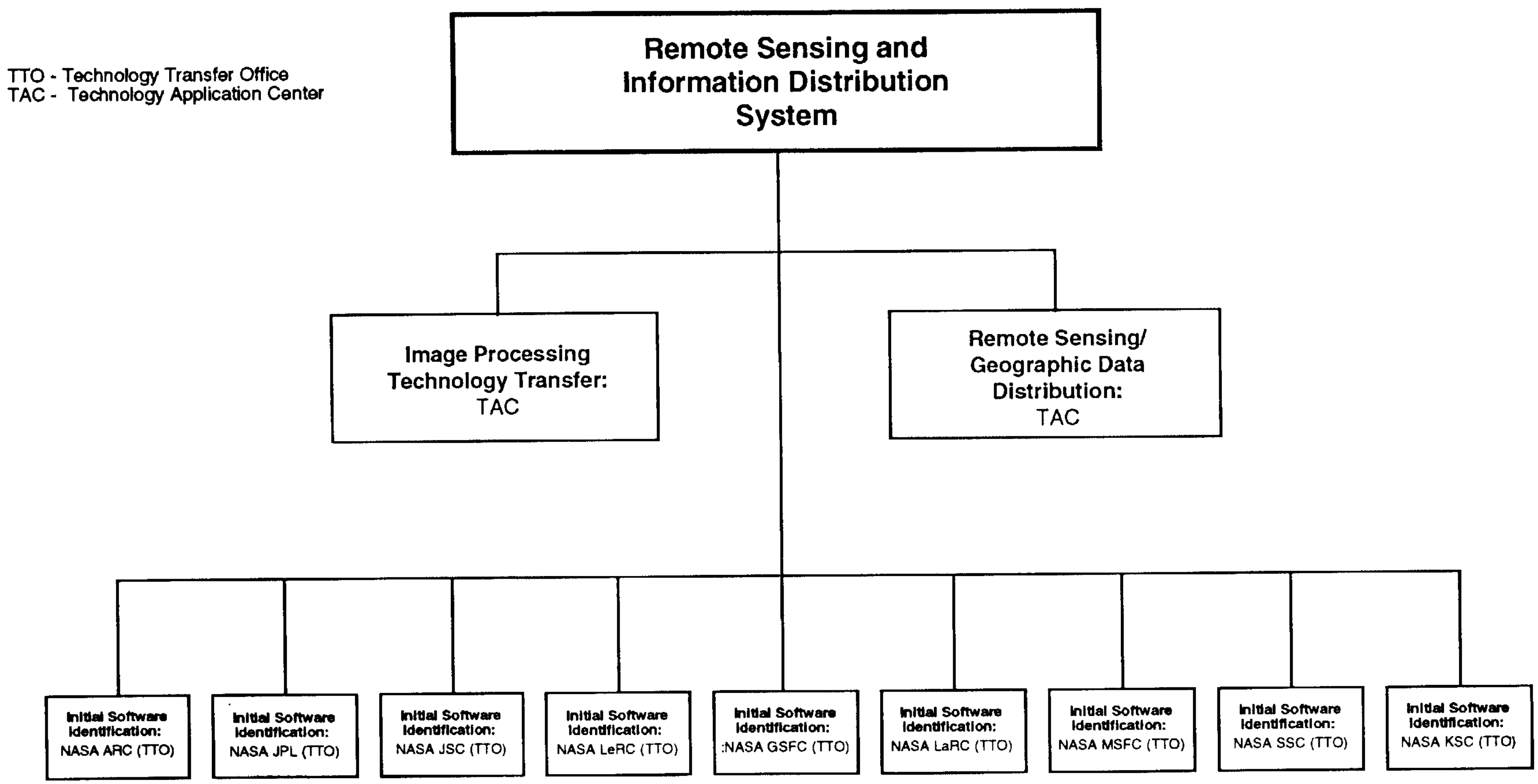
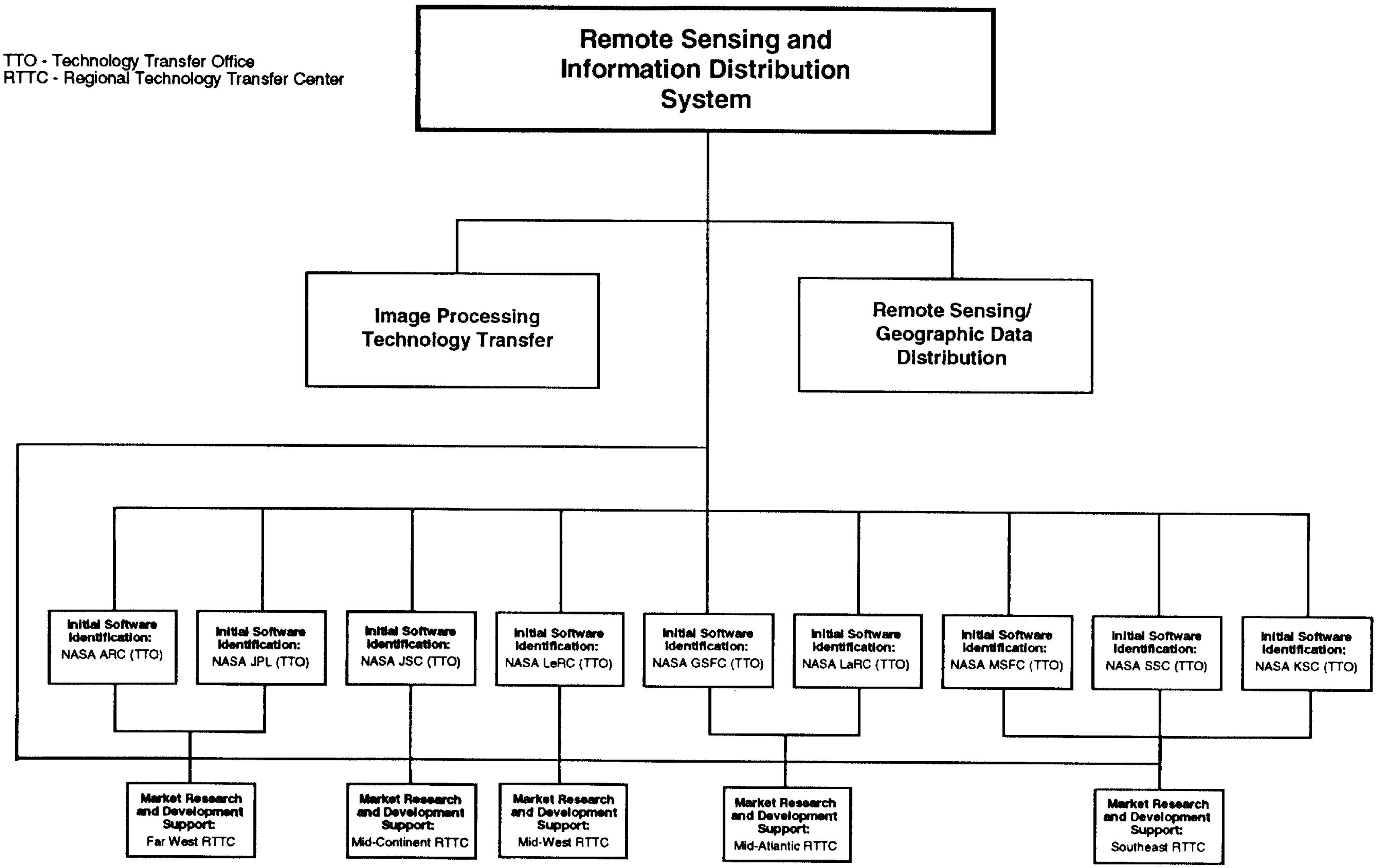


Figure 7A

Horsham/Code C Organization/Office Organization-U 08/92

Implementation Strategy
FY 1993 - 2000

TTO - Technology Transfer Office
RTTC - Regional Technology Transfer Center

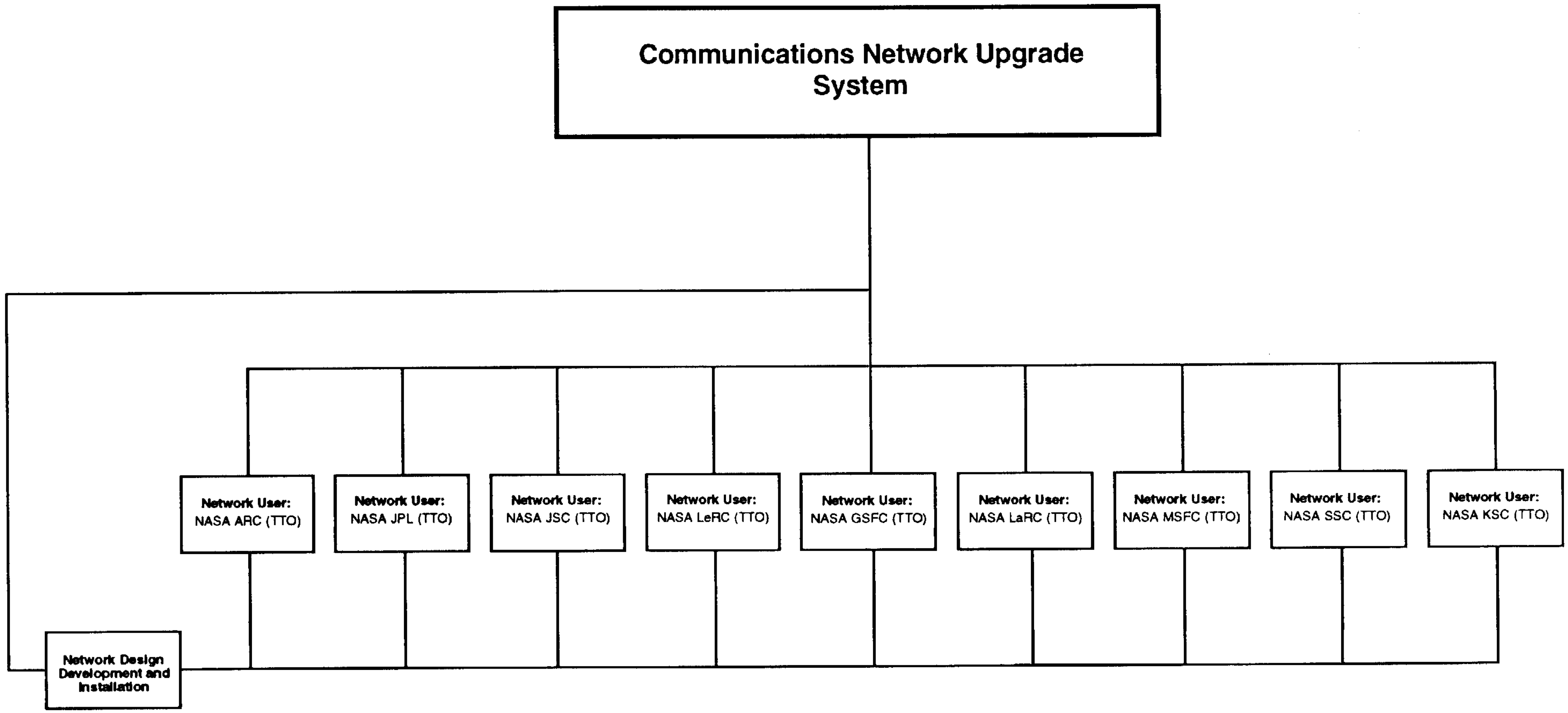


Note: Structure shows initial system interfaces. Northeast RTTC has no NASA Field Installations in its region (refer to Figure 3C).

Figure 7B

Horsham/Code C Organization/Office Organization-U 08/92

Implementation Strategy
FY 1993 - 1994



TTO - Technology Transfer Office

Figure 8

Horsham/Code C Organization/Office Organization-U 08/92

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13. ABSTRACT *(minimum 200 words)*

This report presents a strategic analysis and implementation plan for NASA's Office of Commercial Programs (OCP), Technology Transfer Division's (TTD), Technology Transfer Program. The main objectives of this study are to (1) characterize the NASA TTD's environment and past organizational structure, (2) clearly identify current and prospective programmatic efforts, (3) determine an evolutionary view of an organizational structure which could lead to the accomplishment of NASA's future technology transfer aims, and (4) formulate a strategy and plan to improve NASA's (and other federal agencies) ability to transfer technology to the non-aerospace sectors of the U.S. economy. The planning horizon for this study extends through the remainder of the 1990s to the year 2000.

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